REPORT

OF THE

COMMITTEE ON POWER

GOVERNMENT OF INDIA
MINISTRY OF ENERGY
DEPARTMENT OF POWER
NEW DELHI
1980

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V. G. RAJADHYAKSHA
Chairman

Government of India
Ministry of Energy
(Department of Power)
Committee on Power
Shram Shakti Bhavan
New Delhi, September 4, 1980

Dear Mr. Minister,

I have much pleasure in submitting herewith the Report of the Committee on Power. I am happy to say that it is a unanimous Report.

The Committee was fully conscious that electricity enters a sensitive area of Centre-State relationships. Although, on account of the political changes in many of the States this year, the Committee was not able to hold formal discussions with State Governments at the political level, meetings were held with State officials and Chairman of the State Electricity Boards. The Committee has tried to give the fullest consideration to the sensibilities of the State Governments in formulating its recommendations without compromising the over-riding objective of ensuring an adequate supply of power as economically as possible to all classes of consumers in the country.

The terms of reference of the Committee were very wide and touched on almost every aspect of the power industry. Within the limited time at its disposal, the Committee has dealt with only what it considered to be the more important issues.

Beginning with the planning process, the inadequacies of the present system have been analysed and recommendations made for estimating demand projections over a 15 to 20-year time frame, restricting the growth of demand to the available supply and laying stress on conservation and demand management measures in order to make the optimal use of the available power and installed power generation capacity. In planning new capacity, the Committee has dwelt on the imperatives of moving away from the State as a geographical unit to the region and ultimately to the country as a whole because of the mismatch between the requirements of power of a State and its potential for power generation. The consequent need for a larger role for the Central Government in generation and central control over the inter-State high voltage transmission system has been explained and substantially greater investments in the transmission and distribution network advocated to progressively reduce power losses.

In setting up new projects, an area in which the country's past performance has been far from satisfactory, measures for improving project formulation and implementation, working to more realistic gestation periods, standardising layouts and equipment to save time and costs and making better use of consultants have been outlined. The Committee has also dealt with the possible constraints in the indigenous availability of power plant equipment and the need to improve its quality.

The present power shortage is largely due to the poor utilisation of thermal capacity and it is on this, rather than the operation and maintenance of hydel plants and transmission and distribution systems, that the Committee has focussed its attention. The past performance of thermal plants has been analysed and steps suggested for improving maintenance practices. Measures have been proposed to overcome delays in getting spares, improve the quality and reduce the duration of maintenance shut-downs. To overcome constraints in the full utilisation of rated capacity, it is necessary to improve the quality and flow of coal supplies, upgrade the skills of personnel engaged in plant operation and maintenance, harmonise industrial relations and increase productivity.

Several of these recommendations have been made by earlier Committees but not many have been implemented so far. The Committee has briefly touched on ways in which the Central Government can assist and persuade State Governments and their Electricity Boards to act expeditiously on such of the Committee's recommendations as are accepted.

The Committee feels that rural electrification, not only for energising pumpsets but also for domestic and street lighting and stimulating the growth and profitability of small scale, cottage and village industries, is a programme which deserves high priority. The need to phase out diesel pumping sets in the long term has been pointed out. Administrative measures for ensuring that the benefit of rural electrification programmes reach the small farmers, landless labourers and artisans should be given special attention. Likewise recommendations have been made for ensuring a more equitable flow of funds from financial institutions to the more underdeveloped States for financing their rural electrification programmes. The Committee finds that there is no case for subsidising tariffs to agriculturists as a class and any such subsidies should be confined to only the very poor. Organisational and technological changes have been suggested for improving the quality and reducing the costs of power supply to the rural areas including development of non-conventional renewable energy resources.

The finances of the State Electricity Boards, taken as a group, present today a dismal picture. Fixation of financial goals of utilities, principles for evolving a rational tariff policy and improvements in management information and accounting systems have been discussed.

At the core of the problems of the power sector, especially in project implementation and plant operation and maintenance, is the human factor. Organisations that need to be set up to implement the larger role proposed for the Centre in power generation and to enable the regional grids to operate in an integrated manner have been proposed. The Committee has also made recommendations for rationalising the organisation structure of other agencies connected with the power industry, creating specialised caders in non-technical and technical fields, modernising managerial styles, improving selection, appraisal and promotion systems, harmonising industrial relations and bringing about a measure of national integration into the structure of the power industry.

The Committee has commented on the very low level of research and development work in the power industry and suggested measures and projects for linking it more closely to the day-to-day operational or the so-called 'grass roots' problems faced by utilities and equipment manufacturers. An organisation for ensuring that R&D activity in priority areas is stepped up and coordinated and testing and certification facilities augmented has been proposed.

Finally, the Committee has listed a number of measures for reducing the power shortages in the shortrun.

The Committee would like to emphasise that although there is much that needs to be set right in the power industry, there is no cause for gloom or despair. It is worth remembering that in 1976-77 for instance, the present managements and organisations in the power industry were able to operate thermal plants at reasonably satisfactory levels of efficiency and had they done so in 1979-80 the energy shortage despite the bad monsoon and fall in hydro-electric energy would have been marginal instead of severe. Despite their low level of performance as a whole, several of the public sector utilities continue to operate at efficiency levels which are well above international norms. The Committee thus feels confident that given the leadership and drive necessary to implement the Committee's recommendations expeditiously the power shortages which have ravaged the economy in the last decade could be progressively reduced, if not eliminated, in the next five years.

On behalf of the Members of the Committee and myself, I would like to take this opportunity to express our sincere appreciation of the unstinted help and cooperation we recieved from your Ministry as well as its associated bodies and in particular the Central Electricity Authority, the National Thermal Power Corporation and the Rural Electrification Corporation.

With regards,

Yours sincerely,

V. G. RAJADHYAKSHA

Shri A. B. A. Ghani Khan Choudhury,
Union Minister for Energy and Coal,
Government of India,
Shram Shakti Bhavan,
New Delhi.

PREFACE

The Committee on Power was appointed by the Government of India in the Ministry of Energy (Department of Power) *vide* its Memorandum No. 31(33)/78-US. V. dated 27-12-1978 pursuant to a decision taken at the Conference of State Power Ministers held in January, 1978.

The terms of reference of the Committee are as follows:—

"The Committee will examine all aspects of the functioning of State Electricity Boards and Central Organisations engaged in electricity generation, transmission and distribution, including organisational structure, management practices, planning systems, efficiency of operations, financial performance, tariff structure and legislative framework and make recommendations for improving them."

The following were appointed as Members of the Committee:—

(i)	Shri V. G. Rajadhyaksha, Member, Planning Commission.	Chairman
(ii)	Dr. N. B. Prasad, Secretary, Department of Power.	Member
(iii)	Shri S. N. Roy, Chairman, Central Electricity Authority.	Member
(iv)	Shri J. C. Shah, Chairman, Gujarat Electricity Board.	Member
(v)	Dr. N. Tata Rao, Chairman, Andhra Pradesh State Electricity Board.	Member
(vi)	Shri J. M. Patnaik, Chairman, Orissa State Electricity Board.	Member
(vii)	Shri R. N. Bhargava, Chairman, U.P. State Electricity Board.	Member
(viii)	Prof. V. N. Kothari, Head of the Department of Economics, University of Baroda.	Member
(ix)	Shri K. M. Chinnappa, Managing Director, Tata Electric Company.	Member
(x)	Shri K. V. Raghavan, Chairman & Managing Director, Engineers (India) Ltd.	Member
(xi)	Shri Muthusami Gounder, President, Tamil Nadu State Agriculturists' Association, Karur.	Member

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Dr. S. Ramesh, Joint Secretary in the Department of Power was appointed as the Secretary to the Committee. The Committee decided subsequently to request Shri T. R. Satish Chandran, Adviser (Energy) in the Planning Commission to participate in its meetings as a Special Invitee.

The Committee was originally asked to submit its report to the Ministry of Energy within a period of 12 months but since its work could begin only after the first quarter of 1979, i.e. after the appointment of the Secretariat, the life of the Committee had to be extended by six months.

In view of the comprehensive nature of its terms of reference which cover practically all aspects of the working of the power supply industry, the Committee considered it necessary to identify specific areas within its scope of work for detailed study and to constitute separate Panels for the purpose. It was also felt that as many representative organisations involved with the power supply industry as possible should be consulted by the Committee and its Panels and that conclusions of the Committee should be arrived at after the fullest exchange of views and discussions to ensure wide acceptability of its recommendations.

During its first meeting held on 29-12-78 the Committee constituted 7 (seven) Panels to study in depth the following major aspects of its terms of reference—

1. Power Planning
2. Project Formulation & Implementation
3. Operation and Maintenance
4. Finance, Financial Management & Tariffs
5. Rural Electrification
6. Organisation and Management
7. Research & Development

The membership of these Panels and their terms of reference are given in Appendix-I.

For each Panel, a member of the Committee was designated as the Convenor and, in addition, one or two other Committee Members were also associated with its work so as to link together the work of all the Panels and to facilitate interaction between the approach and thinking of the Committee with that of the Panels. Some of the Panels namely those on 'Project Formulation and Implementation', 'Operation and Maintenance', 'Organisation and Management', 'Finance, Financial Management and Tariffs' and 'Rural Electrification' sent out questionnaires to the State Governments, the State Electricity Boards as also various Central/State organisations within the power supply industry such as the National Thermal Power Corporation, the National Hydro-Electric Power Corporation, the Rural Electrification Corporation (R.E.C.), the Damodar Valley Corporation, the Mysore Power Corporation and to selected project authorities. The information so collected has been very valuable to the Committee in formulating its recommendations.

Some of the Panels also undertook specific studies besides constituting Study/Working Groups and sub-panels within the Panels. The Panel on Power Planning conducted, through a specially constituted group of experts, a detailed energy audit of the Andhra Pradesh transmission and distribution system. The Panel on 'Finance, Financial Management and Tariffs' commissioned a study on accounting practices in State Electricity Boards by the Indian Institute of Management, Ahmedabad. Two studies relating to costs and benefits of rural electrification were undertaken by the REC on behalf of the Panel on 'Rural Electrification'. The Panel on 'Research and Development' conducted an all-India Seminar on 'Research and Development in the Power Industry' at New Delhi on 22nd and 23rd August, 1979 as also a workshop on 'Research and Development in Utilities' on June 28, 1979 at Baroda.

The Panels submitted their interim reports during the month of October, 1979. These reports were considered in detail by the Committee and areas of further work identified. The Panels submitted their final findings to the Committee during April-May, 1980.

The Committee held sixteen meetings during which the main issues relating to its terms of reference and work of the different Panels constituted by it were discussed. On 20-12-79, the committee met the representatives of all the State

Governments at the level of Secretaries to the Departments of Finance and Power and also the Chairman of Electricity Boards to seek their views on some of the important issues being considered by the Committee. Subsequently the Committee met representatives from the Federation of Indian Chambers of Commerce and Industry (FICCI), the Associated Chamber of Commerce and Industry of India (ASSOCHAM), the Institution of Engineers (Ind.), the All India Manufacturers' Organisation (AIMO) and the Central Water and Power Engineering Service Association. The Committee also met the representatives of the Consumer Education and Research Centre, Ahmedabad, the Indian Federation of Consumer Organisations, New Delhi, and the representatives of the All India Power Engineers Federation.

The Secretariat of the Committee was assigned the task of collecting the detailed information and data required for the work of the various Panels and the Committee. Survey and procurement of the available literature on the subject and preparation of background papers were also undertaken by the Secretariat. The officials of the Central Electricity Authority (CEA) and the Rural Electrification Corporation (REC) at various levels assisted the Committee in gathering information and preparing background material.

For much of its data the Committee has depended mainly on the information available in the CEA. In the field of rural electrification, information available with the REC has been made use of and for data on 'Operation and Maintenance' (especially of thermal plants), the publications of the Management Cell in the Department of Power have been extensively used.

ACKNOWLEDGEMENTS

The Committee would like to place on record its sincere thanks to the State Governments and the State Electricity Boards for making available the expertise of many of their officials, for the co-operation shown by way of prompt response to questionnaires and other requests for information and the hospitality extended to the various visiting teams of the Committee. Similar thanks are due to the National Thermal Power Corporation, the National Hydro-Electric Power Corporation and the Rural Electrification Corporation. The Committee would also like to specially acknowledge the assistance provided by the REC, the Planning Commission and, particularly, the CEA who made available the services of many of their officers for the preparation of the Report for the Committee and its Panels. The officers of the CEA at all levels gave their fullest co-operation and support to the work of the Panels and provided invaluable assistance to the Committee in the preparation of its Report.

The Committee is particularly grateful to the Members of the various Panels for the keen interest they took in the work of the Panels. In the finalisation of the Report of the Committee, the findings and the recommendations made by the experts comprising the various Panels have played a very important role. The Committee has also benefited at various stages in the preparation of its Report by the comments and suggestions made by Shri T. R. Satish Chandran, Adviser (Energy) in the Plg. Commission and would, therefore, like to place on record its special appreciation for his contribution. Similarly the Committee is indebted to Smt. Otima Bordia, Joint Secretary, Department of Power and Shri M. K. Sambhamurti, Director, Department of Power, for their contribution to the discussions of the Committee and the drafting of the Report.

Thanks are also due to the officers and the staff members of the Secretariat of the Committee for their valuable assistance in the preparation and finalisation of the Committee's Report. The Committee would like to place on record its special appreciation of the hard and dedicated work put in by Dr. S. Ramesh, Secretary to the Committee, Shri E. A. S. Sarma, Director, Shri Sudhakar Rao, Under Secretary, S/Shri J. N. Maggo, G. G. Nair, Manohar Lal, Senior Research Officers and S/Shri Raj Kumar, Inderjit Malhotra, R. A. Sharma, Research Officers. S/Shri P. K. Maitra, L. D. Chopra, Under Secretaries, handled ably the administrative work of the Secretariat.

Mention must be made of the excellent arrangements made for the various meetings of the Committee, prompt circulation of papers, background material and minutes of the meetings and the quality of the extensive drafting any typing work that devolved on the Secretariat.

CHAPTER I

INTRODUCTION

1.1 Electric power has proved itself to be one of the most powerful instruments of social and economic change that the world has seen. It has many unique properties. To the household consumer, it represents the most convenient and versatile form of energy providing simultaneously motive power, heat or light. In many vital industries, there is no substitute for electric power. Whereas its use in India in the past was largely confined to industrial and domestic consumers, power is today playing an increasingly important role in agriculture and transport spurred on by the rising costs of petroleum products and the growing burden they throw on the country's balance of payments. Power, being a secondary form of energy, can be produced from almost any energy source—coal, wood, petroleum, biogas, water pressure, fissile elements, wind and the sun.

1.2 Against these many unique advantages, electric power suffers from two serious shortcomings. Firstly, it cannot be conveniently stored and must thus be consumed as produced and secondly, it is the most expensive form of commercial energy sources in both capital and operating costs. One of the main reasons for this is that at current levels of technology the highest efficiency of conversion of primary fossil fuel energy into power in commercial plants is 40% and is generally much lower.

1.3 The problem facing non-oil exporting, developing countries such as India is how best to go about developing this vitally important but expensive energy source in relation to other energy sources so that the larger socio-economic goals of employment generation, poverty amelioration, the provision of minimum needs and the attainment of self-reliance can be achieved as rapidly as possible within the severe resource constraints which face most such countries.

Role of Power in the Energy Mix

1.4 Looking back over the past 25 years, some important trends in the nation's energy mix must be noted. The consumption of commercial energy (power, coal and oil) has grown much faster than non-commercial energy (wood, agriculture and animal dung) the proportion of which has fallen from 68% in 1953-54 to 44% in 1975-76*. Again, within the commercial energy sector, the consumption of power has grown much faster than coal or petroleum as a direct energy source for the economy. Its contribution to the total energy consumption has increased from 13% in 1953-54 to 29% in 1978-79*.

1.5 The intensity of the use of electricity in the economy has also increased over the years. Electricity consumed in the industrial sector as energy in terms of coal replacement units per rupee of added value at 1960-61 prices increased from 0.54 kg in 1960-61 to 1.02 in 1975-76 as compared with the increase in total energy consumed from 1.86 kgs to 2.40 kgs during the same period.

1.6 It is thus clear that electricity by virtue of its being a superior form of energy has emerged now as an essential input, very often in replacement of the other forms of energy. In absolute terms, however, the level of electrical energy consumption in India is far behind what obtains in the developed countries. For example, the per capita consumption in India was about 131.3 kwh (1978-79) as compared with 8487 kwh* (1976) in U.S.A. and 4166 kwh (1976) in the U.K.* Despite this what is significant is the pace at which the economy is becoming dependent on electricity as a basic input.

Growth of the Power Industry

1.7 As a result of this rising demand for power during the last three decades, the power supply industry in India has registered a phenomenal rate of growth both quantitatively and qualitatively. The installed generation capacity increased thirteen fold from 2300 MW in 1950 to 29217 MW by the end of 1978-79. The industry generated 110032 million units of electrical energy during 1978-79 as compared with 6575 million units in 1950. During the same period, the number of consumers served by the industry rose from 1.5 million in 1950 to over 26 million consumers today. The per capita consumption of electricity increased from 14.6 kwh in 1950 to 131.3 kwh in 1978-79. As against 3051 villages electrified in 1950, electricity is now available to more than 233000 villages in which 62.1% of the total rural population live. About 3.6 million agricultural pumpsets are being run today on electricity in the rural areas.

Technological Progress

1.8 Because of the economies of scale, the unit size of generation units, especially thermal units, has been increasing rapidly. Whereas till 1960, the largest size in use was a set of 90 MW, today, 500 MW sets are in the course of installation. Much of the equipment required by the power industry including that required for nuclear power plants is now indigenously produced. The transmission system is also getting increasingly large and sophisticated and from 110 KV the H.T. maximum voltage has been increased

*Source.—Working Group on Engery Policy, 1979.

to 400 KV. The transformers, switch-gear and other equipment needed to set up these new high voltage systems are also being made locally.

Investment and Employment

1.9 The investment required to finance this explosive growth has been going up sharply both on account of the increasing size of the power programme and its increasing capital intensity. For example, as compared to 1950-51, the cost of installing a kilowatt of installed capacity has increased 7 times in the case of thermal plants and 5 times in hydel plants. As a result the share of the public expenditure on the power system has gone up steeply rising from 12% of the total public expenditure in the First Plan to nearly 23% in the Draft Plan 1978-83. Today the investment in the power sector at original prices is about Rs. 12,000 crores generating sales of nearly Rs. 2,200 crores and employing directly some 5 lakhs of people and indirectly many times that number.

Generation Mix

1.10 Within the power sector the mix between thermal and hydro-electric generation has changed only slightly over the last 30 years, the hydel contribution falling from 49% to 46% and the thermal increasing from 47% to 51% in terms of electrical energy. Nuclear power today contributes about 3% of the total electrical energy. This decline in the hydel power component of the mix though small is a cause of concern because hydel power has many advantages over thermal and nuclear, such as being based on renewable energy sources and totally pollution free. The mix varies a great deal within the 5 regions, for example hydel power contributes nearly 50% of the energy in the Northern region and falls to 20% in the Eastern region.

1.11 It is clear, therefore, that while the mix at the national level appears to be reasonably satisfactory, there are severe imbalances within the regions and these are further exaggerated at the State level. States like Haryana and Rajasthan, for instance, have virtually no hydel potential which means that, while the steady base loads can be met through thermal plants, peak demands pose problems. Similarly using hydel power plants as base load stations, as happens in Karnataka and Orissa, is sub-optimal use of valuable peaking capacity. Exclusive or heavy reliance on hydel power is also to be avoided because it creates problems when the monsoon fails as happened in many parts of India in 1979-80.

Transmission and Distribution (T&D)

1.12 In general, the growth of the transmission and distribution (T&D) system has not kept pace with the generation capacity as a result of which losses have increased from 16% in 1950-51 to 20% in 1978-79 and system reliability has fallen Experience suggests that the investment on generation and P & D (inclusive of RE) should be roughly equal but in the 3rd and 5th Plans the T & D share of investment fell to 40%.

Patterns of Consumption

1.13 During the past 30 years the most striking change in the pattern of consumption is the growth of the agricultural load. As a proportion of the total energy consumed, it has increased from 4% in 1950-51 to 16% in 1978-79 on, of course a much bigger base. In absolute terms the electrical energy consumption in agriculture has increased nearly 70 fold. One of the disturbing features of the pattern of consumption is the wide variations in the per capita consumption of power in the different States of the Union and in the rates of growth. Table 1.1 below illustrates this.

TABLE 1.1

Growth of per capita electricity consumption Statewise

State/U.T.	Per capita electricity consumption (KWH) 1960-61	1977-78	Annual compound growth rate (%) 1960-61 to 1977-78
1. Andhra Pradesh	19	83	9·1
2. Assam	4	35	13·6
3. Bihar	38	87	5·0
4. Gujarat	52	210	8·6
5. Haryana	111 (1971-72)	172	7·6
6. Himachal Pradesh	9 (1965-66)	54	16.1
7. Jammu & Kashmir	14	65	9·5
8. Karnataka	44	136	6·9
9. Kerala	29	98	7·4
10. Madhya Pradesh	20	94	9·5
11. Maharashtra	73	212	6·5
12. Manipur	4 (1965-66)	5	1.9
13. Meghalaya	27 (1974-75)	25	(—)2.5
14. Nagaland	2 (1965-66)	23	22·6
15. Orissa	43	115	6·0
16. Punjab	33	227	12.0
17. Rajasthan	12	85	12·2
18. Tamil Nadu	50	163	7·2
19. Tripura	3 (1965-66)	9	9·6
20. Uttar Pradesh	15	80	10·3
21. West Bengal	85	120	2·0
22. Delhi	187	340	3.6
All India	38	121	7·1

Source.—General Review Public Electricity Supply All India Statistics, 1977-78.

1.14 In many ways, however, these figures are highly misleading and it would be totally wrong to equate the quality of life with such per capita figures. For instance, Bihar's and Orissa's per-capita consumption was near or above the all-India average in 1960-61, because very large amounts of their power went to power intensive industries like steel and aluminium. Likewise, the bulk of Maharashtra's power is consumed by the industries in the Bombay-Pune belt. The figures do bring out however the varying rates of progress and the slow pace of development in an industrially advanced State like West Bengal.

Planning for Power

1.15 Given the present technological options open to the country, it can be assumed that the bulk of the new capacity that will be added to the power system during the next two decades will come from a judicious mix of coal fired thermal stations and hydro-electric projects. The natural resources for these projects vary widely from State to State as has been discussed earlier. If the power system is to be developed in an optimal way, it is clear that power planning has to be done preferably nationally, but if not, at least on a regional but not on a Statewise basis. This need was recognised as far back as 1948 but, on account of the divided responsibility for power between the Centre and the States, no planning for power outside State boudaries has yet been found feasible. As a result, sub-optimal investments in generation and transmission facilities have been and continue to be made. Inter-State transfers of energy already constitute about 15% of the total energy generated and the scope for reducing costs and improving system conditions by the integrated operation of regional grids is considerable.

Power shortages and the performance of utilities

1.16 While the methodology of planning leaves much to be desired and ways of improving it forms the subject of next Chapter, it does not follow that these shortcomings have been the main cause of power shortages which in varying degrees have been faced by many States during the last 10 years.

1.17 There is no doubt that, in general, power shortages have been largely due to the unconscionable delays by the major utilities in implementing projects for generation and transmission on schedule and the poor utilisation of installed capacities, particularly thermal stations. It is not as if the time frames adopted for implementing projects were unreasonably short or that very high levels of performance were expected from the operating units. It was, however, expected that project implementation and operation efficiencies would improve to some extent in successive plan periods over very low base levels, instead of which they have, if anything deteriorated. The result has been that, in relation to the planned additions to generating capacity, the average shortfall has been as much as 36% in the 2nd, 3rd and 5th Plans and it went up to 50% in the 4th Plan. Likewise the shortfall in energy generated as compared to what was planned increased steadily from 3% in 1975-76 to 14% in 1979-80. It has been calculated that despite the shortfall in hydel energy generation in 1979-80 due to the poor monsoon, had the thermal units performed to levels already achieved by them in the past the gap between energy demand and supply would have been bridged to a very large extent and the power shortages would have been marginal rather than never.

1.18 This deteriorating performance is the result of factors within and outside the control of the power utilities. Typical of the latter is day to day intrusions of some of the State Governments in the management of the utilities, sub-standard equipment supplied by local and foreign suppliers, unsatisfactory after sales service and poor quality and erratic coal supplies. Law and order problems in some States have made things worse. Internal factors include indifferent management, bad maintenance, disturbed industrial relations, inadequate training and low morale. Very little attention has been paid to the efficient use of electricity and power generating capacity by consumers. Conservation and demand management are amongst the most neglected areas in the power sector.

1.19 In short the power shortages during the last decade can be attributed to four major factors—

(a) delays in implementing projects;

(b) inadequate investments in transmission and distribution systems and lack of integrated operation of the regional grids;

(c) poor utilisation of the installed thermal generation capacity;

(d) lack of attention to conservation and demand management.

1.20 There are wide variations amongst States in the efficiency with which thermal stations are run. There are thermal stations which consistently operate at well above the optimal level of 70% capacity utilisation and others that barely reach 35%. The private sector units have generally performed better than the State owned units as a whole, but there are several State Electricity Boards which run their plants just as well if not better. The generally unsatisfactory performance of the State sector units is partly attributable to the way in which the power industry has developed historically and a brief reference to this and to the statutory and financial framework within which it functions is necessary.

The Structure of the Power Industry

1.21 The power utility industry has on account of historical factors developed in diverse ways over the last 100 years as a result of which it has today rather a complex structure which will be discussed in depth in a subsequent Chapter.

Power is a concurrent subject under the Constitution but, since 1956 till very recently, its growth has been almost exclusively in the State Sector

1.22 The most important segment of the power utilities is the State Electricity Boards (SEBs) which came into being with the passing of Electricity (Supply) Act, 1948. They account for about 70% of the generation and nearly all the transmission and distribution of power. About 18% of the generation is contributed by projects owned jointly either by two or more States or by the Central and State Governments. Private Sector and Centrally owned utilities (including those in Union Territories) account for about 5% of the power generated. Whereas the SEBs are statutory bodies the private and Central utility companies are corporations under the Companies Act. In some small States the utilities are run as departments of the Government.

1.23 There are a number of bodies which have close links with the utilities. Of these, the most prominent is the Central Electricity Authority (CEA), a statutory body under the Department of Power, which is expected to formulate power policy and plan the sound development of power industry. All major projects require the technical clearance of the CEA. At the regional level, there are Regional Electricity Boards (REBs) set up to help the utilities in the five regions to operate in an integrated way.

1.24 To do the detailed planning for power, State by State and region by region, there is the Annual Power Survey Committee consisting of the Chairman of the CEA, Chairman of the 5 Regional Electricity Boards, two representatives of the Planning Commission and representative of the Ministry of Finance and Heavy Industry. To ensure that thermal stations get coal of the specified quality, there is a Standing Coal Linkage Committee on which are represented the Department of Power, the CEA, the Department of Coal, the Ministry of Railways and the Planning Commission.

1.25 Finally there is the Planning Commission which prepares the overall national plans for power as it does for all other sectors. All major projects to be executed by the States require the formal clearance of the Planning Commission to ensure that they fit into the national plan and that there are resources available in the States plan to fund them.

Finance, Financial Management and Tariffs

1.26 The power supply industry, as pointed out earlier, is one of the largest consumers of capital in the economy and its share of the total public expenditure is rising rapidly. If it is to sustain this growth rate, it is clear that it must increasingly generate its own resources. Under the Electricity Supply Act, which regulates the operation of the State Electricity Boards, the Boards were not till recently specifically required to earn a return on the capital they use. A number of Committees, of which particular mention should be made of the Venkataraman Committee, 1964, examined the working of the SEBs and recommended a gross return of 9.5% (excluding electricity duty) on capital employed after providing for operating expenses and depreciation. However, when the statute was amended in 1978 although it was provided that Boards should earn a positive return no specific figure was mentioned.

1.27 In actual practice, however, the Boards are often regarded as promotional agencies to be used to subsidise different classes of consumers and with little or no control over their tariff policy. As a result, on the whole, the returns specified by the Venkataraman Committee have not been realised and on the contrary large arrears of interest are due to the State Governments on the loans given by them to SEBs. Here again the picture is not uniform and there are States which have consistently achieved the returns prescribed and others which have made and continue to make huge losses. The loss in 1978-79 for example of the SEBs as a whole was Rs. 230 crores.

1.28 Besides low tariffs the causes of the poor financial performance are the low operating efficiencies, high capital cost of projects due to long delays in construction and high overheads—mainly the result of heavy overstaffing. Although precise comparisons are not possible the average employees per megawatt of installed capacity in India is 7 compared to 1.2 in the U.S.A., 1.5 in Japan and 1.7 in the U.K. Within the country the expenditure on salaries varies from 12% to 40% of the total income of the SEBs. Much of this overstaffing is due to SEBs being compelled under political pressures to take on people they do not need.

1.29 The result of all this is that many of the Boards are wholly dependent upon the State Government even for meeting their normal operating expenses making it even more difficult for them to function as the autonomous bodies which they were set up to be.

Organisation and Management

1.30 The weaknesses in the management of the utilities, in particular the State Electricity Boards, have been touched upon earlier. This arises partly out of the desire of some State Governments to exert a high degree of day to day control on the operations of the Boards and partly due to the management culture, inherited from the bureaucratic style of functioning, that most SEBs had when they were Government Departments.

1.31 Although State Electricity Boards have been in existence for two decades or more and mature enough to throw up their own internal leadership, in practice the Chairman has often been an officer drawn from the Indian Administrative Service and the Accounts Member from one of the Central Accounts Services such as the

IA&AS. Only the Member (Technical) is generally a regular employee of the Board. Because of their ownership pattern, employees of Boards have no natural avenues of promotion in other utility companies. Professionalisation is poor and at best confined to separate cadres for generation and distribution.

Rural Electrification

1.32 Reference has been made to the rapid growth in the consumption of power in the agricultural sector. Most of this power is consumed by agricultural pump sets and has been one of the major factors in insulating Indian agriculture from the vagaries of the monsoon and lending stability to the Indian economy. Village electrification has been shown to have a favourable impact on the growth and profitability of rural industries and domestic power to households contributes a great deal to improving the quality of village life. Despite this the progress made in development of village industries and household electrification has been very slow. Although 40% of Indian villages covering 60% of India's rural population are electrified in the sense there is a source of power in the village, the proportion of households electrified is known to be very small but there are no reliable figures.

1.33 One of the characteristics of rural electrification in India is that it benefits mainly the large and medium farmers. The small farmers, landless labourers and artisans find domestic and agricultural power beyond their reach despite the many schemes and programmes aimed at giving them preferential assistance. Rural tariffs are highly subsidised and account for the bulk of the financial losses of the SEBs. As the remoter and less densely populated villages get electrified T&D and other losses are going to increase. Means will thus have to be found for accelerating the pace of rural electrification for agricultural, industrial and domestic end-uses in a way which allows benefits to flow more evenly across the different income groups and does not cause losses to SEBs.

Research & Development

1.34 For an industry which spends today over Rs. 3000 crores a year on capital expenditure, the R&D back up it has is ludicrously low. During 1978-79 the expenditure on R&D on power excluding the Atomic Energy Commission was approximately Rs. 1.8 crores by agencies directly linked to the generation and distribution of power such as CPRI at Bangalore. To this could be added at most Rs. 15 crores/annum for all the research being done by organisations like Bharat Heavy Electricals Ltd., Instrumentation Ltd., Kota and some private sector organisations. It is customary to relate research to sales rather than capital investment and on this basis the investment in R&D is about 0.70%. The comparable figure in developed countries is higher on a much higher sales turn over. It is clear, therefore, that it will take a long time before the level of R&D in power in India begins to reach levels which would put India into the frontiers of technological development. The only exception is nuclear energy where the external political environment and the non-availability of equipment and knowhow on acceptable terms has left the country no option but to invest heavily in R&D in places like the Bhabha Atomic Research Centre. As a result significant progress has been made in building up indigenous capability in this highly sophisticated field. For the rest the power industry is, and will be for some years, dependent, to a very large extent, on imported knowhow.

The Challenge Ahead

1.35 In addition to the short-term problem of overcoming power shortages, the industry will need to prepare itself for the kind of growth that is likely to be needed. It has been estimated* that by the turn of the century the country would require a minimum of 400 TWH and possibility 470 TWH of energy in the form of power as compared to the consumption of 84 TWH in 1978-79 (inclusive of non-utilities)—almost a five-fold increase. This would require an increase in installed capacity of nearly 110,000 MW* in the next 21 years implying an addition to capacity averaging over 5000 MW a year. This has to be seen in relation to the past record of the industry which shows that the maximum addition in any one year so far has been 2000 MW. If this order of increase is to be achieved in a way which minimises investment and maximises operational efficiency, major structural, organisational, procedural, financial and technical changes will need to be made in the power industry.

1.36 In the following Chapters an attempt has been made to analyse some of these problems and make recommendations for dealing with them. The Committee firmly believes that, given the national and especially the political will to surmount the difficulties that lie ahead, the country has ample managerial, technical and physical resources to accomplish the task of ridding the nation of the endemic power shortages which have plagued it for the last two decades. What is even more important, these resources applied to the twin tasks of conservation and development of new energy sources could do what a few nations today seem capable of doing—surviving the energy crisis that is engulfing the world.

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*Source.—Working Group on Energy Policy, 1979.

CHAPTER II

PLANNING FOR POWER DEVELOPMENT

INTRODUCTION

Analysis of Growth Rates

2.1 Reference has been made in the previous Chapter to the phenomenal growth of the power industry. Details of different facets of this growth are shown in Table 2.1.

TABLE 2.1

A : Growth of the Power Industry

	Dec. 1950	1960-61	1970-71	1977-78	1978-79
Capacity (MW) (CAPS)					
Utilities					
Hydro	559	1,917	6,383	10,020	10,833
Thermal	1,005	2,436	7,508	12,682	14,887
Gas	..	..	168	168	168
Diesel	149	300	230	159	154
Nuclear	..	..	420	640	640
Total	1,713	4,653	14,709	23,669	26,682
Public Sector	628	3,297	13,221	22,375	25,293
Private Sector	1,085	1,365	1,488	1,294	1,389
Total (Utilities)	1,713	4,653	14,709	23,669	26,682
Annual average growth rate % during the decade	4·33	10·50	12·20	7·03	7·49
Non-utilities (including Railways)	588	1,001	1,562	2,506	2,535
All India	2,301	5,654	16,271	26,175	29,217
Energy (GWH) (CAPS)*					
Utilities	5,858	16,937	55,828	91,369	1,02,432
Non-Utilities	1,656	3,186	5,384	7,559	7,600
Total	7,514	20,123	61,212	98,928	1,10,032

*Gross energy generation inclusive of auxiliary consumption.

Transmission & Distribution (Circuit Kms)

	1-4-51	1-4-56	1-4-61	1-4-66	1-4-69	1-4-74	1-4-78
Transmission—HT (22KV to 400 KV).	15,161	27,221	55,860	1,05,077	1,47,969	1,99,115	2,48,811
Distribution and sub-transmission (excluding lines of less than 500 V).	14,110	39,200	1,02,027	4,36,627	6,88,338	13,46,982	17,50,269

2.2 The average annual growth rate in electricity generation and consumption has been about 10% over the past three decades. In per capita terms, generation increased from 18.17 Kwh in 1950 to 171.53 Kwh in 1979 while consumption increased from 14.60 Kwh to 131.34 Kwh. The sectoral consumption of electrical energy is given in Table 2.2 below.

TABLE 2.2

Percentage consumption of electrical energy by Sectors

	Dec. 1950	1960-61	1970-71	1977-78	1978-79
Domestic	12·6	10·8	8·8	9·8	9·8
Commercial	7·5	6·1	5·9	6·4	6·2
Industrial	62·6	69·3	67·6	61·6	61·8
Agriculture	3·9	6·0	10·2	14·6	15·7
Others	13.4	7·8	7·5	7·6	6·5

Source.—Central Electricity Authority.

The share of the household and commercial sectors has been steady for the past decade after some decline from the earlier periods. The share of agriculture grew at a high rate especially in the previous decade, as energisation of pumpsets began to get high priority. The share of industry increased during the sixties and has declined from then on. The rate of growth of electrical energy consumption has been faster than the rate of growth of the economy as a whole as Table 2.3 below will show :

TABLE 2.3

Rates of growth of economy *vis-a-vis* energy consumption

Plan	Period	Average growth rate of economy (Per cent per annum compound)	Average rate of growth of energy consumption (per cent per annum compound)
1st .	1951-56	3·54	9·60
2nd .	1956-61	4·11	10·60
3rd .	1961-66	2·60	12·18
Annual Plans	1966-69	4·08	10·96
4th .	1969-74	3·47	6·27
5th . .	1974-78	4·47	8·08
Draft Plan	1978-83	4·70*	*11.08

*Anticipated

2.3 The power industry is highly capital intensive. The rapid increase in the generating capacity and transmission and distribution network in the country has necessitated substantial increase in the outlays for the power sector in the national Five-Year Plans from the First Plan onwards as will be seen from Table 2.4 given below :

TABLE 2.4

Plan-wise investment in Power Sector and its share in the overall Plan Outlay

Plan	Expenditure/outlay in power sector	
	Rs. Crores	As a share in the total Plan expenditure/outlay (%)
I . .	260	13·3
II . .	460	9·8
III . .	1,252	14·6
Three Annual	1,223	18·1
IV . .	2,932	18·6
V (1974-78) .	5,244*	17·8
1978-83 . .	15,112	21·3

*Provisional.

For the first time since the Five-Year Plans were formulated, the outlay on power in Draft Plan 1978-83 is larger than the outlay on any other sector.

Power Shortages

2.4 In spite of the impressive growth and the massive investments made in the sector, power shortages have been experienced in some region or the other of the country during the last two decades. These shortages which were sporadic in the sixties have become serious and sustained since the Fourth Plan period. Power shortages have affected all sectors of the economy and power, today, is a severe constraint to the growth of the Indian economy. Although it is difficult to quantify accurately the shortfall in power availability because of various power cuts and restrictions on consumption, the CEA has attempted an exercise to quantify the power shortages in terms of energy, based on information furnished by various States. The results of the CEA exercise are given below :

TABLE 2·5

All-India Power Supply Position *vis-a-vis* requirement and supply for the period 1974-75 to 1979-80 (Requirement and supply at station bus-bar as energy).

Year	Anticipated requirement		Supply		Shortage	
	Gwh	% of preceding year's requirement	Gwh	% of preceding years supply	Gwh	%
1974-75	77,600	..	66,647	..	10,953	14·1
1975-76	83,508	107·6	74,909	112·4	8,599	10·3
1976-77	88,489	106·0	83,365	111·3	5,124	5·8
1977-78	1,02,180	115·5	86,343	103·6	15,837	15·5
1978-79	1,08,535	106·2	97,349	112·7	11,186	10·3
1979-80	1,18,370	109·1	99,302	102·0	19,068	16·1

Source.—Central Electricity Authority.

ISSUES IN POWER PLANNING

2.5 It would follow from the above that to study the adequacy of the present planning process and understand the reasons for the continuing imbalance between demand and supply, the following basic issues have to be examined:

(a) How have projections of the demand for power been made in the past and whether these projections for power have been accurate ?

(b) Given these demand forecasts for power, how were additions to capacity planned and whether the capacity was planned realistically to meet this demand.

(c) Whether available capacity for power generation has been utilised efficiently.

(d) Whether the country's power programme has been developed on a least cost basis.

DEMAND FORECASTING

TRENDS AND CURRENT PRACTICES

Demand forecasts

2.6 Forecasting of demand for power, both in terms of peak demand and energy, is the first step in the power planning process. Realistic demand forecasts at the global (national) level and their disaggregation by regions and States are required for capacity planning. Further disaggregation of demand by major load centres is essential for the planning of generating sations, transmission and distribution net-works.

Demand Forecasting bodies

2.7 Demand forecasts for power are made by different bodies—the Annual Power Survey Committees, the State Governments and the Planning Commission. All these use different methodologies and hence arrive at different figures of demand. A brief description on the methodologies adopted by these groups is given below with recommendations on how where possible these forecasts can be reconciled.

Annual Power Surveys (APS)

2.8 One of the basic documents in demand forecasting is the Annual Power Survey organised by the Department of Power at regular intervals. These Annual Power Surveys were started in the early sixties on the pattern of the Semi Annual Power Surveys of the Edison Electric Institute of the U. S. Intended to be carried out annually, they were to project the demands for power over a five year period in order to provide the data for determining the measures required to be taken to ensure adequate power availability in a given time frame.

The surveys are conducted under the aegis of a Power Survey Committee set up by the Department of Power with representatives drawn from the power industry, consuming sectors and Government Departments. The Power Survey Directorate of the CEA acts as the secretariat for the Committee. Since 1962 ten surveys have been carried out and the 11th survey is presently under way. The results of these surveys are used as one of the inputs into capacity planning by the power industry and the Government.

Methodology used by APS Committee

2.9 The methodology adopted for forecasting the medium term demand in the Annual Power Surveys has been modified from time to time and some improvements made. What is now adopted is a combination of the 'end use' method and past trends and deals with the demands of each of the States, the 5 regions and the nation as a whole. The energy demands of the industrial sector, which currently accounts for a major share of the electricity consumption, are projected in considerable detail. Industries which contribute a load of 1 MW and above are identified individually and their requirements are estimated on the basis of their projected output. The consumption requirement of other industries is estimated on the basis of past trends and by correlating demand to the expected growth in industrial activity. The requirements of the agriculture sector are forecast using the projected programme of energisation of pumpsets. The demands of Railways for traction power are based on the planned programme of railway electrification. The consumption of domestic, commercial and other sectors is obtained by projections of past trends. It would be seen, therefore, that the methodology selected for projecting the demand of each sector is different and in many cases largely dependent on the data base available for such forecasts. The major weakness of the APS surveys is that they do not take into account resource constraints and presume that resources will be found to create the capacity needed. Their strength is that they provide a reasonably accurate basis for disaggregating the national demand into Statewise and regional demands as they are based on indepth dialogues between the consumer, the States and the Power Survey Committee.

Long-term forecasts

2.10 Power projects have long gestation periods, varying between 6 to 10 years, and if power planning is to be done optimally, it is necessary to formulate plans for power development on the basis of a perspective of 15 to 20 years and to build in the Five Year Plans into such perspectives. The 9th and 10th Annual Power Surveys have attempted such long term forecasts (20 years) using certain rather simplistic methods. It is necessary, however, to develop more sophisticated techniques for long term forecasting which would take into consideration the total energy demand and growth rates of the various sectors of the economy.

State Forecasts

2.11 Some SEBs also undertake demand forecasting exercises. The methodology adopted varies from State to State depending on the data base. They are primarily based on the SEBs own forecasts of the demands for power both in term of energy & peak demand that are likely to be made on them and are used for the limited purpose of justifying greater investment in power projects and not conceived of as continuing exercises in demand and generation management. Even the historical data on peak demands is not entirely reliable & tends to be reflected. The major shortcomings in the methodology adopted by the States are two. Firstly, like the Annual Power Surveys, there is no link between the projected demand and the supply of power likely to be available to the States on the basis of investments being made in this sector by the States and the Centre. Secondly, the demand for industry, which claims the largest share of power, is based on the States' own forecasts of industrial growth within their boundaries and there is no correlation between this growth and the national plan. States are bound to take an optimistic view and the aggregate industrial demand of the States taken together is, therefore, considerably larger than the industrial demand computed for the nation as a whole.

Planning Commission Projections

2.12 The Planning Commission works out independently the electricity requirements for the Five Year Plan period using an input-output model, detailed material balance studies and capital-output ratios. The resource constraints thus get built into its forecasts. The demands are estimated mainly in terms of energy required for the end-year of the 5 year perspective plan for the nation as a whole. This forecast is not disaggregated for each year or by regions or States as the exercise aims at establishing consistency between the development of various sectors of the economy at the national level. Because they work to physical targets based on the expected rates of growth of the economy, which are lower than what is implicit in the demand surveys, the demand forecasts of Planning Commission tend to be lower than those projected by the APS. As against this, without the disaggregation of demand by States and regions that the APS provide, region-wise and State-wise demand forecasting which is essential for formulating State and National plans would not be possible.

2.13 As the data base improves and the techniques used by both agencies get refined, the gap between the APS and the Planning Commission forecasts has begun to shrink and there are today no significant differences between the two. The States, however, continue to project demands completely out of line with these two bodies, on what must be presumed to be efforts at building up a bargaining position for being allotted more power.

Calculation of Peak Demands

2.14 The aggregate demand as stated earlier for different classes of consumers as worked out in energy terms can be broadly correlated to output in the case of some sectors and assessed on the basis of past trends in the case of others. There is however no scientific way of estimating future peak demands especially as even the past data of peak demand is suspect because of the tendency of State Governments to inflate this figure as mentioned in para 2.11. There is however no other figure which can be used at present for estimating historical peak demands. The practice therefore is to assume that this peak demand will rise pro-rata with energy demand i.e. the system load factor will remain constant. More reliable data on peak demands should be available when the proposed Regional Electricity Authorities come into existence. These calculations of peak demands are made for each region. Since this approach does not project changes that may take place in the pattern of energy consumption as between different consumers and within each consumer group the long term calculations of peak demand can go astray. However, at present no better technique has been evolved.

Variations in Demand

2.15 Implicit in the method of planning for peak demand referred to in para 2.14 is a fixed ratio between average demand and peak demand. Two kinds of peak and average demands must be allowed for, diurnal i.e. daily and seasonal. It is evident that the smaller the differences between peak and average demand the less will be the capacity required to meet a given energy need. The purpose of demand management, therefore is to minimise this difference or as it is technically termed to flatten the load curve that is a graph on which load is plotted against time.

Daily Variations in demand

2.16 Table 2.6 below shows the maximum and minimum demand on typical days during certain times of the year :

TABLE 2.6

Daily Load Factors in Different Regions

Region	Year	Daily Load factor(%)/months of incidence		Average of monthly peak day load factor (%)
		Maximum	Minimum	
1	2	3	4	5
Northern	1976-77	88·9 July, 76	75·5 April, 76	81·9
	1977-78	92·1 July, 77	78·7 Dec., 77	84·0
	1978-79	87·0 May, 78	77·8 Jan., 79	83·0

1	2	3		4		5
Western	1976-77	89·7	June, 76	82·7	Feb., 77	85·7
	1977-78	88·3	Feb., 78	83·0	Aug., 78	85·4
	1978-79	88·3	Sept., 78	82·3	March, 79	85·7
Southern	1976-77	85·6	March, 77	81·38	July, 76	83·8
	1977-78	85·8	April, 77	75·8	Feb., 78	81·4
	1978-79	86·0	March, 79	80·5	Nov., 78	83·3
Eastern	1976-77	86·2	April, 76	77·9	Jan. 77	82·9
	1977-78	86·4	Oct., 77	82·7	July, 77	85·1
	1978-79	88·7	March, 79	82·0	Dec., 78	84·1

Source.—C.E.A.

It will be observed that the proportion of minimum demand as a percentage of peak demand (load factor) is high averaging between 0.82 to 0.86. This however has not been achieved so much by demand management i.e. staggering working hours or shifting demand to off-peak hours, as simply by cutting off power supply at peak demand time. It follows therefore that if power supply had been better this ratio would have been lower. In most countries in which power shedding does not take place or is minimal, this ratio varies between 0.3 to 0.7. No figure can be prescribed for planning purposes as the composition of the demand is critical. For example, systems in which domestic demand is a high proportion of the total demand or the industrial load is restricted to the day will have lower load factors then systems in which large continuous industries absorb the bulk of the power.

Seasonal variations in demand

2.17 The seasonal load curves for four regions are shown in appendices 2.1 to 2.4 and Table 2.7 below indicates the annual load factors i.e. average peak load during the year as a proportion of maximum peak load for certain typical years during the last 15 years.

TABLE 2.7

Annual Load Factors in different Regions (%)

Year	Northern Region	Western Region	Southern Region	Eastern Region	North Eastern Region	All India
1965-66	62·0	67·0	64·0	64·0	35·0	74·0
1970-71	7·0	67·0	63·0	63·0	50·0	62·0
1975-76	58·0	69·9	59·9	69·7	53·1	63·5
1978-79*	58·5	66·6	63·3	66·1	53·8	63·12

* Provisional.

Source.—Working Group on Energy Policy, 1979.

Demand Management

2.18 Although in comparison to most countries load factors in India are high this is largely due, as stated earlier, to cuts which are imposed at peak hours. This is not a good way of raising the load factor as it leads to either loss of production or severe inconvenience to domestic and commercial consumers. The Committee has studied the demand characteristics of the major categories of consumers and has dealt with the scope for demand management and ways in which it can be achieved in paras 2.44 to 2.57.

Conservation

2.19 An important input into maximising physical output of goods and services for a given supply of electrical energy is conservation—an area which has had comparatively little attention paid to it in India. There is a great deal of scope for conservation in industry—the largest consumer of power and some in the other sectors also. Maximising conservation of energy will require some policy and administrative measures by Government but much will depend upon the attention given to it by consumers themselves. The potential, policies and measures in this regard have also been dealt with in paras 2.44 to 2.57. Success in implementing these measures will reduce the power output ratio of the various sectors and would affect favourably the material balances used to arrive at energy demand.

GDP and Power Consumption rates

2.20 One of the questions that concern long term power planners is whether the present high growth of power in relation to the rest of the economy can be sustained.

Table 2.8 reproduced below shows the annual percentage rate of growth of electricity consumption from 1950-51 to 1977-78 and the elasticity of electricity consumption with respect to the gross domestic product.

TABLE 2.8

GDP and growth of electricity consumption

Period	Growth of electricity consumption (annual %)	Electricity consumption GDP Elasticity
1950-51 to 1955-56	9·6	2·71
1955-56 to 1960-61	10·6	2·58
1960-61 to 1965-66	12·2	4·68
1965-66 to 1970-71	9·7	1·98
1970-71 to 1975-76	6·4	2·23
1975-76 to 1977-78	7·2	1·64

While the figures do not show a steady pattern, there is discernible, in the last decade, some dicrease in the elasticity of electricity demand in relation to GDP.

Intensity of Electricity Consumption in Industry

2.21 In the industrial sector, however, which consumes the largest share of power, the intensity of electricity use defined as the ratio of quantity of electrical energy used per unit of added value has been rising steadily during the last two decades as indicated in the Table 2.9 given below :

TABLE 2.9

Intensity of Electricity Consumption

Item	1960-61	1965-66	1970-71	1975-76	1977-78
1. Value added in industry in Rs. 100 Crores (1970-71) prices.	33·73	47·93	56·99	67·87	76·54
2. Electricity consumed 109 kwh . . .	11·60	22·62	31·35	43·35	49·25
3. Intensity of electricity consumption (kwh/Rupee value added).	0·34	0·47	0·55	0·64	0·64

If this trend were to continue, increasing amounts of power would be required to sustain our industrial growth even at current rates, emphasising the importance of looking at less power intensive growth strategies for the industrial sector.

Increase in Electricity consumption in Agriculture

2.22 The most rapid increase in connected load is likely to be from the agricultural sector. Current plans call for energisation of about 4,00,000 pumpsets per year and this rate of energisation of new pumpsets is likely to continue for some years to come since the high priority accorded to rural electrification programmes is expected to remain unchanged. Similarly, the likely target for the 1980-85 Plan period for village electrification is about 1.2 Lakh villages which will take the total of villages electrified to 3.69 lakhs. An aspect of rural electrification, however, that may undergo a significant change in the next decade or so is the domestic sector. Most rural electrification programmes to date have concentrated on energisation of pumpsets and electrification of rural households and street lighting have only been incidental to this objective. This is likely to change over the next decade with ever escalating prices of kerosene and the prospect of its restricted availability.

RECOMMENDATIONS

2.23 With projects having gestation periods of 10 years and more the need for long term demand forecasting covering periods of 15-20 years needs no further justification. Such forecasts should be prepared and updated every 3 years and should form the frame work for formulating 5 years plans. A time frame of this order will permit long gestation hydel and nuclear projects to be planned along with shorter gestation thermal projects so that the generation mix, regionwise, is optimised. The absence of such a long term perspective has been one of the reasons for the neglect of hydel projects during the last two decades.

Long term demand forecasting

2.24 In the absence of data backed by a methodology which could enable detailed long term (15-20 year) modelling exercises to be attempted the Committee would suggest the adoption of a 'Scenario' approach to the task of such perspective planning. Assumptions will have to be made in regard to growth rates, changing shares of demand between consumers, changing patterns of consumptions within consumer groups, elasticity of power demand in relation to agricultural and industrial growth, development of renewable energy resources, progress towards conservation and load factor improvement and so on.

2.25 For estimating such long term demand the Committee has adopted the projections made in the Report of the Working Group on Energy Policy (WGEP 1979), modified slightly to take into account auxiliary consumption. The WGEP has estimated the demand for power by the turn of the century under two scenarios, one a Reference Level Forecast (RLF) which assumes that the present trends in consumption of power will continue and the other an Optimal Level Forecast (OLF) which assumes the implementation of certain measures for conservation and long-term demand management and a less energy intensive development strategy. Details of these are given in the following Tables.

TABLE 2.10

Requirements of the Installed Capacity 1982-2000

OPTIMAL LEVEL FORECAST (OLF)

Particulars	Units	1982-83	1987-88	1992-93	2000-1
Total energy consumption	TWH	128·3	173·6	241·0	395·6
Capacity in Non-utility	MW	2,500·0	3,000·0	3,600·0	4,900·0
Energy supply from Non-utility	TWH	7·0	8·1	10·1	14·7
Energy consumption in utility	TWH	121·3	165·5	230·9	380·9
T & D losses*	%	18	17	15	14
Energy demand at the bus bar	TWH	147·9	199·4	271·6	442·9
Load factor	%	63	64	65	66
Peak demand	MW	26,799	35,565	47,690	76,605
Peak demand served by :					
Nuclear	MW	745	1,302	1,918	3,750
Hydel	MW	11,739	16,800	25,110	38,540
Thermal	MW	14,315	17,463	20,652	34,315
Total	MW	26,799	35,565	47,690	76,605
Installed capacity :					
Nuclear	MW	1,330	2,035	2,740	5,000
Hydel	MW	14,809	21,000	31,009	47,000
Thermal	MW	26,027	30,110	38,464	62,550
Total	MW	42,166	53,145	72,204	1,14,550

TABLE 2.11

Requirement of Installed Capacity 1982-2000

REFERENCE LEVEL FORECAST (RLF)

Particulars	Unit	1982-83	1987-88	1992-93	2000-01
Total energy demand at the consumer end	TWH	128·3	191·2	281·9	471·0
Anticipated capacity in Non-utilities	MW	2,500·0	3,000·0	3600.0	4,900·0
Energy supply from Non-utility	TWH	7·0	8·1	10·1	14·7
Energy required from utilities	TWH	121·30	183·1	271·8	456·3
T & D losses*	%	18	17	16	15
Energy demand at the power station bus	TWH	147·9	220·6	323.6	536·9
Annual System Load Factor	%	63	63	63	64
Peak demand	MW	26,854	39,972	58,636	95,766
Peak demand served by :					
Nuclear	MW	754	1,220	1,808	3,500
Hydel	MW	11,699	19,600	27,540	40,180
Thermal	MW	14,410	19,152	29,288	52,086
Total	MW	26,854	39,972	58,636	95,766
Installed Capacity :					
Nuclear	MW	1,330	20,35	2,740	5,000
Hydel	MW	14,809	24,500	34,000	49,000
Thermal	MW	26,193	34,200	49,280	83,859
Total	MW	42,332	60,735	86,020	1,37,859

* Exclusive of RE

2.26 As per the RLF, the installed capacity by the year 1990 is expected to be about 76000 MW and by the year 2001 about 138000 MW in public sector utilities. This would require the addition of 48000 MW during the eighties and 62000 MW during the ninties. At current prices (1980) for generation, transmission and distribution facilities, the investment required in the power sector for the decades 1980-90 and 1990-2001 would be Rs. 67,200 crores and Rs. 86,800 crores respectively at an overall cost of Rs. 14,000 per KW. This has been worked out on the basis of Rs. 5,500 per KW for thermal, Rs. 7,000 per KW for nuclear power, Rs. 7,000 per KW for hydel, Rs. 6,000 KW for T&D* at 1979/80 prices. A substantial part of the addition to capacity would come from coal based thermal power plants and would require matching investment in collieries and railways for mining and transport of coal respectively.

2.27 The optimal level forecast (OLF) is based on more conservative growth rates, but would require major policy decisions which would seek to build a less energy/power intensive economy. It has been assumed by the Working Group on Energy Policy that such decisions will be taken in the near future, but their impact would be largely felt beyond 1985 and that declining energy intensity rates would become perceptible only then. In the OLF scenario, the additions to capacity for the next 2 decades are respectively 36,000 MW and 50,000 MW at 1979/80 prices, the investment required would be Rs. 50,400 Crores and Rs. 70,000 Crores respectively.

2.28 In either case, the amounts required to be invested are truly massive and would account for a very substantial proportion of the State's budgetary resources unless the internal resource generation of the utilities rises substantially.

2.29 As stated earlier, the methodology for long term forecasts needs to be refined and the figures periodically updated and for this an institutionalised mechanism is necessary. It is recommended that a Committee on Perspective Power Planning, headed by a suitably senior official or a Member of the Planning Commission with representatives of the Ministries of Energy, Petroleum, Coal, Railways, Atomic Energy, Agriculture, Industry and Finance be set up to carry out such an exercise once in 3 years. The Committee should co-opt experts in the field of power and energy planning from academic institutions and industry.

Medium Term Demand Forecasting

National

2.30 For the annual, 5 and 10 year national demand forecast required for immediate decisions on new investments in capacity a Standing Committee on Power Demand should be set up under the Chairmanship of the Chairman, C.E.A. with the 5 Chairmen of the proposed Regional Electricity Authorities, 5 Chairmen of State Electricity Boards to be nominated by the Central Government and Advisers for Energy, Financial Resources and Perspective Planning in the Planning Commission as Members. The Member (Planning) C.E.A. should be the Member-Secretary of this Committee.

Working within the broad framework of the perspective plans this Committee should prepare a national demand forecast both for energy and peak demand, based on the capacity that can be created consistent with the availability of financial resources both in the Centre and States and optimising the energy mix.

State-wise demand forecasts

2.31 This group should then, after discussion with the concerned officials of the State Government and the Chairmen of the SEB's and using the methodology currently adopted by the annual power surveys, recommend the demand growth (both for peak load and energy) that is feasible for each State to meet within the overall totals annually and for the next 5 and 10 years. These recommendations should take into account all relevant factors such as the State's own additions to capacity, its share of Central power, historical growth rates, and such larger socio-economic objectives as reducing regional imbalances. They should also take note of the actual physical progress being made in the execution of generation and transmission projects. These allocations should be considered by the full Planning Commission and after such modifications as are made by the Commission should be endorsed by the Cabinet and placed before the National Development Council for approval.

This exercise which would be done annually would continuously look 5 and 10 years ahead and modify the forecasts in the light of the actual progress made in creating new capacity and changing patterns of development of demand. With the setting up of this Committee the Annual Power Surveys would no longer be required.

Load growth planning

2.32 The above procedure implies that the present approach by the States of doing demand forecasting on the implicit assumption that there are no constraints on the availability of power and that somehow capacity will be created to meet this demand will have to be given up. With the procedure outlined above it will be up to each State to sanction new connection and plan its load growth leaving a cushion to take care of unforseable events such as drought leading to increased agricultural demands, delays in commissioning new capacity, excessive breakdown of plants etc.

2.33 The Committee is firmly of the view that there has to be an awareness created among the States and the public at large that electric power supplies like financial resources are not limitless. They can theoretically be made so if the utility industry as well as all the infrastructure facilities

*Exclusive of RB

which support it such as coal mines, railways etc. are totally self financing. However, to achieve this will require an order of increase in power tariffs, coal prices and freight rates which the Committee regards as impractical and could be detrimental to the economy. This is so even if it were assumed that utilities operated at optimal levels of efficiency.

2.34 As long as the growth of the power industry is dependent on budgetary support i.e. taxes and revenues of the Central and State Governments, the availability of power will be constrained by the resources that can be allocated to it and the power demand 'suit' will have to be cut according to the cloth. The Committee feels that giving States a limit of energy and peak demand growth beyond which they cannot go will force them to look much harder at less power intensive patterns of economic growth, pay much greater attention to conservation, to better utilisation of existing capacity and to reduction of transmission and distribution losses.

Load Planning Cells

2.35 In order to prepare such an optional consumption plan the data base of the SEBs will need to be considerably strengthened. It is recommended that full fledged load planning cells be established by every SEB reporting to the Chairman and staffed with engineers, economists and statisticians so that there is a quantitative frame work within which to take decision about the pattern of load growth. Similarly to help and guide the proposed Regional Electricity Authorities, reference to which will be made later and the CEA, closer links will need to be forged between the SEBs and the planning divisions of the REA and CEA so that medium and long term regional load development profiles can be developed.

Growth of connected load

2.36 In forecasting the structure of demand an analysis of the pattern of growth of connected load would also become relevant. Table 2.12 gives the sectorwise increase in connected load since 1950.

TABLE 2.12

Growth in Connected Load (in MW) for different categories of consumption

Year	Domestic	Commercial	Industrial	Agriculture	Others	Total
Dec. 1950	734	401	1,562	118	20	2,833
55-56	1,226	366	2,455	243	33	4,323
60-61	2,234	526	4,562	827	76	8,225
65-66	3,688	1,025	6,749	2,037	105	13,603
70-71	5,986	1,911	11,631	6,225	477	25,230
71-72	6,672	2,050	12,008	7,246	1,442	29,418
72-73	7,214	2,399	12,954	8,386	1,302	32,255
73-74	7,927	2,566	15,076	9,494	546	35,609
74-75	8,448	2,742	16,619	10,423	1,053	39,285
75-76	8,932	3,398	19,319	11,153	770	425,72
76-77	9,558	3,797	19,805	12,053	658	45,871
77-78	10,123	3,712	19,879	12,913	2,206	48,833

Source.—C.E.A.

Changes in consumption Patterns

2.37 Changes in the consumption pattern of electricity in various States during the period 1950—1978 are shown in Table 2.13.

TABLE 2.13

State-wise analysis of Changes in the Pattern of Consumption of Electricity in the period 1950—1978

(% of total consumption)

Sl. No.	State U.T.	INDUSTRY			AGRICULTURE			DOMESTIC			COMMERCIAL		
		1951	1963-64	1977-78	1951	1963-64	1977-78	1951	1963-64	1977-78	1951	1963-64	1977-78
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Andhra Pradesh	45·12	61·60	53·93	5·00	12·39	21·59	21·33	7·89	9·65	19·0	13·11	11·57
2	Assam . .	13·80	47·25	71·38	—	—	0·64	37·18	29·47	9·39	36·82	16·13	3·55
3	Bihar . .	74·07	79·82	73·54	3·88	1·27	7·10	12·50	3·98	4·00	5·11	2·98	3·06
4	Gujarat . .	81·00	81·00	64·53	0·40	2·78	16·78	9·38	7·72	8·55	3·74	3·46	4·19
5	Jammu & Kashmir.	36·40	39·15	29·62	2·44	1·89	8·46	44·13	47·59	22·00	4·67	3·16	7·13
6	Karnataka .	76·08	77·97	72·34	1·81	3·44	8·57	8·33	8·96	10·77	2·27	1·95	2·35

1	2	3	4	5	6	7	8	9	10	11	12	13	14
7	Kerala . .	83·67	83·39	76·24	3·66	2·33	3·41	8·16	10·98	11·25	1·60	0·81	5·98
8	Madhya Pradesh	39·75	78·77	77·32	0·32	0·90	6·21	25·55	8·54	5·99	12·86	4·96	4·5
9	Maharashtra .	62·08	71·47	61·20	0·21	0·68	8·98	8·22	9·34	11·09	6·55	6·71	7·18
10	Orissa . .	21·79	90·09	86·06	..	0·45	0·98	44·02	5·10	3·67	27·47	2·40	2·99
11	Punjab . .	54·73	86·75	51·91	0·48	5·02	31·78	24·28	4·04	9·66	11·70	3·38	5·49
12	Rajasthan .	29·94	29·88	58·95	3·51	6·22	19·77	22·85	19·86	6·98	12·30	18·42	5·23
13	Tamil Nadu .	59·34	57·10	54·47	12·74	23·42	25·22	10·86	8·59	8·48	10·01	7·68	8·05
14	Uttar Pradesh .	50·44	69·88	50·95	21·45	9·51	30·37	10·83	9.07	10·17	8·83	4·97	1·23
15	West Bengal .	70·78	75·42	66·03	..	0·04	1·13	17·49	13·12	11·63	3·63	3·95	9·75
16	Delhi . .	27·13	37·96	28·55	4·80	1·87	0·29	20·30	28·75	30·84	27·63	15·11	30·22
	All India .	63·70	73·50	61·56	4·30	5·40	14·60	12·40	9·70	9·85	6·90	5·5	6·39

Source.—General Review, Public Electricity Supply, All India Statistics published by C.E.A.
The analysis pertain to energy supplied by utilities only.

2.38 This table brings out some interesting inter-state comparisons, the rapid growth of the agricultural demand for power in States like Punjab, Rajasthan, Andhra Pradesh and Gujarat contrasted with the low level of consumption and poor rate of progress in States with high ground water potential like Bihar, Orissa and West Bengal, the sharp increase in the share of the industrial load in relatively non-industrialised States like Madhya Pradesh and Orissa as a result of the establishment of power intensive industries like aluminium and steel and the relatively static and even declining share of the industrial load in fast industrialising States like Gujarat, Maharashtra and Karnataka.

2.39 The Committee has drawn attention earlier in this Chapter to the need for States to regulate the growth in demand for power according to the availability and the pressures this will put on the State to see that they get the maximum socio-economic benefits from the available power. The table brings out the inhibiting effect of power intensive industries on the growth of other industrial and non-industrial loads and the importance of taking such loads into account in developing the long term power usage strategy. The table also shows how rapidly agricultural loads begin to grow when pumpset energisation programmes begin to take-off.

Sectoral demand forecasting

Agriculture

2.40 Table 2.13 provides a clear indication of the growing importance of the agricultural sector in the total connected load in the coming years. Figures for the years 1978-79 and 1979-80 are still being compiled on the basis of the reports received from individual SEBs. However, the fact that 6.4 lakh pumpsets have been energised during this 2 year period would indicate an addition of about 2500 MW of connected load on account of irrigation alone. On the other hand, reports indicate that the addition to connected load for the industrial sector has been relatively much lower. Keeping in view the number of pumpsets targetted to be energised by 1984-85, the connected load in the agricultural sector will account for nearly 24,000 MW of the total connected load at that time.

2.41 It would follow, therefore, that there is a specific need for a demand forecasting methodology to take into account the gradual but marked changes in the pattern of connected loads in the country. While the actual demand materialising during a particular period of time from the connected load of industrial, domestic and commercial categories of consumption can be predicted fairly accurately the actual agricultural load tends to vary considerably with the yearly rainfall, changes in cropping pattern and so on. The experience of Haryana and Punjab who have taken up rice farming highlights the impact of cropping pattern on load growth. The greater the connected agricultural load therefore, the greater would be the fluctuations in the total demand for power between different years on account of unpredictable factors. One conclusion that would emerge from the above, is that a special additional weightage for agricultural demand may have to be given in the forecasting exercise to allow for these fluctuations.

Industry

2.42 Even if the data base for producing a plan for optimal location of industrial units could be created, in a mixed economy, where the entrepreneur has (except in the case of very large units) the freedom to choose where he will invest, it is not possible to prepare a location specific plan for the industrial sector. The pattern and growth of future consumption of power for industries will thus have to depend on the industrial development strategy each State chooses for itself with only one fixed parameter namely that the maximum energy and peak demand should be within the limits fixed for the State. Thus some States may choose patterns of growth where the employment or value added per unit of power is higher than others. Others who find the peak demand limit restrictive but have energy to spare may find it desirable to go in more for power staggering or go in for continuous process industries. In all cases there will be a strong incentive for the State Governments to adopt such welcome steps as intensification of conservation measures, adoption of differential tariffs—to promote off peak consumption, etc. because the States will realise that their growth rates will depend on making the optimal use of the available power.

Domestic and Commercial Loads

2.43 There is little that can be done about demand management of domestic loads except to make sure that, leaving out the very poor like slum dwellers and harijan busties and the poorer rural communities, consumers bear the cost of what is generally peak load power. With respect to commercial loads, air conditioning of offices is beginning to make a significant impact on power demands especially during the day when industrial loads are also high. In cities like Delhi for instance it contributes 35-40 MW to the peak load of 500 MW in the summer when other demands like the agricultural load are high. Increasingly commercial offices and hotels are being designed to become almost uninhabitable without air conditioning. The advisability of continuing along this path requires to be seriously questioned and the Committee would recommend that an expert group of architects, civil engineers and town planners should be appointed to look into the energy demands of hotels and commercial offices with special reference to the problems of reducing airconditioning loads and/or making greater use of solar energy powered systems.

DEMAND MANAGEMENT AND CONSERVATION

2.44 The Committee has referred earlier to the importance of demand management and conservation in increasing the output per unit of installed capacity. There is, in the Committee's view, considerable scope both for demand management without resorting to peak hour cuts and for reducing consumption of energy. The consumerwise potential for demand management and conservation and steps that can be taken for realising it are briefly outlined below. In general they call for a mix of fiscal and financial incentives and disincentives and some administrative measures.

Industry

2.45 In demand management the opportunities lie firstly in staggering holidays and working hours which despite their obvious benefits has not been introduced in all major load centres. In addition, in many continuous and semi-continuous industries, it is possible to reduce load during peak hours if there are sufficient incentives to do so. A combination of high tariff rates and time differentiating meters which measure peak hour consumption—a subject which has been dealt with in the Chapter on 'Operation and Maintenance' would certainly help to flatten the load curve. Again, large and power intensive industries usually shut down once a year for annual maintenance. By scheduling these shut downs when there are seasonal peaks in the region these peaks can be trimmed without loss of production. This can be done either by incentives or administrative measures.

2.46 In the area of conservation in industry which consumes over 60% of all the power generated, the scope is very large indeed and range from simple measures such as stopping leaks, switching off lights and fans when not wanted, to the installation of more efficient motors, transformers, lighting systems and capacitors for improving the power factor. Steps which could result in large savings could come typically from improvements in technology, taking advantage of the economics of scale, the adoption of total energy systems in plants so that process steam can first be used to generate power and switching from power for heating to using waste heat or coal. Rough calculations based on data available of power consumption in conservation-conscious countries indicate that industry could readily save atleast 20% of the power it would normally consume without loss of output. In industries like steel, cement, aluminium and non-ferous metals the scope for conservation is even greater.

2.47 To induce industry to adopt such measures the most potent incentive would be to raise power tariffs to levels which make attention to and investment in power conservation worthwhile. That such tariffs will become necessary in any case has been dealt with in the Chapter on 'Finance, Financial Management and Tariffs' but in addition further penal levies could be thought of for industries which exceed laid down norms of consumption and fiscal incentives offered to those who improved on them.

Transportation

2.48 Power in transportation is almost exclusively used for electrical traction mainly on the Railways and to a very small extent on tramways. The scope for demand management is limited. The potential for conservation in the technical field lies essentially in improving designs of traction motors. The scope for conservation of traction power will lie in reducing the growing load of industrial commodities on the railways by adopting location policies which optimise the trade-off between proximity to raw materials and proximity to markets. Freight rates which reflect true economic costs of haulage would be a precondition for such location optimisation studies. From this point of view telescopic freight rates work against energy saving.

Agriculture

2.49 Although agriculture consume today only 15% of the electrical energy produced, power forms a critical input into this sector, which together with industry, sets the pace of the growth of the economy. The proportion of power it accounts for varies widely from State to State increasing to 40% in States like Punjab and Haryana. Demand management is possible in agriculture by ensuring that it does not clash with peak domestic consumption and rostering of power to pumpsets is already practised i many States. In States like Punjab farmers are prepared to use power even at night. Such subsidies as are given to the agricultural sector should aim at shifting consumption to off-take hours.

2.50 There is considerable scope for conservation in the agricultural sector. Firstly, more than industry, the electrical efficiency of pumpsets is generally low in many cases below 30% against a norm of 70%. This is partly because, to save initial costs, farmers are persuaded to buy poorly designed pumpsets and partly because the pump is often too large for the duty it performs. It is essential that minimum standards for the efficiency of pumpsets be laid down by ISI and that lending institutions ensure that loans are given only to farmers buying sets built to meet these standards. Advice on the specification of the set the farmer should buy should come from lending agencies like the Banks or from the Rural Electrification Wing of the SEBs or from organisations like the R.E.C.

2.51 A second major step towards conservation is doing away with flat-rate tariffs based on the horsepower of the pumpset which gives no incentive at all to the farmer to conserve power. This has been discussed in the Chapter on 'Finance, Financial Management and Tariffs'.

Domestic and Commercial

2.52 The consumption of power by the domestic sector is today not very lyarge but should grow if village electrification is given the priority recommended by the Committee in the Chapter on 'Rural Electrification'. There is virtually no scope for demand management because the main demand is for lighting.

2.53 The scope for conservation is considerable and fixing tariffs which reflect the true cost of consuming peak power would automatically bring in the incentive not to waste it. Domestic appliances like fans and refrigerators, could be made more efficient and subject to meeting minimum standards of efficiency before they can be sold. Some of the measures that can be taken to conserve power in commercial offices have been referred to in para 2.43.

Institutional arrangements

2.54 For load management the burden obviously rests with the power distributing agencies namely the SEBs and their proposed load planning cells and their strengthened tariff formulation groups. The SEBs should themselves formulate a mix of incentives and administrative measures on the lines indicated earlier. Guidance and exchange of experience could come from the REA and the CEA. The diversity of the demand patterns of different SEBs within a region can be utilised by making better use of the regional grid to flatten the load curve of the region both diurnally and seasonally, and thus improve the utilisation of base load capacity of the system.

2.55 For conservation it is recommended that each State Government sets up a Conservation Committee headed by the Minister in charge of Power in each State and composed of the concerned officials from the Government and representatives of each major consumer group. Specific time bound targets would need to be settled and progress towards achieving them monitored by the Committee. Additionally the various Development Councils for the major industries should set up task forces to quantify the potential for power conservation and recommend a strategy as well as specific measures for power conservation. The total national conservation effort should be overseen by the Power Ministers at their annual conference. The Secretariat work for this should be done by the Member (R&D) in the CEA.

2.56 There is general agreement that if the top management of companies and the rural development sector were to give conservation of power and indeed energy is general, the attention it deserves, especially if this were made financially worthwhile by a hike in power tariffs, progress on this front could be very rapid.

2.57 Depending upon the progress being made in implementing demand management and conservation measures, demand forecasts should be suitably modified.

GENERATION CAPACITY PLANNING

ISSUES AND CONSTRAINTS

2.58 Despite the weaknesses that exist in the methodology of demand forecasting referred to earlier and also of capacity planning which this part of the Chapter deals with, the Committee would like to emphasise the fact that this has little to do with the current shortage of power. As has been explained in the Chapter on 'Operation and Maintenance' a return to reasonable levels of efficiency in capacity utilisation would remove, even today, much of the energy shortage and drastically reduce peak load restrictions. A modest reduction in the enormous delays in constructing and commissioning power projects would have totally eliminated shortages assuming of course that coal and transport did not impose constraints.

2.59 There are, however, some weaknesses in the way in which capacity planning is done today. Had demand built up to the expected levels these limitations would have been exposed. That it did not is largely because energy consuming projects or programmes in other sectors also did not come up on schedule. Some of the issues that arise in capacity planning are—

1. How should the hydel, thermal, nuclear generation mix and transmission net work be planned and what implications does this have on ownership and control of generation and transmission capacity?
2. How long should power projects of different kinds take to come on stream *i.e.* their gestation period?
3. What should be the assumptions regarding peaking and energy output from the

installed capacity in order to meet demands on a reliable and sustained basis?

4. How much capacity should be derated or written off annually?
5. What should be the policy on captive generation?
6. How should new capacity be financed?
7. What should be the policy regarding private sector utilities?

These issues have been discussed in the following pages although not in the order listed above.

The Generation mix

2.60 In the past, investigation and identification of projects for adding new generating capacity have been examined individually and not in relation to the comparative cost benefit of other projects or keeping in view the advantages of operating an integrated system with specific demand characteristics. Instead of evolving a generation pattern which is in conformity with the demand pattern, over the past two decades or so a demand pattern has been created by imposing various restrictions to match the generation pattern.

2.61 India has in varying degrees hydel potential in all its regions. Properly designed hydel plants provide the cheapest source of peaking power both on a daily and seasonal basis. While it is recognised that an ideal hydro and thermal power mix in every region is not feasible it is necessary to plan the power development of regions keeping such an ideal in view and making the optimal use of all available sources of power. The objective should be to meet the demands arising out of the integrated operation of the regional and national systems with their distribution load curves so that the project costs calculated as present net worth are maximised.

Drawbacks of the present system of planning

2.62 The capacity planning process as it is today, suffers from three major limitations. Firstly, it has only a 5 year time horizon. Secondly, planning for new capacity is done on a State-wise basis when, even the region, as will be seen later, has problems in optimising the hydel-thermal mix. Thirdly, there has been no shelf of projects to choose from and projects get approved more or less on a 'first come, first served' basis. To some extent, the distortions that all this has led to is sought to be partially corrected in the last 5 years by Central investment in large thermal and hydel projects.

The present generation mix

2.63 Because of the lack of such a long-term perspective in the planning process, both in terms of identification of projects and in provision of funds, no overall optimised approach for a region could have been taken in the past. Historically, during the early plan periods, power development in the different regions has taken place keeping in view the basic objective of developing hydel projects and filling in gaps by thermal capacity. Hydro development however lagged behind in the Fourth and Fifth Plans particularly due to slackness in investment and slippages in implementation. Therefore, augmentation of thermal capacity was considered necessary to produce power in a shorter time frame. Despite this somewhat *ad hoc* approach to regional planning, the hydro-thermal mix in the different regions has developed in a manner which although not optimal meets by and large the system requirements in the Northern and Southern Regions. In the Western region, there is need for additional peaking capacity and in the Eastern Region, the lack of hydro development has been a serious constraint to meeting peak demands as well as for optimal utilisation of the thermal capacity. The present hydro-thermal mix in the different regions is given below:

TABLE 2.14

Hydro-Thermal/Nuclear mix (March 1979)

Region	Installed generating capacity in MW as in March 79			
	Hydro-	Thermal	Nuclear	Total
Northern .	3,718	3,773	220	7,711
	(48.2)	(48.9)	(2.9)	(100)
Western .	1,770	5,204	420	7,394
	(23.9)	(70.4)	(5.7)	(100)
Southern .	4,303	2,194	..	6,497
	(66.2)	(33.8)		(100)
Eastern .	894	3,859	..	4,753
	(18.8)	(81.2)		(100)
North-Eastern	146	188	..	334
	(43.7)	(56.3)		(100)
TOTAL	10,831	15,218	640	26,689
Utilities	(40.6)	(57.0)	(2.4)	(100)

Note.—Figures in brackets represent % share of each mode in the region.

Source.—Central Electricity Authority.

Planning within a long term perspective

2.64 An optimised programme of generation can be developed only if the long-term perspective is kept in view so that different types of projects with varying gestation periods can be incorporated into the plan in a way which best meets the demand forecasts and also is capable of being adequately funded. Some long term assumptions regarding resource availability are, therefore, essential however tentative they may be. This will require a system for investigation of alternative locations, collection of cost data, assumptions and projections in respect of the operational efficiency of the system, identification of demand centres and planning of a comprehensive transmission net work. All these prerequisites to the formulation of an optimised capacity plan, demand sophisticated techniques involving computer studies and it will be necessary for such studies to be taken up at the regional and national level. It will also require a much closer inter-action among the various agencies involved in the power development programme, namely, the State Electricity Boards, the Regional Electricity bodies and the Central Electricity Authority and also with the representatives of the various consumer groups.

Limitations of State Boundaries

2.65 The implementation of a long term perspective power plan implicitly requires state boundaries to be ignored. Initially, an optimal regional plan will need to be produced and ultimately, this regional plan incorporated into a national plan. That there is going to be increasing incompatibility between the needs and physical and financial resources of a state and the optimised regional and national plans is already becoming manifest. Even a quick examination of the physical energy resources of the various States shows how uneven they are.

Regional distribution of physical resources for power generation

2.66 The Eastern Region has nearly 73 percent of the total coal reserves available in the country while the Western Region has 19.5 percent, the Southern Region only 7.5 percent and the Northern Region nil. Similarly nearly 37 percent of the hydro electric potential in terms of energy, according to an assessment carried out in 1978 by an expert group of the CEA, lies in the Northern Region and about 27 percent in the North-Eastern Region with Eastern, Western and Southern Regions having 9.5 percent and 17.2 percent of the potential respectively. The regional diversity of the potential power resources is therefore quite obvious. If considered State-wise, the diversity is further accentuated with West Bengal, Bihar and Madhya Pradesh accounting for a predominent share of the coal reserves and Uttar Pradesh, Himachal Pradesh and the small North-Eastern States accounting predominantly for the hydel potential. In terms of conventional power resources some States such as Tamil Nadu, Gujarat, Rajasthan and Karnataka appear to be unfavourably placed although they have the financial resources to invest in power. The extent to which the hydel potential in each region has been exploited till 1978-79 varies a great deal as the Table below shows :

TABLE 2·15

Exploitation of hydel potential (TWH) till 1978-79

State	Potential	Exploited	Proportion of potential exploited
Northern . . .	147·3	13·4	9·1
North Eastern . .	105·5	0·4	0·4
Eastern . . .	37·6	3·0	8·0
Southern . . .	68·2	16·1	23·6
Western . . .	37·7	6·6	17·5
All India . . .	396·3	39·4	9·9

Source.—Working Group on Energy Policy (1979

This highlights the fact that nationally only 10% of the hydel potential has been exploited.

Implication of regional diversities

2.67 Given such a wide variation of power potential as between different States, how best to exploit the resources within the total availability of investible funds, regardless of their source, becomes the first question before the power planners. Ideally, power planning under the circumstances should be carried out on all India basis. This would pre-suppose the integrated operation of the regional grids as one composite national grid. However, as is well known integration of the State system within a regional grid is yet to be achieved, let alone integration of the State and regional systems within a national grid. Inter-State and inter-regional transmission linkages and communication and telemetering facilities required for the effective working of any scheme of national control of exchange between power systems are still totally inadequate. Therefore, the Committee feels, as a practical and realistic approach power, planning should, for the immediate future, to have the primary objective of optimising generation and operations on a regional basis, keeping the creation of a fully integrated national power grid as the immediate next step. This of course does not preclude '*ad hoc*' transfer of power from one region to another as is happening even today.

Regional Thermal and Hydel Stations

2.68 There are several advantages in the regional approach to power planning as against the present system with its emphasis on state boundaries and resources. Studies undertaken so far have shown clearly that, on the basis of the known technologies of transportation of coal and transmission of power, it would be generally more economical to generate power at the coal pit head and transmit it to a load centre rather than transport coal from the coal mines to the load centres. Secondly the economies of scale that a large sized power station offer could more easily be accommodated in a larger, interconnected regional system without creating the technical and operational problems that are associated with it in a smaller State system. Similarly hydro electric resources in the easily accessible areas have already been programmed for development by the States. The large resources in the Himalayas and the North-Eastern Regions offer excellent scope for hydro projects but the infrastructure development in these regions as well as the large investment requirements pose resource and implementation problems which call for alternative arrangements such as central assistance and initiatives and the cooperation neighbouring countries.

Regional grid

2.69 If the maximum benefits from regional planning of power projects are to be derived, it is necessary not only to plan but to operate the grids on an integrated basis. The benefits of regional integrated operations are well established. It is possible by such integration to bank energy within a region and by taking advantage of the diversity in the loads in the different

States in a region, improve the capacity utilisation of the system as a whole and thus reduce to a significant extent the additional capacity that would need to be created. A number of other advantages accruing from regional integration are improvement in the overall reliability of power supply in the region and an opportunity to utilise the system capacity available in one part of the region to overcome the effect of slippages in the schedules of new plants in another part of the region. Maintenance schedules can also be timed to ensure that the maximum capacity is on line during peak seasons. Merit order utilisation of thermal station would ensure that the cost of generation is minimised.

Integrated operations and power shortages

2.70 While regional systems have nominally been in existence since the 4th Plan and a degree of integrated operations is taking place in different regions, there is a great deal of room for improvement. Integrating a regional grid becomes much more difficult when there are power shortages in each of the constituent States. It can however be shown that even under these conditions integrated operations of the region can benefit each of the constitutent States. This is because there are brief periods of the day and the year when there are surpluses in almost all States and it is possible often to bank this power so that overall plant utilisation in the region increases.

Inter State Tariffs

2.71 Apart from shortage of power, some of the other difficulties which come in the way of integrated operation is lack of adequate commercial arrangements for exchange of power and maintenance of uniform standards in respect of quality of power as measured by the variations in frequency and voltage conditions in the different sub-systems. Agreements on tariffs for exchange of power during peak hours and emergencies, for spinning reserve assistance or for wheeling to State sub-systems and a coordinated control of generating and transmission systems which would maintain voltages and frequencies uniform, would remove a major bottleneck in the way of integrated operation. Some regions have already arrived at some understanding but they involve sometimes such dubious devices as exchanging power in return for scarce inputs on a bilateral basis. It is clear that the Regional Electricity Boards constituted as they are today do not have the powers to operate the region as an integrated system and as a result there is often wastage of power at a time of power shortages.

Institutional obstacles to integrated regional planning and operation of power systems

2.72 The mechanics of such optimised integrated regional planning and operations of power systems require different demand components of the load curve to be assigned to different plants depending upon the system requirements, the characteristics of the plant, the cost of generation from each plant and the structure and capacities of the distribution system. Difficult technical problems are encountered in planning and operating modern power systems in an optimal manner and these become more complex in a multiple ownership pattern because there has to be single body in the region which makes all these decisions and can over ride the views of individual States who naturally take a more parochial stand.

The role of Central Generation and Transmission

2.73 The Committee is therefore of the view that for the regions to be able to plan their future development in an integrated and optimal way, the present pattern of ownership of generating stations and the mode of operating the high tension transmission systems which control the operation of generating stations and inter state power flows cannot continue and the Central Government will need to play a more dominant role.

The Committee considered a number of options towards this end. These were—

1. All power generation including T&D and rural electrification (RE) to be under the control of the Centre.
2. All power generation and high tension transmission (EHV) system to be under the Central Government leaving distribution and RE to the States.
3. All new generation and existing and new EHV systems needed to optimise inter-state power flows to be taken over by the Central Government leaving existing generation and distribution and RE to the States.
4. The bulk of the new generation and all EHV transmission required for controlling inter-state power plans to be under the Central Government leaving the States to implement projects which fit in with the regional optimal plan provided they have the financial resources.
5. A continuation of the *status-quo* with the centre gradually acquiring through its large hydel and super thermal projects increasing control over regional operation.

2.74 While, purely technically, option (1) would be the best solution, a massive acquisition of the assets and liabilities of the SEBs from the State Governments would be fraught with major practical and political problems. Over-centralised control especially in areas like distribution where there has to be a close operating nexus between the consumer and the State authorities would also be a major handicap. There would also be numerous problems of valuation of assets, payment of compensation, non-uniform terms and conditions of the SEB employees of different States and so on.

2.75 Option (2) was also ruled out on some of the same considerations although it is less unmanageable than (1). Option (5) was ruled ou on the grounds that the *status-quo* could not solve the growing problem of a mismatch between the endowments and resources of the States and would take too long to give the regional authorities the 'teeth' to operate an integrated grid. This has been discussed in detail later.

2.76 The only two alternatives which the Committee felt were practical in our federal system and thus required serious consideration were (3) and (4). Alternative (3) has the merit of being clear cut and treats all the States on the same basis. Option (4) has however two major advantages in relation to (3) namely that it causes the least disturbance of the existing system and it gives a greater incentive for the SEBs to raise resources for investment in power generation. It would achieve, though a little less rapidly, the objective of giving central generation a commanding role in optimising investment in power generation and transmission and operating a regional and ultimately a national grid. Its only drawback in relation to (3) is that in some States which have both the financial resources and projects which fit into the optimal regional power generation plan the SEBs will continue to execute generation projects whereas other States which have resources but no generation projects will have no projects to execute. To partially overcome this apparent discrimination, the Committee would recommend that such States could be permitted to set up projects in another State either in partnership or on their own, subject to agreements being arrived at which satisfy both States and conform to the guidelines and master plan of the region.

2.77 One of the factors that has influenced the Committee against over-centralisation of power generation is the fact that there is no evidence to suggest that centrally owned power stations operate at higher levels of efficiency than State owned ones and in fact in many cases the converse is true. Several of the Boards run power stations which compare favourably in operational terms with the best in the world. There is, therefore, some advantage in leaving such Boards alone. The implications of the recommendation that the bulk of new generation and all EHV transmission systems required to operate the regional system in an integrated way and control power flows between and through States are spelt out in detail.

RECOMMENDATIONS

2.78 Based on the observations above the Committee recommends that if power planning is to be done in a way which minimises the cost of power to the consumer, it must be done on a regional rather than as, at present, on statewise basis.

2.79 The Committee is of the view that power planning in the immediate future and onwards should be done with the objective of having about 45% of the entire generating capacity in the central sector by the year 2000-01 A.D. as against 12.1% today. This recommendation has been made after taking into consideration the likely magnitude of generation in the central sector necessary to bring about regional optimisation both in the utilisation of resources for power development and for the optimum operation of the regional power systems. One of the major benefits that will accrue as a result of a greater role for central generation is that rapid progress could be made in implementing the recommendation of several earlier Committees that exploitation of hydro resources should be speeded up.

Ownership of EHV transmission lines

2.80 The Committee also taken note of the fact the benefits from more Central projects and optimised regional planning and operation cannot be realised fully unless the high tension (H.T.) transmission system connecting the Central projects to the State systems and transmission links of 220 KV and above together with their sub-stations, which are required to ensure integrated operation of the regional grids are under the ownership and control of the Central Government and would recommend that steps to acquire these H.T. circuits be taken forthwith.

Central Generation—the implications

2.81 The implications of the Centre owning 45% of all power generation by 2000 A.D. are as follows :—According to the estimates by the Working Group on Energy Policy (1979) installed capacity in the country is by the year 2000-2001 A.D. likely to be of the order of 1,38,000 MW, if there is no shift in the intensity of power usage in the economy. The Report of the recent Working Group on Power (1980) set up by the Plannng Commission indicates that by the year 1984-85 the total installed capacity is likely to be 51,000 MW of which generation in the Central sector will be 9700 MW. 45% of all generation being in the central sector would require this figure of 9700 MW to increase to 62,100 MW in the next 15 years. This would imply that about 60% of the additional installed capacity from 1984-85 onwards will have to be in the Central sector. In absolute terms 52,400 MW of a total additional capacity of about 87,000 MW expected to be commissioned during the period 1984-85 to 2000-2001 will need to be owned by the Central requiring it to instal an average of 3275 MW of new capacity every year.

Nuclear Power

2.82 Out of this 52, 400 MW nuclear power should play a small but significant role. Based on current costs nuclear power is more expensive than conventional thermal or hydel plant even taking into account the higher transmission/haulage costs to areas which are far from coal mines or hydel sites. However in developing alternative sources of power generation nuclear power is not an option which India can afford to forego. Although India's uranium resources alone cannot sustain a pressurised heavy water reactor programme of more than 8000 MW the fast breeder technologies using Thorium could, if successful, be capable of producing very large amounts of power.

2.83 The current capacity in operation and under installation is 1600 MW. The Working Group on Energy Policy has recommended that a minimum of 5000 MW of nuclear power capacity should be established by 2000 A.D. The Committee would endorse these recommendations mainly because they give the country a technologically feasible option to go into nuclear power in a big way if no better alternatives are developed by then.

Regional Electricity Generating Corporations

2.84 A plan to instal an average of over 3000 MW a year by the Centre is indeed an ambitious one, taking note of the fact that all the State Electricity Boards and Central Government agencies have together yet to commission more than 2000 MW in any year. Various organisational patterns for doing this have been examined in the Chapter on 'Organisation and Management' and it is recommended that four new Regional Electricity Generating Corporations (REGCs) are set up as centrally owned companies.

Regional Electricity Authorities

2.85 Reference has been made to the need to plan and operate the power system of regions in an integrated manner. In order to do this it is recommended that the Central Government sets up by statute Regional Electricity Authorities as the field agencies of the C.E.A. to carry out this task. These authorities should plan power development in their regions and control the flow of power between States through their ownership of the transmission lines and associated sub-stations. The 'modus operandi' of these Boards has been described in para 2.126.

Funding Central Generation

2.86 The implementation of projects required to add nearly 3000 MW of power per year and their associated EHV transmission lines will require much larger resources to be available to the Central Government than at present. Conversely, since the States will have a smaller role to play in the generation sector, their requirements of funds will correspondingly fall. Acceptance of the Committee's recommendations on the larger role for the Central Government in power generation and EHV transmission will require a reordering of the plan assistance that currently flows from the Central to the States. This is a complex problem which will require to be worked upon by a high level group and it is recommended that such a group be set up by the Planning Commission after the recommendations of the Committee in this regard have received the consideration and approval of the Central Government and than the NDC. The only point in this respect which the Committee would like to make is, that whatever formula is worked out should be such as to encourage States to raise and allocate the maximum possible resources for power and there should be a clear link between a State's efforts in this respect and the power allotted to it by the procedure outlined in para 2.31.

Gestation period of projects

2.87 A critical factor, which determines whether planned capacity would actually materialise within the time-frame adopted, is the lead time assumed for various types of projects. Experience has shown that actual lead times have been much longer than those assumed for Power planning in the past with the result that major slippages have occurred and targets for capacity additions have not been met. The slippage in the achievement of targets for additional capacity in each successive Plan period are shown below :

TABLE 2·16

Shortfalls in capacity creation*

Plan	Capacity to be created in MW		
	Planned	Actual	Shortfalls (percent)
Second	3500	2250	35·7
Third	7040	4715	33·0
Fourth	9260	4527	51·1
Fifth (upto 77-78)	12500	7593	39·3

*Inclusive of non-utilities.

2.88 This factor alone has been probably more to blame for the prevailing power shortages than any other. The current assumption of lead times for different types of power projects, therefore, need to be examined.

2.89 Power planning is presently based on the assumption of a total lead time of about 6 years for thermal stations which includes the entire period from the conception of the project to the date of its commercial operation. Similarly for a hydro project the total lead time assumed is 8-10 years. For nuclear stations this lead time is taken as 8 years.

Causes of time overruns

2.90 Time overruns which have been dealt with in depth in the Chapter on 'Project Formulation and Implementation' have been due to delays both at the preconstruction stage in matters such as 'project formulation' and approval, land acquisition, interstate disputes and at the construction stage due to several factors such as bad project management, scarcity of essential materials like steel and cement labour disputes, delays in supply of equipment, constraints of funds, delays in commissioning of units etc. Recent emphasis on clearance of power schemes from the environmental angle has added a welcome but new dimension to this problem. Changing technology and the trend towards larger unit sizes has also contributed to these delays.

2.91 Keeping in view the past experience and the various constraints that the project implementation authorities face in the power sector, the Committee has considered it necessary to recommend the following changes in respect of the lead times to be assumed for capacity planning. For coal fired thermal stations, it is recommended that not more than 2 years time be assumed for the purpose of pre-approval work such as investigation, designing and techno-economic clearance. The time for actual construction, commissioning and guarantee trials to be satisfactorily completed (i.e. commercial operation) should be 5 years. For nuclear plants of the Narora design, a lead time of 2 years for preparatory work till the clearance stage and 8 years lead time for commercial operation after the investment decision has been taken, is recommended.

2.92 In the case of hydel projects, an overall lead time of 7 to 11 years is recommended since the conditions and terrain in which hydel projects are located vary considerably. The Committee also feels that in the case of hydel projects in particular, there is a need to examine the degree of mechanisation adopted so far and to consider whether increased mechanisation, which would result in the early completion of hydel projects, is not warranted in in the overall national interest. Measures intended to reduce the lead time for power projects have been discussed in the Chapter on 'Project Formulation & Implementation'.

Stabilisation period of new projects

2.93 For thermal projects the current basis of planning is that a unit would 'mature' only during the 4th year of operation and would then generate 5350 KW Hrs/KW i.e. 61% plant capacity. The build of this is 2500 KWH/KW in the first year, 4000 KWH/KW in the second year and 5000 KWH/KW in the third year. This is based on U.K. practice but would appear to apply to sets which are being introduced for the first time. The Committee sees no reason why, for a well established size and make of set, the 'stabilisation' period should be more than 1 year after the full guarantee trials have been satisfactorily completed. After this year thermal plants should be assumed to have 80% availability.

Methodology of Planning to meet the load forecast

2.94 Given the demand forecasts for peak load and energy and having worked out the optimal thermal-hydel mix, the question of how much capacity to instal to meet this demand requires to be discussed. Planning for additions to capacity involves two distinct components, capacity planning and energy planning. While the former refers to the capability of the system to meet the highest demand made on it at any point of time, i.e. the peak demand, the latter refers to the total availability of electrical energy over a given period, for example a year basis. An important assumption that is and should continue to be made in the capacity planning exercise (which is carried out for each region) is that if adequate capacity is provided to meet the annual peak demand there will be sufficient capacity available for meeting the energy requirements of the system.

2.95 In order to arrive at capacity additions for each region for each year, the contribution by the hydel system (if any) should be taken up first. Using design data, the effective capacity should be worked out for each hydel station taking into account irrigation constraints, head conditions etc. and the aggregate capacity for all hydel stations available for the peak period calculated. To provide for possible outages, planned or unforseen, a 12% margin should be provided and in addition a 0.5% auxiliary consumption can be assumed. The remaining 87.5% of the effective capacity can be taken as the peaking capability of the installed hydel system.

2.96 On the thermal side, an individual thermal unit's effective capacity is calculated on the assumption that full capacity benefits for peaking purposes would accrue after one year of operation with practically negligible benefits during the first 3 months following the commissioning of the unit and 50% during the next 9 months. From the total effective capacity so worked out, a peaking capability of 64% should be assumed. This has been calculated on the following basis :

	Percentage reduction	Net capacity available for meeting peak
1. Boiler and capital maintenance .	3·5%	0·965
2. Total Breakdowns (Outages) .	18·5%	0·815
3. Partial breakdowns and auxiliaries.	19·0%	0·81

Net capacity available—0·965 × 0·815 × 0·81 = 0·64

These figures have been derived by the C.E.A. from the analysis of the data obtained from the operational performance of thermal units over the past 5 years, although currently the peaking availability is nearer 50% i.e. 0.50. However, the performance of thermal stations in 1979/80 has been abnormally poor and assumptions that they will not perform to reasonable standards in future must be regarded as unduly pessimistic. It has to be recognised that any downward revision of capacity available for peaking purposes is tantamount to a reduction in the already modest rate of economic growth postulated in the 5-year plans, because increased investments in this highly capital intensive utility which a reduction in peaking capability implies will lead to a cut in the outlay on other sectors.

For the Eastern and North-Eastern Regions, a higher margin of 5% over other regions i.e. an availability of 0.59 should be assumed because historically their performance has been significantly lower and because of the lower proportion of hydel support in the eastern region in relation to other regions for meeting peak demands.

2.97 The implications of this methodology and these assumptions need to be understood. The assumption that 64% of the installed thermal capacity will be available for meeting peak loads means that for every 100 MW of thermal capacity installed only 64 MW of peak load will be met. In the U.K. this figure, for the overall system which is entirely thermal, is 80%. By this one assumption, therefore, in India an excess capacity of 25% over what is needed is being provided. This is inspite of the fact that India's position is somewhat easier than other countries in the sense that it often has a hydel back up which allows repairs to thermal plants to be done off season by providing peaking capacity during the peak months.

Nuclear Power

2.98 It is recommended that for peaking purposes 65 to 75% of the installed nuclear capacity can be treated as being available.

2.99 Having determined the existing peaking capability from the hydel, thermal and nuclear capacities (besides some marginal contributions from gas turbines) the net deficit is obtained by substracting the existing peaking capability from the peak demand estimated. For meeting this deficit, new hydro, thermal and nuclear projects need to be identified and the additions to capacity so planned that for each region the demand and supply can be matched as far as possible through a proper mix of generation.

Energy

2.100 Once capacity to meet the expected peak load has been provided for there should be no shortage of energy. In fact if thermal plant availability, namely the proportion of the time the plant is available for generation were to reach the well established norm of 80-85% there should be surplus energy.

2.101 Based on studies of system load factors and past experience the Committee would recommend that for calculating the expected output of electrical energy, an all India plant load factor of 58% for stabilised thermal stations can be assumed. It is emphasized that this factor has no relevance in capacity planning because it is the peak load which the installed capacity will have to meet. A 58% load factor is equivalent to an annual operating performance of 5100 KWH/KW and is well below the 6000 KWH/KW recommended by several Committees and Power Ministers Conferences and which could be achieved if the system were operated in an optimal way. However, a more realistic view had to be taken considering that the system operated at 46% load factor in 1979/80 and is doing so better so far this year. In the recent past the highest it has touched is 56% in 1976/77 although, of course, individual stations have been operating between 75 to 90% capacity utilisation year after year.

Hydel Stations

2.102 In future all hydel stations should be designed as true peaking stations. Where large storage capacities can be provided such stations should be able to meet both seasonal and diurnal peaks. By providing 24 hour storage (pondage) even run-of-the river projects can meet diurnal peaks. The Committee recommends that all future hydel stations should be based on a 40% plant load factor (instead of 60% as at present) so that their peaking capabilities are fully exploited.

Quality of Supply

2.103 In general for a system in which plant availability is high there is an inverse relationship between the quality and dependability of supply and the plant load factor (PLF) i.e. the extent to which the capacity of the plant is utilised.

This can be seen from the Table 2.17 below.

TABLE 2·17]

Plant load factors in various countries

Country	PLF of thermal stations (1974-75) in %	Country	PLF of thermal stations (1974-75) in %
U. S. A. .	44	Germany .	59
U. S. S. R. .	62	Hungary .	60
Canada .	35	Poland .	57
France .	37	Israel] .	53
U. K. . .	37	Japan . .	53

In most of these countries, there is virtually no power demand staggering and plant availability is over 80%. The PLF is low because in order to meet sharp peaks in demand diurnally, weekly and seasonally or to take care of unexpected and major breakdowns, considerable reserve capacity has to be provided which though available would be unutilised due primarilly to lack of load for most of the time. The reason for low plant load factors in India however, is not due to lack of demand but low plant availability as a result of which demands could not be met.

Derating of capacities

2.104 Besides availability, derating of installed capacity has also a considerable bearing on the capacity additions planned. The Electricity (Supply) Act, 1948 as amended in March, 1978, specifies the life of various assets. This is 35 years in the case of hydro-electric plants and 25 years in the case of thermal plants. In actual practice, however, there have been serious distortions. While some of the comparatively new units have failed to take loads according to their rated capacities, some of the old units have continued to be in service much beyond their expected life, although at capacities much below their rated values. This has raised the question of assumptions to be made regarding derating and retirements in capacity planning in a long-term perspective. In the absence of any definite guidelines or norms, the Working Group on Power which was set up by the Planning Commission in 1978, provided an allowance of 0.5% per year to cover derating and retirement on an ad-hoc basis. The subject of derating of capacities has been dealt with at length in the Chapter on 'Operation and Maintenance'. It is recommended there that the C.E.A. sets up a Committee to examine the whole policy of derating and make suitable recommendations. Till then the current figure 0.5% of the installed capacity to be derated per annum should be used for planning purposes.

Probability techniques for capacity determination

2.105 The method of computing capacity available for meeting peaking loads explained in para 2.95 to 2.99 is a rough and ready method based on averaging past performance. This is probably adequate for the time being, especially as shortages of power are likely to persist for another 4 or 5 years, unless there is a dramatic improvement in operation of thermal plants and inter-state grids. There are, however, techniques based on probability analyses which help to provide a more scientific basis for working out the capacity needed to meet a certain load at a given level of reliability or conversely to estimate how frequently the system will not be able to meet the load. It is understood that the CEA has acquired the software for doing such an analysis called the Wien Automatic System Planning (WASP). The Committee would recommend that it be adapted to suit Indian conditions to enable capacity additions to be determined more scientifically.

Captive Generation

2.106 In the context of planning for additions to capacity, the Committee has considered the present policy on captive generation, as well as the problems faced by major industries in getting reliable supply from the grids and is of the view that future policy may be based on the following lines.

Total Energy Power Systems

2.107 The Committee would recommend that as at present, other than small emergency standby diesel sets, captive power units should not normally be allowed to be installed by any industry. However, captive plants based on the total energy concept leading to an overall improvement in the efficiency of energy utilisation, should not only be permitted but actively promoted. It is recognised that there may be technological or economic constraints in setting up such captive plants in all industries. Where, however, such possibilities exist, incentives such as the grant of soft loans, waiver of electricity duty and generation taxes etc., may have to be considered. Typical examples of industries where captive power plants can be encouraged are the new gas based fertilizer plants where the steam required for pressure is generated at high pressures and run through steam turbines before going into the low pressure process steam circuit. Similar systems can be used for sugar, paper and other process chemical industries.

Power Sensitive Units

2.108 These are units such as steel plants and artificial fibre units where a short stoppage of power can do immense damage to the plants or to the product. Here again captive power stations can if necessary, be allowed on a selective basis.

Large scale consumers

2.109 Large aluminimum units belong to a very small list of industries where the size of the power plant required i.e. 200-300 MW makes it an economic unit in its own right. Here also, therefore, captive units, if satisfactorily located from the point of view of coal transportation, may be encouraged. On the other hand the use of hydel power from storage dams should definitely as a rule not be allowed in future for meeting base loads such as aluminium plants and should be reserved where possible for meeting peak loads.

Collieries

2.110 The problem of disposal of fines, middlings and rejects from coal washeries is a serious one as it represents wastage of scarce fossil fuel resources apart from creating waste disposal problems for the washeries. It is recommended that these rejects should be allowed to be used for generating captive power for the washeries and adjacent coal mines so that their precarious dependence on the grid is minimised.

In the Committee's view there is no economic case for allowing captive power generation outside these four special groups.

Private Sector Utilities

2.111 The question of whether or not to change the present policy of restricting the growth of the power utility industry to the public sector except where Government decides that it is in the public interest to allow private utilities to put up new generating capacity, has been the subject of much debate. The main argument for allowing or encouraging the private sector to enter or expand in the utility industry is its demonstrably higher efficiency as compared to the average publicly owned utility today. However, even the proponents of the case agree that there are several generating units run by State Electricity Boards which perform at efficiency levels which compare favourably with private sector units. It is, therefore, not the case that utilities cannot or have not operated efficiently because they are publicly owned. The causes of the problem thus lie elsewhere.

2.112 It must be recognised that regardless of what policy changes are made now, for the next decade or more, the performance of the economy will depend upon the efficient operation of the public sector utilities. The addition of a few private sector units, however, efficient they may be, is not going to solve the problem. Both in the long term and the short term, there is, therefore, no alternative to taking steps to improve the performance of the public sector utilities. There is also a question of public policy. Power unlike other inputs has a far reaching effect on socio-economic activity. Shortfall cannot be made up by, say, imports. It is conceivable that for a variety of reasons, for example because the viability of a project under construction in the private sector falls below acceptable limits for the share holders, it could be abondoned although its completion is essential for the rest of the economy of the State or the region. There is no way Government can compel a private sector unit to complete the project and taking it over midstream bristles with problems.

2.113 The Committee is, therefore, of the view that there is no compelling case of changing the policy in regard to private sector utilities. Government should as at present, consider proposals for expansion/construction of new private sector utilities on a case by case basis.

TRANSMISSION AND DISTRIBUTION (T & D)

Lack of integration

2.114 One of the weakest and most neglected and yet one of the most crucial areas of the power sector is the planning, implementation and operation of an efficient T&D network. While much is talked about the low performance of thermal sets little public attention is focussed on the appalling state of our T&D system. The two major areas of weakness are, firstly, a lack of proper integration of the T&D system with the generation plan as a result of which in many cases generation capacity created cannot be fully utilised. Additions to the T&D system seem to be made on an 'ad hoc' basis without any attempt to work towards a long term T&D system which has been designed to meet the projected needs at minimum cost—an exercise involving computer modelling.

Insufficient investment

2.115 The second major shortcoming of the T&D system is the inadequate investment in T&D as compared to generation. A rough thumb rule for investment in T&D is that the ratio of expenditure on generation, transmission, distribution and Rural Electrification should be 4:2:1:1 *i.e.* equally between Generation on the one hand and Transmission and Distribution, on the other. The actual investment on T&D falls far short of this as can be seen from Table 2.18.

TABLE 2·18

Comparative investment in Generation, Transmission and Distribution and Rural Electrification

Plan	Period	Additions to installed capacity (MW)	Investment in Rs. Crores: Generation	Investment in Rs. Crores: Transmission & distribution	Investment in Rs. Crores: Rural Electrification	Investment in T & D and R. E. as % of total
I . . .	1951/52—1955/56	1100	105 (955)	132 (1200)	8 (73)	53·9
II . . .	1956/57 1960/61	2250	250 (1111)	115 (511)	75 (333)	41·3
III . . .	1961/62—1965/66	4570	774 (1694)	301 (659)	153 (335)	36·3
Annual Plans .	1966/67—1968/69	4188	676 (1614)	291 (693)	237 (566)	43·2
IV . . .	1969/70—1973/74	4157	1555 (3741)	802 (1929)	819 (1970)	51·7
V . . .	1974/75—1977/78	7218	3152* (4367)	1299* (1800)	842* (1166)	40·1

*Provisional.

Figures in brackets are Rs./KW of installed generating capacity.

2.116 On this basis it has been estimated by the C.E.A. that the backlog on investment in T&D upto 1978-79 has been approximately Rs. 2,100 crores. While the thumb rule is a broad general guideline it can hardly be the basis for T&D investment planning. It is necessary that some minimum criteria regarding reliability, power factor etc. are laid down by the C.E.A. in consultation with the R.E.A.s and S.E.B.s and these should become the basis on which systematic T&D planning can proceed. It is clear, however, that for sometime to come it will be necessary for the T&D outlay to exceed the generation investment if the balance is to be restored and the quality of supply to the consumer is to reach acceptable levels.

2.117 To some extent the spread of rural electrification with its long distribution lines and low load densities has added to T&D losses but they could have been partly contained if steps had been taken to raise transmission voltage and instal shunt capacitors.

Rising Transmission & Distribution losses

2.118 The net result of all this has been a disconcerting and rising trend in T&D losses. Since T&D losses are computed as the difference between power delivered to the bus bar and the power sold, these figures are not merely 'technical' losses but also include theft of power. The transmission and distribution losses during the last decade are as follows :—

TABLE 2·19

Transmission and Distribution losses as a percentage of energy delivered to the bus bar

Year	T & D losses
1968-69	17·0
1969-70	16·8
1970-71	17·5
1971-72	18·8
1972-73	19·9
1973-74	20·5
1974-75	20·2
1975-76	19·4
1976-77	19·8
1977-78	19·5

The statewise trend can be seen from Appendix 5.2 of the Chapter on 'Finance, Financial Management and Tariffs'. Apart from losses, in most parts of the country the quality and reliability of power supply is highly unsatisfactory.

Coordination between generation & transmission planning

2.119 Usually, in generation planning it is assumed that the transmission network will be adequate to transmit the power generated to load centres. This in turn permits the planner considerable flexibility in the choice of location, capacity and sequencing. Further, changes in the system involve only addition or deletion of projects or their installed capacity within the relevant time frame. In the case of the transmission network however, it is essential to know, before initiating the system study, the precise location and capacity of generation projects, the load demands real (MW) and reactive (MVAR) and their spatial distribution. The network operation has to be simulated for normal and critical conditions so that the system thus evolved is capable of meeting the transmission needs over the entire range of system operating condtions.

2.120 When, as at present, transmission system planning succeeds generation planning as an independent exercise in determining the network requirements for a given generation programme and load estimates it results in two major shortcomings. Firstly, transmission planning is considerably delayed as system studies cannot be even initiated till the load estimates and the generation programmes are finalised. Secondly, since generation is planned independently of transmission, the resultant plan, both for generation and transmission, is sub-optimal. In addition, owing to the absence of adequate and timely exchange of information under the present procedures, the changes in generation programmes, and these are frequent, do not percolate to the transmission planning group in time to enable them to meaningfully update their system studies.

2.121 It is necessary that T&D and generation planning are done simultaneously and in a co-ordinated way and not sequentially as at present. The final choice of a generation source from among the many candidate sources should be based on minimising the cost of power delivered to the intended consumer locations and the level of power system reliability expected. Therefore, the whole exercise of identification of generation sources and major transmission line planning must be done together and preferably by the same group of power system planning engineers.

Quality of system studies

2.122 Yet another drawback in the present arrangement is the quality of system studies made to back up transmission line projects. This expertise differs from one Board to another. Some SEBs have well-staffed and experienced power system engineers; some use professional institutions or consulting agencies for helping them with the system studies. System studies however need to be carried out regularly and not necessarily only when specific T&D projects are to be approved.

2.123 Such studies will be useful for taking into account revisions in generation plans, delays in project implementation etc. Even afterwards, when T&D lines are commissioned, system studies are necessary to help resolve various system operation problems. It is, therefore, inescapable that SEBs and Regional Electricity Authorities develop well-staffed departments to carry out system studies with the help of computers. Whereever outside help is sought for developing the software whether it is from CEA, educational instiutions or consultancy firms, a continuing arrangement would be preferable to ad-hoc ones and it should be supplementary rather than a primary input into the planning organisation of the SEBs.

Reactive compensation

2.124 The Committee has not considered it necessary to go into the various technical details of transmission and distribution planning. However, within the overall gamut of T&D system planning, one or two specific points do require special mention. Presently, reactive compensation is not optimised for minimising power losses. The basic objective at present is to provide sufficient reactive compensation to ensure that the bus bar voltages are within the desired range without exceeding the capabilities of the generating units for reactive power output or absorption. Optimisation of reactive compensation with regard to its type, size, location, etc., based on separate studies is left to the project authorities. Experience has shown that these studies are quite often neglected.

Inter-state and inter-regional lines

2.125 If the benefits of integrated operation of the regional grids referred to earlier are to be realised, greater priority should be given to inter-state and inter-regional power exchanges. Transmission planning has to be viewed in two parts, the 132 KV system and lower voltages which is required for power distribution within the State and 220 KV and higher voltages, which are essential for intra-and inter-state bulk transfers of power. The progress of construction of inter-State transmission lines for which specific loans were given by the Central Government under central sponsored scheme, has been disappointing in practice. Inter-State lines have been generally viewed by the States as a means of getting power from adjoining States and not as a means of achieving optimising regional generation. Inter-State and inter-regional transactions are yet to be accepted by States as mutually beneficial and consequently, the installation of the load despatch station is yet to take firm roots.

2.126 The recommendation for the creation of Regional Electricity Authorities has been made in para 2.85. The REAs should not only own and operate the regional load despatch centres, the EHV transmission lines and sub-stations required to operate the regional grid in an integrated way but should be exclusively responsible for all purchases and sales of power in bulk whether the power is produced by SEB or a centrally owned generating unit. They should also be responsible for negotiating the tariff structure according to guidelines referred to in the Chapter on "Finance, Financial Management and Tariffs". The organisational structure of the REAs is described in detail in the Chapter on 'Organisation and Management'.

Transmission network planning

2.127 Transmission technology is a rapidly changing feature of power system planning. With the increasing sizes of generating stations the optimum transmission voltage and mode must also change. Constant reviews of voltages & modes are, therefore, imperative in T&D planning. It is also extremely important that such decisions, which involve induction of higher levels of technology are taken expeditiously so that the various agencies affected by this technological change are trained and oriented to absorb it. For example, the decision on going in for 400 KV transmission systems took an unusually long time. The CEA should take the lead in this matter and involve the SEBs, professional and educational institutions and others concerned so that full advantage is taken of indigenous expertise and experience. It may be relevant to note at this point that the 400 KV system is not likely to be adequate for even a decade and CEA should already be giving consideration to the next higher voltage (including DC transmission) to be inducted into the system. With the generation of large quantities of power in concentrated areas as a result of the setting up of super thermal power station as also the possibility of developing very large hydro projects in the Himalayas and the North East Region, the exercise on the technology needed for bulding up such systems should begin now.

Monitoring and Information Systems

2.128 For T&D planning to be a meaningful exercise, there is need to evolve an adequate information and monitoring system. The major elements of the T&D information system would be data relating to design, project implementation, operation, maintenance and performance. For successful implementation of such an information system, a more comprehensive set of recording instruments would be required at all sub-stations. Where permanent installation of such instrumentation is not practicable it is recommended that mobile units, with the necessary instrumentation, be provided and sample data collected on a periodic basis. Standard formats giving precise definitions of terms relevant for the computer compilation process and aggregating could also be prepared. This work should be spearheaded by the C.E.A. and an information system, comparable to that built up for thermal generation projects should be developed for the T&D system also.

Distribution Network Planning

2.129 In view of the expansions that are contemplated in the distribution network over the next few years, planning of the distribution system becomes important. Distribution system planning will have to be mainly in the short-term but some long-term perspectives will also need to be kept in view. These would relate, primarily, to expansion of distribution network in urban complexes keeping in view the land use pattern and optimising the utilisation of land in conjunction with other utilities.

Present Status of planning capability

2.130 At present, in the formulation of distribution projects there is virtually no effort at optimisation. In view of the resource constraints the approach to distribution projects, particularly the rural electrification projects, has been to extend the coverage to as many villages as possible, without regard to the capacity of the system to sustain the load. As a result of such expansion, quite often, even the basic rules of planning distribution systems are overlooked leading to a deterioration in the technical standards, and, in turn, to a fall in the reliability of supply.

Organisation and facilities for T&D planning

2.131 It is observed that the State Electricity Boards, the Regional Electricity Boards and the Central Electricity Authority, as at present organised do not have the requisite software, trained manpower and information flows which can formulate proper integrated medium term and long term T&D plans. It is, therefore, necessary to train and strengthen their planning organisations if an optimised transmission and distribution plan is to be prepared.

2.132 Modern transmission system serving larger power projects can no longer be planned without the aid of computer programmes. The indigenous efforts in software development have been sporadic and fragmented. A concerted effort is essential to coordinate the efforts in this vital area and to make available software packages to the SEBs and to ensure that they are covered in formulating T&D projects. This is yet another area where the CEA should involve itself more actively.

Line losses in A.P. T&D system—A case study

2.133 In order to identify major areas which need further detailed study so that transmission and distribution losses could be reduced and the transmission system optimised, the Committee requested a group under Member (Power Systems), Central Electricity Authority in association with the Andhra Pradesh State Electricity Board, to undertake a detailed study of the transmission and distribution losses of the Andhra Pradesh system.

2.134 The Andhra Pradesh study was undertaken in three parts—Part I on energy audit, Part II on optimisation of distribution system and Part-III on reactive rescheduling. From the energy audit, it has been assessed that the energy losses varied from 24.70% to 22.62% within the 5 year period 1973—78. The EHV system has been found to be responsible for as much as 9.18% to 7.29% loss, sub-transmission system for 3.81% to 2.88% and the distribution system for 12.77% to 11.52%. This data has destroyed the hitherto accept view that the bulk of the T&D losses are in the low tension distribution side and that EHV transmission was being efficiently done.

Need for Energy audit

2.135 The usefulness of detailed studies such as the one carried out for Andhra Pradesh need not be further emphasized. It is unfortunate that such an energy audit cannot be undertaken for most of the Boards since adequate instrumentation, metering and other sources of data are not available to disaggregate and analyse the losses in the various system elements. It is important that the Electricity Boards instal metering arrangements to monitor losses throughout the net work and review these losses periodically to plan system improvement measures.

2.136 Conventional and well known techniques of reducing T&D losses such as optimal sizing of conductors and distribution transformers, installation of capacitors, improved instrumentation and other facilities in sub-stations and its sub-systems, strict vigilance measures in which officers are held accountable for T&D losses under their jurisdiction could sharply reduce T&D losses including pilferage.

2.137 It is also a fairly straight forward exercise to demonstrate to decision makers that investment in cutting T&D losses is generally a far cheaper way of getting more power to the consumer in a dependable and reliable way than investment in new generation capacity and should thus receive higher planning priority. The Committee, however, recognises that such projects lack the glamour and prestige of major generation projects and are, therefore, not looked upon, either by the Boards or the States with much enthusiasm. It is for organisations like the CEA, REAs, Department of Power and the Planning Commission to undertake studies to be able to convince the SEBs and State Governments about the need to re-examine priorities. In addition creating public awareness of the benefits of greater investments in T&D to consumers would be a spur to determined action on this front.

2.138 In addition, optimisation studies of the type indicated earlier are required so that expansion of the T&D system is carried out in a way which gives the best trade-off between costs of investment and costs of losses so that power is delivered to consumers as cheaply as possible.

Diversion of T&D funds to other purposes

2.139 The experience in the past has been that while the outlay on generation is, by and large, fully spent there has been, on occasions, considerable diversion in some States of funds from T&D and Rural Electrification to the generation side or to other sectors of the State Plan. The Committee feels that steps must be taken to stop this practice forthwith and recommends that after the outlay on T&D & RE is agreed in the annual and 5 year plans with the States, any shortfall in expenditure on T&D must lead to an equal deduction from the Central assistance to the State's plan.

Assumptions on T&D losses for planning purposes

2.140 The Committee would like to reiterate its view that before making any new investments in generation capacity, the highest priority should be given to reduction in line losses and that it should be ensured that line losses are steadily brought down. If this recommendation is accepted, the Committee endorses the suggstions of the Working Group on Energy Policy that for the future the following T&D loss assumptions are not unreasonable for the purposes of planning.

By	Loss Percentage
1982/83	18%
1987/88	17%
1992/93	16%
2000/01	15%

If it were not for the policy of rapid spread of rural electrification even lower T&D losses could have been aimed at.

CHAPTER III

PROJECT FORMULATION AND IMPLEMENTATION

INTRODUCTION

3.1 Delays in the formulation and implementation of power projects have contributed largely to the widespread power shortage that the country has experienced in the last decade. Such delays have also resulted in cost over-runs leading, very often, to substantial increases in the planned outlays for power projects. The reasons for these delays are both internal and external to the implementing agencies. Considering that the power sector will make heavy demands in the coming decades on the scarce capital resources available to the country, there is need to ensure that the investments made in the sector yield the desired returns within a reasonable time period. In terms of generation capacity a total installed capacity of the order of 1,38,000 MW could be needed by the year 2000 A.D. which means that the power sector will be required to add capacity at an average annual rate of about 5240 MW. It is, therefore, proposed to examine whether the sector is organisationally and technologically geared to shoulder such a responsibility in the coming years.

3.2 The extent to which Plan targets in regard to additions to power generating capacity could be realised hitherto is indicated in the following table :

TABLE 3·1

Achievement of Physical and Financial Plan targets

	Plan		Achievements		Physical achievement as % of targets
	Rs. in Crores	** MW	Rs. in Crores	** MW	
First Plan . (1951—56)	..	1300	105	1100	84·6
Second Plan (1956—61)	235	3500	250	2250	64·3
Third Plan . (1961—66)	712	7040	774	4715	67·0
Annual Plan (1966—69)	644	5430	676	4381	80·7
Fourth Plan (1969—74)	1255	9260	1555	4610	49·8
*Draft Fifth Plan (1974—79).	4395	16550	4573†	10983	66·4

†Provisional

*Target revised downwards to 12,500MW when Plan was finalised in September, 1976.

**Inclusive of non-utilities.

3.3 The average level of achievement of implementation of generation capacity during the last five Plans has thus been of the order of 65%. It will also be observed that while the physical targets were not met, in financial terms in most years, there was excess expenditure. This has been the result of a combination of inflation and time over-runs. The following table shows the rising capital costs of generation, transmission and distribution and rural electrification projects in terms of investment per KW for generation, per Km of T&D lines installed and per pump set energised.

TABLE 3·2

Cost per KW of generating capacity, per Km of T & D line and per pumpset energised

	Generation Rs./KW	Transmission & distribution Rs./Km. of-line	Rural Electrification Rs./Pumpset energised
First Plan . . .	955	NA	2,282
Second Plan . .	1111	NA	5,250
Third Plan. . .	1694	NA	4,875
Annual Plans (1966—69)	1614	9,844	4,114
Fourth Plan . .	3741	11,299	6,053
Fifth Plan (1974—78) .	4367*	28,676*	9,810*

*Provisional

As a result project costs in the case of some projects have increased two-fold or even more. The magnitude of the delays and cost over-runs is clear from an illustrative list of major hydel, thermal and nuclear projects shown in Tables 3.3, 3.4 and 3.5 respectively.

The work of the Previous Committees

3.4 The problems of project formulation and ways and means of reducing construction delays were studied in the past by several expert groups. The work of the following Committees has been of particular relevance to the subject—

(i) Power Economy Committee (1971).

(ii) Committee on short-falls in generation during the Third Five-Year Plan.

(iii) Committee on Rise in Costs of Irrigation and Multipurpose Projects.

(iv) Committee for Speeding up of Construction of Hydro-electric Projects.

TABLE 3·3

Time and Cost over-runs of Hydro Power Projects

(From date of project sanction)

Sl. No.	Project	Original cost (Rs. crores)	Actual or Expected cost (Rs. crores)	Percentage cost over-run (%)	Original time (months)	Actual or revised time (months	Time over-run (months)
1.	Beas Sutlej Link						
	(i) Dehar (4×165 MW)	97·67	382·57	291·7	120/144	192	72/48
	(ii) Pong (4×60 MW)	75·34	259·80	244·8	120	192	72
2.	Kalinadhi State I (6×135 MW)	125·66	228·23	81·6	72	102	30
3.	Idukki (3×130 MW)	68·20	115·00	68·6	60	108	48
4.	Loktak (3×35 MW)	10·10	80·62	698·2	72	144	72
5.	Baira Suil (3 60 MW)	20·49	92·20	350·0	60	120	60
6.	Kyredumkulai (2×30 MW)	9·24	23·28	152·0	48	96	48
7	Lower Jhelum (3×35 MW)	17·98	72·53	303·4	84	108	24
8.	Subernrekha P.H.I. (1×65 MW)	15·26	31·80	108·4	60/72	84	24/12
9.	Giri (2·30MW)	8·71	26·76	207·2	60	132	72
10.	Gumti (2×5 MW)	3·00	16·60	437·2	60	120	60
11.	Salal	55·15	222·15	302·8	96	192	96
12.	Srisailam	45·75	237·25	418·6	84	192	108
13.	Balimala	45·82	89·94	96·3	72	96	24

TABLE 3·4

Time and Cost Over-runs of Thermal Power Projects

(From date of project sancion)

Project	Orginal cost estimates (Rs. crores)	Actual or expected cost (Rs. crores)	%age cost over-run (%)	Original time (months)	Actual time Revised time (months)	Time over-run (months)
1. Santaldih (4×120 MW)	75·58	106·89	41·4	110	111	1
				122	129	7
				149	182	33
				158	188	30
2. Patratu (2×110MW)	35·16	63·49	80·6	99	124	25
				111	138	27
3. Panki (2×110 MW)	35·20	70·00	98·9	71	78	7
				76	72	(—) 4
4. Obra (5×200 MW)	157·90	374·40	137·1	60	90	30
				39	63	24
				33	51	18
				51	81	30
				57	90	33
5. Kothagagudem (2×110 MW)	42·30	79·12	87·0	58	61	3
				61	71	10
6. Amarkantak (2×120 MW)	41·37	75·35	82·1	53	59	6
				62	68	6
7. Chandrapura (1×120 MW)	19·95	39·50	98·0	61	79	18

TABLE 3.4—*Contd.*

1	2	3	4	5	6	7
8. Gandhi nagar (2×120 MW)	45·60	58·25	27·7	50	53	3
				53	53	..
9. Badarpur (1×210 MW)	38·37	66·40	73·1	55	67	1[illegible]
10. Vijayawada (1×210 MW)	76·86	156·64	103·8	66	77	11
				72	81	9
11. Koradi (1×200 MW) (2×210 MW)	112·40	212·50	89·1	42	61	19
				54	94	4[illegible]
				66	101	3[illegible]
12. Panipat (2×110 MW)	46·57	86·00	84·7	53	71	18
				59	77	18
13. Tuticorin (2×210 MW)	75·05	152·30	102·9	61	68	7
				67	76	9
14. Satpura (1×200 MW)	75·19	136·00	80·9	55	67	1[illegible]
(1×210 MW)				62	64	2
15. Bhatinda (2×110 MW)	41·38	71·15	71·9	54	51	(—) 3
				60	61	1
16. Ukai (2×200 MW)	78·30	88·31	12·8	38	53	1[illegible]
				50	62	1[illegible]

TABLE 3·5

Time and cost over-runs of Nuclear Power Plants

(From date of project sanction)

Sl. No.	Project	Original Cost (Rs. crores)	Actual or Expected cost(Rs. crores)	Percentage cost over-run	Original time (months)	Actual or revised time (months)	Over-run in time (months)
1	Rajasthan, APS-1 (220 MW)	33·95	73·27	115·8	96	96	..
2	Rajasthan, APS-2 (220 MW)	58·16	95·90	64·9	117	156	39
3	Madras, APS-1 (235 MW)	61·78	107·87	74·6	132	156	24
4	Madras, APS-2 (235 MW)	70·63	103·02	46·1	..	..	..
5	Narora, APS-1 / Narora, APS-2 (2×235 MW)	209·89	327·40	56·0	..	..	..

(Tarapore APS has not been included because it must be regarded as an exception as it was a turnkey job involving very little indigenous plant and equipment).

(v) Committee to assess Adequacy of construction Agencies for Thermal Power Projects in Sixth Plan and Measures for Speedy Implementation.

(vi) Committee to review Procedures for Investigation and Implementation of Multipurpose Hydro-electric Projects.

3.5 The views of these Committees have been kept in mind by this Committee in making its recommendations.

Approach

3.6 As stated in the Chapter on Power Planning the main goal in power project planning is to meet the demand for power at the lowest possible cost, for this purpose, it is essential that the existing power potential is assessed accurately, that all feasible alternatives for developing these resources are explored fully; that the changes in the pattern of load growth are taken into account and that an optimum choice is made from these alternatives on the basis of the anticipated regional demands within the given time frame taking into account transmission and distribution costs. Once a choice is made and the necessary investment decision taken, the next step would be to ensure that the project is completed in all respects so as to yield the desired benefits within the time schedule and cost estimates originally planned. Project formulation and appraisal, followed by implementation thus represent two distinct phases in the development of the power potential of the country.

PROJECT FORMULATION

3.7 Formulation and appraisal of power generation and transmission projects needs to be examined in relation to two aspects viz. formulation and evaluation of individual projects and consideration of each project as a part of an overall regional plan.

AGENCIES INVOLVED IN PROJECT FORMULATION

3.8 Formulation of individual projects is mainly carried out by the SEBs or other owning and operating agencies, unless they do not have the capability for doing so as sometimes happens in the case of major hydel projects. Technical evaluation of projects is carried out by the Central Electricity Authority and final clearance given by the Planning Commission for State Government projects and the Central Cabinet in the case of Central projects.

Role of Central Electricity Authority

3.9 In the case of all power projects, the cost of which exceeds Rs. 1 crore, a statutory clearance by the CEA is required before the project can be implemented. While according technical clearance, the CEA is required to ensure optimality of the project from the operational point of view taking note of both the short-term and long-term perspectives. In addition, the CEA is also required to make sure that the project yields a reasonable rate of return on the investment to be made in it. In the case of hydro projects the CEA is further required to ensure that the proposed project does not prejudice the interests of other potential uses of water i.e. for irrigation, flood control, navigation etc.

3.10 The appraisal of multi-purpose river water projects is more complex. All project proposals in such cases are first appraised by the Central Water Commission (CWC) whereafter the CEA examines and clears the proposal in so far as it relates to power generation. Finally the Technical Advisory Committee set up by the Planning Commission scrutinises the proposal for overall techno-economic clearance. If there is an inter-State river water dispute involved, the project is referred to the Ministry of Energy, which attempts to persuade the concerned States to come to a mutually acceptable agreement.

Role of the Planning Commission

3.11 All State Government projects after technical clearance require the clearance of the Planning Commission whose responsibility it is to see what priority should be attached to the various power projects in a State both 'inter se' and in relation to other sectors and to ensure that there are sufficient funds available in the State Plans to finance these projects.

Nuclear Projects

3.12 Nuclear projects are formulated by the Department of Atomic Energy mainly on the basis of the demand deficits anticipated in the region, the non-availability of coal and the existence of the required infra-structural facilities. The projects take into account the overall operational requirements of the regional grid.

Environmental Clearance

3.13 Before a project is finally cleared by the Government, it is also referred to the Department of Science & Technology for clearance from the environmental angle.

Central Government Projects

3.14 Any Central Government Project, the cost of which exceeds Rs. 5 crores, requires clearance of the Public Investment Board (PIB) and then Cabinet approval. The Planning Commission which is concerned with intersectoral allocation of resources scrutinises the proposal to ensure that resources are available to fund it and also carries out a techno-economic appraisal of the project on behalf of the PIB.

3.15 For proper appraisal of a power project, it is necessary that the relative merits of all other options available in the region are fully considered. In the case of hydro projects, an assessment made by the erstwhile Central Water & Power Commission supplemented by the investigations carried out by some of the individual States provides a starting point for making a rough appraisal of this kind. However, in the case of a thermal project, where a variation in the location of the project has a direct bearing on the economics of the project due to factors such as coal transportation and transmission costs etc., such an appraisal is not possible because the alternatives to it have not generally been formulated.

3.16 In the case of large transmission and distribution schemes, which require the CEA's clearance, each project is appraised on the basis of its suitability in relation to the regional grid. Although the CEA does carry out regional system studies based on the demand forecasts and the generation plans of the region, these tend to be based on data which is incomplete.

RECOMMENDATIONS

PROJECT FORMULATION

Need for a Regional approach

3.17 The existing procedure and approach to project formulation and appraisal is broadly summarised in the preceding paragraphs. While there is always scope for improvement in the formats in which project reports should be set out by the sponsoring agencies, the Committee does not propose to go into this aspect of project formulation as these formats have already been carefully considered and are periodically modified and refined by the CEA and CWC through guidelines issued by them from time to time to the project authorities. What is discussed here are some of the wider issues relating to formulation and appraisal of projects.

Responsibility for Project Formulation

3.18 In the Chapter on 'Power Planning' reference has been made to the necessity of planning for power on a regional rather than a State basis and that Regional Electricity Authorities (REAs) should be set up to do this. In order to be able to prepare such a plan the REAs will need to have detailed project reports (DPRs) for a shelf of hydel, thermal and possibly nuclear projects. The task of the REA would be to choose from these projects those which would meet the regional demand for power so that the cost benefit ratio is optimised.

3.19 The preparation of the DPRs for thermal projects should, in the Committees view, be prepared by the agency which is going to own, construct and operate the unit, e.g. the SEB or the Regional Electricity Generation Corporation (REGC). The DPRs for nuclear projects should continue to be prepared by the Department of Atomic Energy. In the case of hydel projects for reasons, which will be dealt with later, the DPR should be funded by the REA though the actual work could be entrusted to the local State Electricity Board, if it has the requisite capability. Otherwise it could be entrusted to bodies like WAPCOS and later on to the proposed Power Design and Consultancy Corporation referred to later.

Quality of Project Formulation

3.20 Perhaps more than weaknesses in implementation, it is poor project formulation which is responsible for the very serious delays and cost over-runs especially in hydel projects. This is also true, though to a lesser extent, of thermal projects.

MAJOR HYDEL PROJECTS—

3.21 The Committee has commented upon the fact that only 10% of the nearly 400 TWH hydro-electric potential of the country has been developed. Of this, 64% is in the Northern, Eastern and North-Eastern regions. One of the reasons for slow development of hydel projects is the uncertainty about when power will be available from them and the problems they pose for the states in finding the resources to fund them because of their long gestation periods. Despite this, there can be no doubt that ways and means will have to be found to ensure that hydel power is developed far more rapidly than in the past, that projects are executed speedily and that estimates are adhered to. Some of the causes of these problems with hydel projects and suggestions for removing them are:—

Inadequate Preliminary Investigations

3.22 The major weakness in project formulation is inadequate preliminary investigations. This is due to a combination of three factors—reluctance of the investigation agencies to commit the funds required for a full investigation because they can run into crores of rupees; a deliberate policy of under-estimation of costs to get projects approved knowing that once they are started they cannot be stopped and lastly reluctance on the part of engineers and other project formulation staff to work in inhospitable conditions without any incentive.

Funding DPRs

3.23 It is recommended that after a preliminary survey to establish that the project proposed is 'prima facie' viable and generally conforms to the agreed long term plans for the region, the funds required to prepare a detailed project report (DPR) to be based on a complete and thorough an investigation of the geological and hydrological aspects as possible should be sanctioned. The fact that the DPR could cost upto Rs. 20 crores or more should not be a deterrent. In future the REGCs will have a major share in the ownership of these projects if the Committee's recommendations are accepted. In view of this and anticipating that State Governments and Electricity Boards may be reluctant to commit funds of this order for a DPR which may not be implemented immediately, the Committee recommends that the Regional Electricity Authorities who have the responsibility for the planning of power supply in the five regions should henceforth take on the full financial responsibility for preparing the DPRs of major hydel projects for their regions.

Strengthening Project Investigation Capability

3.24 Considering the volume of work that will be involved if an appreciable impact is to be made in exploiting the hydel potential of the country on the basis of an optimised choice of projects, full time groups specialised in hydel project investigation will need to be set up in the Boards of the three regions which have high hydel potential. The capability of WAPCOS to take on major investigations will also need to be enhanced. The available number of experienced engineering geologists in the country is short of requirements. The strength of the engineering geologists in the GS and the investigating agencies should be increased to deal with the increased work load. They will need to be equipped with the latest equipment for undertaking geological and other investigations.

Reluctance of competent staff to work on the DPRs

3.25 Detailed studies of geological and hydrological conditions are required to prepare a sound and realistic DPR. To do this and to analyse alternative construction and location options requires competent engineers of a variety of disciplines to work together for long periods under inhospitable conditions. Unfortunately postings to such projects either for investigation or construction is often treated in some States as a 'punishment' posting. The objective should, in fact, be just the reverse as the very best geologists, civil, mechanical and other engineers should be put on such jobs, fir at the project formulation stage and then later at the implementation stage. In order to do this, the Committee strongly recommends that people on posting to such projects should be fully compensated for what they lose by giving them allowance either for the cost of maintaining two establishments or enabling their children to go to boarding schools.

Welfare Facilities

3.26 Likewise welfare facilities and social amenities for people working at such sites need to be provided on a more generous scale and the tedious procedural formalities for giving them leave, sanctioning travelling allowances etc streamlined. It must be recognised that the cost of providing these is an infinitesimal fraction of the savings on the project cost. The contribution to the economy that competent and motivated people on such projects can make far outweighs any other considerations.

Logistic Support

3.27 Working in mountaineous terrain, communications present a major problem. A great deal of time could be saved and project costs sharply cut if much greater use is made of helicopters. Money spent on these and first class telecommunication facilities will not only help physical progress but improve the morale of people working in dangerous inaccessible places who know that helicopters and telephone connections are readily available in case of emergencies. These inputs are particularly important in the project preparation stage because explorating, drilling and mapping can then proceed without access roads which take a long time to build and frequently get blocked or washed away.

Errors in cost Estimation

3.28 It is recognised that it is not possible to predict with a high degree of accuracy the problems and costs of constructing hydel projects, despite detailed investigations, especially in the Himalayan ranges, because of the relatively young age and lack of compactness of the rock. Nevertheless the costs could be far closer to the actuals than they are today. A good deal more precision in project evaluation would also be possible when such DPRs are evaluated. It is quite extraordinary for instance that in a project like Salal, expected today to cost Rs. 222 crores and which was approved as far back as 1970 at a cost of Rs. 55 crores, there is still no approved design for the main dam.

Investment Decisions

3.29 An investment decision on hydel and other projects should be taken only after the DPRs are ready updated for current prices and the choice of the projects made only after all the other options for generating power have been evaluated in relation to the long term plan which has been drawn up for the region. The Committee recognises that this could mean that the preliminary expenses may be infructuous for a while but this is to be preferred to entering into an investment in which the investment could vary by a factor of 3 or 4, as can be seen from Table 3.3 or where the project is not the best from the point of view of meeting the nation's needs. Had detailed investigations been done it may be that some of these projects would not have been taken up at all.

Inflation

3.30 The current practice is to estimate project costs at constant prices which in an inflationary situation makes cost over-runs inevtable. While in order to accord with normal planning conventions in the rest of the economy, this practice can continue, it is recommended that, in order to compare estimates with actuals, the executing agency should periodically prepare a statement of what the expenditure should have been had the project proceeded as planned but allowing for the actual inflation that took place from year to year.

SMALL HYDEL PROJECTS—

3.31 Uncertainty about future availability and rising costs of fuel has stimulated interest in the development of small hydro-electric projects (Micro and Mini) all over the world. The cost of micro hydels (up to 1 MW) and mini hydels (up to 5 MW) in terms of energy per unit of investment is generally higher than the larger stations, due to the small quantum of power generated. However, the relative economics of these small stations are improving day by day and schemes which were once considered costly are proving to be competitive with the progressive increase in fuel prices.

3.32 There are compelling reasons for the country to take a hard look at exploiting the available small hydro potential simultaneously with the bigger schemes. Although the CEA is presently engaged in reassessing the available hydro resources in the various river basins, no systematic study has been undertaken of the small hydro potential available on canal falls using low head 'bulb' type turbines, irrigation outlets and small hill streams and rivers. Tentative estimates put this potential at around 5000 MW. There are presently 32 micro hydel power stations in operation and another 30 are under construction mostly in Uttar Pradesh, Himachal Pradesh, Jammu & Kashmir and in the North-Eastern region. The time frame for implementation of these projects is around 3 years and the capital cost varies from Rs. 8000 to Rs. 14,000 per KW as against a cost of approximately Rs. 5000 per KW for the bigger hydro projects. These costs however do not take into account the interest during construction which in the case of big projects can last for 8 to 12 years. Secondly, there is no premium for quick returns i.e. discounted cash flow. If both these accounting refinements are adopted before costs are compared, the difference in per unit cost between small and large projects would narrow down substantially.

3.33 In addition, if transmission costs are also taken into account, the difference in delivered costs to the consumers, which is the ultimate goal, could be negligible because micro hydels would generally serve a much smaller consumer area than the big projects. The advantage is specially marked in the case of projects which serve remote sparsely populated villages which are far away from major power projects. The major component in these schemes is the construction of the power channel, and the shorter this is kept, the better the economic viability of the scheme. Maximum importance should be given to cost reduction in the civil works by the use of local human and material resources as far as possible.

3.34 Since the majority of micro hydel schemes (upto 1 MW) cost below Rs. 1 crore, the SEBs/State Governments themselves are competent to sanction projects and implement them. The Committee has noticed however that State Electricity Boards show no enthusiasm for such schemes and concentrate on prestigious large projects. The Committee would recommend, therefore, that the REC be given special funds to encourage the development of micro hydel projects and that in States where the potential exists, the SEB should have a separate division, quite distinct from the major project group, for planning and executing such projects. To begin with, both the SEB's and the REC should undertake detailed surveys of the micro hydel potential in a few districts and establish the viability of possible projects.

THERMAL PROJECTS—

3.35 The performance in regard to thermal projects, while generally not as bad as hydel projects in terms of delays and cost over-runs, still leaves much to be desired. Some of the more striking examples of delays appear in Table 3.4. Unlike hydel projects, there are no naturally unpredictable geological factors which make it difficult to hold to the original cost and time estimates. The problem here appears to be either excessive optimism in regard to the time required to complete a project or incompetent project management or both.

Definition of completion of a project

3.36 There is today almost a total lack of precision and agreement on what is meant by a project being complete. There are various stages of a project e.g. completion of all engineering work in respect of construction, or the unit being 'rolled', or synchronised or lastly fully proven and ready to generate at full capacity *i.e.* in commercial operation. The Committee is firmly of the view that a project is not complete until it has generated power at full load for the period specified in the contract and it has been demonstrated that all systems and sub-systems including automatic controls, relays, indicators are working satisfactorily and guarnatees and responsibilities of suppliers and consultants have been fully discharged. Instead, today units are sometimes treated as complete when they have been 'rolled' at which time many of the auxiliary facilities and instruments are yet to be installed. Occasionally the completion date is considered to be the day when the unit is connected to the grid (*i.e.* 'synchronised') even if it did not run for more than a few minutes. Besides causing needless confusion, these practices mislead all those who are connected with the planning, generation and consumption of power.

Gestation Period of thermal projects

3.37 It will be observed from Table 3.4 that from the time of project sanction, the actual time for completion of project has varied from 51 to 188 months. Some of these delays are due to the work, which should be completed before the project is approved, being taken up after the sanction has been granted. This also partly accounts for the very large cost over-runs. The Committee would recommend that a full two years should be allowed for the preparation of the feasibility report, detailed design engineering work and the submission and sanction of the DPR. From the date of this sanction to commercial operation as defined above, 5 years should be allowed. The Committee is aware that on the basis of present quoted delivery periods for long delivery items, this is fairly generous and PERT charts would indicate a period of between 42 to 48 months. However, while this should be the target to which project authorities should aim at and be judged by, for planning purposes a degree of slack to provide for a cushion against unforeseen contingencies would be desirable.

Coal linkages

3.38 The Committee views with concern the growing lag between the rate of growth of coal output and the demands of thermal stations and feels that this may become a major constraint in power generation unless coal production is stepped up rapidly. The current practice is that before a thermal project is cleared the coal mine from which it will be supplied has to be specified. The Railways have also to agree to move the coal taking into account the capacity of the railway lines and the flow of empty and full wagons so that irrational or wasteful movements are minimised. Adherence to these linkages has not been in the past, always possible and the Committee would suggest some changes in the procedure to take practical problems into account.

3.39 The Committee would recommend that the Coal Department produces a 15-year coal production plan indicating mine by mine how production of coal and its quality will vary with time. It has to be recognised that while new mines are being developed existing mines get exhausted and the quality of coal tends to deteriorate as leaner seams are operated. If the actual growth of coal production were to take place quantity and quality-wise exactly as planned and the location and sequence of setting up new thermal plants also took place exactly as anticipated, it may be possible to stick rigidly to planned linkages. In practice, this is not likely to happen and the past few years have shown that linkages have had to be changed to take care of delays in mine development or because a new thermal plant has been constructed nearer a linked mine or because some changes have taken place in the pattern of movement of other railway freight and so on. It must also be remembered that coal mines have a longer gestation period (6 to 10 years) than a thermal power plant (4 to 5 years).

3.40 The Committee would, therefore, recommend that while coordinated planning of mine development, location of thermal stations and build-up of railway capacity should continue, linkages should be made as flexible as possible in the sense that the plant should be designed to operate within a reasonably broad range of coal qualities. Linkages with mining areas may be more practicable than with specific mines, so that the quality of coal varies only within certain well defined limits and the rationality of movement of coal is preserved. However, with the increasing emphasis on pit head stations this problem of changing linkages is likely to become less severe.

NUCLEAR POWER PROJECTS—

3.41 Nuclear power stations have come in for considerable criticism because of sharp cost and timeover-runs. The Committee felt that the issue is important enough to be examined in some detail. Time and cost over-runs for nuclear power plants are summarised in Table 3.5.

3.42 The work of RAPP-I commenced in December, 1964 and the reactor achieved criticality in August, 1972, *i.e.* in a period of 7 years and 9 months. Power supply to the grid however, was delayed till May, 1973, *i.e.* for additional 9 months due to problems encountered with the turbine bearings and lubrication system. In this instance, the arrangement with the Canadians was that they would furnish designs and major equipment, but the construction and installation responsibility was with the Indian side.

3.43 Sanction for RAPP-2 was issued in December, 1967 and the reactor could have been made critical in September, 1977 if the requisite quantity of heavy water was available at that time. In other words, this project took a total of almost 10 years for completion. However, in this instance, a deliberate policy decision was taken to make all major nuclear components in India and these included end-shields, calandrias, boilers, etc. Setting up of indigenous capability to manufacture this wide range of nuclear equipment for the first time was a time consuming process.

3.44 In the case of MAPP-1, sanction was accorded in December, 1967. However, civil construction on the major plant buildings could be started only by about middle of 1970. The major reason for the delay in starting the main plant construction was delay in the finalisation of the civil designs which envisaged a prestressed concrete reactor building as also delay in TG design finalisation. On present indications, the reactor should be ready for starting by about December, 1980. Although a total of 10½ years would have been taken from commencement of main plant construction, about 2½ to 3 years of delay is attributable to the effect of the Canadian embargo which became effective in 1974. Various items such as special valves and fittings, tube sheet forgings etc. were ordered out in Canada on commercial considerations and these were embargoed after 1974. Making alternative arrangements for obtaining these items from Indian or non-Canadian sources was time consuming. In addition, the very substantial indigenisation programme which included a wide range of equipment added to the delay.

3.45 Regarding Narora, the requirement of the site being located in a seismic zone necessitated complete redesign of the reactor. In addition, certain design changes which would be required for the future 500 MW reactors were incorporated. Notably, the number of circuits in the primary system was reduced from 8 to 4, and the end shields and the calandria vault designs were modified very significantly. In addition, many safety related design features were incorporated in line with the current trends in nuclear plant technology.

Cost over-runs

3.46 A review of the cost over-run at the different atomic power stations in the country shows a steep price escalation after the 1973 oil price hike

3.47 The earlier projects, *viz.* Tarapore and Rajasthan encountered some cost increases due to devaluation. However, subsequent projects, Rajasthan, Madras and Narora have encountered cost increases due to the following reasons. They are of course not at all unique to nuclear projects.

(1) Effect of the abnormal inflation arising from oil price rise during the 1973-74 period which has continued in various degrees even to the present and is likely to continue in future also.

(2) More stringent requirements of quality and safety which have resulted in substantial design improvements, additional fabrication requirements and safety related additions to the reactor design.

(3) Increases in customs duty.

(4) In respect of Madras and Narora Projects (and also to an extent Rajasthan) arising from the operating experience, it has been necessary to provide for additional heavy water upgrading capacity at the plant sites.

(5) In the case of the Narora Project, although initially 'once-through' cooling was envisaged, it became necessary to construct natural draught cooling towers.

3.48 The Committee notes that if a comparison were to be made with current international cost of nuclear power projects, Indian costs have risen less rapidly than elsewhere. As a result the cost/kw of Indian reactors, in spite of being of a smaller size, is generally less than for reactors under construction in other parts of the world. The DAE's view is that a plateau has been reached in regard to modifications and no further significant design changes are contemplated. This comment also applies with regard to systems such as heavy water upgrading, waste management etc. Hence future projects would only be affected by normal inflationary factors and delays on account of design changes and developing indigenous manufacturing capability would be minimal.

3.49 On this basis for a new project, the Committee recommends a completion period of **8 years for the first unit as a planning period on the assumption that**

(a) Advance action is taken for procurement of imported raw materials in time;

(b) Site investigations are completed prior to sanction of project;

(c) Consulting Engineers (in the field of conventional areas of design) are appointed early enough to get a quick start on the project; and

(d) Design is basically standardised to that of Narora.

Heavy Water

3.50 One of the major problems faced by the nuclear plants is the serious delays that have taken place in commissioning four heavy water plants and as a result of which RAPP-II has been unable to start. The Committee would recommend that in order to give it a clear identity both commercially and managerially and to help in establishing public accountability for results, the heavy water division of the Department of Atomic Energy be constituted into a public sector corporation, just like the other production operations of the Department e.g. Uranium mining, Rare-earths processing, electronic components. In the Chapter on Organisation and Management, the formation of a Nuclear Power Corporation to construct and run nuclear projects has been recommended.

TRANSMISSION AND DISTRIBUTION PROJECT—

3.51 The preparaion of optimised transmission and distribution projects requires a specialised group of people capable of doing computer based simulation exercises. In order to do this, detailed data regarding the load at different times of the day and seasonally should be available. Similarly, reasonably dependable long term forecasts of load growth are also required. Currently, macro level Statewise data on load is available but detailed region and district-wise data required to prepare optimal sub-transmission and distribution systems is not available. This is one reason why the RE programme which plans from the L.T. system onwards runs into problems if the distribution system up to the L.T. Stage is inadequate. Collection, storage and analysis of data on T&D systems is an area in which much greater attention should be devoted. The advice of consultants specialised in MI systems should be sought for building up this data base.

3.52 The whole area of planning and implementation of T&D projects is a major area of weakness with SEBs. This is reflected, as the Committee has pointed out in the Chapter on 'Power Planning', in the relatively low emphasis that has been given to T&D in comparison to generation and as a result of which T&D losses have risen and the quality of service to consumers, has deteriorated.

3.53 With the setting up of Regional Electricity Authorities as proposed by the Committee, it is expected that full time and expert attention will be devoted to the long and short term planning of the national EHV transmission system network.

3.54 It will be for the State Electricity Boards to ensure that the planning of their own T&D system as an integrated component of the regional system is also undertaken on a priority basis and organisational changes required to do this have been outlined in the Chapter on 'Organisation and Management'. Measures to penalise Boards which divert funds from T&D and rural electrification to other purposes have also been suggested in the Chapter on 'Power Planning'.

STANDARDISATION

3.55 The benefits of standardisation are well established—doing away with tailor made designs and detailed engineering drawings, allowing repititive production of equipment thereby facilitating the use of jigs and fixtures so as to reduce production costs, improving quality, and reducing inventory levels. Standardisation would also facilitate the development of common experience and expertise in construction, commissioning and operation and permit inter-changeability of components, assemblies and so on. There is thus no doubt that standardisation of power plant equipment and lay-outs would reduce both costs and gestation periods of project formulation and implementation and improve standards of operation and maintenance.

Thermal Power Stations

3.56 The Thermal Power Development Programme during the Sixth and Seventh Five Year Plans is mainly based on installation of 200 MW units. About 90 units of this capacity are likely to be installed during the decade. The turbines, generators and their auxiliaries are being manufactured by BHEL which is the only manufacturer of this equipment in the country. The fact that the bulk of the units would also be equipped with BHEL boilers facilitates standardisation of design and layout of the main plant and equipment with their associated auxiliaries. A thermal power station, however, comprises numerous other items of equipment of different types manufactured by different firms. Standardisation of such equipment would be feasible only in so far as some of the technical characteristics are concerned.

3.57 Based on the above premises, standard schemes and layouts for 200/210 MW Bharat Heavy Electricals Ltd. (BHEL) units have been prepared by the CEA in consultation with BHEL/specialised Consultants and State Electricity Boards. These standard schemes include enough data to enable commencement of foundation design as soon as soil data is available, thus enabling an early start of the civil engineering works. These standard layouts and schemes have been made available to the various State Electricity Boards, Public Utilities in the public and private sectors, consulting engineers and manufacturers of main plant and equipment. The standard designs so evolved have been adopted by the National Thermal Power Corporation for the Singrauli Super Thermal Power Station (STPS) for which the CEA is itself the consultant and, with some modifications, for the Korba STPS as well. The above, however, refers to stations with turbo generator units of USSR design. It is necessary to evolve similar standard layouts with the turbines of KWU design. A similar exercise needs to be done with AVB boilers and items of equipment bought out by these two manufacturers.

3.58 As regards other electrical equipment, a manual on basic electric design features for thermal power stations has been prepared. The motors for thermal power station auxiliaries are also being standardised. As regards accessories for electrical and mechanical equipment, the Indian Standards Institution has brought out relevant standards for a number of items, and equipment offered by various suppliers generally conform to these standards. There is no reason why the instrumentation and control systems cannot also be standardised in consultation with the two or three major suppliers.

3.59 Once this is done these layouts should be tried out on one or two units of the new super thermals. After getting a feedback from the groups in-charge of erection, commissioning and operation and effecting such modification as they consider necessary, these schemes and layouts should be more or less frozen and their adoption made obligatory except for such minor modifications as may arise from time to time. A full review of these designs should however be made every 3 years to take into account past experience and expected changes in external inputs e.g. quality of coal, improvements in metallurgy etc. Any major technological changes or innovations which may have taken place in India or elsewhere should be carefully assessed for their techno-economic benefits in the Indian context before they are incorporated into up dated designs. Typical of innovations which may not have relevance in India are those primarily intended to save labour or economise on floor space.

Standardisation in Hydro Power Stations

3.60 There are severe limitations to the exent to which the design and layout of hydro power stations are not amenable to significant standardisation. Hydro stations can be standardised to suit individual conditions and operational requirements. A limited amount of standardisation is, however, possible in areas such as ancillary and auxiliary systems. Modular approaches could be attempted for systems for compressed air, cooling water, drainage and dewatering, fire protection, station grounding, illumination, ventilation, L.T., A.C. and D.C. supply, and it is recommended that the CEA and CWC set about preparing such standard modules.

3.61 There is considerable scope in the country for utilisation of the power potential of low head canal drops by the use of tubular or 'Bulb' type mini-hydel generating units. Certain measures of standardisation and simplification of these units should be possible and in fact, would be essential for economic exploitation of this source of energy as otherwise initial costs would be prohibitively high. Such standardisation would have to aim at evolving a limited number of combinations for heads and discharges for which standard designs of bulb units could be made.

3.62 One of the areas where standardisation is needed relates to safeguards against earthquakes for civil foundations, structures and generation equipment. This is a specialised area and, if necessary, external consultancy inputs can be used.

Transmission and Distribution Systems

3.63 There is considerable scope for standardisation in transmission and distribution projects. Already some attempts have been made in this direction by CEA for the 400 KV system and standards have been evolved for major components, covering specifications and design parameters for sub-station equipment such as power transformers, shunt-reactors, circuit breakers, etc., and line material including conductors, ground wire, towers and insulators. These standards have been evolved by an Expert Committee under the aegis of the CEA and forwarded to the State Electricity Boards and manufacturers for their adoption. A follow-up to ensure that these standardised components are being adopted by utilities should be carried out by the CEA.

Specifications and Design Parameters for Equipment and Materials for Voltage upto 220 KV

3.64 For systems of 220 KV and below, the CBI&P have evolved standards and manuals for sub-station layouts though on a limited scale and considerable work remains to be done. Despite this, different designs and specifications are still being followed by the various State Electricity Boards for such lay-outs. This results in delays in delivery of the equipment and contributes to increase in the cost of the equipment. The areas where standardisation would lead to savings in costs and time are :—

(a) Sub-station layouts

Optimised, standard layouts for sub-stations of different voltages should be evolved by CEA on the basis of available equipment.

(b) Transmission Line Clearances

The present practices are based on ad-hoc projections of the clearance originally evolved for the 33 KV system. In view of the extensive addition to the transmission systems, at 220 KV and 400 KV, it has become imperative to recalculate the clearance for transmission lines after considering such aspects as induced potential and heights of vehicles which might pass under the lines.

(c) Design of Transmission Line Towers

At present, the design of transmission line towers is undertaken by utilities on a line to line basis. In many cases, the design of towers is entrusted to fabricators and supply contractors. The tower designs evolved under these conditions are, therefore, based on the availability of steel sections at the time of design apart from wide differences in design practices. Considering the magnitude of the transmission programme envisaged in the future, there is an urgent need to standardise a set of designs suitable for different villages, ground and atmosphere conditions.

(d) Protection Schemes and Instrumentation

Protection schemes are presently being tailored to the requirements of each transmission line. As regards the 400 KV and 220 KVA systems, standardisation of protection schemes is feasible and the CEA should set up groups to undertake this task. There is also a need for introducing standardisation in instrumentation systems. It would be necessary to provide adequate instrumentation in all the major grid sub-stations to cater for—

(i) Energy loss evaluation ;

(ii) System controls ; and

(iii) Evaluation of performance of various system elements.

(e) Standardisation of Accessories

Several accessories and hardware items like sleeves, preformed sections, clamps etc., used in T&D projects, are manufactured in the small scale sector. There is a need to standardise the specifications for these items and ensure rigid quality control in their manufacture.

(f) Installation and Maintenance Facilities

The Indian Standards Institution have issued manuals for installation and maintenance in respect of number of items of equipment required for power transmission lines and sub-stations. Apart from installation of the equipment, there are major items of works like stubsetting, tower erection, stringing of conductors, etc. Specifications and standardisation of practices in this regard would help in minimising installation periods apart from reducing costs.

3.65 It is to be noted that standards are not static and efforts need to be made to improve/update these from time to time based on experience gained. Standards have also to keep pace with advancements in technology.

Agency for Carrying out Standardisation

3.66 In the case of thermal stations, the CEA in consultation with BHEL and SEBs have prepared standard designs. Similarly the CEA should take the initiative in respect of developing standard designs in all the areas outlined above. The standardisation could go down to detailed engineering drawings so that much of the preliminary work prior to calling for tenders is eliminated. CEA should prepare a time bound programme for completing this work. In order to devote the attention to this, that is necessary to see that significant results are achieved within the next one or two years, it is recommended that a full time officer of the level of Chief Engineer is appointed to assist the proposed Member (R&D) in the CEA.

Project Appraisal

3.67 The current procedure for project appraisal should be modified to permit the REAs to carry out a preliminary appraisal of all major generation and transmission schemes submitted by utilities before including them in their programme for meeting the regional power demand. Detailed guidelines for this appraisal should be provided by the CEA. Final approval of the project should proceed as at present *i.e.* State projects to be cleared by the CEA and the Planning Commission and the Central Projects by the CEA the PIB and the Cabinet. Given the formulation of a sound regional power generation and transmission plan and conscientious application of the guidelines issued for project formulation, the REAs themselves should be able to do much of the routine preliminary appraisal that now comes to the CEA.

PROJECT IMPLEMENTATION

RECOMMENDATIONS

3.68 In general, the two most crucial factors, the lack of awareness of which has a major role to play in the implementation and commissioning of projects, are :—

(a) the value of time, and

(b) the importance of rigid adherance to quality specifications on critical items.

3.69 These shortcomings which appear in various degrees in different agencies need to be rectified not only in organisations directly responsible for the implementation of power projects but a whole host of agencies such as State land acquisition authorities, Ministries in charge of release of scares raw materials like cement and steel, the Directorate General of Technical Development for import of machines and spare parts, the Controller of Imports and Exports, Department of Economic Affairs, Ministry of Railways, Posts and Telegraphs, manufacturers of equipment, port authorities and customs and excise staff. If projects are to be implemented to tight schedules, the Central Government must instruct its agencies that procedures for dealing with matters which are connected with erection of power systems must be given top priority. In particular, the practice of notings on complex issues on files and correspondence should be substituted by personal discussions followed by on the spot decisions with the cost of delay to the project and to the economy constantly in mind. To facilitate this, the executing agency, the CEA and the Department of Power should make everybody connected with the project fully aware of the losses due to cost escalations, accumulated interest charges and lost generation as a result every day's delay in completing the project and, 'per contra', the savings in finishing ahead of schedule.

3.70 Similarly, shoddy or off-specification work requires to be dealt with a heavy hand and on the other hand encouragement given to those manufacturers/contractors who keep to schedule and regularly meet quality standards. This requires the exercise of discrimination, otherwise the rigid adherence to the "lowest tender" principle can become a serious hinderance.

Some of the other major causes of delays are—

Delays in Sanctioning Staff

3.71 The DPR must not only cover technical inputs but the qualifications and experience of staff at all levels that must be available and when they will be needed to be in position, the facilities they will need for accommodation, transport and other welfare facilities etc. Action for recruitment, training etc. must begin as soon as the project is sanctioned and no separate sanction for staff should be required. The consultants to be appointed and the fees that are going to be paid to them should also be a part of the DPR. As far as possible, the consultants who assisted in the preparation of the DPR should see the project through to completion.

Inter-State Water Disputes

3.72 A second major cause of delay in implementing hydel projects is the time taken to resolve inter-State disputes. A number of projects, the generation and energy potential of which totals up to 4000 MW of capacity and 12 TWH of energy annually, some of them formulated nearly 15 years ago, have been awaiting clearance for want of settlement of such disputes. Even though, there are legislative provisions under the Inter-State Water Disputes Act (1956) and the River Boards Act (1956) laying down detailed procedures for settling the disputes, these disputes have remained unresolved for years. For example, the Narmada River Valley problem could be resolved only after two decades of protracted negotiations during which time colosal quantities of energy has been wasted.

3.73 Disputes relating to major inter-State rivers, *viz.*, Godavari-Krishna and Narmada have been settled recently. The problem, however, still remains in regard to some smaller projects such as projects in the Yamuna basin, Cauvery basin etc. Even though the number of such cases is now limited, it is necessary to evolve some mechanism that can help resolve inter-State water disputes expeditiously. With the growing involvement of the Centre in major projects including hydel projects, problems between the Centre and the State are also likely to arise. In fact the prolonged debate about the Koel Karo project between Bihar Government and the Centre illustrates the point.

3.74 To resolve these problems, it will be necessary to impose in the national interest, if necessary by suitable legislative amendments, an upper limit on the time taken for such negotiations. If the parties to the disputes cannot reach a mutually acceptable settlement in, say, three months, it should become mandatory that such disputes automatically stand referred to an arbitrator to be appointed by the Central Government. Such an arbitrator would be required to deliver his findings within a certain prescribed time limit, say, three months. The legislation should also ensure that the findings of the arbitrator become binding on the parties concerned and be made non-justiciable, if necessary, by a constitutional amendment. Another possibility is to declare water a national resource and give the Central Government overriding powers to allocate water and power between States, decide location and heights of dams, lower and upper riparian rights etc. Unless some such drastic measures are taken, it will not be possible to develop the hydro electric potential of the nation speedily.

Project Evaluation and Review Techniques (PERT)

3.75 The CEA and the Planning Commission have instructed all the utilities to produce resource based PERT charts *i.e.* charts which not only plan the progress of various physical activities but also indicate the phasing and quantum of inputs such as financial resources, manpower of different types, scarce materials and so on. As of today very few organisations prepare such charts and even these simple PERT charts often do not show the depth of study that is necessary in estimating the time required for various activities. What is perhaps more distressing than this is the fact that such PERT charts as are prepared are often more done as a ritual and seem to serve as wall coverings rather than operating documents. This is largely because while technical staff have been taught how to prepare PERT charts in a theoretical way, very few have been taught how to use them in the field to maintain a project on schedule. As a result the charts are generally out of date and serve no useful purpose. If PERT charts are to be relevant, then they must be kept up-to-date and with them must go powers to 'crash' activities which often may mean a rise in the cost of that particular job but a net benefit to the project by keeping it on schedule. In complicated systems mini-computers may need to be used to indicate which activities are on the critical path. A typical example of a lamentable sense of proportion and realism is the Khodri project in U.P. This project was originally scheduled to cost Rs. 17.96 crores (1966) and to be completed by 1977-78. The current estimate is Rs. 65.16 crores and completion date has been projected to be 1982-83. All the equipment has been in position for several years and the entire delay is due to differences in the cost of the headrace tunnel between the contractor and the State Electricity Board amounting to less than Rs. 3 crores. The loss to the Board and the State as a result of this delay has been many times this figure.

3.76 The Committee would recommend that resource based PERT charts prepared to the desired standards should be a precondition to the clearance of all DPRs, thermal, hydel and nuclear. The SEBs and other utilities should be given, where necessary, further guidance on their preparation by the CEA/Planning Commission. Detailed discussions are necessary with external agencies such as suppliers, contractors and subcontractors to see that activities are realistically planned. Good examples of how the PERT system should be used are the NTPC projects and the seamless steel tube project put up by Bharat Heavy Electricals at Ranchi. The usual excuse for non-adherence to PERT schedules is that many of the activities on which the PERT is based are outside the purview of the executive agency. Given the priority that the nation attaches to power it is assumed that, presented with a reasonable case, all external organisations will recognise the need for timely action. The fact that several major projects in other sectors as, if not more complex than power projects, can be executed with little or no slippages shows that it can be done. To assist the project authorities, the project monitoring group of the CEA should, through the Ministry, bring it to the notice of the highest levels in the State and Centre, cases of schedules slipping back due to lapses on the part of external agencies.

Land Acquisition and Rehabilitation

3.77 Land acquisition and resettlement is becoming a major constraint in execution of power projects. While, that it is a time consuming process in the case of storage hydel projects is understandable, it is now becoming a cause of delay even in the case of thermal projects where the land requirements are relatively small. In some of the storage hydel projects which are under construction, this item alone forms 40% of the project cost. It thus requires the creation of a full time organisation headed by a senior land acquisition and resettlement officer. The organisation for this work should be created as soon as the project is sanctioned and steps should be taken to create the necessary confidence in the minds of the people who are going to be displaced, that they will be as well if not better off than they are at present. The current practice is to deal with displaced persons only in terms of monetary compensation whereas there are serious socio-economic and human problems to be overcome. It is the lack of sensitivity in dealing with these people, who are sometimes instigated by outsiders trying to profit by delays and litigation, which has delayed many projects.

3.78 The Committee recommends that it should be the responsibility of the project authorities and not the State Government to create modern and well planned rehabilitation centres near major hydel projects for rehabilitating the persons that will be displaced well in advance of the submersion date so that an incentive is created for the affected families to move. To begin with, every family should be suitably compensated for the lands and buildings affected. The salvage material should be transported free of cost to the new rehabilitation centres for construction of new houses. Where possible, unallotted agricultural lands should be made available well in advance to enable the cultivators to prepare the lands for cultivation before shifting. Such land should not, however, be created as has been done in the past by clear felling of forests.

3.79 If land is not readily available the possibilities of resettling displaced people in the upper reaches of the dam and employing them full time on afforestation should be given serious consideration. Given the rate of denudation of forests and the impact this will have on the life of the project, the cost of carrying out aforestation in the denuded catchment areas, should be treated as a part of the project cost. While technical supervision can come from the forest department the displaced labour should do the job under the control of the project authority. Displaced persons should also be given free domestic power during their life time and encouraged to take up horticulture as a part of the tree planting programme together with handicrafts, animal husbandry, sericulture and a variety of small and cottage industries. In order to do this, a senior officer with a staff of specialists in agriculture and allied activities, and village and small industries, as well as sociologists and experts in finance and marketing, should be attached to the project manager. This officer and his staff should be accountable for ensuring that all bonafide displaced persons are helped to become fully self reliant and well-adjusted to their new environment. The district administration must be given instructions to extend their full support to ensuring the success of these efforts.

3.80 A small proportion of the staff and workmen employed on project construction may be needed to run the project after completion if there are not already surpluses available in other parts of the SEB who can be transferred there. This staff should be identified well in advance of the completion of the project on the basis of merit and aptitude and given special training in other power stations on operation and maintenance. The State Government must ensure that pressures are not put on the Boards or the project managers to employ people they do not need. Some of the manpower problems of projects arise out of the decision to do jobs departmentally and such departmental employees cannot be retrenched and become a permanent burden on the project. Project work should be exclusively done by contractors except for a small number of managerial, supervisory, technical and accounts staff.

Contracting Companies

3.81 The deficiencies that exist and need to be rectified in the organisation of executing agencies such as the SEBs have been dealt with in the Chapter on 'Organisation and Management'. For non-departmental work, there are numerically an adequate number of contractors but not many of them are properly equipped to do the civil or erection work of major hydel and thermal projects.

3.82 The CEA and CWC should regard the building up of existing and new contractors who can effectively compete with the major established firms and help keep down costs as one of their important tasks. Organising training courses in the practical problems of working in difficult terrain, encouraging contractors to obtain sophisticated equipment, both imported and indigenous which would help improve the speed and quality of work, freely permitting young engineers working with contractors to get training in India or abroad on the operation and maintenance systems for such equipment are some of the steps that should be considered.

Placement of Orders and Contractual Arrangements

3.83 This is one of the activities in project implementation which has often resulted in inordinate delays. Between the sanction of a project and the placement of orders on contractors and suppliers, there are delays of a year or more. Work on detailed designs and engineering designs should begin as soon as the decision to prepare a project proposal is taken. Even tender bids can be invited. The risk that the project may not be ultimately sanctioned is a real one but it must be taken and design costs written off if necessary.

3.84 Once the project is approved, orders should be placed forthwith on reliable suppliers/contractors. A system of pre-qualification bids is necessary to ensure that only competent agencies are considered for supply and erection of equipment and executing civil works. Especially in the case of those SEBs who are executing a number of projects, there is need to organise specialised wings to evaluate and finalise the contracts and to set up purchase and contract committees at various levels depending upon the size of the contract. The importance of delegation of financial and administrative powers in this regard cannot be over-emphasised. As noted earlier, there is a great deal of scope for improving and standardising, within the States and between States, the technical specifications which form the basis of tender notices and the terms of the final contract entered into with the suppliers. There is also need to examine the existing escalation clauses to be included in the contract relating to different types of equipment. Even in cases of limited tenders, the lowest tender need not necessarily be accepted if the Contract Committee set up by the Board find that it is unsatisfactory. These are subjects on which guidelines should be issued by the C.E.A.

Construction Materials

3.85 Delays have occured in power projects due to periodic shortages of essential raw materials like cement, structural steel, industrial gases, explosives, P.O.L. and spare parts of construction machinery. It is, therefore, necessary to plan the requirements of each season well ahead and make storage arrangements as far as possible to meet such contingencies. A special cell for procurement of key materials should form an integral part of project management. Here again, standardisation of design, wherever possible, would go a long way in advance planning of various raw materials especially steel sections. This is particularly relevant to some elements of thermal power projects and transmission system.

Finance

3.86 The Committee's attention has been drawn to the fact that some State Electricity Boards have not been given funds by the State Government in accordance with the agreed annual Plan for that year as settled with the Planning Commission. States should ensure that funds flow smoothly and regularly throughout the year and that at no time is the project starved of its legitimate inflow of funds. The question of inadequate generation of internal resources as a result of SEBs not collecting outstandings should not be lead to delays in project execution.

Transportation Bottlenecks

3.87 In power projects, a number of heavy consignments like the generator stator, step-up transformer, boiler drum, high pressure heater etc. have to be transported to the construction sites. Inadequacy of wagons of 90, 130, 180 and 250 tonne capacity has caused delays in such movements. In order to overcome this bottleneck, the Railways should augment their rolling stock, particularly the 90/130 wagons.

Power Telecommunication Coordination Committee (PTCC)

3.88 When high tension cables run alongside telephone and telegraph lines, high induced currents can be generated in the latter sufficient high to cause a fatal or near fatal accident to P&T staff working on these lines. Laying of such H.T. cables near P&T wires thus requires the permission of the PTCC and this often takes time. Steps to speed it up should be taken expeditiously. According to the existing legal provisions, the utilities including the SEBs are required to compensate the P&T authorities for any re-engineering of P&T lines involved when new power transmission lines are laid. Of late, the costs to the utility by way of such compensation have been increasing rather alarmingly. There is a general feeling amongst SEBs that the P&T authorities are modernising and improving the communication circuits at the expense of the power industry. Considering the rapid development of the power supply network envisaged in the future, it is felt that there is an urgent need to review afresh the existing legislation and evolve acceptable modalities for determining the re-engineering costs and the manner in which they should be shared by the utilities and the P&T.

3.89 The Government of India recently deputed a multi-disciplinary team to study the practice being followed in a few of the developed countries and the recommendations of the team are available with the Government. Keeping these in view, it is recommended that these recommendations be studied in arriving at a cost sharing formula.

EQUIPMENT FOR THE POWER INDUSTRY

3.90 The large programme of expansion requires the availability of equipment to be kept under close review in order that equipment supplies do not act as a constraint on generation, transmission and distribution. The current position in respect of different types of equipments is summerised below and, wherever necessary, corrective action has been recommended.

Hydro Generating Equipment

Large Hydels

3.91 The estimated requirement of large hydel sets on the basis of a 1978 survey was as follows:

		Average /Year
1978-83 . .	115 units	23
1983-88 . .	180 units	36
1988-93 . .	325 units	65

The present capacity of BHEL is about 16 units per year and plans to augment it to about 24 units are under way. Considering the lead time of five years required to manufacture a turbine, it is evident that even for the current five-year period, there are likely to be gaps between demand and supply. In some cases, however, the project itself may have slipped so much since the survey was carried out that the actual requirement of units particularly in the 1978-83 period may be lower. It is recommended that CEA and the project authorities undertake a review of the current status of the various hydel projects and BHEL's time schedules to see if there is any mismatch. If there is a risk of the equipment from BHEL being delayed, orders on foreign suppliers should immediately be placed.

3.92 It is clear that even the expanded capacity will not be enough to meet the 1983-88 requirements and imports will be required. Finally a very substantial further expansion—more than double the expanded output—has to be in position during the 1983-88 period if the 1988-93 demand is to be met. This will thus require an early investment decision and action on this should be initiated immediately.

Micro Hydels

3.93 The availability of suitable generating equipment for Micro/Mini hydro generation, which is both simple and robust is another important area where the supply position is unsatisfactory. Out of the average cost of around Rs. 10,000/kw for such projects, the cost of the generating equipment is around Rs. 3000/kw. In view of the low profit margin allowed in the pricing of these small units, very few manufacturers have entered this area and there are presently only two indigenous manufacturers in the field. Another problem is the lack of continuous demand. Unless a manufacturer is assured of a continuous demand of these small sets, his investment in any special facilities he proposes to creat would become a liability. The Committee has stressed the need to fully exploit the large potential of short gestation micro hydels to take advantage of this renewable and widely dispersed energy source to provide power economically to remote areas. If this is done, the flow of orders to manufacturing units will stabilise. The CEA should, as recommended earlier, survey the micro hydel potential and assess the demand for equipment.

Low-head Turbines

3.94 While the country has the technology in respect of high-head hydel projects, the designs of low-head schemes like 'Bulb' type turbines has to be acquired through foreign collaboration. The establishment of a separate manufacturing facility, catering entirely to the requirement of these small hydro stations either in the public or private sector will go a long way in the development of the low-head hydro programme. Assessment of the demand for such turbines and work on setting up manufacturing facilities should be started as soon as possible.

Thermal Plants

3.95 Over a period of the next ten years, the maximum requirement of thermal power plant equipment, as projected at present, is of the order of 3500 MW per year. This consists mainly of 11 × 200 MW units and about 2 × 500

MW units per year and the rest will be a few of 110, 60 and 30 MW units mainly for captive power units. There are two boiler manufacturers in the country, viz. BHEL and Associated Vickers Babcock (AVB). The present capacity of BHEL for the manufacture of boiler plant is 2500 MW/annum. This capacity is being further increased to 4000 MW/annum AVB has a capacity of 1000 MW per year. The combined capacity of BHEL and AVB is, therefore, in theory adequate to meet the demand of power/industrial boilers and spare parts.

3.96 There is only one turbine manufacturer, viz. BHEL. BHEL's present capacity for the manufacture of TG. sets of 1500 MW is being raised to 3500 MW per year during the course of the Sixth Plan. Orders for all plant and equipment for the major portion of the units to be commissioned during the period upto 1982-83 have already been placed with BHEL including a major portion of units to be commissioned in 1983-84. BHEL is, therefore, expected to be in a position to meet the demands of main plant and equipment required for expansion of thermal power during 6th and 7th Plans.

3.97 In practice, however, a problem which has frequently occurred is the bunching of orders when manufacturers are asked to supply equipment for a number of projects at about the same time. While the plant capacity of BHEL, therefore, may appear to be adequate to fulfil the power generation programme during the next decade, past experience shows that there have been slippages ranging from 18 to 24 months in fulfilling supply contracts. BHEL has tried to make up these gaps by substantial imports of components and equipment during the past few years.

3.98 On the other hand, there have also been many cases in which equipment supplied by BHEL has been lying in crates for years at the site because the SEB was not ready to start erection. Any general conclusion that all project delays have been on account of late deliveries by BHEL cannot, therefore, be supported.

3.99 The Committee is of the firm view that the supply of spares and components which is necessary to maintain existing thermal capacity utilisation at the highest possible level must receive the maximum priority. The Committee has received repeated representations from State Electricity Boards that there is a tendency on the part of manufacturers to give preference to the completion of plant for new projects. It is clear that priorities must be reversed so that power generation from existing units is stepped up as fast as possible. BHEL for example should take a realistic view of their commitments to provide spares, renovate and replace components, and assemblies in the light of the frequent breakdowns reported and then assess if there is likelihood of its not meeting its supply commitments on schedule. It may for instance be desirable to permit four of the proposed Regional Electricity Generating Corporations (see Chapter on Organisation and Management) to import one 500 MW set i.e. 2000 MW in the next five years from BHEL's foreign collaborators, so that there are no problems of spares. and thus release BHEL's capacity for producing the spares for existing units. While giving BHEL some breathing time to catch up, this will also permit the generating companies and BHEL to make a valid comparison of performance of imported and indigenous sets. The same approach could be adopted for other manufacturers like Instrumentation Ltd. (Kota). Attention to this aspect of power plants has been drawn in the Chapter on 'Operation and Maintenance'.

Setting up manufacturing facilities outside BHEL

3.100 From the preceding analysis it is apparent that an immediate decision should be taken to augment the indigenous manufacturing capability for hydel turbines. Further looking at gestation periods for setting up new facilities and the possibility that retirement of old sets may be stepped up to levels beyond those envisaged today, a decision on starting additional thermal plant capacity cannot be deferred by more than a year. The question which the Committee has considered is whether this facility should be set up as a part of BHEL or outside it.

3.101 In this connection the Committee's attention has been drawn to the deep concern amongst many State Electricity Boards that BHEL's monopolistic position gives it disproportionate strength in fixing prices and makes it somewhat indifferent to customer complaints regarding delivery schedules, quality and after sales service. While several of the complaints about BHEL's performance do not bear scrutiny, the Committee is of the view that there is a case today for setting one or more facilities either in the public or private sector to produce equipment which is today BHEL's exclusive preserve so that competition is fostered. In order to derive the benefits of standardisation the foreign collaborations could be the same as BHEL's.

3.102 While at one time the power equipment market was too small to sustain two manufacturers and the decision taken nearly a decade ago to merge Heavy Electricals (India) Ltd. with BHEL was correct in order to derive the economics of scale, the market today is much larger and is growing rapidly. BHEL is also getting to a size at which, in the Indian milieu, further rapid growth may make its managerial structure unwieldy and sluggish. The growth in BHEL should come by more intensive use of its existing and planned production facilities. There are also risks in putting all the power engineering facilities in one company as any natural or manmade causes such as go-slow or stoppage of production would give a severe setback to the economy.

3.103 If despite these arguments a decision is taken to confine further growth to BHEL, then in order to resolve customer-supplier problems it is recommended that BHEL, whose main task is to feed the power utility industry, should come under the administrative control of the Department of Power.

3.104 There is at present a shortage of pressure parts for boilers, HP piping and valves. Along with the capacity expansion of the main boiler equipment, the capacity for manufacture of HP piping also requires to be expanded. The capacity for manufacture of HP valves should be doubled so that these are available off the shelf.

3.105 The capacity for manufacture of boiler and turbine auxiliaries such as boiler feed, condensate and CW pumps, feed heaters, deaerators, mills, fans, motors for power station auxiliaries etc. will not only have to be stepped up to match the capacity of boilers and turbines but there is also need for updating the designs and technology of such equipment to improve its performance.

3.106 The capacity for other major items of plant and equipment viz. power transformers, switchgear etc. is adequate. The manufacturing capacity for coal and ash handling plants and coal crushers and pulverizers, however, would need to be increased to suit the growing programme of thermal power generation.

Transmission and Distribution Equipment

3.107 Indigenous manufacturing capacity is not geared at present to meet the requirements for sophisticated protection equipment particularly for H.T. transmission lines and consequently this has to be imported. As this is a small component of the total project cost and the demand is limited, there should be no hesitation in importing it. Timely steps will have to be taken for initiating the process so that projects are not delayed for want of protection equipment. The question of increasing indigenous manufacture should, however, be kept under review in case the demand exceeds current forecasts.

3.108 400 KVA lines require extensive reactive power compensation facilities along the line and at various load centres. Except for capacitors, other forms of reactive power compensation equipment are not manufactured in the country at levels which meet completely future needs. Imports in this area will therefore be necessary until indigenous production capability can be established on a viable basis.

Transmission line towers

3.109 The manufacturing capacity in the country for transmission line towers and substation structures is about one lakh tonnes/annum and is adequate for the present requirements. This capacity is available in the private sector, in both large and small scale units supplemented by the Electricity Board's own manufacturing facilities. However, the requirements during the period 1983-88 would be about four lakh tonnes per annum. The manufacturing capacity has, therefore, to be suitably augmented. This can be done by developing further manufacturing facilities in the small scale sector. The Committee is not in favour of the SEBs getting into manufacturing activities and where possible, it should phase out what it has got. Neither the Electricity Boards nor the small scale sector have facilities for galvanising towers. Where possible and economically feasible, common galvanising facilities can be set up covering a number of small scale units.

Distribution Equipment

3.110 Past experience and future projections indicate that adequate manufacturing fabrication capability exists in the country in respect of energy meters, supports for primary and secondary distribution lines (RCC poles and PCC poles), distribution and power transformers, LT and HT capacitors, switches, fuses circuit breakers, protection devices, etc. While there is no immediate problem of capacity, there is quite a serious problem of quality, and as mentioned in the Chapter on R & D and in the section on 'Standardisation' in this Chapter, vigorous efforts will need to be made by the CEA, the Indian Standard Institution and the Boards to improve, standardise and introduce much stricter quality control measures and some form of ISI certification. For instance, it has been brought to the notice of the Committee that there have been large number of failures of small distribution transformers pointing to substandard manufacturing practices/designs.

ACSR Conductors

3.111 The manufacturing capacity for ACSR conductors and power cables in the country is 3.8 lakh tonnes which is adequate for meeting the needs during the current Plan provided aluminium supplies, indigenous or imported, are assured. To meet the needs of the power industry beyond 1985, new capacity will have to be created and action to this end should be initiated now.

H. T. Insulators

3.112 At present, there are six units manufacturing HT Insulators with a licensed capacity of 26,300 tonnes per annum which is currently fully utilised. The demand for HT insulators is estimated at about 40000 to 45000 tonnes per annum for the T & D programme in 1987-88. Letters of intent have been issued for expansion of the manufacturing capacity by 32,100 tonnes. While the licensed manufacturing capacity for other items is adequate for meeting the needs including that of the Railways in the immediate future, it would be necessary not only to increase the production of 220 KV and 400 KV bushings and insulators in the existing units and set up new units but also meet any gaps with imports till such time the expansion programme envisaged actually materialise.

3.113 It has also been pointed out that the present quality of HT insulators of 220 KVA and 400 KVA class is not up to the requisite standards. One of the reasons for this is the lack of adequate test facilities in the country. Facilities for testing this class of insulators should be put up expeditiously and other measures to improve quality initiated.

Data Acquisition and Control Equipment

3.114 It may be necessary to import on-line data acquisition and control equipment for system operation but before doing so indigenous capability in this regard must be fully utilised.

Non-sequential Supply of Equipment

3.115 A frequent complaint from utility companies is non-sequential supply of equipment from manufacturers. If erection is to proceed according to a predetermined sequence, it is necessary that the equipment delivery should follow the sequence that has been laid down in the contract.

QUALITY CONTROL

3.116 As a result of a policy decision to attain self reliance, Indian industry has made rapid strides in a relatively short time to come up from virtually nil to near self-sufficiency in a sector producing highly sophisticated equipment. This indeed has been a very credible achievement and reflects great credit on organisations like BHEL who have had to do in two decades what developed countries have done in the last 50 to 60 years. This forced draft growth perhaps has not allowed the industry to devote the depth of attention that is necessary to produce the quality of product that is required for smooth and trouble-free operation under Indian conditions. The first phase of indigenisation is over and manufacturers should now pay special attention to seeing that all impediments to achieving the highest possible quality of manufacture are removed. It is not possible or necessary to catalogue the long list of failures and problems with thermal and hydro-electric generating equipment, auxiliary equipment, switchgear, control and instrumentation etc. which were brought to the notice of the Committee. Broadly these defects fall into three categories—

(i) Off-specification components and materials bought out by the manufacturer;

(ii) Design and manufacturing defects in the manufacturers shops;

(iii) Failures or lack of close supervision at plant site.

Bought out Items

3.117 The manufacturers reputation tends to suffer a great deal on account of (i) above as the customer blames the supplier of the total equipment package as he must. If, despite strenuous efforts at improving indigenous quality standards, main equipment manufacturers are unable to get products locally which fully conform to specifications, imports should be freely permitted for limited periods till the quality problems are resolved.

Design Weakness

3.118 It is understood that steps to correct design weakness have been taken mainly by seeking collaboration with more reputed foreign manufacturers and partly by in-house R&D. As regards manufacturing defects and quality control this not confined to thermal plants and is dealt with later on.

Hydel Plants

3.119 While shop assembly in case of thermal generating units, involving mostly shop fabricated items is common practice, in the case of vertical hydro-electric plants where considerable final field assembly is involved, it is possible that given sophisticated testing techniques, shop assembly of the complete unit can be dispersed with. However, it is recommended that in the present state of development of manufacture in the country, this would not be desirable and full or almost full shop assembly of hydro-electric generating equipment should be carried out. This would ensure that all matching of components and sub-assemblies is fully taken care of in the shop before despatch. This would minimise if not eliminate the problems of mismatch, missing components etc. and would enable speedy installation of the units at site. Such practices are being followed by many of the best international manufacturers even today.

Instrumentation

3.120 As far as instrumentation and control equipment is concerned, there are at present two major indigenous manufacturers of complete instrumentation systems and two others are expected to enter into the field shortly. Their capacity is expected to be adequate to meet the requirements during the next decade. There is, however, need for continuous updating of technology in this field and very careful attention to quality control.

3.121 As a result of these quality defects one of the most persistant problems faced by power station operation and maintenance staff at present is inoperative/defective instrumentation. Auxiliary control equipment, like contactors, relays, pressure and level switches, limit switches, solenoid operated valves, temperature indicating instruments, pressure and draft gauges, push-button switches etc. procurred from indigenous sources are often found to be substandard and have often failed at critical moments. There is urgent need to improve the quality of these items by introducing strict quality assurance programmes. It is also necessary to augment capacity for the production of these items.

3.122 It is clear from the above that at the root of the quality problems that the power industry faces today is the inadequacy of the control on the quality of equipment supplied to utility companies by even some of the largest indigenous manufacturers. The proposal of setting up an independent quality control (QC) organisation to check the quality of goods supplied by manufacturers to the utilities is not an ideal solution. There should normally be no intermediary between a buyer and seller to judge quality. If there is one, there is a risk that the manufacturers will feel less accountable for the quality of their products and lean on the QC organisation to carry out the checks and tests and similarly the SEBs will tend to blindly accept what is approved by the QC organisation abondoning such limited checks as they do now.

3.123 The Committee is of the view that the manufacturer's responsibility for building quality into the product at every stage of manufacture—quality assurance in its true sense—cannot be diluted. Nor can the buyer accept unquestioning somebody else's views of what is acceptable and what is not. Yet while there is need to strengthen the quality assurance organisation of both the buyer and seller, there are advantages in having agencies who will be able to assist the buyer in certifying the quality of the goods tendered by the manufacturers.

3.124 The role of such organisations is not to duplicate the tests carried out by manufacturers at their works from start to finish. It would rather be to critically examine the quality control systems that have been adopted by the manufacturers in their workshop and if necessary, suggest ways in which they could be improved. They would need to establish a few critical parameters for each type of equipment and carry out a quality audit from time to time to see that quality standards and procedures are being maintained. Based on their experience, they could suggest modifications to test procedures adopted by the producers and where necessary, supervise the tests on behalf of the buyer.

3.125 The Committee recommends that this function in the public sector should be assigned to the proposed Power Design and Consultancy Corporation referred to in the Chapter on 'Organisation and Management', which is to be set up to help SEB and other utilities in the design, engineering, construction and commissioning of projects. Private sector consultancy groups which already offer such services should also strengthen their capabilities in this area.

Organisation and Management

3.126 Organisation structures of utilities have to recognise that project formulation and implementation is a complex task requiring a specialised organisation appropriate training inputs and substantial delegation of powers backed by a sound management information system. These aspects have also been dealt with in the Chapter on 'Organisation and Management'.

CONSULTANCY SERVICES

3.127 Competent consultancy services are a critically important input in the formulation and implementation of major power projects. Inadequacy of such consultancy inputs has been a major source of problems in many projects. Standardisation of design and layouts can only take care of a part of the problems for which consultancy inputs are required. It is necessary for instances to see how far the standard designs are suitable for the quality of coal, temperatures of water, soil conditions and to take into account the availability of infrastructural inputs such as workshops foundries etc. The Committee has come across several instauces where a competent consultant would have provided installed spare capacities in such relatively inexpensive units as cost grinding facilities I.D. fans, condensors and ash handling equipment to cater for a deterioration in the quality of coal. Had this been done, unite like Talcher thermal power station would have been able to perform at far better levels of capacity utilization then has been possible.

3.128 A review of the available consultancy agencies in the country shows that the base for adequate consultancy facilities exists in the country but it needs to be strengthened.

3.129 Consultancy facilities for thermal power plants are being provided by a number of firms in the private sector and by the Central Electricity Authority in the Public Sector. Some of the consultancy firms began their initial activities in collaboration with foreign consultants while some others have developed more or less independently in the recent past. This is an area in which first class foreign expertise could be relevant and if collaborations are sought by these companies they should not be refused. No State Electricity Board or other utility owner has the capacity to do the design and engineering work of a thermal power station by itself nor should it need to. However, it must have a group, experienced and trained in design work, to be able to interact with the consultant and bring to bear on the designs submitted, the practical experience it has gathered so that design weakness can be eliminated. While the CEA should not get itself involved in consultancy work, it should oversee the designs submitted by consultancy organisations and ensure that their work is up to expectations. Its consultancy wing should form the nucleus of a new public sector consultancy corporation, the Power Design and Consultancy Corporation as has been recommended in the Chapter on 'Organisation and Management'.

3.130 In the case of hydro-electric power development, the position is some what different. Quite frequently the State Electricity Board or Sate Government carry out the design and engineering work through their own departmental staff assisted by Boards of Consultants or Technical Advisory Committees of experienced senior engineers. A fairly large proportion of the consultancy work in the hydroelectric field, however, devolves on the CEA and CWC acting jointly (the former CW&PC). The reason for this is the high level of complexity of the site work requiring close interaction between the consultants and various governmental agencies such as the Geological Survey of India, the Meteorological Department, Forest and Irrigation Departments of State Governments and so on. It is of significance in this context that, even in a country like U. S. A., the execution of major hydro-electric projects including their design and engineering has been done by government organisations like the U. S. Bureau of Reclamation, the Army Corps of Engineers and the Tennessee Valley Authority.

3.131 The Committee recognises that creation of independent consultancy agencies will not be a simple task in the field of hydro-electric projects but that is no reason for allowing the 'status quo' to continue indefinitely. The weakness in the CEA and the CWC acting as consultants is that if they make a mistake, as all bodies are liable to do, there is no one to correct them. Similarly, any biases or idiosyncrasies which creep in, cannot then be corrected. There is already a public sector consultancy company (WAPCOS) in this field which is capable of being equipped in due course to take on such work. The Committee recommends that this company which currently reports to the CEA should become a part of the proposed Power Design and Consultancy Corporation and come directly under the Department of Power. At the same time one or two private sector firms could be encouraged to enter this field especially for mini and micro-hydels. Considering the number of hydel projects that are being envisaged there should be room for all. CEA/CWC should, as the highest level of experts oversee the performance of these organisations, provide training inputs, vet designs and generally function as an appellate body.

Transmission and Distribution Systems

3.132 In respect of transmission and distribution systems upto 220 KVA the State Electricity Boards are in a position to carry out most of the designs for their transmission and distribution systems. However, when it comes to 400 KVA systems and their successors like high voltage DC and 700 KVA systems there is need to provide exepert consultancy inputs. The real problems in the T&D field lie in the planning of the systems more than the detailed design of the various components. This has been dealt with in the Chapter on 'Power Planning'.

Load Despatch Centres and Engineering of on-line Computer Systems

3.133 The expertise for engineering system control centres with on-line computers is available in the country but requires augmentation. A large number of control centres will come up in the states and the regions. Some expertise is available in designing control centres in the CEA and one or two consulting engineering organisations. While utilising this expertise, the more complicated problems could be resolved by retaining as consultants, individuals and institutions like IITs who have developed specialisation in particular areas of load despatch including the hardware configuration, software development etc. Specific problems will have to be formulated before such advice from consultants is sought.

1.134 From the foregoing, it is clear that while there are pockets of expertise in different Boards, consultancy organisations, technological institutes, there are hardly any organisations which can provide comprehensive and contemporary consultancy services in all fields of power engineering. Reference has been made to the Committee's recommendation of creating Power Design and Consultancy Corporation which should have a consultancy wing for Transmission and Distribution. The CEA should identify which special tasks should be taken on by the wing so that the country has no gaps or areas of weakness in its consultancy services. This wing should then draw on experts within the country and go in for foreign collaborations where the need arises.

3.135 As regards nuclear power stations, the entire activity e.g., formulation of projects, appraisal, design and engineering and execution, is being handled by the Deparment of Automic Energy. It seeks specialised help from external agencies wherever it feels the need for doing so. No change in the existing arrangement is called for.

Use of Thermal Power Plant Consultancy Services

3.136 The role assigned to consultants varies from project to project depending upon the approach and attitudes of different project authorities. The Committee feels it would be useful to define the scope and role of consultancy services.

3.137 Consultants should be appointed at the very inception of the project. Their terms of reference should preferably include all the following areas of responsibilities.

(a) Site investigation
(b) Economic evaluation
(c) Feasibility Reports
(d) Detailed Design and Engineering
(e) Procurement specifications
(f) Vendor Rating and Tender Analysis
(g) Procurement
(h) Contract preparation
(i) Quality assurance
(j) Inspection and chasing
(k) Co-ordination
(l) Construction scheduling
(m) Construction supervision
(n) Start up and testing
(o) Preparation of Operation & Maintenance Manuals and Instructions
(p) Training of Personnel
(q) Guarantee Tests.

Once a competent consultancy organisation has been selected for the preliminary jobs it would be desirable to retain it for all subsequent operations also so that accountability and continuity is maintained.

3.138 Most of the Electricity Boards and other electricity enterprises in India have been using the services of indigenous consultancy organisations for their thermal power projects. The selection of the consultants has generally been on the basis of the tender system analogous to the system adopted in procurement of hardware. This is not considered to be a healthy practice. A High Level Committee appointed by the Government of India in 1966 had recommended 'inter-alia' that engagement of consultants and fixation of minimum fees should be done in acordance with international practice and that it would be harmful to the growth of professional and competent consultancy services in India if contracts were to be awarded on the lowest tender basis. The selection should be on the basis of proven professional competence and quality of advice offered.

3.139 To ovecome the problems of co-ordination of the many agencies engaged in putting up a big thermal station, some of the Electricity Boards have felt that turn-key contracts to be given to a manufacturer would be a answer In such contracts, the responsibility of co-ordination is merely shifted from the owner of the project to the manufacturer. A manufacturer who is undertaking a job on turn-key basis will not be manufacturing all the equipment himself and will have to buy many items from the market. His interests and those of the owners are likely to be in conflict and problems are inevitable and such turn-key controls are not desirable.

3.140 The Committee would reiterate that the appointment of a consultant does not absolve the management of the utility from responsibility for the timely and efficient execution of the project. A consultant's function is to do certain tasks and give advice. It is the job of the owner of the utility e.g. the SEB, its project divisions and the project manager to ensure that the tasks assigned to the consultant are properly done and that the advice it receives is critically examined.

CHAPTER IV

OPERATION AND MAINTENANCE

INTRODUCTION

4.1 The ability to make the best use of the installed generating, transmission and distribution capacity is crucial to the quality and quantity of power available in a system. As has been pointed out earlier the sub-optimal performance of the existing thermal generating units in the country has been the principal cause of the recent power shortage as well as the fluctuating and unreliable quality of power supply in the country. That there is considerable scope for improvement in the operational performance can be gauged by the fact that from the installed thermal generating capacity, an additional 15,000 million units of energy could have been generated in 1979-80 had the thermal units in the country registered the overall capacity utilisation or plant load factor (PLF) of 55.3% achieved in 1976-77. The actual PLF reached during the year 1979-80 was however only 45.4% and so far this year there appears to be no imporvement.

4.2 This has to be seen against the fact that the CEA has estimated (albeit crudely) that the energy shortage in 1979-80 was about 19,000 million units (see table 2.5). It would follow therefore that over 75% of the energy shortage during the year 1979-80 could have been overcome had the thermal plants worked at the same efficiency as in 1976-77. Although 1976-77 was a relatively good year, it was by no means a year in which all the plants operated at reasonable levels of efficiency. If the fairly modest norms of plant utilisation recommended by the Committee (58%/PLF) had been reached, there would have been practically no energy shortage in 1979-80.

Generation

4.3 It may be mentioned at the outset that the emphasis in this Chapter is predominantly on the working of thermal plants since operational problems have essentially been wide-spread and acute in these units. In general, the performance of hydel stations has not been a problem area and fairly effective utilisation has been made of the available water resources. During the year 1979-80, for instance against a targetted generation of energy of 45846 MUs for hydel projects, the actual hydel generation was 45494 MUs despite a bad monsoon.

4.4 On the nuclear side, during the year 1979-80, 2876 MUs of energy was generated against the target of 3300 MUs. Although the contribution from the nuclear power stations to the energy requirements of the country is only marginal, it makes a significant difference to the power supply in States like Rajasthan.

Transmission and Distribution

4.5 Due to lack of data, the performance of the transmission and distribution (T&D) system is harder to measure. Poor operation of the T&D system can take four forms—

(a) Failure to make the optimal use of the intra-regional and inter-regional links to maximise the generation of power. This is basically due to inadequate linkage and coordination between the power systems of the States.

(b) Poor quality of supply due to bad maintenance of distribution lines, transformers, switch gear etc.

(c) High T&D losses due to lack of supervision leading to leakages, thefts non or faulty metering of supply, failure to maintain and operate capaciters etc.

(d) Lack of load management and energy conservation.

THERMAL STATIONS

ANALYSIS OF PERFORMANCE

Attainable plant load factors (PLF)

4.6 Before examining the performance of the thermal plants, it is necessary to consider the maximum attainable capacity utilisation (plant load factor) in a given set of system conditions. The starting point is the plant availability which is dependent on the proportion of the time that the plant is shut for planned maintenance and for unforeseen break-downs i.e. forced outages. Taking into account international norms and the actual performance of thermal power stations in India, an 80% plant availability is considered a reasonable norms to work to i.e. for 20% of the time the plant will be shut down due to planned maintenance and forced outages.

4.7 Translating plant availability into attainable plant load factors for each plant is a complex exercise which requires a computer based analysis of partial break-downs, the shape of the demand curve, the timing and quantum of hydel generation, the merit order rating of the plant etc. to be carried out. In the absence of such studies, the judgement of the experts assisting the Committee is that 58% would be a reasonable all India average norms for thermal stations but this will vary from system to system. The difference between 80% and 58% should, in well run systems, be largely the result of lack of demand though a small allowance has to be made for 'partial unavailability' arising out of the full capacity not being generated due to unforeseeable break-down in parts of the plant, lack of fuel and so on.

4.8 The Table below gives an analysis of the actual performance of thermal plants on an All-India basis for the last seven years.

TABLE 4·1

Performance of Thermal Plants

Year	Planned maintenance %	Forced outages %	Plant availability %	Partial unavailability %	Lack of demand %	PLF %
1973-74 .	19·9	8·8	71·2	20·8	..	50·4
1974-75 .	13·2	10·5	76·3	23·6	..	52·7
1975-76 .	15·8	10·3	73·9	22·0	..	51·9
1976-77 .	9·8	13·2	77·0	14·4	7·3	55·3
1977-78 .	13·4	14·2	72·4	14·3	5·4	52·7
1978-79 .	14·3	14·7	71·0	16·2	5·3	49·5
1979-80 .	12·3	18·8	68·9	17·5	6·0	45·4

These figures reflect the generally poor state of thermal plant efficiency in India today. A 100% increase in forced outage in the last 7 years is a matter of grave concern. A particularly steep drop in thermal capacity utilisation has been observed in the last two years 1978-79 and 1979-80 mainly arising out of decreases in plant availability. The fact that 5% to 7.5% of the available capacity was lost due to lack of demand in conditions of severe power shortages indicates the scope there is for demand management and integrated operation of regional grids to which reference was made in the Chapter on 'Power Planning'.

4.9 One of the practices to which the Committee would like to draw attention to here is the tendency to declare as commissioned and make attempts to run plants which have not completed the full commissioning trials and to which reference has been made in the Chapter on 'Project Formulation & Implementation'. This practice could lead to serious damage to the plant apart from leading to law capacity utilisation. For example, of the 12 units declared as commissioned since April, 1978 totalling to 2010 MW, the loss because of inability of these units to give sustained rated output is 770 MW i.e. nearly 35%. The figures of PLF and other parameters would look less depressing if units which have not been properly commissioned were to be left out of the calculations.

Regionwise, statewise and plantwise performance

4.10 The performance record is however not the same for the various States and regions and there are very significant variations within regions and within States. The regionwise, statewise and plantwise analysis of the operations over the last six years is shown in Tables 1 to 6 and figures 1 to 6 in Appendix 4.1.

4.11 This analysis clearly distinguishes the Western Region from the rest of the country as having a plant availability well in line with the prescribed norms and steadily high capacity utilisation mainly on account of the low rate of forced outages. The PLF could have been still higher but for the un-utilised power available, especially in Gujarat which, had the inter-regional grids functioned well, could perhaps have been used elsewhere. Plants like Amarkantak in Madhya Pradesh, Renusagar in U. P. and Parli in Maharashtra performed at over 80% PLF.

4.12 The Northern region's PLF has been adversely affected by the poor performance of the thermal stations of Haryana and especially Punjab although their weightage in the total powe system is small in comparison with U.P. U. P.'s performance had been good till 1976-77 but has slipped badly since, with sharp increases in the duration of forced outages. Delhi also has not performed well after 1976-77.

4.13 In the Southern Region, Tamil Nadu's performance has been generally poor. Andhra Pradesh which achieved a record capacity utilisation of 70% in 1973-74 has slumped to 48% in 1977-78, 41% in 1978-79 and 42% in 1979-80. The fact that the Southern Region has one of the largest hydel peaking capacities in States like Karnataka and Kerala should make it possible, by integrated operation of the grid, to operate the system at well above the all-India norm of 58% for thermal stations as they can be run steadily as base load stations leaving the peaks to be taken care of by hydel capacity. Instead it will be observed that consistently 8-12% of the installed capacity has been lost due to lack of demand which underlines once again the importance of integrated inter and intra regional operations and the imperatives of moving away from Statewise operations of power system.

4.14 The Eastern region has been consistently at or near the bottom of the league both in regard to plant availability and capacity utilisation with the Bihar and Orissa thermal stations showing particularly low efficiencies. It is particularly unfortunate that the performance of the Eastern region is so poor because it contributes the largest quantum of coal for power stations. The poor capacity utilisation of the regions' power stations has affected coal production and hence adversely affected thermal power generation and the economic growth of the country as a whole. The consequences of an ineffective regional grid emerge from the fact that though the region was short of power in 1976-77, almost 13% of Orissa's power could not find an outlet. Here again, the existence of large peaking capability in Orissa ought to permit the thermal plants to work at high PLF's if they were efficiently run and the Eastern grid were operated as an integrated system.

4.15 The poor performance of thermal stations has been the subject of study by several Committees and Groups. Over 45 such reports were studied by this Committee of which special mention should be made of the Power Economy Committee Report (1971), the VGB Report (1977), Fuel Policy Committee Report (1974), Kulkarni Committee Report, periodic monitoring reports and publications of the Ministry of Energy/C.E.A., the NPC studies on coal beneficiation, the proceedings of the recent seminar in July, 1979 on thermal power plants in Obra, the proceedings of the Conferences of the State Ministers of Power, etc. Almost each power crisis gives birth to Committees to re-examine this problem.

4.16 The areas where action is needed are well known and not unique to power stations and apply to almost all complex modern manufacturing plants. These are supplies of adequate quantities of raw materials of acceptable quality i.e. coal, application of modern methods of preventive and planned maintenance of plant and equipment including instruments, ready availability of spare parts, greater delegation of powers to field personnel to get repairs and maintenance jobs done, proper training of operations and maintenance staff, high productivity and morale, harmonious personnel relations, good housekeeping and so on.

4.17 It is not as if these problems have not been faced and overcome by any utility companies in India. Operating under similar generation constraints as the rest of the State-owned power generation industry, many power stations in the State Electricity Boards of the Western Region, for example, have maintained a consistently high standard of performance year after year, which compares with the best in the world. Similarly there are private sector utilities whose record is also very good. The Committee is thus driven to the conclusion that although there are a number of specific actions which need to be taken to improve the performance of thermal stations as a whole, the real problem is bringing in competent, motivated and experienced people into top and senior positions in the Board and giving them the powers and support to get on with implementing the corrective measures referred to earlier. Recommendations in this regard have been made in the Chapter on 'Organisation and Management'.

4.18 In judging the performance of the thermal power stations the Committee feels that the last two years should be distinguished from the rest and in particular 1979-80 which has been the worst on record. The deterioration that has taken place is so rapid that it cannot be entirely due to the quality of top management because this has not charged so significantly although management morale is not high. After its discussions with the various Boards and other experts the Committee came to the conclusion that the external environment in which the power sector functions has been a major facor. The law and order situation in certain parts of the country, declining labour productivity, disturbed industrial relations and unsatisfactory relationship between State Electricity Boards and the Government, especially its political leadership, have contributed to the decline in efficiency. A new feature of the thermal power system is the increasing proportion of the generation capacity which is contributed by indigenously manufactured equipment.

4.19 There has been no systematic study of the quality and performance of imported versus indigenous equipment in relation to its performance in power plants. Taking note of the fact that even some of the well run Boards have complained about the quality of indigenously manufactured equipment, the Committee has carried out a quick analysis of how this equipment has performed in service.

4.20 Table 4.2 shows the proporation of capacity and energy contributed by indigenous and imported thermal units in 1979-80. Sets of 20 MW size and below have been excluded.

TABLE 4·2

Capacity and Energy contributed by imported and indigenous thermal units in 1979-81

	Capacity (MW)	Percentage Share	Energy (Mkwh)	Percentage share
Indigenous	7080	49·7	21,500	39·8
Imported .	7165	50·3	32,500	60·2
Total .	14,245	100·0	54,000	100·0

4.21 It can be seen from the above that the indigenous sets are contributing less energy than their share of capacity and they currently represent the only new equipment being inducted into the power system. It is essential therefore that this new capacity should perform significantly better in future if the energy shortage is to be overcome.

4.22 In order to probe this question further the performance of indigenous and imported sets for the last six years has been compiled and is shown in the following tables.

TABLE 4·3

Performance of indigenous power plants in India during the past six years (1973-74 to 1978-79)

	1973-74	1974-75	75-76	76-77	77-78	78-79
(1) No. of units . .	11	17	24	30	38	46
CAP (MW)* . .	710	1360	2080	2720	3530	4670
(2) POR % . .	23·60	14·61	14·82	8·81	16·10	15·84
(3) FOR % . .	18·05	21·02	21·60	32·96	28·29	22·48
(4) AR % . . .	58·33	64·37	63·58	58·23	55·61	61·68
(5) LLR % . .	..	..	0·40	2·51	0·53	1·86
(6) PUR % . .	18·67	21·14	20·18	14·73	17·26	18·71
(7) CUR % . .	39·66	43·23	43·00	40·99	37·82	41·11

TABLE 4.4

Performance of imported power plants in India during the last six years (1973-74 to 1978-79)

	1973-74	74-75	75-76	76-77	77-78	78-79
(1) No. of units . .	108	112	113	115	115	115
CAP (MW)* . .	6608·5	6818·5	6938·5	7178·5	7165	7165
(2) POR % . .	19·62	12·97	16·11	10·16	12·13	13·35
(3) FOR % . .	8·14	8·83	7·29	6·12	7·58	9·58
(4) AR % . . .	72·24	78·20	76·60	83·72	80·29	77·07
(5) LLR % . .	..	..	..	9·01	7·71	7·49
(6) PUR % . .	21·03	23·95	22·32	14·35	12·90	13 96
(7) CUR % . .	51·21	54·25	54·28	60·56	59·68	55·62

CAUSES OF POOR PERFORMANCE

4.23 It would appear from the above that the indigenous sets have a lower availability on the whole than imported sets. This may partly be due to the fact that the indigenous sets have come in relatively recently and are taking more time than anticipated to settle down. No general statement can, however, be made that all imported sets perform better than indigenous once and some, in fact, do significantly worse. There is, however, sufficient data to suggest that the better imported sets currently show superior performance to the indigenous sets even after the stabilisation period of the latter is over. The performance gap, however, appears to be narrowing with the more recently supplied indigenous 200 MW sets although they too still have to settle down.

4.24 A second point which has been brought to the Committee's attention and which perhaps partly accounts for the relatively low capacity utilisation is the reported inability of the indigenous 110 and 120 MW to operate at more than 90% of the name plate capacity, on a sustained basis. Here again either design changes will be required or else the rated capacities will have to lowered.

4.25 The Committee recognises the need for attaining self-sufficiency in the manufacture of equipment for power generation. Some of the collaborations into which BHEL and ILK originally entered were not entirely satisfactory and basic design deficiencies existed, as for instance, in some of the earlier boilers produced by BHEL. As a result, some collaborations have been changed and further efforts to improve the design are being made.

4.26 All major indigenisation plans involving sophisticated equipment do run into teething troubles even in developed countries like the USA and UK and some teething troubles in the performance of the initial sets were more or less inevitable. However, the Committee feels that the performance of indigenous units might have been better had the indigenous maufacturers bestowed more attention and care to quality control and application of more rigorous testing procedures during manufacture.

4.27 There is also no doubt that the rapid expansion of thermal stations has not been backed by a commensurate growth in the training inputs required to man them and the quality of operation and maintenance staff has declined while the

*Represents derated capacity which has been used for these calculations.

Abbreviations :

POR = Planned Outage Rate
FOR = Forced Outage Rate
AR = Availability Rate
LLR = Low Load Rate
PUR = Partial Un-availability Rate.
CUR = Capacity Utilisation Rate.

sophistication and complexity of the equipment to be operated has grown. Indigenous equipment has come in at the more sophisticated end of the power generation plants and is, therefore, suffering to some extent from being in the hands of insufficiently trained staff.

Linkage between users and manufacturers

4.28 One obvious lacuna in this respect appears to be the absence of effective linkages between users and manufacturers. The Committee feels that there is urgent need for close inter-action between the CEA, SEBs, NHPC, NTPC and their consultants on the one hand and BHEL, ILK and other indigenous manufactureres on the other, in order to speedily incorporate in the design of the equipment, the operational experience gained from the first few units of a particular design which has gone on line. The Committee recommends the setting up of a formal consultative machinery comprising senior representatives of the various concerned agencies viz the manufacturers, consultants/designers and the users to ensure that the experience gained from the units in operation is regularly fed back and incorporated into the design and manufacture of the new units. Such a consultative machinery should fuction preferably under the Chairmanship of Member (Thermal) of C. E. A.

Maintenance

4.29 The long felt demand that manufacturers should provide comprehensive instruction manuals for erection, operation and maintenance to the station staff should be met expeditiously. These should be prepared for different levels of operating staff so that operators and mechanics, supervisors, junior and senior officers are clear about what functions they are expected to perform.

4.30 The Committee has noted with concern the progressive dilution of maintenance standards in thermal stations for reasons of expediency. The C. E. A. review of thermal plant outages (1977-78) clearly brings out the disturbing practice of potponement of annual boiler overhauls (ABO) and capital maintenance (CM) of turbo-generators. The broad picture is presented in the following tables.

TABLE 4·5

Maintenance of Boilers

	1975-76	1976-77	1977-78	1978-79
1. No. of boilers and TG sets	137	145	153	162
2. Boilers under ABO	44 (32)	40 (28)	37 (24)	36 (22)
3. Turbo generators under CM	22 (16)	14 (10)	23 (15)	12 (7)
4. No. of days for boiler maintenance	68	42	37	40
28 days recommended by Kulkarni Committee)				
5. No. of days for TG maintenance	126	71	70	105
(45 days recommended by Kulkarni Committee)				

(Figures in brackets show percentages)

TABLE 4.6

Number of units in 1977-78 not overhauled for

	1 year	2 years	3 years
Boilers . .	30	23	39
Turbines	..	..	85

4.31 These tables point to a number of very disturbing trends which account for much of the problems of the thermal stations. Under the law, every boiler should be taken out for planned maintenance once a year and the figures corresponding to Row 3 in Table 4.5 should be 100%. The figures show that the position is deteriorating and the number of boilers and turbines which are long over due for maintenance is increasing. That 39 boilers have not been overhauled for 3 years (Table 4.6) is not only detracting from plant efficiency but presents a serious safety risk.

4.32 Although the time taken for boiler maintenance is coming down according to Table 4.5 there is no indication of the quality of maintenance. If forced outages due to boiler problems are not dropping the quality of the overhaul must be examined. The record on maintenance of turbo-generators is just as bad if not worse because a major breakdown in a turbo generator can be far more difficult to rectify than in a boiler and would take much longer to do and cost more. Turbo generators are to be taken out once every 3 years so the figures in row 2 of Tables 4.5 should be nearer 33%. In short, the maintenance picture is dismal-plants not being taken out in time, maintenance jobs taking twice as long as they should and the quality of work unsatisfactory.

4.33 It would be wrong to blame only the State Electricity Boards for this state of affairs. Many State Governments, in an attempt to avoid aggrevating shortages but without realising the consequences of what they are doing, refuse to let the SEBs take out plants for maintenance or insist that they are brought back on stream without the overhaul being complete and all the tests having been successfully carried out. There are also several other constraints which delay or affect the quality of the overhaul which are outside the perview of the SEBs and which are referred to later.

Forced Outages

Trend

4.34 The inadequate attention to planned maintenance has inevitable resulted in increasing forced outage rates of thermal units, reaching an overall figure of 14% in 1977-78. However, an overall figure of 14% in 1977-78. However, a significant proportion (over 60%) of this has been contributed by units commissioned since 1973-74 which continue to have high forced outage rates as the following table indicates.

TABLE 4·7

Forced outage rate for plants of different vintages

Year of commissioning	F.O.R. %
1976-77 . . .	32·55
1975-76 . . .	24·49
1974-75 . . .	41·00
1973-74 . . .	28·95
1970-73 . . .	14·06
1965-69 . . .	12·29
1960-64 . . .	6·64
1955-59 . . .	1·72
1950-54 . . .	2·54

The normal pattern would have been for the older plants which are wearing out to show high rates of forced outage but the reverse seems to be true in the case of power plants. One of the reasons is that the older plants though thermodynamically less efficient are smaller and less sophisticated and presumably easier to maintain and operate.

4.35 During the last 2 to 3 years the proportion of foreced outages caused by turbo-generators has become markedly higher than that contributed by others as the table below illustrates:—

TABLE 4·8

Contribution to forced outage as % loss of electricity energy

F.O.R. contribution	1975-76 %	1976-77 %	1977-78 %
Boiler . . .	41·2	33·77	35·18
Turbine . .	10·3	26·72	31·09
Generator . .	19·7	28·09	22·44
Others . .	28·8	11·42	11·29

4.36 The above trend is the result of teething troubles following the substantial addition of new capacity of indigenous manufacture which still has not settled down to stable operation even after 5/6 years of operation.

Recommendations of earlier Committees

4.37 The Kulkarni Committee (1975) which went into the modernisation of maintenance measures in large thermal stations made the following important recommendations:—

(1) A co-ordinated scheduled of overhaul of units in the system should be drawn up at the beginning of the year in consultation with the State/Regional load despatch station and the specialised maintenance agencies in the system.

(2) Meticulous and detailed planning of scheduled maintenance will enable substantial improvement in the speed and effciency of maintenance.

(3) Only those essential items of work which cannot be done while the unit is running should be included in the maintenance programme.

(4) Detailed planning of the maintenance work should be taken up far in advance of the actual scheduled unit shut-down.

(5) All the activities should be carefully assessed and put in the form of a PERT Chart to be able to plan and control the activities properly.

(6) The work must be organised in two full shifts using the third shift for preparatory work for the ensuing day and for completion of routine work, which does not require much skill.

(7) A group of a minimum of 4 engineers including the leader of the team and one engineer for the boiler, one for the turbine and one for the electrical and instrumentation should be exclusively put on the planning and execution of maintenance works.

(8) Advance action should be taken to assess and procure spare parts, manpower and materials required for maintenance sufficiently in advance, so that they are all available at site before the unit is taken down for maintenance.

(9) Continuous round-the-clock supervision by higher level personnel should be provided.

(10) Modern tools and appliances should be used to ensure speedy and high quality of work.

(11) Persons in charge of executing maintenance work should enjoy adequate powers to enable decisions to be taken on the spot to keep the activities going as per schedule.

(12) Management must take conscious steps to motivate and involve its staff in achieving the objectives.

4.38 The VGB Committee in addition drew attention to the very poor water quality and neglect of water chemistry.

RECOMMENDATIONS

MAINTENANCE

4.39 Most of these recommendations on maintenance practices remain as valid today as they were when these Committees submitted their Reports, as little progress has been made in implementing them especially by the Boards which need them most. It is recommended that they be pursued vigourously.

4.40 Although there has been some reduction in the average period required to overhaul boilers and turbines, the quality of the overhaul has not improved and a significant proportion of power stations showed a drop in availability after overhauling. The Committee would recommend that, while maitaining the time schedules, the steps required to improve the quality of maintenance be given special attention.

4.41 It is quite evident that units are not taken out for maintenance when problems are noticed e.g. boiler leakages but are continued to be run to augment power generation resulting in subsequent prolonged shut-downs. If station authorities are to be held responsible for over-all plant performance, the need for short plant outages particularly during week-ends and other off peak periods must be met in order that overall improvement in plant availability is achieved.

4.42 In addition, steps will have to be taken to see whether the entire thermal plant maintenance can be concentrated during the monsoon period when the hydel generation is at its maximum. For this to become practical, planned maintenance shutdowns will have to be held down to the prescribed 28 days for boilers and 45 days for turbo-generators against the 40 days and 105 days required at present. As a first step towards better planned maintenance, detailed data about forced outages during the preceding year should be analysed to enable to plant authorities to formulate future maintenance programmes.

4.43 On the basis of decisions taken at the 10th Conference of Power Ministers and Chairmen, SEBs, BHEL produced a manual for preventive maintenance along the lines prepared for Badarpur and circulated it to the utilities. There has however been no feed back information from States on the results achieved after implementation of the maintenance procedures recommended. The Committee would suggest that follow up action in this matter be taken up by the C.E.A. so as to evaluate the efficacy of the manual and to bring out such modifications or additions as are seen to the necessary on the basis of practical experience.

4.44 Finally, Boards must establish independent internal multi-disciplinary audit groups reportng directly to the General Manager/Chief Executive of the Plant to report independently on the quality and comprehensiveness of the planned maintenance operations.

Specialised maintenance groups

4.45 The annual maintenance of modern power plants including all the instruments and auxiliaries, is becoming an increasingly complex task technically and the creation of specialised task forces, which are given rigorous training in maintenance, systems requires urgent attention. Each station should have a group of such specialised group who could be deployed on annual overhauls, preventive maintenance and on force outage repairs. Depending upon the size of the Board's operations, expensive equipment or special tools required to attend to major break down and repairs can be held in a central place either in the State or the region and used by stations as required.

Dissemination and exchange of information

4.46 Although there are many common problems faced by thermal station, the opportunities for engineers, supervisors, specialists and skilled workmen to learn from each other are very limited. It is recommended that CEA arranges for exhange of visits between personnel of power stations having similar equipment and common problems of, say, coal quality, and also organises seminar on various aspects of plant maintenance. The Committee also observes that reports on subjects which are of direct relevance and interest to shop floor supervisory technical personnel do not reach them. Such reports should receive the widest possible circulation amongst the technical officers of the power industry.

SPARES

Availability of Spares

4.47 Non-availability of essential spares required for maintaining the equipment in good condition is one of the causes for poor availability of power units. The spares problem in the country is complicated because of different sizes and makes of imported, semi-imported and indigenous machines in operation. Some of the important instruments, controls and protective relays which are not in service because of lack of spares can lead to serious damage and prolonged outages.

Spares for Imported Machines

4.48 One of the major problems with imported equipment is the rapid rate of technological developments making some of the models/designs obsolete. Occasionally the manufacturer requires the user to abandon the old equipment and replace it by the new design or quotes a very long delivery period at exorbitant rates. In such circumstances, it should be possible to anticipate these problems and, before the stage of obsolescence is reached, orders should be placed for life time spares or for a long enough period to give ample time for indigenous substitutes to be developed. Because of their expertise in the field BHEL and ILK could provide assistance to indigenous manufacturers—in designs/material selection. This effort should be coordinated by Member (Thermal) of the C.E.A. in consultation with Technical Members of the concerned SEBs and manufacturers. In case the number of such units in large, e.g. the 14 Nos. of 62.5 MW sets imported under USAID BHEL could also, consider manufacturing some of the items as an import substitution effort.

Spares for indigenously manufactured units with imported parts

4.49 Local manufacturers like BHEL, AVB and ILK who make available units partly of indigenous manufacture and partly imported components have to be fully responsible for the timely supply of all spares for the units supplied by them. In cases where there are a number of similar units, the local manufacturer should import and stock such spares in a pool and supply them to the users as needed. In case of indigenously manufactured items also, the delivery period has to be improved since many Boards have reported the tendency on the part of manufacturer to concentrate on the production of complete equipment and not give adequate attention to the supply of spares although this may be causing loss of valuable power generation. This happens particularly in the period January to March when all efforts are made by manufacturers to meet the financial year's targets of physical production of complete equipment. Boards in their turn do not pay enough attention to the planning of spares procurement and as a result the lead time they can give to the manufacturer to import the spares is shorter than is required.

4.50 The Committee would like to emphasize that manufacturers must give the highest priority to the manufacture of spares and even let the regular output be curtailed if necessary. The CEA should, through its operations wing, ensure that SEBs place orders sufficiently in advance for them to be built into the manufacturers production programme and should monitor their production.

4.51 The concept of common pools of major spares for machines of similar design and capacity requires to be worked out in depth jointly by the CEA, the utilities and the manufacturer with the CEA taking the initiative. The manufacturer can then plan his production in such a way that a certain capacity is reserved for executing spares orders only. Also the CEA should be in a position to advise the station authorities of any new indigenous manufacturer whose quality they have checked and found to be satisfactory.

Ordering of Spares

4.52 Spares are classified as start-up, essential and insurance spares. The start-up and essential spares are the spares which have to be ordered along with the equipment in order that the critical components which are likely to fail or wear out quickly are readily available while commissioning and during the initial period of operation. Project estimates must provide at least 3% of equipment costs for these spares. The insurance spares are the spares that may be required at a later date for preventive maintenances overhauls after, say, 3 years' of operation and adequate provision should be made to procure them in time. Where there are a number of similar plants there is a possibility of pooling such spares as they tend to be costly ad contribute substantially to the money locked up in inventories.

4.53 The solution to the problems of spares has been much debated and most of the suggestions in this area including procedures for the ordering of start-up and essential spares, computerising inventories, the role of the maufacturer in supplying imported spares, assistance of organisations like Bharat Heavy Electricals Limited in indigenising imported spares etc. have been covered by the Advisory Committee constituted by the Planning Commission in 1972. As in the case of maintenance, it is the lack of will to implement them which appears to stand in the way. Like many of the problems in the field of operation and maintenance, it is again a question of the quality and dedication of the top management.

TRAINING

4.54 The Committee has drawn attention to the inadequacy of the quality and quantity of training inputs required at semi-skilled, skilled, supervisory and managerial levels in relation to the rapid growth of thermal power generation programme.

4.55 Availability of an adequate number of trained personnel for operation and maintenance of power stations; the T&D system and Load Despatch Centres is vital to the efficiency of operation of the power system and the reliability of supply. Realising this need, Thermal Power Station Personnel Training Institutes have been set up by CEA at Neyveli, Durgapur, Nagpur and New Delhi for training of personnel for operation. Some of the Electricity Boards such as those of U.P. and Maharashtra also have their own training schools for their staff. The training simulator developed at Trombay by the Tata Power Supply Company imparts training to operation engineers from SEBs and Utilities.

Training Institutes set up by CEA

4.56 At present two regular courses one for Supervisors, and another for Operators, are being run at each of the Institutes except at Durgapur which imparts training to operator level personnel only. The supervisory level course was expected to start at Durgapur by end of 1979. The basic qualification for supervisory level personnel is a degree in engineering while for operator level personnel, it is a B. Sc./I.T.I. Certificate/Diploma. The duration of the Supervisory level course is one year and the operator level course is 20-22 weeks depending on experience. Though each of the Institute has the capacity to train 50 supervisory and 100 operator level personnel each year, the number of personnel actually being trained by each institute has been much smaller as can be seen in Table 4.9 below.

TABLE 4·9

Training output of Institutes

Sl. No.	Institute	Year of commencement	Personnel trained (upto August, 1979)		Total	Averag of both categories trained per year.
			Supervisor	Operator		
1.	Neyveli .	1965	519	69	588	42
2.	Durgapur	1968	..	822	822	75
3.	Delhi .	1974	114	159	273	54
4.	Nagpur .	1975	67	53	120	30
	Total .		700	1,103	1,803	201

4.57 The primary causes of this poor output are said to be lack of facilities required to attract competent faculty, inadequate hostel accommodation and poorly equipped workshops. Steps are understood to have been taken for providing these Institutes with improved facilities along with proper buildings and amenities. The Committee would recommend that a special group be appointed by the Department of Power to study the shortcomings of the operation of these Institutes and make recommendation for making them effective instruments for training operators and supervisory staff who are the key personnel in the smooth operation of any power plant.

Requirement of Trained Operation Personnel

4.58 If used fully, the four training institutes set up by CEA could impart training to around 200 engineers and 400 technicians/operators every year. During the next ten years new capacity of the order of 4000 MW would need be added per year out of which at least 3000 MW would be thermal. The annual requirement of staff for these new units would be about 350 trained engineers and 850 trained technicians/operators for operations and maintenance. This clearly points to the necessity of augmenting training facilities and work on this should start immediately.

Requirement of Trained Maintenance Personnel

4.59 Since the present regular training courses are meant for operation personnel only, there has been a shortage of trained maintenance personnel for working on sophisticated power station equipment and this has contributed a great deal to poor equipment performance. The Committee recommends that special training course for supervisory maintenance staff should be instituted. These training courses should also be of one year's duration interspersed with a total of six months practical training at power stations and in the manufacturers works. Though separate courses for mechanical, electrical and instrumentation maintenance are required, the basic approach, objectives as well as the planning and management subjects would be common. In this context it should be noted that maintenance engineering is a multi-disciplinary area and substantial theoretical and specialised practical training is required to be given to fresh electrical and mechanical engineers which cannot be done by the Boards.

4.60 Discussions were held with the IIT Madras in this regard as they have evolved tailor-made courses for the aircraft industry. It is recognised however that the IITs are too few to cater to the bulk needs of the State Electricity Boards and such training has to be a joint effort by the Boards, the manufacturers and the academic Institutions through which all could benefit. It would, therefore, be preferable and feasible for the Boards to use the resources of the Engineering Colleges in their area and evolve suitable programme, utilising the assistance of IITs for drawing up the curricula in specialised areas.

Requirement of Trained Maintenance Craftsmen

4.61 The operator/technician training courses which are mainly oriented to operation will have to be augmented to cater for maintenance training. For this purpose individual State Electricity Boards, or in the case of smaller Boards two or three of them, could come together to set-up training schools for providing such training or use ITIs if they have spare capacity. Maintenance training workshops which it is understood are under consideration at the four Institutes to provide training in maintenance need to be put up expeditiously. Proper diplomas should be awarded, and possession of such diplomas should be an essential legal requirement for maintenance staff.

Short-term Refresher Courses

4.62 Short-term advanced refresher courses on subjects such as water chemistry, maintenance planning techniques, erosion and problems of power plants, performance monitoring etc. currently conducted by CEA should be held at more frequent intervals to cover a large number of officer level personnel. If necessary, separate institutional facilities can be set up for this purpose.

Training at Manufacturers Works

4.63 The State Electricity Boards and other utility operators should train the personnel intended to operate and maintain new power stations for at least one and a half years in advance of the commissioning date. Such people should be given a thorough grounding on the details of power plant operation and maintenance, followed by six months' practical training and familiarisation at the main manufacturers' works and feeder plants as well as with operating plants which use their equipment and six months' direct involvement with the actual testing and commissioning of the equipment which they are going to operate and maintain. This investment in training would be more than compensated by the delays/trippings/damages to the power plant which could then be avoided. The SEBs should ensure that the persons so trained are not transferred till full advantage is taken of their experience and training and there is a steady induction of trained staff to replace them when they do get promoted or transferred. This would mean at least 5 years of association with a particular unit in the same job. The SEBs/Utilities also need to ensure that the detailed O&M instruction manuals are obtained from the suppliers in advance to enable the staff to study and prepare check lists for each piece of equipment.

Simulator Training

4.64 To build up their sense of confidence and to test reactions to situations encountered in actual operation, simulator training has a major role to play in the training of operators and supervisors. This is being done at the Tata Centre at Trombay where 10-12 Supervisory level engineers are trained for operation during a 3-week course. To augment this facility and to cover the training of operator level personnel, a simulator is to be installed at the Delhi Institute. This is expected to be functioning by end of 1980. Even with this facility, the total number of trainees that can be accommodated would be about 250 per year and several more centres need to be established. These simulators can be locally built and programmed to take care of a wide range of operating situations and here again urgent action is called for.

On-the-Job Training

4.65 It is the practice in many power stations to train persons by putting them as understudies with the regular operating/maintenance staff. While this practice is sound and should continue, it is reommended that a training officer be appointed in each station for the sole purpose of co-ordinating all training inputs. Trainees need to be given orientation classes at which experienced staff members give talks on various subjects pertaining to the station, with flow sheets and interlock diagrams and simple operating models, as an aid to imparting the training quickly and effectively. They need to be taught how to anticipate problems and deal with emergencies.

4.66 In addition, the trainees could be exposed to practical training on some redundant power plants. Here the trainees could themselves do the jobs such as maintenance, cleaning, repairs, re-erection with their own hands under the supervision of experienced supervisors. This training should be mandatory for supervisors and management trainees so that they have the 'feel' of grass roots operations.

Statutory licensing for operational personnel

4.67 Another measure which the Committee would advocate is that statutory licensing should be organised by the CEA and REAs for all operations personnel (as suggested earlier by the Power Economy Committee) simliar to what obtains for boiler operators today. No station should be allowed to run with operator who have not been so licensed. This recommendation is all the more relevant now considering the increasing unit sizes and the high cost of a single operator error. Likewise personnel engaged on maintenance of power plants should be similarly licensed before they can be employed on maintenance work.

INDUSTRIAL RELATIONS—

4.68 As with the other sectors of the economy, management-labour relations in the power sector have unfortunately tended to deteriorate in the recent past and the industry has been severely hampered by go slows, indiscipline, strikes and other labour problems. Even the middle management in many Boards are strongly minimised and have added a new and difficult dimension to personnel problem. There appears to be, in many stations, very little sense of commitment to achieving high performance levels or any sense of pride in doing well the crucial jobs entrusted to them. The Eastern Region has in particular been very seriously affected by labour problems and some other Electricity Boards such as the UPSEB. have also faced acute industrial unrest. While the Government must provide a supportive environment by acting firmly and quickly in dealing with violence, intimidation, indicipline and go slow and inter union disputes, the main change will have to come from managerial initiatives aimed at a more participative approach to technical and human problems, instituting objective mechanisms for giving rewards and penalties and above all creating 'the esprit de corps' which is so sadly lacking in many Boards.

STAFFING—

4.69 The heavy overstaffing of Boards is a major deterrent to achieving reasonable levels of efficiency. As often happens, too little work often produces more operational problems than too much. The number of personnel employed per MW varies with various stations depending on the age, size, number of units in a station. The detailed norms for the staffing of power stations laid down by the Power Economy Committee (1971) form a good guide for new stations and would enable the surpluses to be readily quantified Fresh recruitment should be stopped till wastage; separations or growth absorb this surplus. The norms themselves should be periodically reviewed to take into account technological changes. The PEC also recommended a system of incentives and special pay for the generation cadre to attract and retain suitable persons. This is an area where quick action appears to be called for. Incentives for O&M staff to achieve higher plant availability should be based on past performance or on accepted international norms, whichever is higher.

PARTIAL UNAVAILABILITY—

4.70 Table 4.1 shows that the reduction in the load factor due to partial outages leads to more loss of energy than either forced outages or planned maintenance.

4.71 Measures to reduce the forced outage rates and improve planned maintenance are by their character, generally such as to show results only in the medium or long-term. While examining, therefore, measures which could bring in immediate improvement, it was felt that croser attention needs to be paid to obtaining the maximum generation from thermal plants operating as they are today. It has been observed that operating availability of thermal plants in 1978-79 was 71 whereas plant utilisation factor was only 49.5%. The difference of nearly 22% is due to either low system load or restricted generation from thermal plants. The loss of capacity utilisation due to low system load has been quantified to be only 5%. While this can and should be reduced, if not eliminated, when the inter-State/inter-region links are strengthened, regional load despatch centres and Regional Electricity Authorities are set up, the major thrust should be towards reducing partial unavailability.

Causes of Partial Unavailability

4.72 Partial unavailability can be conveniently divided into problems affecting three categories of equipment—main equipment, auxiliaries and the rest. Within each category there are short term constraints which can be rectified fairly quickly and those which could be tackled given careful advance planning at the time of the annual shut downs. The major faults in each of these three areas are :—

4.73 *Main Equipment*

Short-term—	Condenser tube leakage, air heater fouling, air leaks, fan vibration.
Longterm—	Damaged turbine blades, turbine vibration, blocked leaking tubes wear and tear on burners, crushers and mills. High differential expansion of turbine. High temp. in SH/RH resulting in tube failures.

4.74 *Auxiliary equipment*

Short-term—	Erosion in ID fans, minor repairs to feed water and other pumps. Condensor and other heat exchanger fouling or leakages/repairs to water treatment plants.
Long-term—	Poor quality of coal, wear and tear of mills, Inadequate capacity of auxiliaries like B. F. Pumps, ID fans, W. T. plant, air ejectors, etc.

4.75 *Others*

Short-term—	Fuel shortage, Hydrogen/Chemical shortage.
Long-term—	Inadequate transmisson line capacity, higher cooling water temperature than designed, old age of equipment.

Minimising Partial Unavailability

Short term

4.76 A 1977-78 review of partial unavailability identified that, of the 16% total partial unavailability in that year, 10.5% was due to defects which could be dealt with in the short term. It would have been possible for the different Electricity Boards acting in consultation with manufacturers and specialist consultants to take immediate remedial steps for rectifying at least these quickly removed constraints and this itself would have resulted into increased availability of the plant to the extent of 10%—a very considerable improvement.

4.77 A detailed study carried out by the Committee of thermal plants of 100 MW and above (44 units with a capacity of 5140 MW) which constituted about 45% of the country's thermal capacity revealed that on account of partial unavailbiliy energy equivalent to 1000 MW of capacity was lost in 1977-78. A substantial portion of this loss was on account of short term constraints considering the peak output the units were able to achieve on a sustained basis during parts of the year. It is estimated that about 600 MW of this loss could have been avoided if timely corrective action had been taken. For units below 100 MW, a rough estimate is that 300 to 400 MW could have been added to available capacity making a total of 1000 MW altogether which vigorously implemented short term measures could have added to the generation system.

Long term

4.78 It is estimated that there are 54 units in the country, installed prior to 1978, which have long term unavailability to the extent of 685 MW against their rated capacity of 3569 MW due to removal of turbine blades, inadequate coal grinding capacity etc. A further 46 units with a rated capacity of 4264 MW had external constraints in auxiliary equipment capacity due to faulty, due to inadequate coal supplies, water treatment systems insufficient, cooling water supplies, sub-standard quality of coal etc. resulting in a loss of capacity of 1045 MW.

4.79 With concerted efforts and marginal investments, it should be possible to increase the average output of these thermal plants by at least 600 MW by tackling the new larger sized units. Even if these units are available on line for only 70% of the total period, the additional energy contribution per year will be about 3700 GWH or 7% of the total thermal generation.

4.80 In the somewhat longer run, partial unavailability can be further reduced by 685 MW by tackling the long term constraints in thermal plants such as improving supply and quality of coal, turbine blade and redesigning of heat transfer surface in boilers, condensors etc.

FUEL SUPPLIES—

4.81 Coal will continue to be the basic fuel for the country's thermal stations for many more decades. However, the bulk of our coal reserves is of inferior grade and the limited reserve of good quality coal will have to be earmarked for other priority uses such as metallurgical industries. By 1982-83, about 96% of the thermal generation in the country will depend exclusively on coal. Thermal plants which presently consume about 30% of the total coal production will use about 35.7% of the estimated coal production by 1982-83. The availability and the quality of coal will thus play an increasing role in the operation of thermal power plants in the country.

4.82 The country has modest reserves of lignite in Tamil Nadu and Gujarat and the main problem here appears to be one of mining adequate quantities due to geolcgical and other problems. Power generation at Neyveli is constrained by the rate at which lignite can be mined. No problems of quality or logistics have been reported.

4.83 The Committee has examined the practicability of implementing many suggestions for improving the grade of coal delivered to power houses. Washing non-coking coal has many attractions but it is a costly process. As a result, its economics and the problem of what is to be done with rejects, poses serious problems.

Rejects may contain as much as 30 to 40% of the carbon in the original coal and because coal reserves are limited, it cannot be discarded. If the viability of coal washeries 'per se' is established, then along with them, must come pithead power plants to burn rejects even if these plants cannot be economically sized. Technologies for burning material with coal content of 40% or less will need to be developed. Such plants which could be put up using the rejects of existing washeries will also help to overcome the problem of coal production being hampered by inadequacies of power supplies from the grid.

4.84 It may not be possible for the coal industry to guarantee coal of the committed specifications to power stations indefinitely because although new sources of coal which meets their specifications can perhaps be located, linkages with power stations through the railways cannot be made totally flexible. Methods of designing and operating power stations efficienly with a fairly wide variation in the quality of coal may have to be considered. The Committee suggests the following corrective measures for two kinds of situations—

(a) Existing power stations which have been designed for low ash content coal but which are forced to burn high ash coal.

(b) New stations which can be designed to burn high ash coals.

4.85 In the existing power stations, the solution will vary with situations depending on the disparity in quality between the required and available coal and specific problems encountered on this account. However, in general the problems can be alleviated by ensuring a uniform coal quality to each power station. For this whatever blending is required, should be done by the collieries at the loading points. The collieries should also put in mechanical shale separating units and ensure that coal is crushed to the correct size before despatch. They should for the time being do as much selective manual picking of stones, shale, etc. as possible. The station authorities should monitor the coal supplies and representatives of the coal companies should be deputed to power stations to jointly check coal quality and quantities as received.

4.86 A few stations have regular mechanical coal blending facilities but many do not use them because the equipment is not working or the stocks of coal are so low that the equipment cannot be used. It would be better in such cases to reduce output and wait till stocks have built up till blending becomes possible. Where such blending facilities do not exist, blending by the use of bull-dozers could be tried out.

4.87 The systems and techniques adopted at Renusagar Thermal Power Station which manages to achieve high load factors with the same coal as is being supplied to many other stations, can be considered for adoption. This requires, 'inter alia', control over coal receipts, keeping in stock spare assemblies which are replaced instead of trying to replace the individual components and paying much greater attention to preventive maintenance techniques. Similarly, attention should be paid to use of better abrasion resistant materials (e.g. Ni-hard, stainless steel), for wearable parts of coal mills, coal pipes, ID fans etc. to the extent possible. Modifications in design such as increasing the size of ID fans, shielding of the vulnerable tubes, use of low speed mills, augmenting capacity of dust collection equipment either by additions or by flue gas conditioning should be done wherever possible.

4.88 For the future power stations, the boilers should be designed to burn high ash coals but additional design aspects that need to be considered are—the velocity of flue gas to be restricted to less than 10 m/sec; sharp bends in the flue gas path to be avoided so that erosion on account of high velocities is minimised; vulnerable areas such as bends in super heaters and economisers to be properly shielded; low speed mills to be used for pulverising as they give fairly constant size of output over a longer time period; coal pipes and bends to be lined with hard materials like basalt, ceramic, glass, etc.; adequate spare pulveriser capacity to be provided to cope with maintenance breakdowns and the size, capacity and number of ID fans to be increased to allow for more frequent maintenance. Slow speed fans should be provided to reduce erosion and vibrations; higher efficiency ESPs should be installed to maintain the specified dust concentration at the ESP outlet.

Transport and storage

4.89 In addition to poor quality of coal, recently many power stations have experienced problems due to shortfall in supplies of coal. The reasons for the shortage have been intensively investigated by the concerned authorities but unless concerted efforts are made by all concerned, the situation is likely to deteriorate. The coal requirements of power stations which are around 30 M tonnes per year at present are expected to increase to 113 M tonnes by 1987-88 based on the planned expansion of thermal capacity. While the bulk of the increased consumption is expected to come from pithead stations there will be some increase in the demand from thermal stations fed by rail.

4.90 The coal stocks at thermal stations away from pithead need to be built up to the minimum 30 days' requirements prior to the monsoons and maintained at this level. The concept of unit trains and coal movement by sea and inland water transport have to be seriously pursued. The feasibility and economics of movement of coal by pipelines has not yet been fully established. Organisations like EIL, which are taking the initiative in developing the capability to set up coal slurry piping systems should be encouraged to set up a few such pilot systems to get hard operating data. In particular, problems of erosion under Indian conditions, requirements of water, loss of efficiency due to increased moisture content of coal etc. based on experimental data using different types of coal need to be studied to establish the economics of this mode of transport in relation to movement by road, rail and sea.

DERATING, REHABILITATION AND REPLACEMENT—

4.91 The Committee has observed that there is a tendency to derate equipment without a careful examination of whether the equipment can, with suitable modifications and repairs, be restored to its original rating. The total capacity of sets of 20 MW and over which has been officially reduced by derating is 400 MW during the past decade but in practice the derating amounts to 2400 MW for reasons mentioned below. Putting in new facilities equivalent to a capacity of 2400 MW would require an investment of Rs. 1320 crores and take a minimum of six years. The Committee feels that the economics of measures to restore at least some of this capacity to its original rating requires to be given much greater consideration. This derating some of which is classified as partial unavailability is due to four broad categories of problems.

1. Units not being able to deliver rated capacity due to removal of blades, heat transfer surfaces, etc.
2. Units not being able to deliver full output for substantial periods due to constraints of auxiliaries e.g. coal grinding equipment, I. D. Fans, feed pumps, low quality of coal, etc.
3. Units which even when new cannot perform to rated capacity because of design constraints.
4. Units which, to be able to deliver to rated capacity, would need total replacement of major components such as the turbo generator/boiler.

4.92 As has been discussed in the section on 'partial unavailability', it is possible to restore category 1 and 2 derated capacities back to their original rating particularly if manufacturers like BHEL can devote their full attention to this task, and specialised multi-disciplinary groups are set up by Boards to tackle each derated unit in turn.

4.93 There comes a time, however, when technological developments giving higher efficiencies, rising costs of making very specialised components and non-availability of coal of a sufficiently high grade makes it economically advantageous to shut down an old unit and replace it with a new one. The magnitude of this requirement will increase within the next few years corresponding to the rapid expansion of thermal capacity in the sixties and should be allowed for in planning replacements.

4.94 In regard to units in categories 3 and 4, it has been brought to the Committee's attention that none of the 110 MW and 120 MW units supplied by BHEL has ever delivered their full rated output for sustained periods of say 2 or 3 weeks. The Committee understands that the CEA has recently appointed a Rating Committee which would 'inter-alia' carry out joint testing of these sets under ideal conditions. Based on operations at sustained load the correct ratings of the 100 and 120 MW set should be established.

"GRASS ROOTS" RESEARCH AND DEVELOPMENT—

4.95 Out of the major R&D inputs which the power industry needs is a thorough and deep study of the causes of failure and breakdowns in thermal plants. The contrast between the massive R&D back-up that nuclear energy plants are getting and the non-existent or negligible R&D inputs available to thermal plants is very marked, despite the fact that their relative contribution to the energy produced was in the ratio of 1 nuclear to 25 thermal in 1979-80.

4.96 R&D inputs are needed to supplement knowledge, available from the literature and the practical experience of operating plants, in the solution of some of the problems which bedevil the power industry. This could range from what to do about the high levels of ash and shale in Indian coals, problems of ash fusion, to water treatment and cooling plants, system optimisation studies including sub-systems such as rural electrification programmes and so on. This work should be farmed out to institutions like the IITs, CSIR laboratories and Universities. R&D work in public sector organisations like BHEL and ILK should mesh in with this to avoid unplanned duplication of effort in the same field.

HYDEL STATIONS

4.97 There are, relatively speaking, very few problems of any consequence when it comes to hydel stations. With an installed capacity of 10833 MW, hydel stations generated 47,000 GWH of power in 1978-79 as compared to 56187 GWH of thermal/nuclear energy generated from 14,888 MW of capacity. The Table below gives the performance of major hydel stations in different regions of the country and also for all-India in 1977-78.

TABLE 4·10

Output of selected hydel stations

	Design output in (GWH)	June to July GWH	Performance in %
All India	21,981	23,064	104·93
Northern Region .	5,580	5,966	106·92
Western Region .	5 796	5,837	100·70
Southern Region .	8,370	7,824	93·48
Eastern Region . .	2,235	2,088	93·42

Source : CEA.

Comprehensive unit-wise data on the operation of hydel plants is not available as it is in the case of thermal plants. Standardised formats have yet to be prepared which, apart from generation levels achieved, forced and partial outages, would cover efficiency parameters like water consumption/MW generated and capacity indicators like water stored, charging and depletion ratios etc.

4.98 The equipment associated with hydro-electric plants is generally of a reliable nature and is not normally subject to the kind of stresses and strains under which equipment failures usually occur. The generating equipment consists of slow speed machines as compared to steam turbo alternators and, therefore, it does not normally present any major operational and maintenance problems, provided that the equipment is properly designed and its quality is ensured during manufacture. In general, the performance of hydel stations has not been a problem area and fairly effective utilisation has been made of the available water resources. There are, however, some problems of recent origin which need to be referred here especially with indigenous equipment. For example while the Sharavathi generating station of Mysore Power Corporation has reported 95% availability with units Nos. 1-8 all of which were imported units 9-10 of indigenous manufacture had insulation problems which took nearly one year to overcome.

4.99 Such problems are, by an large, attributable to the lack of adequate quality control or material problems in the manufacture of equipment. For example, welded fabrication is now being made use of extensively for structural and dynamic parts and pressure vessel type of components. Failures of shop welded joints of even relatively simple items have taken place on hydraulic testing at site. Distortion of welded components has been noticed in a number of cases at the time of assembly for installation at site. Apart from welding, the insulation of generator windings, fabrication of bearing coolers and of guide vanes and links also give rise to problems. These occur due to failure of the lubrication and cooling systems apart from manufacturing defects. These defects can be overcome by modifying designs and improving quality control during manufacture. The Committee has recommended elsewhere the setting up of an independent quality control/assurance group to ensure that the manufactured items conform to agreed specifications and test. It has also been recommended in the previous Chapter that shop assembly of hydro generating sets should be done to the extent possible so that matching and assembly problems at site are minimised.

4.100 Despite their sturdiness and reliability there is still a need to carry out periodic overhauls and maintenance of hydro electric generation equipment to ensure trouble-free operation. This calls for specialised training to be given to the personnel working in hydro electric stations although it does not have to be as long as in the case of thermal plant personnel.

NUCLEAR POWER STATIONS

4.101 The operation and maintenance standards obtaining in the Tarapur and Rajasthan (Kota) Atomic Power plants have been fairly satisfactory although the energy generation at the latter has been below expectations. Elaborate training and certification schemes have been developed by nuclear power plant group in the Department of Atomic Energy which has helped them in developing well-trained operation and maintenance personnel.

4.102 Performance-wise, the achievement of the Tarapur Power Station has been satisfactory in spite of the fact that the units have had to be operated on several occasions at restricted output due to non-availability of fuel which has to be secured from abroad. Table 4.11 below brings out the operational indices of the two nuclear stations for the period 1974-75 to 1978-79.

TABLE 4·11

Performance of Nuclear Power Plants

Name of Nuclear Plant	Capacity of the nuclear plant (MW)	Year	Generation (MW)	Planned outage (%)	Forced outage (%)	Availability (%)	Partial unavailability (%)	PLF (%)
1	2	3	4	5	6	7	8	9
Tarapur Unit No. 1 . .	210	74-75	706	26	9	65	27	38
		75-76	1,114	20	0·05	80	20	60
		76-77	1,017	20	..	80	25	55
		77-78	1,103	10	9	81	21	60
		78-79	950	24	4	72	20	52
		79-80	735	37	..	63	23	40

TABLE 4.11—*Contd.*

1	2	3	4	5	6	7	8	9
Tarapur Unit No. 2 . .	210	74-75	752	37	10	53	12	41
		75-76	980	32	0·15	68	15	53
		76-77	1,141	24	..	76	14	62
		77-78	972	29	2	69	16	53
		78-79	1,336	12	2	86	13	73
		79-80	1,010	24	..	76	21	55
RAPP Unit No. 1 . .	220	74-75	748	20	29	51	12	39
		75-76	533	43	21	36	8	28
		76-77	1,095	3	21	76	19	57
		77-78	198	75	9	16*	6	10
		78-79	483	47	15	38	13	25
		79-80	1,131	..	26	74	16	58

*Industrial relations problem following shut-down for major repairs.

4.103 The performance of RAPP has obviously been discouraging. The low availability has in the past been due partly to an external reason, namely the poor security of the power grid to which the station is connected. The second unit at RAPP was completed quite sometime back but due to non-availability of heavy water, it has not been commissioned. The security of the Rajasthan power grid has in the past been low because the RAPPs capacity formed a high proportion of the system load. As a result, there have been a number of grid failures due to failure of the RAPP unit and the resulting loss in auxiliary supply from the system has prevented a quick re-start of the unit. The consequent poisoning of the reactor has caused considerable delay in restarting the unit. Steps have since been taken to see that its links with the northern grid are strengthened and grid security is no longer a serious problem. Some of the internal reasons for outages are the RAPP turbine which had failures of its 3rd and 4th stage blades. These have been replaced by blades of new design to avoid resonance with diaphragm impulse frequencies.

4.104 Lacking an independent source of expertise, the Committee has not found it possible to go in depth into the operational and maintenance practices of nuclear stations especially with respect to their reactors. As far as the rest of the plant is concerned the Committee generally feels that the operation, maintenance and house keeping standards achieved by the nuclear stations are worthy of emulation by thermal stations and the Department of Atomic Energy should organise suitable training programmes for operators and supervisors of utilities on the non-nuclear aspects of thermal plant operation and maintenance.

Safety of Nuclear Power Stations

4.105 Of late, there has been considerable public debate in USA and other countries on the environmental hazards that are likely to be associated with the operation of nuclear power stations. The Committee feels that, while these hazards should be given the most careful consideration in planning the nuclear power development programme in India, at this stage, the evidence does not suggest that the nuclear power programme should be stopped or even slowed down. Indeed, as indicated in the Chapter on 'Power Planning', it needs to be accelerated. What is, however, necessary is that an independent and expert agency outside the Department of Atomic Energy modelled on the Nuclear Regulatory Commission in the U. S. A., which will lay down and monitor the observance of safety standards for siting, design, construction and operation of nuclear power stations, should be set up and given enough 'teeth' to see to it that its recommendations are adhered to.

TRANSMISSION AND DISTRIBUTION SYSTEMS

4.106 The broad problem areas identified in respect of operation and management of the T&D system in the prevailing power shortage conditions and in which scope exists for improvement have been mentioned in para 4.5 namely :

(i) Full utilisation of available thermal capacity particularly in relatively light load periods
(ii) reliability of transmission and distribution systems
(iii) T&D losses
(iv) load management and energy conservation.

Regional Load Despatch Centres (RLDCs)

4.107 While there is urgent need for paying attention to deficiencies in the T&D system, it is necessary to keep them in perspective by taking note of the fact that the primary cause of power interruptions and poor quality of supply today is generation rather than transmission. However, if generation were to improve to, say, 1976/77 levels of performance, the weakness in the T&D system would begin to show up as is apparent from the fact that several plants have had to back down generation due to lack of demand in off-peak hours. In the absence of effective regional load despatch centres and detailed data on demand, it is not possible to quantify the extent to which shortages in regions at off-peak hours which could have been alleviated by the wheeling of this power. But the extent of capacity unutilised is shown in Table 4.1.

4.108 It is quite clear that Regional Electricity Boards are not playing as effective a role as they can in maximising power generation, partly because of the constitution of these Boards and partly because of the delay in constructing inter-state transmission lines and putting up regional load despatch centres (RLDCs). Only one RLDC is in operation viz. in the Southern region but its ability to optimise generation and ensure equitable allocation of shortages has not been entirely satisfactory. To overcome this, the Committee has suggested the creation of statutory Regional Electricity Authorities in the Chapter on 'Power Planning' and their functions have been described in the Chapter on 'Organisation and Management'.

Transmission and Distribution

4.109 In order to optimise regional T&D operations, a major pre-requisite today is a sound data base on the basis of which detailed load profiles area-wise can be drawn up. Steps required to create this base have been dealt with in the Chapter on 'Power Planning'.

4.110 A second important precondition for improving T&D operations is the determination of indices of performance in respect of capacity utilisation, line losses, power factor, breakdowns, etc. These are characteristics of a T&D system which can actually be measured.

4.111 In respect of reduction of T&D losses the major role is that of planning and design. The three aspects where improvement on the operation and maintenance front can be achieved are :

1. Metering of energy at all generating units, their station and unit auxiliary transformers, step down transformers at major receiving stations and interconnection points, etc. and metering of losses down to the village level. Considerable corrective action is possible even in H. T. transmission systems as has been mentioned in para 2.134.
2. Monitoring of losses at the divisional level and assessing the performance of the Divisional Engineer in respect of losses.
3. Vigilance squads for preventing pilferage of energy.

The rate of progress in implementing these recommendations, which have been made in the past by several Committees, has been very slow and needs to be speeded up.

Power Supply Reliability

4.112 This is an area where little effort has been made in implementing the Power Economy Committee's recommendations. This is evident by the lack of full data on the performance of major 220 KV lines, their protection systems, the interruptions to various categories of consumers and absence of investigative reports into failures in the transmission and distribution systems.

4.113 From the response received to a questionnaire issued by this Committee, the trippings of 220 KV/100 KV lines in the country appear to be far in excess of internationally acceptable standards and call for closer attention by the Boards. For instance, Tamil Nadu Electricity Board has reported trippings of 110/220 KV lines of the order of 5-7 times/100 KM/year. Orissa SEB has reported 17 trips/100 KM/year for 33 KV circuits. International experience is that trippings should not exceed 1/100 KM year for EHV lines and highlights the potential for improvement in this area. The reasons for line trippings could be insulation failures, absence of protection coordination, faulty design etc.

Remedial Measures

4.114 Among other measures, the recommendations of the Power Economy Committee included :

1. Use of underfrequency relays for automatic load relief. In Karnataka, it is reported that these relays which are designed for a 230 MW load are inoperative because of continuous low frequency operation;
2. line fault locators on all 220 KV lines;
3. continuous review of protection coordination;
4. preventive measures against bird faults;
5. quality control on supply of clamps and monitoring by infra-red temperature detectors, heat sensitive paints, etc.
6. Good communication systems/VHF equipment for speedy restoration of supply and attention to faults;
7. reporting of faults and their analysis, distributors analysis by load despatch centres;
8. good consumer relations and coordination so that industrial plant design takes into account quality of supply available in respect of voltage and frequency fluctuations, etc.

4.115 Substantial work remains to be done in implementing the recommendations in the above areas and the Committee would urge that the CEA, the proposed REAs and the SEBs should give these matters their close attention and prepare a time bound programme.

Frequency of operation

4.116 Despite general acceptance at all levels of their damaging impact on electrical machinery, low frequencies continue to be a problem area in many States and greater discipline needs to be exercised in maintaining frequency of operation between at least 49.5—50.5 cycles. Low frequency operation by some States has also place restrictions on integrated operation of inter States systems. Installation of underfrequency relays to cover a quantum at least equal to the size of the largest generation unit needs to be pursued.

4.117 In addition to measures designed to improve the reliability and the performance of transmission and distribution systems, there are certain other measures which would enable better utilisation of available capacity especially in the context of the current power shortages. These are load management, energy conservation and power factor improvement. These issues have been discussed earlier in the Chapter on 'Power Planning'.

Management Information Systems and data base

4.118 Consequent to the recommendations of the Advisory Committee of the Planning Commission in 1972, the Ministry of Energy has established a cell for continuous monitoring of the performance of thermal plants. This cell is working well and as a result comprehensive data on the unit-wise operating performance of thermal stations from 1973-74 onwards are readily available. No such action has been taken on hydel projects and the T&D system.

4.119 The Committee therefore strongly recommends that the national data base presently created by the CEA for thermal plants should be extended to hydro generating stations and transmission systems.

4.120 Data acquisition systems should be compulsorily incorporated into the designs of all new plants so that all the data required to monitor the operation of the plants and to give guidance to maintenance personnel is continuously logged. These will substantially bring down forced outage rates due to operator error as well as give early indication of likely equipment problems.

IMPLEMENTATION OF RECOMMENDATIONS

Standing Committee on Operation and Maintenance of Power Systems

4.121 It is suggested that instead of intermittent ad-hoc committees and seminars to discuss the problems, a Standing Committee of Members and Directors of SEBs and other utilities respectively who are in direct charge of maintenance be set up. Meetings of this Committee could be convened by the CEA periodically to discuss all issues relating to operation and maintenance of power system with participation by all concerned at the field level. The Annual Power Ministers Conference covers too many subjects for O&M problems to be discussed in the depth and detail necessary to come to concrete and detailed recommendations. Case studies should be prepared and these together with major issues could be discussed by expert sub-committees of the main Committee, correctional and developmental needs identified and workshops/courses conducted. Manufacturers could also be asked to indicate what plans they have for improving design and quality.

4.122 It is also suggested that the CEA publish in addition to the present very comprehensive data on plant performance, data on critical parameters like power generation/unit of BTU in coal, T&D losses, water levels in lakes, tariffs etc. Such public knowledge of performance data and investigations done, would on the one hand generate pressure on the Boards and station authorities for improving their performance and on the other, may restrain Governments from taking action which might adversely affect the efficiency and accountability of the Boards.

4.123 The Committee has pointed out earlier that many of the recommendations made in this Chapter have been made in the past but implementation has been poor and the question arises as to whether the same fate will befall the recommendations of this Committee.

4.124 Since power is a concurrent subject, implementation constitutionally can lie in the hands of both the Central and State Governments. If the Central Government concurs with the recommendations of this Committee, it should ensure that such of the recommendations as are applicable to its own activities, should be implemented forthwith. The scope for improvement in the operation of plants like Badarpur and DVC for instance is very considerable. As regards the States, the CEA, should in consultation with each Board draw up an agreed time bound programme for implementing these recommendations. Through their powers of sanctioning projects and releasing funds, the CEA, the Planning Commission and the Finance Ministry could link the progress on implementation of the recommendations with the exercise of these powers.

TAKE OVER OF STATE ELECTRICITY BOARDS

4.125 It has sometimes been suggested that State Electricity Boards which do not implement such recommendations as are accepted by the Central Government and whose operations continue to be unsatisfactory should be taken over by the Central Government till such time as they perform efficiently. In the Committee's view, such a step should not be taken to as it strikes at the root of the federal structure. In any case without the active support of the State Government, no such step is likely to succeed and in the Committee's view, any attempt to do so in the face of opposition of the State Government is doomed to certain failure.

4.126 There could be situations however, where the State Government itself may request the Centre to step in and take over the running of a plant or plants or even the Board as a whole. In such a situation, provided the Central Government is confident of being able to put together an adequately skilled and mature team of the kind required to rescue a sick utility, the Committee would recommend that the State's request may be met. However, considering the fact that the thermal plants currently run by the Central Government at Badarpur and the DVC are by no means models of efficiency, it would be necessary for the Central Government to first establish some credibility about its managerial prowess by making these two organisations run efficiently.

CHAPTER V

FINANCE, FINANCIAL MANAGEMENT AND TARIFFS

FINANCING THE POWER SECTOR

5.1 As already pointed out in the Chapter on Power Planning, there are two features which characterise the power sector in India and have relevance to the overall financial performance of the electricity supply industry. Firstly, the industry is increasingly capital-intensive. Secondly, the industry is growing at a much faster rate than the rest of the economy. Consequent to these two factors, the share of the power sector outlays has increased from 12% in the First Plan to 23% in the Draft Sixth Plan. About 85% of these outlays has been financed by the States and the share of the Centre has so far been small. Table 5.1 below indicates the proportion in which the power sector has been financed during last five years from internal and external sources. It is to be noted that State Electricity Boards have no equity base.

TABLE 5·1

Percentage distribution of contributions by (i) Internal resources, (ii) Government loans, and (iii) Other net borrowings (including market) for financing the total block Capital of the Electricity Boards

(Percentages)

Name of the SEBs	Percentage of annual contributions 1974-75	1975-76	1976-77	1977-78	1978-79	Cumulative contributions upto the end of 1978-79
1	2	3	4	5	6	7
1. Andhra Pradesh						
(i) Internal resources	28·4	40·4	24·1	14·2	19·2	18·0
(ii) Government loans	44·5	40·0	53·5	62·5	43·4	54·7
(iii) Other loans (net)	27·1	19·6	22·4	23·3	37·4	27·3
2. Assam						
(i) Internal resources	1·1	4·9	6·3	2·8	26·7	0·3
(ii) Government loans	46·6	13·1	33·5	72·9	50·6	63·0
(iii) Other loans (net)	52·3	82·0	60·2	24·3	22·7	36·7
3. Bihar						
(i) Internal resources	12·2	24·9	30·4	(—) 6·6	(—) 17·7	19·7
(ii) Government loans	24·8	35·2	31·5	54·6	65·9	48·9
(iii) Other loans (net)	63·0	39·9	38·1	52·0	51·8	31·4
4. Gujarat						
(i) Internal resources	26·4	22·4	28·7	16·7	18·6	24·8
(ii) Government loans	54·4	54·7	48·7	53·8	52·0	50·9
(iii) Other loans (net)	19·2	22·9	22·6	29·5	29·4	24·3
5. Haryana						
(i) Internal resources	13·7	12·9	15·5	11·1	1·6	10·7
(ii) Government loans	65·0	69·7	57·6	56·6	73·5	64·7
(iii) Other loans (net)	21·3	17·4	26·9	32·3	24·9	24·6
6. Himachal Pradesh						
(i) Internal resources	9·7	(—) 5·5	9·5	0.2	2·1	5·4
(ii) Government loans	37·2	48·0	48·9	60·3	60·5	64·8
(iii) Other loans (net)	53·1	57·5	41·6	39·5	37·4	29·8
7. Jammu & Kashmir						
(i) Internal resources	(—) 8·1	(—) 16·0	(—) 34·9	(—) 15·9	(—) 10·9	14·8
(ii) Government loans	56·6	59·4	60·9	50·7	52·8	58·7
(iii) Other loans (net)	51·5	56·6	74·0	65·2	58·1	26·5

TABLE 5.1—*Contd.*

1	2	3	4	5	6	7
8. Karnataka						
(i) Internal resources	56·7	71·3	69·2	64·3	76·0	34·2
(ii) Government loans	24·9	22·8	14·8	18·6	11·8	36·4
(iii) Other loans (net)	18·4	5·9	16·0	17·1	12·2	29·4
9. Kerala						
(i) Internal resources	6·7	15·3	41·8	42·3	42·8	24·9
(ii) Government loans	25·6	28·7	5·1	4·8	10·4	41·2
(iii) Other loans (net)	67·7	56·0	53·1	52·9	46·8	33·9
10. Madhya Pradesh						
(i) Internal resources	42·0	13·9	17·3	18·0	16·1	21·7
(ii) Government loans	15·6	58·0	57·4	53·1	61·0	53·8
(iii) Other loans (net)	42·4	28·1	25·3	28·9	22·9	24·5
11. Maharashtra						
(i) Internal resources	10·7	33·0	22·5	14·7	17·2	23·9
(ii) Government loans	47·2	42·2	71·5	68·8	71·1	55·3
(iii) Other loans (net)	42·1	24·8	6·0	16·5	11·7	20·8
12. Meghalaya						
(i) Internal resources	..	(—) 6·2	(—)36·1	0·9	10·7	10·4
(ii) Government loans	..	..	68·7	36·7	0·6	46·7
(iii) Other loans (net)	..	106·2	67·4	62·4	88·7	42·9
13. Orissa						
(i) Internal resources	24·8	36·3	22·0	9·8	15·7	12·1
(ii) Government loans	14·2	10·4	37·5	45·8	32·3	42·1
(iii) Other loans (net)	61·0	53·3	40·5	44·4	52·0	45·8
14. Punjab						
(i) Internal resources	4·4	12·8	7·5	22·0	1·5	9·1
(ii) Government loans	77·9	72·3	77·6	54·4	71·8	74·5
(iii) Other loans (net)	17·7	14·9	14·9	23·6	26·7	16·4
15. Rajasthan						
(i) Internal resources	32.3	39.8	34.9	22·8	26·7	19·8
(ii) Government loans	6.9	1.5	28·7	41·3	28·7	48·8
(iii) Other loans (net)	60.8	58.7	36·4	35·9	44·6	31·4
16. Tamil Nadu						
(i) Internal resources	63·3	77·3	44·5	23·0	26·5	34·2
(ii) Government loans	55·0	9·2	34·8	48·3	52·6	40·4
(iii) Other loans (net)	(—)18·3	13·5	20·7	28·7	20·9	25·4
17. Uttar Pradesh						
(i) Internal resources	9·5	23·6	20·9	10·8	19·6	1·3
(ii) Government loans	75·5	68·3	70·7	77·2	64·8	82·4
(iii) Other loans (net)	15·0	8·1	8·4	12·0	15·6	16·3
18. West Bengal						
(i) Internal resources	6.5	12·6	6·6	16·9	9·1	10·1
(ii) Government loans	22.4	35·4	35·6	41·3	49·6	41·9
(iii) Other loans (net)	71·1	52.0	57·8	41·8	41·3	48·0
Total all Boards (18)						
(i) Internal resources	19·5	27·7	23·3	15·8	16·2	16·9
(ii) Government loans	49·8	48·1	53·3	57·3	56·3	57·3
(iii) Other loans (net)	30·7	24·2	23·4	26·9	27·5	25·8

5.2 It is necessary to explain here as to what is implied by the term "internal resources". In accordance with the provisions of the Electricity (Supply) Act, 1948 (till it was amended in 1978), prior to meeting the liability on account of interest charges payable to State Government, the State Elctricity Boards (SEBs) were required to make specific transfers every year at the prescribed rates to the general reserve and depreciation funds. These "internal resources" were supplemented by items such as voluntary loan contributions from consumers, deposits from contractors, security deposits, employees' provident fund contributions etc. However, according to the amendment brought out in 1978 to the Electricity (Supply) Act 1948, the Boards are now required to meet their interest liabilities prior to transferring funds to depreciation. No revenues are to be transferred to the general reserve fund. These would, in effect, reduce the funds available to them as internal resources. The figures indicated in Table 5.1 do not reflect this position.

5.3 From Table 5.1, it is evident that the capital expenditure of the Boards is financed largely by borrowings from the State Governments and other institutional and internal resources represent a relatively small share of their investment and this share has been falling. In fact, the percentage contribution of the borrowings have increased from 80.5% in 1974-75 to 83.8% in 1978-79. As a result, the SEBs have, over the years, become excessively dependent on the State Governments. This is one of the important factors that has led to the dilution of the autonomy of the State Electricity Boards.

5.4 In the Chapter on Power Planning, an indication has been given of the magnitude of the funds that will require to be invested in the power sector over the next 21 years on two alternative scenarious. The first assumes that the present trends in the growth of demand will continue unaltered over the period and the second that less power intensive growth strategies will be adopted. The range of investments in power on these two assumptions will vary from Rs. 120,000 crores to Rs. 154,000 crores over the next 21 years at current prices.

5.5 The Committee is of the view that, both to generate the requisite resources and to restore to the Boards a measure of financial independence, about 50% of the annual investments in power on an average should be funded by internal resources. This would notionally amount to a debt equity ratio of 1:1 which is by no means too low by normal commercial practices. This would mean that of the Rs, 120,000 crores to Rs. 154,000 crores required for the power sector, approximately Rs. 60,000 crores to Rs. 77,000 crores would need to be generated internally. The feasibility of this will be discussed in a later portion of this Chapter. As things stand today, considering that the power supply industry as a whole is not in a position even to discharge its present liabilities such as interest payments, it will not be possible for the industry to meet this order of resource generation, even partially. To be able to do so, the industry will have to minimise its operational costs and rationalise its tariff structure. It is in this context that it becomes necessary to examine the financial performance of the power supply industry and to review its financial objectives with a view to securing its long term viability and its operational autonomy.

FINANCIAL PERFORMANCE OF UTILITIES

i) Financial provisions in the Electricity (Supply) Act

5.6 Prior to the recent amendment of the Act in June 1978, the Electricity (Supply) Act, 1948 had laid down in Section 59 that the Electricity Board shall not, as far as practicable, carry on its operations at a loss and shall adjust its charges (tariffs) accordingly from time to time. Revenue recepits of the Board constitute tariff revenues from sale of power and other receipts like licence fees, meter rent etc. in addition to subventions from the State Government under Section 63. Section 63 lays down that the State Government may, with the approval of the State Legislature, from time to time, make subventions to the Board for any purpose and on such terms and conditions as the Government may determine. The electricity duty levied by the State Government on consumption of electricity does not form part of the revenues of the Board. Revenue liabilities as per 1948 Act constitute operation, maintenance and management expenses, provision for depreciation, transfer to general reserve fund and interest on loans. Other resources of the Board like net borrowings from the Government and elsewhere, consumer contributions, security deposits, net accretions in funds including appropriations from revenue etc., form part of the capital resources of the Board for financing the capital outlays.

5.7 Section 67 lays down the order of priority in regard to discharge of revenue liabilities out of the available revenues of the Board during a year. According to this Section, the revenue should be utilised for meeting operating, maintenance and management expenses and after payment of tax on income and profits, the balance shall be distributed in order of priority for payment of interest due on loans raised from the market and financial institutions, provision for depreciation, provision for general reserve fund and payment of interest to the State Government, according to these priorities. In case revenues of a Board during a year are insufficient to meet these liabilities in full, contingent liabilities are created to the extent of shortfall by under providing for interest to the Government and depreciation. On the other hand, if there are surpluses after discharging the revenue liabilities fully (including contingent liabilities created so far), the balance could be appropriated to finance development activities or for repayment of loans advanced under Section 64.

5.8 The Electricity (Supply) Act, 1948 was amended in June 1978 to make the State Electricity Boards commercially viable and to earn a net return on their investments. Section 59 of the Amedment Act accordingly lays down that the Board shall, after taking credit for any subventions from the State Government, carry on its operations and adjustments tariffs so as to ensure that the total revenues in any year of account shall, after meeting all expenses properly chargeable to revenues, including operating, maintenance and management expenses, taxes on income and profits, depreciation and interest payable on debenutres, bonds ad loans, leave such surplus as the State Government may, from time to time, specify. In specifying such surplus, the State Government shall have due regard to the availability of amounts accrued by way of depreciation and the liability for loan amortisation and leave a reasonable sum to contribute towards the cost of capital works. The Amendment Act also enables the State Government to convert a part of the outstanding loans into equity capital under Section 12A, and in case any part of the loans has been so converted into equity, a reasonable sum by way of return on the equity capital may also be assured. Section 67 of the Amendment Act lays down the order of priority in regard to discharge of the cash revenue of the Board.

5.9 The present Act makes it incumbent on the Board to meet the current interest burden on all loans obtained by it, before making provision for depreciation. Though the Amendment Act specifically lays down that there should be net revenue surplus to finance the capital works, such amounts for each Board are to be determined by the State Governments from time to time. The Act does not specify what should be the rate of return to be achieved by the Board on its capital investment. The Central Electricity Authority, in a communication addressed to all the Chief Secretaries of the State Governments had in August 1978 directed that a percentage around 20 to 25 of the annual plan programme should be considered as an appropriate target of internal resource generation (after repayment of loans). So far, however, no State Government has specified the quantum of surplus to be achieved by any Electricity Board in accordance with Section 59 of the Amendment Act. Neither has any Government so far taken steps to convert any part of the outstanding loans of the Electricity Boards into equity.

(ii) Recommendations of various Committees on financial returns

5.10 The poor financial performance of Public Sector Electricity Undertakings has been and continues to be a matter of great concern for the Central as well as the State Governments. Various Committees have been constituted in the past and these bodies have made many recommendations to improve the operational and financial performance of the Electricity Boards. A Working Group set up by the Planning Commission in 1963 on Price Policy of the State Electricity Undertakings had recommended that the State Electricity Boards should earn a return of 12% (including electricity duty) on capital investments after providing for operating expenses and depreciation. The capital base was to be calculated on the basis of the definition given in the Electricity (Supply) Act, 1948.

5.11 The Venktaraman Committee, in its report of 1964, had recommended that the State Electricity Boards should earn a return of 11% on the capital employed, if not immediately, at least within a period of 10 years. This return was to be computed after providing for operating cost and depreciation but included receipts from electricity duty which were estimated to be about 1.5% of the capital. The net return was about 3% after providing for interest charges (6%), transfer to general reserve fund (0.5%), and after excluding receipts from electricity duty (1.5%), representing the revenues to the State Government. The Committee was in favour of capitalisation of interest charges during construction period if the Board was not in a position to meet the full interest liability.

5.12 In negotiations for assistance for power projects with external lending agencies e.g. the World Bank, a return of 11% (after operating expenses and depreciation) including revenue of 1.5% from electricity duty, on the average capital base has been mutually agreed upon. The average capital base, as defined by these agencies, represents the average of the 'total capital' at the beginning and end of financial year. The 'total capital' is to be computed as follows :—

(a) The gross value of fixed assets in operation;

(b) The cost of intangible assets; and

(c) An amount on account of working capital equal to 1/6th of administrative and operating expenses (excluding provision for depreciation) for the fiscal year ending on the date under consideration.

Reduced by

(i) The amount of accumulated depreciation charged on account of fixed assets in operation;

(ii) The amount contributed by the customers for fixed assets in operation; and

(iii) The amount of security deposits of consumers.

(iii) Returns achieved by the State Electricity Boards vis-a-vis these recommended by the Venkataraman Committee

5.13 The Venktaraman Committee, as already mentioned, had recommended that the State Electricity Boards should earn a gross return of 9.5% (excluding electricity duty) on the capital base after providing for operating expenses and depreciation charges. Today the average interest rate on Government as well as institutional loans is generally higher than the average rate of

6% assumed by the Venkataraman Committee about 15 years back and hence even if the Electricity Boards do earn a return of 9.5% on their capital base, the net return available for financing their investment programmes would be much smaller than the 3% envisaged. The following Table 5.2 indicates the rate of return achieved by each Electricity Board in the year 1977-78 on the average capital base as defined in para 5.12. The net return shown in Table 5.2 is before payment of tax and provides for operating expenses and depreciation only.

TABLE 5·2

Rate of Return in 1977-78 on average capital base of State Electricity Boards

Sl. No.	Board	Net operating surplus* (Rs. crores)	Average capital base (Rs. crores)	Rate of return on average capital base (per cent)
1	2	3	4	5
1.	Andhra Pradesh	29·70	389·90	7·6
2.	Assam	2·84	41·74	6·8
3.	Bihar	10·66	294·39	3·6
4.	Gujarat	32·21	334·50	9·6
5.	Haryana	12·56	192·10	6·5
6.	Himachal Pradesh	..	25·50	..
7.	Karnataka	14·18	167·00	8·5
8.	Kerala	20·40	241·80	8·4
9.	Madhya Pradesh	35·16	282·00	12·5
10.	Maharashtra	76·92	496·70	15·5
11.	Meghalaya	0·79	27·20	2·9
12.	Orissa	4·84	169·10	2·9
13.	Punjab	33·35	352·10	9·5
14.	Rajasthan	37·48	259·80	14·4
15.	Tamil Nadu	41·89	410·70	10·2
16.	Uttar Pradesh	3·37	853·50	0·4
17.	West Bengal	13·72	144·80	9·5
	Total (17 Boards)	370·07	4,682·83	7·9

Source.—Data furnished by the SEBs or CEA (Aug. 1979)

*Revenue receipts minus operating expenses and depreciation. Provision has not been made for interest, General Reserve Fund etc.

5.14 The preceding Table shows that only a few Boards e.g. Gujarat, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Tamil Nadu and West Bengal earned a rate of return of 9.5% and above on the capital base. Even here, the Boards of Tamil Nadu and Punjab had the benefit of substantial subsidies from the State Government in that year and in the case of Rajasthan in particular, the Board had taken credit for revenue arrears of Rs. 23.1 crores relating to previous years. Some of the Boards such as Bihar, Himachal Pradesh, Meghalaya, Orissa and Uttar Pradesh show a rate of return of less than 5% which would be inadequate to service even the cost of capital. For all Boards taken together, the rate of return based on the data available comes to 7.9% i.e. lower by about 1.6% than the rate recommended by the Venkataraman Committee.

5.15 This however is an over-statement of the return because the capital bases for many of the Boards shown in Table 5.2 do not represent the correct position on commercial principles, since works-in-progress which are excluded here from the base, often contain a portion if not all assets in a project which are actually completed and productively used. The omission is mainly the result of non-completion of accounting formalities such as the payment of a few bills. Likewise the depreciation charges at an average of 3.5%, are by modern concepts much too low. The operating expenses would also turn out to be more if all State Electricity Boards had followed the accrual concept in their accounting systems rather than the cash concept. In short the rates of return shown in column 5 of Table 5.2, if calculated correctly, would be considerably lower. The actual financial returns are thus much lower than the rates recommended by the earlier Committees and far lower than recommended for public sector undertakings i.e. 12-15% post tax return on shareholders' funds or 15% net return on capital employed.

(iv) Contingent Liabilities

5.16 One reason for the poor financial performance of the Boards was the working of the 1948 Electricity Supply Act which allowed Boards "to carry on their operations as far as practicable without revenue loss", as a result of which the authority vested with them under the Act for enhancement of tariffs was not adequately exercised. The Boards had also the option to default in the matter of payment of interest to the Government and in regard to provision for depreciation. Most of the Boards failed to discharge their interest obligations to the Government in full due to steep increases in the operating costs and the high interest burden on institutional borrowings. Some of the Boards even failed to provide for adequate depreciation in respect of fixed assets in use. The interest burden on works-in-progress imposed a heavy burden on most of the Boards. As years passed, the contingent interest liability of the Electricity Boards to the State Governments has gone up. This contingent interest liability did not attract any penal interest and was to be liquidated only in the event of revenue surpluses in future years. On the basis of data furnished by the Boards, contingent interest liability at the end of 1977-78 amounted to about Rs. 1,000 crores for all Boards together and exceeded Rs. 200 crores in the case of Uttar Pradesh and was about Rs. 100 crores or more in the case of Bihar, Punjab and Tamil Nadu.

5.17 Table 5.3 shows for eighteen Electricity Boards and the Mysore Power Corporation, the net revenue surpluses or losses for the years 1974-75 and 1977-78.

TABLE 5·3

Net Revenue Surpluses (+) or Losses (—) during 1974-75 and 1977-78

(Rs. in Lakhs)

Sl. No.	Electricity Board and M.P.C.	1974-75		1977-78	
1	2	3		4	
1.	Andhra Pradesh	(—) 171		(—) 70	
2.	Assam	(—) 599		(—) 548	
3.	Bihar	(—)1,793		(—)1,790	
4.	Gujarat	(—) 613		(—) 440	
5.	Haryana	(—)1,055		(—)1,423	
6.	Himachal Pradesh	(—) 217		(—) 491	
7.	Jammu & Kashmir	(—) 563		(—) 828	
8.	Karnataka	(+) 15	—64	(+) 16*	—1,038
9.	Mysore Power Corporation	(—) 79		(—)1,054	
10.	Kerala	(—) 829		(+) 85	
11.	Madhya Pradesh	..		(—) 256	
12.	Maharashtra	(+) 867		(+)2,080	
13.	Meghalaya	(—) 40		(—) 236	
14.	Orissa	(—) 425		(—)1,281	
15.	Punjab	(—)1,988		(—) 792	
16.	Rajasthan	(—) 774		(+)1,450*	
17.	Tamil Nadu	(+) 541		(+) 498	
18.	Uttar Pradesh	(—)5,798		(—)9,658	
19.	West Bengal	(—) 878		(—)1,060	
	Total Boards	(—)14,399		(—)15,798	
	(Surpluses)	(+) 1,408		(+) 4,129	
	(Losses)	(—)15,807		(—)19,927	

Source.—Based on the data furnished by the State Electricity Boards to the Committee on Power or as given in annual accounts or based on the data circulated by the Central Electricity Authority, Ministry of Energy, in August, 1979 in the document '*Financial Performance Review of SEBs during the 5th and 6th Plan period.*'

Note.—1. Net revenues take into account all revenue liabilitites including transfer to depreciation and general reserve funds.

2. Total losses for all the Boards shown in this Table include the surplus of Karnataka Board also in 1974-75, since there is a loss taking Karnataka Board and Mysore Power Corporation together.

*Before appropriations to investment allowance reserve fund.

5.18 The Committee would emphasise that care should be taken to avoid jumping to conclusions regarding the relative financial health and efficiency of different Boards on the basis of the data presented above on account of five major reasons, viz. differences as between States in

(a) financial concessions/burdens given to Boards by state Governments;

(b) generating and distribution costs;

(c) proportions of capital used for works-in-progress;

(d) rate of interest and proportion of loan capital financed by State Government; and

(e) accounting practices.

5.19 (a) Not all the Boards were placed in similar conditions for meeting their revenue requirements. Some of them had the advantage of securing subventions from the State Governments for meeting rural electrification losses partly or fully, while other Boards had to discharge such subsidies without any assistance from the Government. The Maharashtra SEB, for instance, enjoyed the benefit of interest moratorium on Government loans for a period of six years. The Board of Andhra Pradesh and to some extent the Board of Tamil Nadu enjoyed the benefit of non-levy of electricity duty by the State Governments.

5.20 (b) Different Boards have different hydel-thermal mixes, and hydel power, especially from old projects, is much cheaper than from newer projects. Secondly, conditions relating to population density, nature of the terrain to be served and the extent of rural electrification differ from Board to Board. Several States suffer from a locational disadvantage from the point of view of the distance over which the coal has to be hauled before it reaches the thermal power stations.

5.21 (c) Works in-progress constitutes a widely varying proportion to total block capital in different Boards, ranging from 17% of total capital in Andhra Pradesh to 34% for Madhya Pradesh and going to as high as 66% for Himachal Pradesh. The component of works-in-progress to the total block capital at the middle of 1978-79 is given in column 11 of Appendix 5.1. Works-in-progress does not earn revenue but still interest on it is payable. There is also considerable divergence between the approach to declaring assets as being in productive use. Owing to a lack of understanding or to present a better picture of return on capital, some Boards, as stated earlier, have included under the head "works-in-progress" assets which are contributing to production but on which some formalities regarding payment of residual bills remain to be completed.

5.22 As far as (d) is concerned, different Boards borrow different proportions of their block capital from their respective State Governments and other sources. The State Governments also charge different rates of interest on loans advanced to their Boards. Finance from other sources is generally obtained at higher interest rates as compared to State Government loans and market borrowings.

5.23 Lastly, coming to (e), accounting practices vary widely as no clear formats and definitions have been laid down centrally. There is also wide divergence between Boards in respect of what expenditure should be booked to capital and what to revenue. For instance, some Boards like Bihar, Rajasthan, West Bengal, etc., follow the practice of capitalising a part of the interest charges and even administration and establishment costs, while others put the entire burden on the revenue account. In several Boards, repairs and replacements such as wooden or concret poles used by distribution systems are booked to revenue; in others to the capital account. Some Boards follow the accrual concept while the others follow the cash concept. In the latter case, expenditure during the year is not fully represented in their accounts. This leads to non-provision of bills owing to contractors and suppliers making it difficult to correlate financial expenditure with physical progress. Another area which is responsible for creating uncertainties in the financial picture is the large scale transfer of materials from one division of a Board to another leading to internal disputes about the quantity and value of such transfers. The quantum of such disputed amounts runs into crores of rupees.

5.24 In the annual accounts of the State Electricity Boards, the losses shown in Table 5.3 are not explicitly presented as such, since the Act permits the Boards to under-provide for interest to the Government and depreciation in the event of revenues falling short of full obligations actually due to be discharged.

5.25 However, apart from these inter-Board disparities, the fact remains that many of the Boards had been suffering heavy revenue losses year after year. On the basis of information so far received from eleven Boards and the data obtained from the CEA for the remaining Boards, total revenue losses in 1979-80 after providing for operating expenses, depreciation and interest charges are estimated at about Rs. 350 crores.

5.26 One readily understood parameter is the extent to which each Electricity Board is losing financially in terms of each unit of energy sold. Table 5.4 indicates the average revenue per unit sold (excluding subsidy from the Government), average cost per unit and net revenue per unit derived in 1978-79. Losses of over 11 paise per unit sold in the case of large systems like U. P. are bound to act as a major drag not only on the finances of the Board and the State but on the economy as a whole.

TABLE 5·4

Average tariff, average cost and estimated net revenue per unit sold in 1978-79 (Paise per unit)

Sl. No.	Electricity Boards/ Corporations	Average revenue per unit sold			Average cost per unit sent out			T & D loss per unit	Average cost per unit sold (7+8)	Net revenue per unit sold (4—9)
		Tariff	Other receipts	Total* (2+3)	Variable cost	Fixed cost	Total (5+6)			
1		2	3	4	5	6	7	8	9	10
1.	Andhra Pradesh	27·6	4·0	31·6	14·3	9·9	24·2	7·0	31·2	(+) 0·4
2.	Assam	37·0	1·3	38·3	29·5	19·6	49·1	11·7	60·8	(—) 22·5
3.	Bihar	31·4	1·3	32·7	25·6	11·0	36·6	12·2	48·8	(—) 16·1
4.	Gujarat	28·1	1·0	29·1	16·8	8·6	25·4	5·6	31·0	(—) 1·9
5.	Haryana	24·0	2·7	26·7	12·1	11·7	23·8	6.3	30·1	(—) 3·4
6.	Himachal Pradesh	20·0	0·6	20·6	12·6	9·5	22·1	6.1	28·2	(—) 7·6
7.	Jammu & Kashmir	22.3	0·3	22·6	13·9	13·4	27·3	15.3	42·6	(—) 20.0
8.	Karnataka	20·9	1·1	22·0	11·2	3·5	14·7	4·1	18·8	(+) 3·2
9.	Mysore Power Corporation	3·0	1·8	4·8	3·4	4·8	8.2		8·2	(—) 3.4
10.	Kerala	16·7	0·4	17·1	9·3	6·0	15·3	2·0	17·3	(—) 0.2
11.	Madhya Pradesh	26·7	1·7	28·4	15·0	11·0	26·0	5·7	31·7	(—) 3·3
12.	Maharashtra	24·4	1·7	26·1	15·0	5·5**	20·5	4·3	24·8	(+) 1·3
13.	Meghalaya	19·0	0·4	19·4	12·5	22·9	35·4	3·1	38·5	(—) 19·1
14.	Orissa	14·9	0·5	15·4	11·1	7·2	18·3	2·8	21·1	(—) 5·7
15.	Punjab	20·0	1·6	21·6	8·7	13·5	22·2	4·9	27·1	(—) 5·5
16.	Rajasthan	24·4	1·6	26·0	15·5	8·7	24·2	7·2	31·4	(—) 5.4
17.	Tamil Nadu	28·3	0·3	28·6	19·5	5·8	25·3	5·9	31·2	(—) 2·6
18.	Uttar Pradesh	27·1	1·4	28·5	17·2	14·7	31·9	8·0	39·9	(—) 11.4
19.	West Bengal	28·0	0·8	28·8	20·4	11·2	31·6	4·1	35·7	(—) 6.9
20.	D. V. C.	20·9	0·3	21·2	13·4	4·9	18·3	0·5	18·8	(+) 2·4

*Excluding subsidy from State Governments.

Note. 1. Subsidies in 1978-79 are Rs. 5.37 crores for Kerala Board, Rs. 6·9 crores for Orissa, Rs. 12·15 crores or Punjab and Rs. 6.0 crores for West Bengal.

2. The average revenue and cost for MPC and Karnataka Board are not comparable with other Boards. MPC being the generating body sells power to Karnataka Board at low tariff as bulk consumer and the Board sells power to the consumers at higher rates. Cost of power for MPC represents the generating cost and the same for the Boards represents mainly transmission and distribution cost.

**Fixed charge is low due to interest moratorium on Government loans for six years.

(v) Rate of return for Central Electricity Undertakings

5.27 The three major Central Sector electricity undertakings are the Damodar Valley Corporation (DVC), the National Thermal Power Corporation (NTPC) and the National Hydro Electric Power Corporation (NHPC). The DVC has been a financially self-sustaining operation, earning returns which went up to 20% in 1977-78 before interest charges. During the last five years (1974—79), it financed 59% of its total investment through internal resources.

5.28 The NTPC and NHPC are relatively new Corporations who have recently taken over a number of departmentally run undertakings mostly under construction and two (Badarpur and Baira seal in operation). It is planned that NTPC and NHPC will earn a return of 10% on their equity before tax and dividends. The nuclear power stations under the Department of Automic Energy are expected to earn a return of 12% on total capital. The return on the Tarapur Automic Power Station, if treated as a separate accounting entity, has been about **16%**.

CAUSES OF POOR FINANCIAL PERFORMANCE

5.29 The poor financial performance of Boards is the result of several factors. Some of these are:

(i) Poor operating efficiencies

5.30 The performance of the thermal stations in particular leaves a good deal to be desired and the causes of this have been explained in the Chapter on Operation & Maintenance. Although it is of paramount importance that the utility companies improve their efficiency, the effect of this is not likely to have such a dramatic impact on the financial performance of the SEBs, as is sometimes supposed. For instance in 1976-77 when the overall plant load factor reached a record high of 55.3%, the highest for the last 15 years and when the power shortages were not unduly severe (5.8%), the SEBs incurred a revenue loss of Rs. 112 crores. The plant load factor, which the Committee feels would represent a reasonable level of efficiency in the Indian environment, is only 2.7% more viz. 58%.

(ii) High fixed costs

5.31 Fixed costs can be high partly on account of low out put, high inventories, and a variety of other causes. While the differences in accounting systems make direct comparisons difficult, Appendix 5.1 shows that administration and establishment charges varied from figures as low as 2.3 and 3.0 paise per unit in Gujarat and Maharashtra respectively to 6.4 paise in U. P. and 7.6 paise in West Bengal in 1977-78.

(iii) Tariff Structure

5.32 The two largest consumers of power today are industry and agriculture accounting for 64% and 14% respectively of the total energy sold. Generally speaking, domestic and commercial users, the two other categories of consumers already pay reasonably high rates. The major areas of subsidy are therefore industry and agriculture. One of the major beneficiaries of these subsidies to industry have been power intensive industries. Turning to agriculture, although the proportion of the total power consumed by agriculture is smaller, the losses on agriculture/rural electrification have been disproportionately high. Table 5.5 gives a Board-wise analysis showing the impact of losses of rural power supplies on the overall performance of the Board. It is apparent that the R. E. programmes have wiped out the surpluses from other consumers by incurring an aggregate loss of Rs. 157 crores (approximately) in 1976-77.

TABLE 5.5

Distribution of revenue losses of the Electricity Boards in 1976-77 Between Rural Electrification Schemes and other schemes

(Rs. lakhs)

Sl. No.	State Electricity Board	Net Surpluses/losses for the Board	Rural electrification losses	Surpluses (+) or losses(—) from operations other than R.E.
1	2	3	4	5
1	Andhra Pradesh	(—) 104	1,170	(+)1,066
2	Assam . .	(—) 232	N.A.	(—) 232
3	Bihar . .	(—)1,897	1,220	(—) 677
4	Gujarat . .	(—)1,233	1,200	(—) 33
5	Haryana . .	(—)1,214	1,440	(+) 226
6	Himachal Pradesh	(—) 418	N.A.	(—) 418
7	Jammu & Kashmir	(—) 730	N.A.	(—) 730
8	Karnataka .	..	N.A.	..
9	Kerala . .	(—) 324	51	(—) 273
10	Madhya Pradesh	(+) 146	1,070	(+)1,216
11	Maharashtra .	(+)1,346	1,640	(+)2,986
12	Meghalaya .	(—) 251	N.A.	(—) 251
13	Orissa . .	(—) 569	680	(+) 111
14	Punjab . .	(—)1,371	1,500	(+) 129
15	Rajasthan .	(+) 579	30	(+) 609
16	Tamil Nadu .	(+) 794	2,080	(+)2,874
17	Uttar Pradesh .	(—)4,763	1,370	(—)1,593
18	West Bengal .	(—) 936	430	(—) 506
	Total all Boards	(—)11,177	15,681	(+)4,504

Source : RE losses in 1976-77 are based on the information furnished by the SEBs to the Committee/data obtained from REC. For the Board's of Assam, J & K, Karnataka, Himachal Pradesh and Meghalaya RE losses are not separately available.

Note : (1) Surpluses or losses shown in this table take into account subsidy from the state Govt. in these cases where subsidy has been included in the receipt in the annual account.

(2) The net suplusses/losses provide for working expenses, interest, transfer to DRF and general reserve and other appropriations also in the case of Karnataka.

TABLE 5.6

Average cost of power supplied to L. T. consumers by SEB's and Tariffs for agricultural purposes in April, 1979

(Paise per unit)

Sl. No.	Name of Electricity Boards	Average cost of power at LT end		Agricultural tariffs in April, 1979
		Year	Average Cost	
1	2	3	4	5
1	Andhra Pradesh	1978-79	48.64	16
2	Assam . .	1978-79	48.93	21
3	Bihar . .	1976-77	51.22	7.4*
4	Gujarat . .	1976-77	33.23	23
5	Haryana . .	1977-78	26.10	20/22*
6	Himachal Pradesh.	1978-79	29.00	9—8
7	Jummu & Kashmir.		N.A.	10
8	Karnatka . .	1976-77	28.26	20—22
9	Kerala . .	1977-78	50—14	10
10	Madhya Pradesh	1976-77	49.14	16
11	Maharashtra .	1977-78	42.02	22
12	Meghalaya .		N.A.	17
13	Orissa . .	1978-79	68.79	16
14	Punjab . .	1976-77	36.70	12.5/17.4*
15	Rajashtan . .	1976-77	45.82	23/13.4 22.8*
16	Tamil Nadu .	1977-78	43.04	12—14
17	Uttar Pradesh .	1978-79	44.04**	16.1*
18	West Bengal .	1976-77	48.50	35

Source : Average cost at LT end is based on the information obtained from SEBs and REC.

* B.H.P. rate per annum converted to KWH rate assuming operation of 1200 hours in a year.

** 67 paise for rural areas.

5.33 Table 5.6 shows the average cost of supplying low tension power to urban and rural consumers together, because due to lack of data it has not been possible to calculate the cost of supplying the two groups separately. It also shows the large gap between rural tariffs and the cost of LT supplies.. As urban consumers represent relatively concentrated load centres, it can be safely concluded that the real cost of supplying the rural consumers is considerably higher than the figures shown in Table 5.6 as is actually the case with U.P.

5.34 There is an increasing tendency to shift from metered supplies to flat tariffs related to the horsepower of the pumpset used, on the grounds of administrative convenience, saving in cost of meters and overcoming the problem of theft. States like Rajasthan, Bihar, Haryana, Punjab and U. P. have adopted this system. In practice, however, in such States when power is available it is used far in excess of the few hours of operation on which the rate is calculated and in fact offers no incentive for conserving either power or water. When power is not available, it becomes an impost on a consumer for which he gets no benefit.

5.35 There are today no principles guiding the power tariff structure and decisions are made largely on grounds of political expediency coupled with some uninformed thinking on the correlation between cheap power and the economic development of a State. In particular, there is considerable evidence to suggest that in rural areas the beneficiaries of the power subsidies are the larger and more affluent farmers who could well afford to pay the real cost of their power supply. In most parts of India, diesel pumps are used where power is not available or supply is erratic and despite the fact that diesel pump set power costs more than Re. 1 per unit and involves higher capital and maintenance costs, farmers still regard it as a worthwhile input into their farm operations. The case for indiscriminate subsidies on rural consumers as a class has no rationale in a situation where the number of people below the poverty line is large and growing year after year are getting little or no benefit from such subsidies.

5.36 The stark reality of the current situation is that there have been sharp increases in the costs of all inputs going into the power industry—plant, wages, coal, fuel, oil, cement, steel, aluminium and transportation. Partly due to resistances from the State Governments or partly just lack of awareness of even relatively simple economic realities, the case for evolving a rational tariff structure has neither been studied nor does it seem to be a cause of concern, both to States and the SEBs. The realisation that, as things stand, the Centre has no option but to bail out improvident Boards has been a contributing factor to their financial indiscipline.

Transmission and Distribution (T&D) Losses

5.37 Although some Electricity Boards are showing a fall in T&D losses, the national trend is towards a steady increase (see Table 2.19 and Appendix 5.2). This has been the result of a falling emphasis on T&D in relation to generation over a long period and as a result of which the system is becoming increasingly inefficient. Included in these losses, there are many cases of thefts not merely of power but of electrical equipment like transformers and switch-gear belonging to State Boards.

Arrears of Revenue Collection

5.38 Systems of billing and collection in many State are slow and ineffective. Sums outstanding and payable to the SEBs in 1977-78 amounted to Rs. 309 crores. Besides delays in billing and collection, payments of bills by various bodies—even Governmental and public sector agencies—get tied up in legal disputes.

Delays in project implementation and commissioning

5.39 The substantial delays that take place in executing projects and commissioning has added substantially to the interest paid on works-in progress and led to significant increases in costs on account of inflation.

Poor accounting and management information systems

5.40 The absence of uniformity in the preparation of annual accounts, the obvious errors in computing profit and loss accounts, delays of more than a year in preparing balance sheets and the near absence of a Management Information System which can focus the attention of management at various levels on the critical problems facing the SEBs, brings one to the conclusion that most of the non-technical inputs that are required for the efficient running and management of SEBs are almost non-existent. Likewise there are no statistical or economic cells which can advise on matters such as pattern of load growth, tariff fixation, or carry out inter-division and inter-Board comparisons —all inputs which a Board must have to plan its growth, control costs and operate as an efficient and viable industry.

5.41 The fact that several SEBs report on a cash basis and not on accrual basis which is the accepted system for the preparation of all commercial accounts, is illustrative of this general lack of competence in the accounting organisation. The forms prescribed by the Comptroller and Auditor General also appear to go into unnecessary details as a result of which it becomes difficult to see the wood for the trees. For instance, the excessively detailed classification of the various parts of a power system for the purposes of calculating depreciation or the break-down of heads of expenditure into say the different kinds of poles to be used for distribution systems does appear to go into excessive detail for no good purpose. The reason for this lack of professional inputs, which applies to other aspects of the Board's working, probably arises from the fact that most Boards began as departmental undertaking and the financial objectives and practices of Government departments have persisted and no great effort to change them has been made.

RESULTS OF POOR PERFORMANCE

(i) Slowing down of investments in Power Sector

5.42 On account of the various factors mentioned in the preceding paragraphs, partly within the control of the Boards and partly beyond, the State Electricity Boards have been facing serious financial and ways and means difficulties. The recurring losses incurred by them even after two decades of their formation has placed a heavy burden on the State Governments.

5.43 The demand for electricity has been increasing all over the country and this calls for substantial investments. Successive Five Year Plans have placed greater emphasis on power development and allocated a growing share of the total public sector investments to power. Whereas in 1974-75, about 50% of the SEB's capital outlay had come from the States' resources by 1978-79, it had risen to 56% (see Table 5.1). This understates the impact on the States' resources, because of the rapidly increasing capital intensity of power projects. As a result, as compared to 1951-56 when only 19.8% of the State Plans were devoted to power, by 1978-79, this figure had risen to 33.2%. It is clear that any further increase in allocation of funds from the States exchequer for power will adversely affect the other priority sectors of development. The failure of the Boards to raise adequate resources has thus generally resulted in a slowing down of the pace of investment in the power sector. Power being an essential input for economic development, this has adversely affected the overall pace of economic development in the country.

(ii) Erosion of SEBs autonomy

5.44 Under the Electricity Act the Board has been given wide powers, both financial and administrative, and does not need to seek the concurrence of the State Government even in major items of capital expenditure, appointment and terms and conditions of service of all staff (other than the Chairman and full-time members of the Board), tariffs, revenue expenditure and so on. The Government can only give written directives to the Board on policy issues but what those 'policy' issues are have not been clearly defined. In practice however, the combination of a lack of job security of the full-time Board members including the Chairman and the need to go to the State Government for loans even to carry on their day to day business, has helped to reduce the Boards to a position of total subservience where the concept of autonomy, as it is commonly understood, has no meaning.

(iii) Transfer of Resources

5.45 At the behest of the State Governments, the Boards continue to supply electricity at subsidised rates to agricultural, industrial and other groups of consumers, thereby incurring heavy losses. These losses are partly made good by raising tariffs for other consumer groups, such as domestic and commercial consumers, but such cross subsidisation has been ad-hoc in nature and, as pointed out earlier, has not enabled the Boards to earn sufficient returns to finance their future expansion requirements or even to meet their revenue expenses in many cases. This situation has led to two anomalies. Firstly, the practice of cross subsidisation of tariffs has resulted in transfer of resources as between the different categories of electricity consumers without any clear principle being adopted and therefore its rationale can be questioned. Secondly, the inability of the Boards to earn adequate surpluses to meet their commitments has resulted in the requirements of the power sector being largely met from public taxation. This has led again to a transfer of resources from the tax payers (who are not necessarily all consumers of electricity) to those who consume electricity without the objective or principle underlying such transfers having been established.

(iv) Problem of attracting external finance

5.46 The low internal resource generation of the power sector could pose problems of finding sufficient resources for the sector from external sources. As already stated, there is a limit to the funds that can be allocated by Governments from the exchequer for power development considering the requirements of the other priority sectors of the economy. In view of this, the resources that are required for future power development may have to be augmented significantly by financial institutions within and outside the country. The funds that can be attracted from these sources will obviously depend upon the ability of the power supply undertakings to generate adequate returns on their investments. If the level of returns that are generated by the undertakings continues to be as low as it is now, it will become increasingly difficult for the undertakings to attract investment from financing agencies.

RECOMMENDATIONS

POLICY OBJECTIVES

5.47 Considering the circumstances that led to the poor financial performance of the electricity undertakings on the one hand and the challenge of having to raise massive resources for financing its future growth on the other, it is necessary to formulate clearly the financial and tariff policy objectives that should guide the working of the undertakings in the future. These may be set out as follows:—

(a) Financial returns should be adequate to sustain the growth of the utility without excessive dependence on external finance. Precautions have however to be taken to prevent monopolies like SEBs from exploiting consumers.

(b) Tariffs should be related to both costs and the consumers capacity to pay.

(c) Tariffs should discourage waste, promote only justified use of power and increase capacity utilisation by flattening the load curve.

(d) A distinction should be drawn between the role of a utility as outlined above and the policy of the State to grant explicit subsidies to special categories of consumers and levy duties on others as part of a wider socio-economic objective.

If accepted, these objectives may be incorporated into the Electricity Act so that the tariff and financial policies of Boards can be modified to meet them. These objectives are discussed in detail in the following paragraphs.

RATE OF RETURN

5.48 The State Electricity Boards, Central Sector undertakings, State departmental and other electricity undertakings should run on commercial principles and should earn a minimum rate of return on capital investments. In examining this issue, four questions, which the Committee has considered, are:—

(i) What should constitute the capital base on which a return has to be prescribed?

(ii) How should this return be calculated?

(iii) What should be the capital structure?

(iv) What should be the rate of return?

Each question is examined in the following paragraphs.

(i) Capital base

5.49 It is a well accepted principle that in calculating the rate of return, works-in-progress which do not contribute to income—should be excluded from the capital base. The present accounting practices, as mentioned earlier, classify as works-in-progress, capital assets which are completed and are productively used but in respect of which audit and accounting formalities are not over or which are a part of a larger scheme. The Committee recommends that the works-in-progress should be genuine and should not include an asset which is commissioned for production. Subject to this condition the capital base should be defined as the average at the beginning and the end of a financial year of the total of the gross value of the fixed assets in operation and cost of intangible assets and working capital to the extent of 1/6th of the administrative and operative costs for the fiscal year reduced by the amount of accumulated depreciation, consumers' contributions to fixed assets and security deposits from the consumers i.e. the same base as is used for calculating the return on external borrowings (para 5.12).

(ii) How should the return be calculated?

5.50 The return should be calculated by taking the gross revenue receipts of the Board consisting of revenue from tariffs, subsidy from the Government and miscellaneous receipts like meter rents, licence fees etc. (excluding receipts from electricity duty) and substracting from it—operating cost consisting of fuel cost, cost of power purchases, administration and establishment charges, operation and maintenance charges and Central excise payments and provision for depreciation of fixed assets in use; and dividing this net revenue figure by the capital base as calculated above.

(iii) Capital Structure

5.51 The capital structure of a Board should continue to have two parts viz. loan capital and own resources. The Committee is not at this stage in favour of any conversion of the outstanding loans into equity/share capital or future Government participation by way of share capital. An equity base may have some merits if there was a prospect of the Boards paying a dividend to Government or if it were to help the Boards to attract funds. Neither of these considerations applies because, for the foreseeable future, Governments will have to continue to make a contribution to the capital resources needed by utility companies and the absence of an equity base is not likely to come in the way of attracting external finances. On the other hand, there is a risk that, because there is no compulsion to service equity whereas there is a commitment to repay interest on loans, a conversion of loan into equity will optically improve the revenue picture of the Boards and will reduce the pressure on them to improve their financial performance.

(iv) Prescribing a rate of return

5.52 The Committee would recommend that the annual rate of return, based in the method of calculation as shown in para 5.50 should be 15% of the average capital base i.e. after providing for operating expenses and depreciation. On this basis the net returns of the Electricity Boards as a whole, which would provide the internal resources for the capital outlays, would be roughly 6%* of the average capital base (inclusive of internal resources) after meeting interest on the loan capital both in respect of the completed works and works-in-progress. The actual generation of internal resources will vary from Board to Board depending upon the proportion of the capital tied up in works-in-progress to the total capital. The gross return of 15% has been recommended on the assumption that the average composite lending rate (i.e. weighted average of the interest rates being charged by the Government and other lending institutions) to all State Electricity Boards taken together is 7%. If this interest rate should rise or is higher in the case of a particular State Electricity Board, then the return of 15% must be increased correspondingly. The reurn of 15% should be equally applicable to Central sector undertakings on the basis of the total capital employed (to be calculated in the same manner as for SEBs) but likewise adjusted for the rate of its borrowings. The figure of 15% which is prescribed by various Government agencies including the Planning Commission as a target return on capital employed, is by no means excessive considering the scarcity of capital and the need to find sufficient internal resources. The return should be exclusive of any electricity duty that the State wishes to levy but inclusive of any subvention made by the State Government in order to subsidise any class of consumer or any programme.

Effect of achieving the recommended rate of return on resource generation

5.53 The likely order of resources required for the power plan for the next 21 years has been referred to in para 5.5. An attempt has been made to work out what a return of this order would lead to in terms of internal resource generation during the next four Plan periods. Net internal resources from the industry on the basis of returns prescribed would amount to about 50% of the total investment in power sector in the last decade of the century. Internal resources include profits and transfers to depreciation reduced by interest liability (including works-in-progress) and repayment of loan liabilities. The position is shown in Table 5.7.

TABLE 5.7

Internal resources likely to be generated by the power industry during 1980-2000 AD for financing the Five Year Plan outlays on the basis of recommendations of the Committee

At 1979-80 prices

Period	Additions to capacity (MW)	Plan investment required (Rs. crevers)	Cumulative investment at the end of each plan (Rs. crores)	Net internal resources (Rs. crores)	Proportion ofnet internal resources to the plan outlays(per cent)
1	2	3	4	5	6
1980-85	20,000	18,140	37,140	5,312	29.28
1985-90	24,000	28,170	65,310	11,337	40.24
1990-95	28,000	39,780	10,50,90	18,(46	45.36
1995-2001	38,000	67,530	17,2,620	36,461	54.00
Total	11,(0,00	15,3,620			

These figures represent an aggregate for both the Centre and the States.

Interest on works-in-progress

5.54 The Committee has given serious consideration to the suggestion that utilities should adopt the conventional practice of capitalising interest on works-in-progress rather than debit it to the revenue account. The Committee has not favoured this because of the effect the commissioning of a large project would have on the tariffs if the principle of maintaining a constant return on capital is accepted. Projects, especially large super thermals and hydels, are becoming increasingly capital intensive and gestation periods are likely to increase. The effect of adding interest during construction to capital cost would require a further increase in tariffs when the project is commissioned. In effect, the non-capitalisation of interest amounts to present consumers partly bearing the cost of providing power for future consumers. However for purposes of cost control on projects the Committee would recommend that internally the Boards and other utilities should formulate project costs on the basis of capitalising interest charges, so that the financial cost of time over-runs is clearly brought out. At present only a few Boards, for example, Bihar, Rajasthan and West Bengal capitalise interest charges and the Committee recommends that the practice followed by the majority of the Boards today, of debiting interest on works-in-progress to the revenue account, be continued and other Boards should conform to this practice.

*Gross return of 15% *minus* 6.2% representing interest on capital base and 2.6% representing interest on works in progress.

Rate of Interest on Government Loans

5.55 An examination of the interest rates in regard to past and present loans advanced by the State Governments to the Electricity Boards shows that they vary widely from Board to Board and from time to time. The interest rates for the recent Government loans, for example, vary between 6% to 11% per annum. The Committee is not in favour of changing the terms of loans already taken. However, combinations of these variations with the varying proportions of Government to non-Government loans would mean that the average rates of interest at which Boards borrow would vary so widely that any attempt to get some broad uniformity in tariffs as between States would become virtually impossible. The Committee, therefore, recommends that all future Government loans to SEBs and other utilities should carry an interest rate which is 0.5% above the rate at which the State Government borrows from the market for loans maturing over a period of 10-12 years. The Central Government should also try and ensure that its own loans to Central Government undertakings are broadly in line with these rates of interest.

Contingent Interest Liability

5.56 To enable the State Electricity Boards to start on a clean slate, the Committee recommends that the contingent interest liability for each Board should be converted into an interest bearing loan carrying a rate of interest equivalent to the rate at which the State Government borrowed from the market during that year (for a loan of 10-12 years) plus 0.5% for servicing charges.

Provision for Depreciation

5.57 At present there is no uniformity in regard to provisions made by the Electricity Boards for depreciation on fixed assets in use. The form prescribed by the C.A.G. under the Electricity (Supply) Act, 1948 is cumbersome and ad-hoc provisions are made by the Boards taking various assets clubbed together. A scrutiny of the provisions made by the Boards in 1978-79 shows that generally provisions for depreciation varied between 3-3.6% of the total block capital. The percentage is below 3 in Haryana, Himachal Pradesh, Jammu & Kashmir and Meghalaya, and in Andhra Pradesh it is 4.2%. The Committee recommends that the C.E.A. should set up a Committee to examine this question in detail and prescribe a simplified and more rational formula for calculation of depreciation charges, more in line with normal commercial practice.

Receipts from Electricity Duty

5.58 The question of electricity duty being considered a source of revenue to the Boards was discussed with several Boards and has also been discussed by an earlier Committee. This Committee is not in favour of any mixing up of tariffs and electricity duties. Tariffs are prices and duties are taxes, though both are ultimately paid by the consumers. If the Boards are to have commercial viability and independence, tariffs plus subsidies should be adequate to yield the prescribed return. Besides, the purposes of taxation are many and varied such as curbing luxury consumption, raising revenues, encouraging substitution, etc. In a fast changing energy situation, taxation will have to play an important role. It would, therefore, not be proper to club together tariffs and duties as if both are going to serve the same purpose. Revenue from electricity duties should continue to be the resources of the State Governments.

Central Excise Duty on Electricity

5.59. Currently this duty although levied by the Central Government is passed on to the State Governments by way of share of excise duties. In computing the States' resources the 7th Finance Commission have taken this into account in the assessment of the State resources. The Committee recommends that the next Finance Commission may consider the proposition that these excise duty receipts should form a part of the resources of the SEB, and converted into an equivalent increase in tariffs.

Implications of a 15% return on present tariffs

5.60 At current levels of operational efficiencies, the implications notionally of a 15% return on capital employed would be a 40% increase in tariffs taking the country as a whole. The actual increase will depend upon the performance and existing tariffs of the Boards in each State and in some, a higher increase may be required and in others, less.

This increase could be moderated or future increases would be smaller if operational efficiencies could be improved and superfluous staff, excess inventories and all other contributors to costs could be curbed.

Exemption from Income-tax Liability

5.61 In terms of Section 80 of the Electricity (Supply) Act, 1948 an Electricity Board is deemed to be a company within the meaning of the Income-tax Act, 1922 and is liable to income-tax on its income, profits and gains. The Committee understands that so far no State Electricity Board has presented accounts which were liable to income-tax. Many of the Electricity Boards as well as State Governments have represented to this Committee that to enable the Boards to raise maximum resources for their investments, the Electricity Boards should be exempted from income-tax liability. The Boards have argued that the reluctance on the part of the State Governments to raise tariffs is attributable to the fear that the Board would become liable to payment of income-tax to the Central Government and hence the imposition of electricity duty to mop up surpluses. It must, however, be pointed out that if the Boards were to take advantage of the income-tax provisions relating to depreciation and development rebates, for a long time to come, they will not be liable to income-tax. However, to remove any psychological barriers to resource mobilisation that the apprehension of an income-tax liability may arouse, the Committee recommends that the Electricity Boards, through suitable legislation, be exempted from Income-tax.

TARIFF STRUCTURE

General Tariff Rates today

5.62 In general, tariff rates have not kept pace with the rise in costs and have lagged behind the prices of primary fuels such as coal and petroleum products including kerosene and diesel all of which are heavily subsidised. Table 5.7 below illustrates this.

TABLE 5.7

Growth in the price Indices

Year	All commodities	Coal	Kerosene	Diesel oil	Electricity
1	2	3	4	5	6
1961	100.6	100.0	100.0	100.0	100.0
1962	104.1	104.2	98.9	99.8	105.8
1963	107.9	110.8	126.4	123.6	112.2
1964	119.1	114.8	135.2	128.9	119.2
1965	128.9	120.4	141.9	117.5	122.3
1966	144.3	126.9	154.4	115.4	135.4
1967	166.0	141.3	154.8	119.3	137.8
1968	165.3	159.9	156.3	120.8	140.7
1969	168.8	164.7	168.8	122.8	143.4
1970	179.2	167.9	176.0	121.6	148.3
1971	186.1	169.1	182.8	126.4	152.9
1972	200.7	173.6	199.4	130.5	157.7
1973	239.3	189.7	214.7	139.9	161.5
1974	303.0	230.8	317.9	286.7	196.7
1975	309.2	288.0	354.1	324.2	230.8
1976	301.0	333.4	405.7	341.9	254.1
1977	326.1	333.4	405.7	341.9	269.7
1978	325.4	354.0	411.3	345.3	4.6

5.63 Likewise the failure of tariffs to keep pace with rise in costs is reflected in Table 5.8 below from which it will be observed that the cost as a proportion of the revenue has been going up from 69% in 1950-51 to 76% in 1975-76. The result has been smaller and smaller surpluses.

TABLE 5.8

Cost of energy and average revenue per unit sold

Year	Cost per kWh excluding purchase of electricity (paise)	Revenue per kWh sold to final consumer (paise)	Cost as a proportion of revenue (%)	Revenue per kWh (paise)			
				Industry	Agriculture	Commercial	Domestic
1	2	3	4	5	6	7	8
1950-51	4.5	6.5	69	4.7	N.A.	N.A.	N.A.
1960-61	6.4	9.1	70	6.6	6.3	N.A.	N.A.
1964-65	5.9	9.0	66	5.3	7.6	14.3	21.0
1969-70	8.2	12.4	66	9.1	13.8	N.A.	23.9
1970-71	9.0	14.9	60	9.7	14.2	N.A.	25.0
1971-72	9.9	13.9	71	9.9	14.4	25.1	24.8
1972-73	11.6	14.9	78	10.8	15.6	28.4	24.7
1973-74	12.7	15.9	80	11.5	16.0	27.2	26.0
1974-75	16.0	20.4	78	15.4	18.9	35.7	27.0
1975-76	17.4	23.0	76	18.8	21.9	38.8	29.0

Tariff Structure

5.64 The recommended objectives of tariff policy have been outlined in para 5.47. The question of the rate of return has already been discussed and a recommendation made. As regards the question of fair distribution of costs among consumers, the Committee would recommend two principles to be adopted. They are—

5.65 No single class of consumers (to be classified according to end use and the voltage at which power is received) shall be sold power at less than cost. 'Cost' for this purpose is to be defined as the costs of meeting all operating expenses plus the depreciation of the assets that can be allocated to each class of consumer, i.e. the interests on borrowed funds and return on capital can be excluded. It is recognised that this is not a strictly equitable allocation of costs as they vary according to the location and type of load even within a consumer category. The Committee is of the view, however, that such fine tuning of tariffs, while desirable, is not practicable. Within a State there should be one uniform tariff for each category of consumer.

5.66 Any consumer group or region which the State, for meeting its socio-economic objectives, feels should be sold power at less than this cost, specific written instructions to this effect should be given to the Board and the loss* on this account must be given as a specific and quantified subsidy to the State Electricity Boards. Such subsidies should form a separate item in the Budget so that the public is aware of the quantum of subsidies and its recipients and can be voted on by the Legislature. The Committee would recommend, however, that such subsidies should be made highly selective and wherever possible for a limited period of time.

5.67 Groups which in the Committee's view qualify for such subsidies are the really poor, small and marginal farmers, landless labourers, artisans and urban slum dwellers. Where subsidies are extended to electrification programmes in remote rural areas, in order to compensate the Board for the initial low load and heavy capital costs, these should be tapered off after five years or so when the load develops.

5.68 The Committee would emphasize the need to set up suitable administrative mechanisms for ensuring that subsidies for the poor do in fact reach the poor and do not go, as often happens with programmes for this target group, into the pockets of middlemen and affluent farmers.

5.69 Subject to the above, the Board should be left free to fix tariffs so that the overall objective of a 15% return on capital base is met. In working out such tariffs no hard and fast rules can be laid down but the following principles may be kept in mind :—

(a) Tariffs should recognise that peak hour consumption adds directly to the demand on capacity. By working on the principles of marginal costs scaled down proportionally to realistic levels, it is possible to ensure that consumers pay for power in relation to the cost of providing it.

(b) The capacity of the consumer to pay is taken into account.

(c) Conservation measures are given incentives. The importance of this has been referred later on in this Chapter.

5.70 In regard to (a) above, the Committee would recommend that time defferentiating meters be installed for all bulk consumers who take loads of 1 MW and above, so that their peak hour consumption and off peak consumption can be measured and charges levied accordingly. There is scope in most industries and the bigger commercial offices to minimise peak hour demand and if the price differential makes it worthwhile, the Committee believes that many consumers will respond and help flatten the load curve. Carrying peak hour tariff pricing to smaller industrial consumers or domestic consumers would involve heavy investment in equipment and manpower and is not worth doing at present.

5.71 Coming to (b) above, power charges (except in power intensive industries) usually constitute a relatively small portion of the total added value in industrial operations and increases in tariff should not affect their production costs significantly. Likewise domestic and commercial consumers who can afford to use air-conditioners, lifts and refrigerators and other electric house-hold appliances can be made to pay for these through inverted block tariffs, namely the larger the quantum of power used by a consumer the higher the rate.

Conservation

5.72 Reference has been made elsewhere to the need for encouraging conservation and curbing the wasteful use of power that takes place in many sectors of the economy. The Committee endorses the views of the Energy Policy working Group at that tariff structure should fully reflect the real economic cost of providing power to the consumer, so that the financial advantages of taking conservation measures, reducing waste and improving the efficiency of consumption of power become worthwhile. In fact in the case of several consumers, economic prices may not be enough to make the effort to save power worthwhile and still higher tariffs may be necessary.

Rural Tariffs

5.73 The Committee would draw special attention to the present high levels of tariff subsidies extended to farmers as a group. Studies, for instance, the agricultural census (1971) for U. P., referred to in the Chapter on Rural Electrification, show that the major beneficiaries of these subsidies are large and medium farmers most of whom can well afford to pay the full cost of power including the recommended return on the capital employed. Studies referred to in the Chapter on Rural Electrification show that the benefit cost ratio of electricity to the agriculturist who uses it efficiently is so high that even diesel power can be economically justified. The Committee, therefore, recommends that general agricultural tariffs must reflect the full cost of supplying power including the full rate of return.

5.74 As mentioned earlier, there is a strong case for administratively effective measures which give incentives for the small and marginal farmers, both for pump energisation and domestic lighting as also for the landless labourers and artisans but not for the larger farmers. Unfortunately the political will to take measures, which are mistakenly felt to be harmful to agricultural interests as a whole but are economically fully justified, does not appear to exist.

*(inclusive of loss of return).

Power intensive Industries

5.75 A significant class of consumers which require special mention are power-intensive industries which traditionally have had the benefit of excessively subsidised tariffs and in many cases still continue to do so. Amongst these are aluminium, are furnaces, caustic soda and calcium carbide. The Committee sees no justification in such subsidisation and on the contrary feels that it has led to power being less efficiently used than can be achieved with upto date technologies. It also tends to distort decisions on the priority to be attached to power intensive industries in the national planning strategy.

5.76 The Committee would recommend that subject to these guidelines the Boards should have some freedom to carry out cross subsidisation of consumers to suit its own load growth profile but on no account, except where explicit subsidies are granted by the State Government, should consumers be charged prices which are below cost.

Inter-State competition

5.77 The Committee notes with concern that States have been vying with each other in attracting industries to their States by offering subsidised power tariffs. This is ruinous to the finances of the Government/SEB's and the only beneficiaries are the entreprenures who really do not need them as, in fact, they place a much higher value on such things as the totality of the infrastructure, on the quality rather than the cost of power, the availability of skilled and managerial manpower, water supply and transport services, the access to raw metarials and the market, the industrial relations climate the attitude of the State Government to industry in regard to providing facilities and taking decisions quickly the law and order situation etc. The Committee would urge therefore that such subsidies should not be offered and that if a State insists on doing so it must be explicitly given as a subvention to the Board at a rate equal to the difference between the rates charged and the price, including the full return on capital as prescribed. and voted through the budget. It is only in highly power intensive industries that power costs become critical. If such industries tend to get located in places where power costs are naturally lower, this would, in terms of holding down prices, be a favourable development. In any case for large consumers like those pulling aluminium smelters the Committee has recommended in para 2.109 that they should be permitted to put in their own captive power plants.

Norms of Performance

5.78 The Committee has repeatedly been urged by various consumer interests that the in efficiencies of the SEBs and other utility companies should not be passed on to the consumer in the form of higher tariffs. The Committee recognises the merit of this argument and would, therefore, recommend that minimum norms of performance, which should be lower than the optimal norms, be prescribed for all aspects of the SEBs' performance. These norms would relate to its physical and financial performance i.e. capacity utilisation, consumption of fuel, staff costs, repair charges and inventory levels. Tariffs should be formulated on these minima so that the failure to achieve them reflects itself in a lower return to the SEB than has been recommended and likewise Boards which do better build up reserves faster and can expand more rapidly. In recommending minimum rather than optimal norms, the Committee has been guided by the consideration that losses or failure to generate adequate internal resources ultimately leads to an increase in burden on the general tax payer.

5.79 In order to arrive at a set of norms, both minimum and optimal, based on uniform principles and methodologies for utility compnies throughout the country, the Committee recommends the setting up of an expert group to be termed the Bureau of Electricity Costs and Prices (BECP) as an independent body under the Ministry of Energy on lines somewhat similar to the Bureau of Industrial Costs and Prices (BICP). This would be a multi disciplinary body consisting of economists, management accountants, tariff experts and electrical and industrial engineers etc. The BECP should be given statutory status to give it authority and prestige, though its reports would be recommendatory as far as the State Electricity Boards and the Central Government are concerned. The Bureau would be expected to evolve operating and financial norms on the basis of which a practical and sound system of tariffs could be evolved for different State Electricity Boards.

5.80 In addition to overall performance figures Boards would work out their cost structure in respect of various consumer categories on the basis of the guidelines given by the Bureau from time to time. The Bureau would have the authority to call for such records and make such reports as the Ministry of Energy may consider necessary. The tariffs evolved by the different State Electricity Boards would also be required to be shown to the Bureau, whose advice would be taken into account in finalising the tariffs. If the Bureau is manned with experts of the requisite quality and led by men of stature, it is expected that its recommendations would command respect from the legislatures as well as the Governments at the State and the Central levels.

Flat rate tariffs

5.81 A few States like Bihar, Haryana, Punjab, Rajasthan and Uttar Pradesh have adopted flat rate tariffs (based on H. P.) for agriculture. This tendency is gaining ground in other States also mainly owing to administrative simplicity. The Committee feels that flat rate tariffs invariably encourage wasteful use of energy as the marginal cost for use of electricity becomes zero in such a case. Moreover, such unmetered supplies make it impossible to measure the distribution losses of electricity in the system. A clear directive should be issued to all States not to adopt such flat rate tariffs in respect of any sector whatsoever and to tackle directly the administrative problems of enforcing metering. If the issue of such directives requires an amendment of the Electricity Supply Act, such changes should be. made.

5.82 Considering the far-reaching implications of tariff policy, the Committee recommends that the State Electricity Boards should greatly strengthen their commercial wing so as to be in a position to carry out detailed studies on the lines indicated above. This will obviously call for multi-disciplinary groups to be set up. Economists and accountants familiar with the subject should be inducted into the commercial wing of the SEB's and in addition, engineers should be provided training in costing and financial analysis to equip them to understand the objectives and principles of tariff formulation.

ACCOUNTING PRACTICES

5.83 In order to ensure that the utilities prepare and maintain their accounts in a uniform way, the Committee would recommend that the CEA form an expert group to prescribe in complete detail such tasks as how accounts should be kept, how budget should be prepared, how the internal audit should be carried out and set time limits for completion of various tasks. The changes which the Committee would like to recommend are :—

(a) Accounts should be presented on accrual concept and not on a cash basis.

(b) Assets in use should comprise all projects and works which have been completed and commissioned, though there may be accounting formalities, disputes in settlement of bills etc. still pending.

(c) Rational principles should be evolved and followed for classification of expenditure between revenue and capital.

(d) Costs of excess staff, on the basis of norms prescribed by the BECP, should be clearly brought out and the divisions of the SEB where such surpluses exist identified.

(e) The accounting heads should not only be terminologically uniforms but should also refer to the same items in actual practice. The ambiguity in regard to classification of items as between different heads that exists today should be removed.

(f) The Sections in the Act relating to disposition of revenues should specify whether they relate to discharge of cash or accrued revenues.

(g) Inter-divisional and inter-branch transfers should be immediately and properly credited to the relevant heads of account rather than shown under a suspense account.

(h) Accounts should exhibit cost of supplying electricity at different voltage levels.

(i) The annual accounts of the Electricity Boards should be audited and published within six months after the expiry of the financial year.

(j) Performance budgeting should be introduced by the Electricity Boards. The budget documents should include a Section on the financial allocations and actual expenditure incurred for various projects, schemes and works undertaken and also the physical targets and achievements. To start with, these details could be presented along with the budget in a separate volume, giving explanatory notes.

(k) Internal audit procedures should be modernised to move away from merely checking vouchers and looking for minor technical irregularities to examining procedures and systems which could reduce costs, plug major leakages or misuse of funds and improve efficiency.

To ensure that these practices are adopted uniformly across the country, the CEA should issue detailed guidelines and proformance to the SEBs and suitable amendments made in the Electricity Act, to get SEB's to adopt these practices.

INTER-STATE TARIFFS

5.84 Inter-State exchanges of power are a matter of increasing importance in the management of the power supply industry. The uneven distribution of power resources and requirements in the country between States has been discussed in the Chapter on Power Planning. As power planning has to be based on the concept of regional optimisation, the mismatch between power generating resources and power requirements in individual State systems is bound to increase in future and inter-State flows of power will grow. Exchanges of power will also not be confined as at present to transactions between State owned stations when centrally owned super thermal stations go on stream. It is, therefore, necessary to formulate some principles which could govern inter-State and Central tariffs so that power which flows from States and Central generation stations is priced on a rational basis.

Summary of recommendations of previous Committees in regard to inter-State tariffs

5.85 The principles that should form the basis for the fixation of inter-State tariffs were examined in the past by two Committees. The recommendations of one of these Committees set up in 1966 and headed by Shri K. Venugopal were, in brief, that inter-State tariffs should be based on the pooled cost of generation and transmission applicable to the selling Board. A two-part tariff covering fixed and variable costs was recommended in the case of all long-term supplies. In addition, in the case of long-term commitments exceeding three years, the tariff was also to provide for a 3% profit element. As far as restricted power supply i.e. peak/off-peak supply is concerned, it was recommended that it should be left to the parties concerned to negotiate a mutually acceptable tariff. In all other cases of inter-State exchanges, the tariff was to be based only on the variable costs. These recommendations of the Committee were by and large accepted by the Central Government, subject to some modifications in so far as they relate to the profit margins. While agreeing with the Venugopal Committee's recommendations in regard to the profit margin to be allowed in the case of long-term supplies, the Government felt that there should be similar profit margins allowed on a reduced scale in the case of the other categories of inter-State sales also. The Government expressed itself against the levy of any kind of duty on the sale of power between States. The Government further suggested that CEA should be the final authority to arbitrate on all disputes arising in regard to inter-State tariffs. However, in practice few of these recommendations have been implemented.

Present practices

5.86 The present guide-lines for inter-State transfers which have been evolved after discussions at meetings of Regional Electricity Boards, vary for different categories of transactions and are different from region to region. Appendix 5.3 gives these guidelines in tabular form. The Committee understands that very often these guidelines also are not always followed in practice. Cases have been noticed for instance where two States have made a barter deal involving the exchange of power for commodities such as rice, aluminium, etc. and quite frequently these decisions have been arrived at on political rather than techno-economic considerations. The Committee feels that it is important to evolve and enforce equitable and uniform practices in inter-State exchanges of power as well as to develop rational principles for the pricing of power sold by Central stations to different State systems. The objectives of such tariff fixation should be to encourage the flow of power between State systems so that the objective of integrated regional grid operations is facilitated.

Tariff fixation as between State systems

5.87 Inter-State exchanges of power can conceptually be divided into the following categories:—

(a) Long-term agreements (i.e. for more than one year) made by States with surplus generating capacity with neighbouring deficit States.

(b) Short-term commitments by States having a surplus capacity for a limited period.

(c) Economy exchanges between State systems covering—
  (i) Peak/off-peak exchanges;
  (ii) backing down of the thermal station in one State system to take advantage of cheaper energy generated in another thermal station i.e. merit order generation being applied on a regional basis;
  (iii) backing down of thermal generation to take advantage of spillage conditions in hydel reservoirs.

(d) Emergency/unplanned exchanges between State systems.

(e) Wheeling of power from one State system, to another State system, using the facilities of an intermediary third State system.

5.88 Before examining each category, the Committee would like to refer to its recommendation in the Chapter on 'Power Planning' that there should in future be no bilateral exchange of power between States. With the setting up of Regional Electricity Authorities (REAs), all power should be bought and sold by the REAs whether it originates in Central or State owned stations.

Long and Short-term exchanges for specified periods

5.89 In suh cases, the Committee recommends that tariff should be related to the highest incremental cost of generation of the selling State plus an element of profit to ensure a return of 15% on the additional facilities used including the relevant transmission facilities. The calculation of this return should be on the same basis as has been recommended for the SEB as a whole in para 5.52. The principle underlying this recommendation is that the selling system would not have generated power from its most expensive stations but for the necessity to produce power for another State. Broadly, this principle is covered by the traiff guidelines of the SREB and NREB at present, as will be seen from Appendix 5.3 but the EREB and WREB follow priniples of average cost of thermal generation plus profit and pooled cost (inclusive of non-thermal power) plus profit, respectively. The Committee cannot emphasise too strongly the need for uniform principles in all these respect.

Economy exchanges

5.90 As indicated earlier, economy exchanges are of three types, but the basic principle underlying these exchanges is the concept of optimal running of the more economical stations in the region as a whole to meet varying power demands. In pursuit of this principle, a thermal station in one State may have to be backed down for certain periods of time in the year in view of the availability of economical hydel power when reservoirs in another State are full and spilling. Another possible situation relevant when there is a genuine surplus of supply over demand could be where a thermal station in one State has to be backed down to ensure merit order operation as between thermal stations in the region. In both these cases, the Committee would recommend that the tariff should be based on the power cost of the selling station plus 15% rate of return on the capital employed or the cost of power that would have been generated by the station being made to back down in the buying system, whichever is lower.

5.91 The third category of economy exchanges consists of peaking assistance to a system deficient in capacity. Here also, Appendix 5.3 will show somewhat different principles being followed in the different regions. The assumption made in most of these guidelines is that the energy received by the buying system during the peak hours, will be returned during off-peak hours to the selling system. The general approach in the present guidelines of the SREB is to levy 50% of the annual charges of the previous year for the morning and evening peaks separately per KW based on the maximum demand touched during these peaks. There apears to be no economic logic in this form of tariff fixation. The Committee would suggest instead the following approach. The cost of supplying peaking energy by the sellling State should be worked out by adding to the total annual operating costs (i.e. depreciation and O & M) incurred by the peaking stations in the State for the previous year, a 25% return on the capital employed in this station and dividing this figure by the energy actually generated in that year by that station. This cost per kWh should thus be high enough to encourage the selling State to sell peaking power to States which lack peaking capacity rather than run their peaking stations as base load stations as happens today. It should also compensate the selling State for having to adjust its irrigation flows to meet demands for peaking power when the peaking station is a multi-purpose project.

5.92 The pricing energy returned by the buying State during the off-peak period should be based on the incremental variable cost of producing power from the stations which it would otherwise have backed down. In no case, for obvious reasons, should this price exceed the price at which peaking power was bought.

Emergency or very short-term assistance

5.93 The Committee agrees with the present approach being followed in the different regions, where emergency or very short-term assistance is returned in kind between systems. It should be emphasised that emergency assistance does not mean peaking assistance which has been dealt with already.

Wheeling of Power

5.94 The use of transmission network facilities of a State system to transfer power between two other State systems will assume increasing importance in the coming years. This will also be necessary in cases where new Central generating stations are going to utilise State transmission grids. If the Committee's recommendations are accepted, the REAs will own and operate the inter-State transmission lines and buy and sell power in bulk. The REAs should, for wheeling power, charge the receiving State rates based on achieving a 15% return on the capital employed.

Pooling of Centrally generated power

5.95 If the Committee's recommendation that the Centre should progressively have a larger role in power generation is implemented, Centrally generated power will increasingly form the largest and ultimately the only source of power that a State will be able to buy. Fixation of tariffs for Central power will, therefore, assume considerable importance. Now that the Centre will own and operate more than one station in each region, the Committee is of the view that instead of deciding upon the allocation of power from each station in isolation as at present, it would be desirable if the allocation is made on a pooled basis in each region for all Centrally generated power irrespective of whether it is from thermal, nuclear or hydro electric stations. This should apply even in regard to the allocation of power for which the Central Government might have already entered into commitments with the State Governments. For example, instead of apportioning the power generated from the Singrauli Thermal Station of NTPC among the different States in the northern region, it is necessary to cosider power generation from all those stations in this region which are owned by NTPC, NHPC or the Atomic Energy Department or any other Central Corporation and make allocations on a pooled basis. The Committee is aware that this would involve a review of the existing commitments made by the Central Government but such a review is considered desirable from the point of view of optimum operation of the Centrally-owned stations.

Pricing of Power from Central Generating Stations

5.96 Power being a key input into all forms of economic and social activity, the Committee considers that there is a case for aiming eventually at some degree of uniformity in tariffs throughout the country for each type of consumer. The few exceptions could be power intensive industries and subsidised consumer groups. One of the objectives of the Centre's role in entering in a big way into power generation would be to ring about such uniformity. The Committee therefore recommends that Central power should be sold at a uniform price throughout India to SEBs by pooling the costs of generation of all Centrally-owned stations. Here again, the pricing should be based on a 15% return on capital mployed subject to the same proviso as has een made for SEBs, namely, that they should chieve the minimum levels of efficiency laid lown by the proposed BECP. Such a policy if ccepted will eventually resolve the question of fixing wheeling charges as the cost of such wheeling will be built into the uniform tariff and shared equally by all States.

Private Sector Utilities

5.97 The financial return to private sector utilities should follow the general guidelines prescribed by the Government for fixing administered price i.e. they should be allowed to earn a 12-14% return after tax on shareholders funds on the basis of their achieving the prescribed minimum norms of performance.

Annual Review of Tariffs

5.98 There is in some quarters a view that tariffs should not be changed frequently—not oftener than, say, once in five years. The Committee sees no rationale whatsoever in this view. The costs of generating power are increasing rapidly both on the capital and revenue side as a result of domestic and international inflation. If the costs of even more basic needs such as foodgrains can be reviewed once a year as also other essential commodities such as cement and drugs, the Committee sees no reason why a regular annual review of power tariffs cannot be carried out, together with such mid-year increases that may arise out of increases in the prices of basic inputs such as coal and wages. Small and periodic increases are to be preferred to big increases after long time intervals.

CHAPTER VI

RURAL ELECTRIFICATION

INTRODUCTION

6.1 Ever since Independence the quantum of human and animal energy used in the rural sector especially in agriculture, that is being replaced by primary and secondary forms of commercial energy has been growing sharply. Table 6.1 below gives the figures for 1953-54 to 1978-79.

TABLE 6·1

Consumption of commercial energy in agriculture sector 1953-54 to 1978-79

(in MTCR)

	53-54	60-61	65-66	70-71	75-76	78-79
Coal	..	..	..	..	..	..
Oil	1·6	2·8	4·4	4·5	9·4	19·37
Electricity	0·2	0·8	1·9	4·5	8·7	11·95
Total Commercial Energy	1·8	3·6	6·3	9·1	18·1	31·32

Source :—Working Group on Energy Policy, 1979.

6.2 The agricultural sector's share of total consumption of commercial energy in terms of million tonnes of coal replacement (mtcr) has gone up from 3% in 1953-54 to 7% in 1975-76 and 11% in 1978-79.

6.3 Rural electrification covers a wider field than just power for agriculture. It includes, for instance, domestic and street lighting and power for rural based industries but by far the largest share of the power consumed in the rural areas goes to agricultural pumping sets.

6.4 Rural electrification, as a planned programme, was initiated in the country in the 1950s. In the early stages the emphasis was on electricity as a social amenity rather than as an input into agriculture and industry. The programme, which was confined during the first Five Year Plan to a very limited number of States, was stepped up sharply during the two subsequent plans and extended to all States, though not on the same scale. However, the progress made up to late 1960's was not significant. Till the end of the 3rd Plan (31-3-1966) electricity had reached only about 45,000 villages out of the total of 5.76 lakhs. The total number of pumpsets energised in the country was 5 lakhs at that time.

Emphasis on Agriculture

6.5 The drought period of 1965-67 resulted in greater emphasis being laid on energisation of pump sets, with the main aim of under pinning agricultural production. The investment on rural electrification during the five year period from 1966-67 to 1970-71 was nearly Rs. 450 crores which was far more than the total money spent on rural electrification in the first three plans put together. By the end of March 1971, the number of villages electrified stood at about 1 lakh and the number of pumpsets energised had risen sharply to about 16 lakhs. During the Fifth Plan (1974—79) the RE programme was integrated with the minimum needs programme and a target of covering at least 30-40% of the rural population in each State during the Plan period was adopted. At present, the objective of RE programme, which is now a part of the revised minimum needs programme, is to cover at least 50% of the villages in each State and Union Territory by 1988.

Agencies connected with Rural Electrification (RE)

State Electricity Boards

6.6 The primary burden of carrying out the RE programme rests on the State Electricity Boards. The uneven progress of RE in the country is partly due to the varying competence of the Boards, and the different orders of priority they have given to RE. There are widespread complaints about the poor quality of service provided to rural consumers by several SEBs. In some cases farmers have been compelled to switch back to diesel sets despite their higher initial and running costs.

6.7 An attempt to create a more decentralised pattern of RE has been experimented with and rural electricity cooperatives have been started in 5 States. The overall assessment of these cooperatives based on a study done in 1973 by the REC suggested that the more successfully ones provided a service to the consumers that was better than from the SEBs and construction jobs were done more expeditiously. On the financial side the cooperatives have not proved to be viable and the growth of RE cooperatives has been slow. Viability in such cases is however a relative term and although the cooperatives have not been viable in the strict sense of the term there is reason to believe that the losses would have been greater had the job been done departmentally by the SEBs themselves.

Rural Electrification Corporation

6.8 To finance the construction of rural feeders and energisation of pumpsets the Rural Electrification Corporation (REC) was set up in 1969. Besides funding viable schemes and subscribing to RE Bonds issued by SEBs, the REC guides and assists SEBs in identification and formulating schemes for different consumer groups; appraises such schemes, offers technical guidance and monitors the physical and financial progress of the schemes. It is also expected to promote rural cooperatives.

6.9 It was found necessary to augment the funds required for carrying out the pumpset energisation programme and such funds are now found by loans from organisations such as the Agricultural Refinance and Development Corporation, Commercial Banks, State Land Development Banks and by floating rural debentures.

6.10 Establishing the availability of ground water, on which the programme of pumpset energisation is based, is the responsibility of the Central and State Ground Water Boards. Disregard of the advice of these expert bodies has led on occasions to over-exploitation of ground water and infructuous expenditure as wells run dry or, when it comes to coastal areas, wells become saline.

Outlays on Rural Electrification

6.11 The increasing emphasis on RE has led inevitably to sharp increases in outlays for the RE programme during successive Plan periods as indicated in Table 6.2 below:

TABLE 6·2

Investment on Rural Electrification

(Rs. crores)

Period	Financial outlay for power sector	Investment on Rural Electrification
1	2	3
First Plan . .	260	8*
Second Plan . .	460	75
Third Plan . .	1252	153
Three Annual Plans . 1966-69	1209	237
Fourth Plan . .	2932	819**
Fifth Plan (1974-78) (4 years)	5244	842@
Sixth Plan (1978-83)	15112	1699@@

Source.—Planning Commission.

*The outlay was fixed at Rs. 27 crores.

**From the Fourth Plan onwards institutional finances were made available for RE outside the Plan allocations. The expenditure includes a sum of Rs. 202 crores obtained from financial institutions other than REC.

@Includes Rs. 99 crores from AFC/ARI and Commercial Banks.

@@Includes Rs. 415 crores from sources other than REC & Provisional.

Physical Achievements

6.12 It was only from the Fourth Plan onwards that specific targets in terms of villages electrified and pumpsets energised were fixed for rural electrification programmes. In Table 6.3 these targets have been compared with the acutal achievements.

TABLE 6·3

Progress of Rural Electrification

(figures in thousand nos.)

Period	Villages electrified		I.P. Sets/Tubewells energised		Progressive Total	
	Target	Achievement	Target	Achievement	Villages electrified	Pump sets energised
1	2	3	4	5	6	7
4th Plan (1969-74)	87	83	1250	1337	157	2442
5th Plan (1974-78)	58	60	917	858	217	3300
Annual Plan . (1978-79)	24	16	353	299	233	3599

Source.—C.E.A.

6.13 In general, it would appear from this comparison that both village and pumpset electrification have progressed satisfactorily during the Fourth and Fifth Plans. In fact, during the Fifth Plan, the village electrification targets were more than fully achieved. It is only in the year 1978-79 that there was a significant shortfall in the achievement.

6.14 One has, however, to interpret statistics relating to village electrification with caution. A village is considered to have been "electrified" once the distribution network is extended to the village and the first connection in the village taken. The subseqent utilisation of electricity and the number of connections taken for village industries, households and street lighting or for any other purpose is not reflected in the statistics. There is, in fact, a pressing need to improve the statistical base by generating accurate data on the number of households electrified in each village, the industries using power and the kilometerage of street lighting provided. Even the data base for pumpsets energisation is misleading in the sense that it does not take into account sets which have gone out of the system either due to theft, or have become unserviceable or have been disconnected due to failure to pay dues or because the well has run dry or because there is no power.

6.15 Another factor to be taken into account in interpreting these figures is that they give no indication of the quality or dependability of the power supply and there are no data about how many of these villages or pumpsets actually get power when it is needed and whether the voltage is such that the pumps can be run without burning out. A significant number of energised pump sets have, therefore, been disconnected by the farmer. The dissatisfaction of the farmer with the quality of supply is reflected in Table 6.4 showing the phenomenal growth of diesel pumpsets in the last 15 years despite their high costs and the heavy subsidy given for rural power supplies.

TABLE 6·4

The use of electrical and diesel pumps in Agriculture in India 1953-54 to 1975-76

(in thousands)

	1953-54	60-61	65-66	70-71	75-76	78-79
Number of Elect. pumpsets .	39	196	509	1417	2792	3599
Number of Diesel pumpsets .	107	230	471	1377	2178	2704

Source —Working Group on Energy Policy, 1979.

6.16 Despite the much greater initial and operating costs of diesel sets, it is clear that the farmer is prepared to pay a high price for getting an assured supply of water for his crops.

6.17 Nevertheless, on the whole, the country's achievements in this sector are not unimpressive and rural electrification is and will become, an increasingly important input into the economy. The table below gives the share of the total energy that was produced by the power sector which went to agriculture. As mentioned earlier, growth has been stunted by the quality or non-availability of power supply.

TABLE 6·5

Share of Agricultural consumption of Electricity in Total consumption

Year	Total consumption (Mkwh)	Agricultural consumption (Mkwh)	Percentage share
1	2	3	4
1951 . .	6415	203	3·16
1956 . .	10150	316	3·11
1960-61 . .	16900	833	4·93
1965-66 . .	30020	1892	6·30
1970-71 . .	48450	4470	9·23
1971-72 . .	51780	5000	9·66
1972-73 . .	54250	5920	10·91
1973-74 . .	55592	6310	11·35
1974 75 . .	58253	7760	13·32
1975-76 . .	66080	8721	13·20
1976-77 . .	72990	9621	13·18
1977-78 . .	75910	10107	13·31
1978-79 . .	84435*	11950*	14·15

*Provisional.

Source.—General Review. Public Electricity Supply All India Statistics—CEA.

6.18 The estimated energy requirements for the agricultural sector till the end of the century are given in Table 6.6 below.

TABLE 6·6

Energy demand in Agriculture 1982—2001

A. Reference Level Forecost

Energy form	Unit	82-83	87-88	92·93	2000-01
Electricity . .	TWH	16·2	22·2	28·2	33·0
Diesel oil for pumps	Million Tonnes	2·6	3·0	3·2	3·5
Diesel oil for tractor	—Do—	1·1	1·6	2·4	3·6
Diesel oil total .	—Do—	3·7	4·6	5·6	7·1

B. Optimal Level Forecast

Fuel form	Units	82-83	87-88	92-93	2000-01
Electricity . .	TWH	16·0	21·1	25·4	28·0
Diesel oil . .	Million tonnes	3·70	4·2	4·6	52·6

Source.—Working Group on Energy Policy, 1979.

6.19 The energy requirements have been calculated on the basis that the average size of pumpset is 5 H.P. and that each pump runs about 3000 hrs. per year. The basis of these figures is data supplied by the SEBs. While they cannot be considered a substitute for a detailed study, based on metered supply of power, they do give a general indication of orders of magnitude.

STATEWISE GROWTH OF RURAL ELECTRIFICATION

6.20 The power consumption figures per pump set have varied with time and differ widely from State to State, ranging from 6000 hrs/year in Punjab to 1500 hrs/year in Karnataka and Madhya Pradesh. The data suggest that both the consumption per consumer as well as the kWh/Kw of connected load has steadily declined in the agriculture sector till 1973; from then on, there has been a marginal increase probably due to a greater proportion of tubewells getting power but mainly due to the adoption in an extensive way of multi-cropping pattern of agriculture in a few States like Punjab, Haryana and parts of U. P.

6.21 Both in respect of village electrification and pump set energisation there have been significant differences in the progress registered by the individual States. Table 6.7 shows the State-wise progress in the electrification of villages.

6.22 It is difficult to pinpoint all the factors which have been responsible for the poor performance in village electrification in several States, especially States like Uttar Pradesh, West Bengal and Bihar. However, two of the main ones have been the low priority attached to this programme in these States combined with organisational weaknesses in project formulation and implementation. In geographically large States like Madhya Pradesh and Rajasthan, however, it is the distances to be covered and the distant, sparsely populated areas to which lines have to go, that present a major obstacle to rapid coverage of the villages.

6.23 Similarly, there is a considerable variation among the States in the extent to which the irrigation potential has been developed as is evident from Table 6.8.

TABLE 6.7

State-wise progress in rural electrification

Sl. No.	States/Union Territories	Total No. of villages (1971 census)	As on 31-12-51 No. of villages electrified	As on 31-12-51 %age of col. 4 to col. 3	As on 31-12-79 No. of villages electrified	As on 31-12-79 %age of col. 6 to col. 3
1	2	3	4	5	6	7
1	Andhra Pradesh	27,221	119	0.4	15,899	58.4
2	Assam	21,995	..	..	3,440	15.6
3	Bihar	67,566	4	Neg.	19,490	28.8
4	Gujarat	18,275	37	0.2	10,283	56.3
5	Haryana	6,731	..	..	6,731	100.0
6	Himachal Pradesh	16,916	9	Neg.	8,697	51.4
7	Jammu & Kashmir	6,503	..	..	4,428	68.1
8	Karnataka	26,826	551	2.1	16,037	59.8
9	Kerala	1,268	159	12.5	1,268	100.0
10	Madhya Pradesh	70,883	9	Neg.	21,175	29.9
11	Maharashtra	35,778	33	0.1	24,470	68.4
12	Manipur	1,949	9	0.5	309	15.9
13	Meghalaya	4,583	..	..	489	10.7
14	Nagaland	960	..	..	303	31.6
15	Orissa	46,992	..	..	15,660	33.3
16	Punjab	12,188	42	0.3	12,126	99.5
17	Rajasthan	33,305	2	Neg.	13,083	39.3
18	Sikkim	215	..	..	53	24.7
19	Tamil Nadu	15,735	1495	9.5	15,531	98.7
20	Tripura	4,727	..	..	667	14.1
21	Uttar Pradesh	1,12,561	110	0.1	36,688	32.6
22	West Bengal	38,074	386	1.0	12,602	33.1
	Total (States)	5,71,251	2965	0.5	2,39,429	41.9
	Total (UTs)	4,685	96	2.1	1,365	29.1
	Total (All India)	5,75,936	3061	0.5	2,40,794	41.8

Source.—Central Electricity Authority.

TABLE 6.8

Ground water development (Irrigation potential in 1000 Hectares)

S. No.	Name of State	Ultimate potential	Likely cumulative achievement up to 78-79	%age of utilisation up to end of 78-79 against ultimate potential
1	2	3	4	5
1	Andhra Pradesh	2200	1010	45·91
2	Assam	700	22	3·14
3	Bihar	4000	1405	35·12
4	Gujarat	1500	1285	85·67
5	Haryana	1500	1183	78·87
6	Himachal Pradesh	50	6·5	13·00
7	Jammu & Kashmir	150	4·5	3·00
8	Karnataka	1200	395	32·92
9	Kerala	300	42	14·00
10	Madhya Pradesh	3000	950	31·67
11	Maharashtra	2000	2045	52·25
12	Manipur	5	Neg.	..
13	Meghalaya	15	4	26·67
14	Nagaland	5	Neg.	..
15	Orissa	1500	240	16·00
16	Punjab	3500	2840	81·14
17	Rajasthan	2000	1470	73·50
18	Sikkim	2	Neg.	
19	Tamil Nadu	1500	1125	75·00
20	Tripura	15	3·5	23·33
21	Uttar Pradesh	12000	7450	62·08
22	West Bengal	2500	490	19·60
	Total (UTs)	120	62	51·67
	Total (States & UTs)	39762	21032.5	52·89
	Say	40000	21000	52·50

Source.—Minor Irrigation Division, Ministry of Agriculture.

8—402 Deptt. of Power/80.

6.24 Broadly, till the end of 1979 Andhra Pradesh, Haryana, Punjab and Tamil Nadu accounted for about 45% of the total number of pumpsets energised in the country whereas the ground water potential in these States forms only 22% of the country's total potential. On the other hand, Assam, Bihar, Orissa and U.P. which have 52% of the total ground water potential accounted for only 14% of the total number of pumpsets energised.

6.25 There is no need for undue concern over the non-uniformity of achievement amongst the States, in respect of utilisation of ground water resources. For instance, in States where surface water can be provided more cheaply there is no case for going in for ground water exploitation.

6.26 This is not however to suggest that all regional imbalances in pumpset energisation can be fully explained on this basis. It has to be accepted that efforts put in by the different Boards towards the implementation of RE programmes have not been uniform and this has indeed been responsible to a significant degree for the different levels of achievement. Nevertheless the objectives and policies for rural electrification have necessarily to vary from State to State and often between regions within a State taking into account the local needs and the environmental and agronomic conditions. A Committee such as this which makes an attempt to consider rural electrification from a national perspective can only recommend broad policy guidelines for formulating and implementing the future programmes of rural electrification.

Demand for Power from the rural sector

6.27 The historical growth of connected rural (mainly—agricultural) load in relation to total load is shown in Table 6.9.

TABLE 6·9

Share of connected load in Agricultural Sector

Year	Total connected load (MW)	Connected load in agriculture sector (MW)	Percentage share
1950 . .	2835	118	4·66
1956 . .	4323	243	5·62
1960-61 . .	8225	827	10·25
1965-66 . .	13603	2037	14·97
1968-69 . .	22060	4220	19·10
1970-71 . .	26230	6225	23·73
1971-72 . .	29418	7246	24·63
1972-73 . .	32255	8386	26·00
1973-74 . .	35609	9494	26·66
1974-75 . .	39285	10423	26·53
1975-76 . .	42512	11153	26·23
1976-77 . .	45871	12053	26·27
1977-78 . .	48833	12913	26·44

Source.—General Review : Public Electricity Supply. All India Statistics 1977-78—CEA.

6.28 It will be seen that although the share of connected agricultural load in 1977-78 was 12913 MW or 26.44%, its share of energy consumed was only 13% (Tables 6.5 and 6.9). This reflects the short duration for which pumpsets are generally run. The implications of this on the planning of capacity of the power sector could be severe if this load were all to come at the peak hours. Currently it has been possible to roster supplies during the day but there is understandable reluctance to take power at night. The Committee expects that if the development of the power sector is planned and implemented as recommended in its Chapter on 'Power Planning' the energy requirements of the agricultural sector are not likely, to add except in a few States, significantly to the peak demands which is the critical element in determining capacity and investment in the power sector.

BENEFITS OF RURAL ELECTRIFICATION

6.29 The direct and indirect benefits of rural electrification are well known. The direct benefits include increased agricultural production through energisation of pumpsets and rural electrification. Increased opportunities for employment through intensification of agriculture and rural industrialisation and an overall improvement in the quality of life are some of the indirect benefits. Some of the studies in this regard are referred to below.

Pumpset energisation

6.30 From the individual consumer's point of view the benefits of electrification have been well established and documented in respect of pumpset energisation. A study conducted by the Programme Evaluation Organisation of the Planning Commission in 1965 revealed that as a consequence of the installation of electric pumpsets on existing irrigation works, the area irrigated increased by 66% for both Khariff and Rabi crops. The average area irrigated per household increased by 60% from 6 acres to 9.6 acres and substantial modernisation in cultivation practices also took place. Existing crops were more extensively cultivated, new crops were introduced and intensity of irrigation increased. Ground water pumpsets have generally provided the much needed insurance for the Indian farmer against the vagaries of the monsoons. A detailed study on the economic benefits of rural electrification in Gujarat was undertaken by Prof. V. N. Kothari, and Shri M. M. Dadi on behalf of the Gujarat Electricity Board. The study found that even at 1972-73 prices the net social benefit cost ratio of rural electrification is high and positive at as high a discount rate as 15%. It also concluded that with the petroleum price hike of 1973 the benefit cost ratio will be even higher. This was inspite of the fact that the study considered only benefits that are quantifiable. The benefit cost ratio would therefore have been much higher, had the intangible social benefits that are expected to accrue from domestic and street lighting etc. also been taken into account. These findings are, by and large, supported by similar other studies.

6.31 In July 1979, the REC conducted two studies on behalf of the Committee (one in South Arcot District in Tamil Nadu and the other in Gazipur District in U.P.) on the costs and benefits of pumpset energisation. According to these studies, the net additional return from irrigated farming in South Arcot District worked out to Rs. 635 per hectare or Rs. 2470 per pumpset per annum and in Gazipur the average annual benefit from irrigation per tubewell worked out to Rs. 2530/-. These returns exclude the benefit derived by the farmer from other uses of his motor such as operating threshers, cutters etc.

Rural Industries

6.32 Electric power plays an equally significant role in the growth of rural industries. With the introduction of electricity, some of the traditional industries tend to change over to the use of electric power. Besides, new power operated industries also come up. Where the existing industries are converted to electric power there is a reduction in labour and fuel cost and at the same time an increase in the productivity of such units. The findings of various research studies corroborate these views. The Programme Evaluation Organisation, which investigated 479 industrial units in the course of its study, found that more than 3/4th of the units were established only after electricity came to the area, while the rest switched over from diesel to electricity when it became available. There was a reduction in fuel cost and the average annual profit for all the units investigated increased by 11% after electrification.

6.33 The Small Industries Extension Training Institute in their impact studies on rural industrial development has come out with the findings that, after electrification, the number of small agro-processing industrial units increased from 8 to 40 in selected villages of Pattikonda Taluka of Kurnool district in Andhra Pradesh. Typical of the power operated industries that came up were cereal grinding and processing, oil-seed crushing, Khandsari sugar industries, cotton ginning and processing, weaving and powerlooms, coir spinning and weaving, jute bailing and pressing, wood-saw milling, bonecrushing, workshops for common service facilities, production of small agricultural implements and manufacture of screws, nuts and bolts. One of the research studies* estimated with reference to conditions in the Punjab, that on an average about 6 persons per village found employment in seasonal jobs, while 13 persons per village found employment in permanent occupations after the introduction of electricity.

Change in quality of life

6.34 It is generally agreed that rural electrification brings about a basic change in the life style of rural masses. A research study recently conducted by the ORG** brings out a close relation between electrification of a village and the spread of radios and cinemas as a source of entertainment, improved working conditions in farms, workshops, schools, dispensaries and shops and increase in available working hours, etc. The shift from manual to power driven pumpsets was found to reduce the time required for irrigation from 8 to 4 hours per acre giving the farmer greater time to pursue other occupations or enjoy some leisure. The combination of the growth of radio coverage and increase in leisure could, in the Committee's view, create the conditions required to keep the rural population fully informed about developmental needs and to propagate family planning, health, nutrition, educational and agricultural extension measures and this opportunity should be vigorously pursued.

6.35 It is clear that rural electrification brings positive benefits not only to the individual consumers but also to the country as a whole and therefore merits high priority in the allocation of developmental resources.

Beneficiaries of Rural Electrification

6.36 One of the criticisms of the rural electrification programme has been that its benefits go mainly to large and medium farmers and the small and marginal farmer, despite the many programmes that have been formulated to help him, rarely gets his due. The panel on Rural Electrification set up by the Committee found on its visits to various villages that this criticism was well founded. There are one or two studies which also brought out the skewed flow of the benefits of the RE programme. Data in the agricultural census† show that 84% of the holdings in U.P. are less than two hectares, 67% being below one hectare showing that, numerically small farmers still predominate in U.P. This census also shows that, of the area irrigated by private tubewells/pumpsets, only 10% comes in the size-class of holdings up to one acre and 19% up to two acres. It would thus appear that 80% of the area irrigated by pumpsets belongs to medium and large farmers, who comprise about 16% of the farming population. There is reason to believe that U.P. is not unique in this respect and the same general pattern obtains in other States also. There is an urgent need for more indepth studies to be carried out by the Programme Evaluation Organisation or the REC on the flow of benefits of RE in rural areas to different income groups in different States and to correlate with this uneven flow of benefits, the administrative, organisational and environmental factors which are responsible for it.

6.37 'Prima facie' there are several reasons why small and marginal farmers find it difficult to get the benefits of RE programme. The foremost constraint is their inability to obtain the

*Impact of Rural Electrification Punjab—NCAER-1967.

**Operations Research Group—Rural Electrification Social Soundness Survey, 1979 (unpublished).

†Agricultural Census, 1970-71, Board of Revenue, U. P., Lucknow, 1974.

necessary credit. Firstly, the existing institutional framework for advancing loans to the rural areas is inadequate and does not fully cover all the villages. Secondly, even where such arrangements exist, there are organisational and financial limitations that come in the way of meeting the credit requirements of the small farmers. For instance, some of the rural credit agencies are not in a position to advance loans due to the problem of overdue loans. Even where such a problem does not exist, the small farmer is subject to harassment by the officials of the lending agencies. Finally the procedures of granting loans are lengthy and cumbersome and the small farmer finds it difficult to go through all the prescribed formalities such as obtaining the necessary certificates from the Revenue authorities, the S.E.B. Ground Water Board and providing guarantees.

6.38 In additional, substandard equipment, without relevance to his actual requirements, is often thrust upon the farmer depriving him from deriving the full benefits from his investment. In most States, the efficiency of the electric pumpsets used in agriculture is well below standard. Studies carried out by the ARDC on the existing pumpsets reveal that as against an optimum efficiency of 70-75%, the actual efficiency in Andhra Pradesh is about 50% and in West Bengal, Bihar and Orissa less than 30% for almost every one in every three pumpsets. It is noticed, quite often, that farmers have been advised to purchase motors of higher horse power than required. As a result because the minimum guarantee is to be paid on the basis of the horsepower of the motor used, the farmer is compelled to pay larger amounts than he should. Apart from this, oversized motors also lead to a low power factor for the system and require investment in corrective equipment. These difficulties are further compounded by the fact that the after sales service presently available in most villages is inadequate and the small farmer cannot afford to go frequently to local towns to get his pumpset repaired.

Domestic lighting

6.39 The demand for domestic connections in villages has been generally poor. The main reason for this has been the heavy investment required for interval wiring that is involved in such connections. In addition the consumer has to pay a statutory deposit to the Board before he can get the connection. Very often, competent contractors are not available in the villages to take up wiring and repair works. Besides all these stumbling blocks, frequent peak time restrictions on power supply leave little incentive to the villager to obtain domestic connection which is mainly intended for lighting. Such domestic connections as exist again generally are found in the houses of the larger farmers and other comparatively well-to-do strata of the village population.

Harijan Basties

6.40 Since the Fourth Five Year Plan, Harijan Basti electrification has become a regular part of the schemes which qualify for REC assistance. About 8880 Basties are reported to have been electrified and the pace of the programme is expected to be increased in future.

Street Lighting

6.41 As far as street lighting is concerned, the main problem seems to be the financial inability of the local bodies to meet the recurring expenditure on electricity consumption. This not only adversely affects the ways and means position of the Electricity Boards but also prevents the Electricity Boards from extending supply to more street lights. In Karnataka the electricity dues payable by Village Panchayats are directly credited by the State Government to either the Electricity Board or rural cooperatives from the Government grants payable to the Panchayats or other local bodies. A similar procedure could be adopted in other States also.

FINANCIAL IMPACT OF RURAL ELECTRIFICATION ON SEBs

6.42 In para 5.26 of the Chapter on Finance, Financial Management and Tariff the impact of losses due to rural electrification on the finances of SEBs for the year 1976-77 has been quantified. These losses, for all the Boards put together, amounted to Rs. 157 crores and wiped out the surplus of Rs. 55 crores the Boards had earned on their other operations.

6.43 To a large extent this is the result of highly subsidised tariffs but the losses have been aggravated due to the inadequate attention paid in planning and designing the R.E. projects, increase in construction costs as a result of non-standardisation of equipment and poor maintenance—all of which have led to high T & D losses, low power factors and over capitalisation. While some of these deficiencies are common to the power sector as a whole, because they lack the glamour of large projects and even more because of the strong urban pull, RE projects at the field level do not attract the best talent in the SEBs.

6.44 One of the causes of losses on RE systems is the low initial intensity and slow development of the load which tends to be confined largely to pump set operation. The need to develop domestic lighting has already been dealt within the Chapter on 'Power Planning'. Electricity should however be seen in the much wider context of a major input and as a catalyst in rural development. While such development does eventually take place the pace of it could be greatly accelerated if the RE programme was dovetailed into the integrated rural development (IRD) plans. Currently the Block level IRD plans have still to get off the ground and except for one or two States there are no worthwhile block level plans. The IRD programme must look at

RE as one of its most crucial infrastructural inputs and plan activities like manufacturing, processing, storage and service industries accordingly.

6.45 To summarise while the RE programme has brought economic benefits to the rural areas it suffers from the following shortcomings—

(a) A bias in favour of the large farmer and inadequate availability of RE benefits to the small and marginal farmers.

(b) Poor progress of domestic lighting and street lighting programmes.

(c) Unsatisfactory planning, execution, operation and development of RE systems by SEBs leading to capital and operating costs being higher than they should be.

(d) Heavy losses incurred by State Electricity Boards as a result of high costs and heavily subsidised tariffs.

FINANCIAL INSTITUTIONS AND RURAL ELECTRIFICATION

6.46 During the first three plans, the rural electrification programme was financed as a plan programme and earmarked central assistance was made available to States for approved rural electrification schemes included in the Plans. This continued till 1968-69. In 4th Plan (1969-74) the entire pattern of Central assistance was revised on the basis of the "Gadgil" formula. The Rural Electrification Corporation was set up in 1969 to provide finance for RE programme but loans advanced by REC did not meet fully the requirement of energisation of pumpsets etc. This necessitated supplementing the resources provided by REC by funds from other financial institutions such as Agricultural Refinance & Development Corporation, Commercial Banks, State Land Development Banks, Agricultural Finance Corporation, Rural Debentures etc.

Rural Electrification Corporation

6.47 The role of the Rural Electrification Corporation is to help the State Electricity Boards to formulate viable schemes for rural electrification, appraise them, sanction funds for their implementation and monitor and evaluate their progress. The criteria for viability are not uniform and for backward and sparsely populated and remote areas, softer loans and repayment terms are given. The REC is by far the largest source of funds for rural electrification programmes and brief comments on its performance follow.

6.48 The total sum loaned by the REC till the end of 1979-80 was about Rs. 840 crores accounting for almost half the investment in rural electrification. REC lends money to SEBs for RE schemes which cover either a Block or a Taluka. The schemes normally consist of electrification of villages and pumpsets, provision of domestic and street lighting and upgrading of sub-transmission and distribution systems of the area. The criterion for the selection of projects is the degree of overall development of the area.

6.49 According to the established practice in the Corporation, a project is deemed to have been completed if all instalments of loan have been drawn and 100 per cent village electrification (in the sense that electrification has been defined at present) along with 80% of the physical work has been executed to ensure that a minimum of 80% of the connected load envisaged in the project has been provided.

6.50 The Committee notes with concern that on 31st March, 1979, of the 774 projects which should have been completed, only 407 have been completed in physical terms but only in 206 have all instalments been drawn and the scheme closed. Out of the schemes so closed about 20% were behind schedule and a few schemes lasted 4 years longer than the original time schedule.

6.51 By and large, the shortfall in the attainment of REC targets in individual States is mainly due to the unrealistic formulation of schemes, poor management of the construction programme by the SEBs and more recently the shortage of materials such as aluminium conductors. Diversion of REC funds to other activities of the Board and delays in obtaining ground water clearance and State guarantees have also been responsible for the poor implementation of REC schemes.

6.52 With all its limitations, however, there is no doubt that the RE programme has been given a major impetus by the REC and progress in this area has been distinctly faster since 1969 when the REC came on the scene. In fact there appears to be a strong case for widening the scope of Corporation's work. For instance, although quite some work in the area of standardisation of items required for RE has been done by the REC, there is scope for expediting this work and bringing into its purview many more items. There is, as mentioned in the Chapter on Power Planning, considerable potential for developing mini and micro hydels in several States and especially hilly areas. REC could consider assisting State Governments in setting up such projects. Considering the role that non-conventional energy sources can play in meeting the energy requirements of rural areas in the future, the Committee is of the view that as a promotional agency, REC could engage itself in overseeing the 'grass roots' R&D effort and setting up demonstration units, pilot plants and prototypes.

6.53 The REC should also promote the electrification of rural households. Today a farmer can get subsidies and loans from various agencies for the electrification of pumpsets but no financial institution provides adequate facilities to the poorer rural consumers for obtaining loans for electrifying households and they have to go to private sources of credit.

System Improvement Schemes

6.54 While discussing the role of the REC the Committee considered it necessary to review the existing policy in respect of system improvement schemes. At present, these schemes are being financed by the REC and the implementation of these schemes is done by the State Electricity Boards. Up to March, 1979, 110 system improvement schemes and 33 LT schemes were sanctioned by the Corporation involving a total financial assistance of Rs. 73 crores. They have undoubtedly helped to improve power supply and reduce T&D losses to a limited extent.

6.55 There has, however, been some debate as to whether system improvements which are purely technical in nature should be taken up by the REC or by the Electricity Boards. It is argued that REC is basically a financing institution and that SEBs are technically much better placed to prepare and appraise system improvement schemes and it is for the State Government to see that they do so and provide such funds as are necessary. It has also been urged that improving the RE system in isolation at the tail end of the distribution network, will not be very effective and that system improvements must be planned in conjunction with the rest of the transmission network. There is substance in these arguments. It is, therefore, recommended that the REC, which is essentially concerned with the electrification of the rural areas, should not involve itself in such programmes. The second and more basic point in the Committee's view is that system improvement schemes imply that the schemes originally sanctioned were not properly conceived. The objective should be to ensure that the REC only sanctions schemes which are properly designed 'ab-initio'.

6.56 There could, however, be situations where as a result of factors beyond the control of the SEB the scheme needs to be modified because, say, the load has developed faster than anticipated or projections of ground water availability have not been realised in practice. In such cases of modification of the original scheme, REC assistance can continue to be provided.

Statewise flow of benefits from REC programmes

6.57 Despite every effort to treat all States equally and to err on the side of giving the less developed States special assistance the benefits of the REC programmes have like other such programmes, gone disproportionately to the more developed States. Table 6.10 shows the physical result of REC schemes Statewise. It is apparent, especially in respect of pumpset energisation, that developed States like Punjab, Haryana, Gujarat, Maharashtra, Tamil Nadu, Karnataka and even States like Rajasthan, Madhya Pradesh and Andhra Pradesh have managed to get the lion's share of funds. On the other hand Bihar, U.P., Orissa and West Bengal are lagging behind in almost every sphere of REC's activities despite their vast potential and population.

Agricultural Refinance and Development Corporation

6.58 Agricultural Refinance and Development Corporation (ARDC) provides refinance assistance to commercial banks and Land Development Banks up to 90% of their loans to SEBs in respect of pumpsets actually energised @ Rs. 5500/- per pumpset (5 HP) with an increase of Rs. 1000/- for every additional 2.5 HP in respect of pumpset energised in areas outside REC's programmes. ARDC does not make any deliberate Statewise allocation of resources. A State's share of ARDC funds, therefore, depends on the capabilities of the SEB to implement the projects and avail of the refinance facilities from the ARDC. As of June, 1979, ARDC provided refinance assistance of Rs. 106 crores to banks for energisation of about 2.12 lakh pumpsets.

TABLE 6.10

Statewise Achievements as on 31-12-1979 in respect of R. E. C. Schemes

State	Total No. of villages (1971 census)	Villages electrified	Pumpsets energised	LT/Agro-industries connected,	Domestic/ commercial connections	Street-lights
1	2	3	4	5	6	7
Andhra Pradesh	27,221	4,067	45,760	3,541	97,849	43,663
Assam	21,995	1,842	647	317	10,203	691
Bihar	67,566	4,907	13,406	2,926	20,970	594
Gujarat	15,275	2,083	24,033	2,768	102,175	32,304
Haryana	6,731	90	39,389	4,137	65,326	2,324
Himachal Pradesh	16,916	3,345	484	1,848	118,446	15
Jammu & Kashmir	6,503	2,655	104	1,008	69,192	1
Karnataka	26,826	2,226	21,456	2,101	54,657	39,538
Kerala	1,268	151	9,245	1,767	63,169	9,144
Madhya Pradesh	70,883	6,409	52,509	4,378	80,680	48,232
Maharashtra	35,778	5,279	61,962	6,324	110,988	64,058
Manipur	1,949	34	..	..	37	12
Meghalaya	4,583	319	41	45	2,901	16
Nagaland	960	107	..	11	2,057	1,816

1	2	3	4	5	6	7
Orissa	46,992	6,516	4,136	1,796	53,746	4,497
Punjab	12,188	3,908	55,377	2,674	208,484	117
Rajasthan	33,305	6,364	59,559	6,173	96,009	8,981
Tamil Nadu	15,735	825	57,098	3,698	148,256	23,131
Tripura	4,727	499	60	52	1,984	33
Uttar Pradesh . .	112,561	6,438	25,109	2,350	39,955	7,258
West Bengal	38,074	6,821	11,674	3,837	44,836	11
TOTAL	571,036	64,885	482,049	51,751	13,91,920	286,436

Commercial Banks

6.59 The Commercial Banks loans to SEBs for rural electrification are both from their own resources and those refinanced by ARDC. The banks have already committed Rs. 120 crores from their own funds to the Special Programme in Agriculture schemes for the period 1978-88. In addition, about Rs. 30 to 40 crores is expected to be available as 10% contribution under ARDC's independent scheme. As of December, 1978, total amount sanctioned by Commercial Banks by way of loans and advances were of the order of about Rs. 93 crores and the outstanding were of the order of Rs. 45 crores. Statewise details of loans by ARDC and by Commercial Banks are shown in Table 6.11.

TABLE 6·11

Statewise loans under ARDC's normal refinancing programme and by Commercial Banks from their own resorces to SEBs

		ARDC		Commercial Banks	
Sl. No.	State	No. of Pumpsets	Refinance provided upto 30-6-1979 (Rs. lakhs)	Limits sanctioned/ original loan (Rs. lakhs)	Amount outstanding (Rs. lakhs)
1	2	3	4	5	6
1.	Andhra Pradesh	48,700	2,435	90·40	..
2.	Bihar	1,980	99	640·58	105·77
3.	Guajrat	22,980	1,149	2,098·16	1,424·74
4.	Haryana	6,680	334	50·00	7·75
5.	Karnataka	9,940	497	11·39	..
6.	Kerala	9,700	485	227·65	66·78
7.	Madhya Pradesh	26,080	1,304	468·46	81·96
8.	Maharashtra	39,880	1,994	3,681·87	1,706·30
9.	Orissa	1,440	72	47·50	24·80
10.	Punjab	5,220	261	41·78	..
11.	Rajasthan	12,020	601	121·23	44·99
12.	Tamil Nadu	3,940	197	43·49	..
13.	Uttar Pradesh	20,260	1,013	1,351·60	851·15
14.	West Bengal	3,100	155	422·40	213·53
	TOTAL	2,11,920	10,596	9,296·51	4,527·77

Source.—ARDC.

It will be observed that both in the case of ARDC and the Commercial Banks, the more developed States except West Bengal have again been the major beneficiaries whereas the less developed States although they have large ground water potential are unable to draw funds.

State Land Development Banks

6.60 Land Development Banks (LDBs), by the very nature of their operations do not mobilise resources on their own. Their loaning is supported by ARDC, certain institutional agencies like LIC, Commercial Banks and the State Governments. No substantial amount is likely to become available from the LDBs from their own resources except for the amount that would be provided by the ARDC and the State Governments. In respect of their loans to SEBs by June 1977, nine State Land Development Banks financed 18 rural electrification projects involving a total loan commitment of Rs. 1899 lakhs. The Statewise details of the number of schemes sanctioned, financial commitment and actual disbursement is given in Table 6.12 below.

TABLE 6.12

Funds advanced by State Land Development Banks
(as on June, 1977)

(Rs. in lakhs)

State	No. of schemes	Commitment	Disbursement
1	2	3	4
1. Haryana . .	1	906	149
2. Rajasthan . .	1	22	8
3. Orissa . .	1	11	11
4. Madhya Pradesh .	4	549	457
5. Uttar Pradesh .	..	101	..
6. Gujarat . .	3	40	..
7. Maharashtra .	5	140	140
8. Karnataka . .	..	..	436
9. Tamil Nadu .	3	130	130
	18	1,899	1,331

Source.—Report of the RBI working group on planned participation of Commercial Bank in rural electrification, May, 1978.

It can be seen from the above table that here also distribution of funds to the SEBs has been uneven. About 85% of the funds have been drawn by Haryana, Madhya Pradesh, Maharashtra and Karnataka.

Agriculture Finance Corporation

6.61 The Agriculture Finance Corporation has been arranging finance for the SEBs for energisation of pumpsets on a consortium basis since 1969-70. As on September, 1977, it arranged for total consortium finance of over Rs. 80 crores for energising 2.67 lakhs pumpsets in 7 States viz. Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Madhya Pradesh and Uttar Pradesh. Its own financial involvement in this programme was of the order of Rs. 3.30 crores during the same period. The Corporation's finances are mainly available for the transformer centres. LT centres, LT supply lines, service connections and a reasonable length of 11 KV line. The Corporation stipulates that the projects should generate enough surpluses for payment of interest and repayment of loans.

Aggravation of regional imbalances

6.62 While an important role is played by the commercial banks and other financing institutions in the field of rural electrification, the major deficiency that has emerged in the utilisation of such institutional finances, as is evident from the above, is the uneven flow of funds to different States. Only some State Electricity Boards, mostly in the advanced States, who happened to have a good organisation and the ability to formulate sound projects and 'self' them to the commercial banks and State LDBs, have utilised the bulk of these finances. Most backward States, despite their greater need for rural electrification for pumpset energisation have not been able to draw adequate funds from these sources. Thus there has been some aggravation of regional imbalances.

GROWTH PROSPECTS FOR RURAL ELECTRIFICATION

Pumpset energisation

6.63 The Working Group on Energy Policy has attempted a scenario of the long term utilisation of ground water and has arrived at the figures shown below:

TABLE 6·13

Future trends of utilisation of ground water potential in the country

(In thousands)

Item	Ultimate potential	1977-78	1982-83	1987-88	1992-96	2000-01
Dugwells	12,000	7,700	8,700	9,700	10,700	12,000
Private Tubewells . .	4,000	1,740	2,300	2,800	3,300	4,000
Public Tubewells . .	60	30	45	60	60	60
Total Wells . . .	16,060	9,470	11,045	12,560	14,060	16,060
Elec. Pumps		3,300	5,400	7,400	9,000	11,000
Diesel Pumps . . .		2,500	3,250	3,750	4,000	4,400
Animal powered lifting devices		3,670	2,395	1,410	660	660

Source.—Working Group on Energy Policy, 1979.

6.64 The table assumes that diesel pumpsets, despite the increase in the price of petroleum products, will continue to grow initially at the current rate of about 1.5 lakhs per year for the next 5 years or so and will taper off to about 50,000/annum for the rest of the period. On the other hand, it forecasts that electric pumpsets will continue to be added at the rate of about 4 lakh pumpsets per year for the next decade and taper off slowly thereafter. Based on these figures, the Working Group on Energy Policy has worked out the power needs on the basis of existing practices and efficiencies.

Optimal Level Forecast (OLF)

6.65 Reference has been made already to the low efficiency of the pump sets used and that very often farmers are sold larger sets than they need. The Working Group on Energy Policy worked out, on a normative basis, the scope that there would be for saving energy on these and other measures and concluded that it would be possible to save 5% by 1987-88 and 15% by the year 2000 A.D. The effect of this optimal level forecast (OLF) on the energy demand for agriculture is shown in the Table 6.14 below:

TABLE 6.14

Energy as power required for pumpsets (TWH)

	1982-83	1987-88	1992-93	2000-01
R.L.F.	16.2	22.2	28.2	33.0
O.L.F.	16.0	21.1	25.4	28.0
Saving in energy possible by adopting conservation measures (in percent) .	1.0	5.0	10.0	15.0

Source.—Working Group on Energy Policy, 1979.

6.66 The Committee is of the view that given the recent trend in oil prices it may be difficult to sustain the order of imports of diesel oil implicit in Table 6.13 and unless subsidies go on growing the use of diesel sets will become prohibitively expensive. The Committee, therefore, feels that the OLF forecast is likely to under-state the demand for power for pumpsets and even the RLF may be a bit low. It may be desirable to work on the basis that after 1990 there will be no new diesel sets added and that by 2000 AD either conventional electricity or other energy sources like biogas or wind or photovoltaic systems will replace even the existing diesel sets.

Domestic consumption

6.67 The Working Group on Energy Policy has also made forecasts on growth of power for domestic consumption on the assumption that very nearly all of it will be for lighting. The bulk of this is likely to be in rural areas and, therefore, has some implications for the RE programme. It projects a substantial but not complete shift from kerosene to electricity by the year 2000-01 AD as the table 6.15 below brings out.

TABLE 6.15

Change in the Pattern of Households using different fuels 1975—2000

Reference Level Forecast

(Percentage)

	1975-76	1982-83	1987-88	1992-93	2000-01
A. Rural					
Electricity .	4.4	12.9	19.3	27.6	45.2
Kerosene .	91.4	84.0	78.8	71.4	53.9
Others .	4.2	3.1	1.9	1.0	0.9
Total . .	100.0	100.0	100.0	100.0	100.0
No. of households in million .	90.1	100.9	108.6	116.1	128.3
B. Urban					
Electricity .	42.1	53.0	62.3	73.8	89.0
Kerosene .	53.6	45.2	36.9	25.5	10.4
Others .	4.3	1.8	0.8	0.7	0.6
Total . .	100.0	100.0	100.0	100.0	100.0
No. of households in million .	26.1	32.1	36.9	42.0	51.7

6.68 The implication of only 45.2% rural households electrified by the year 2000, apart from its impact on import of kerosene, would mean that a large part of the country's population will continue to be deprived of the socio-economic advantages of village electrification. The Committee feels that the target of 100% households to be electrified by 2000 AD is not unattainable once the priority that this programme requires is recognised. The investment of Rs. 400 crores per year at current prices for the next 20 years to achieve 100% electrification of households does not appear to be beyond the country's capacity.

100% Village Electrification

6.69 As shown in Table 6.7 of this Chapter, out of the 22 States, 3 States have achieved 100% electrification—Punjab, Haryana and Kerala—and so have 3 Union Territories, Delhi, Pondicherry and Chandigarh. States like Tamil Nadu are close to it and a few like Maharashtra, Karnataka, Jammu & Kashmir, Gujarat and Andhra Pradesh are well past the half-way mark. All the SEBs have accepted that it would be possible to electrify all villages by 1994-95 subject to availability of funds on a reasonable scale.

6.70 The Committee would strongly endorse this target but would recommend that load development in an electrified village must receive the same priority as electrifying new villages. A second point to which reference has been made earlier is that, as the target of 100% electrification gets nearer, the villages that will not be covered are the more distant and inaccessible ones and hence very costly to electrify in the conventional way. They are however in the very areas where backwardness is at its height. For these it may be desirable for purposes of lighting, but not immediately for pumpset energisation, to develop vigorously renewable sources such as micro and mini hydels, biogas, photovoltaic cells, windmills and energy plantations. In short rather than wait for the day when conventially generated power reaches these isolated villages in States like Rajasthan, Madhya Pradesh and the hill areas at a prohibitive cost, renewable energy technologies should begin to be inducted into these areas as of today even though they may not be commercially viable elsewhere.

RECOMMENDATIONS

PLANNING AND PROJECT FORMULATION

Acceleration of RE Programme

6.71 For planning purposes the Committee suggests that it be assumed that there will be no net addition to diesel sets in the country after 1990 although replacement will of course be required for sometime. It can further be assumed that by 2000 AD all diesel sets will have been replaced either by electric pumps or by pumps using renewable fuels like biogas, photovoltaic cells, energy plantations and so on.

Full electrification of villages and households

6.72 The target of 100% electrification of all villages by 1994-95, proposed by the Conference of Chairmen of SEBs in 1976, should be adopted but should be accompanied by the development of the load in villages already connected and to be electrified so that the wider socio-economic objectives of the RE programme are achieved. In order to get the maximum benefit cost ratios from such load development, the RE programme should as discussed later, be fully built into the integrated rural development programme. Likewise domestic lighting should be given high priority to achieve 100% electrification of households by 2000 AD.

Integration with Generation and T & D Planning

6.73 One of the reasons for the lack or poor quality of supply to rural feeders is, as mentioned earlier, the lack of close integration in many States between the planning of rural electrification and the rest of the distribution network. It is essential that the integration of generation, transmission and distribution planning recommended by the Committee in its Chapter on 'Power Planning' should encompass the rural electrification system also. Optimisation studies of the distribution network must include the optimisation of the RE system also if this programme is going to be done at the least cost. It is recognised that RE growth cannot be based on viability considerations alone but having drawn up an RE plan taking into account other socio-economic considerations such as electrification of Harijan bastics, the system must be designed to minimise investment.

Limiting Load Growth

6.74 In order to improve the quality of the rural power supply one of the important planning measures is to ensure that the connected load does not exceed the capacity of the system to meet it. In some areas where the commitments are already in excess of capacity no further connections or new loads should be accepted till generation, transmission and distribution capacity is suitably augmented.

Project Formulation and Integrated Rural Development Programmes

6.75 State Electricity Boards should prepare on a block by block basis, a perspective programme for rural electrification in consultation with the minor irrigation development agencies and ensure that it is integrated with the overall distribution plan referred to above. The projects chosen for this programme should conform to broad pre-set criteria so that prima facie their viability is not in question. In order to improve the viability of such blockwise projects, the extent to which they can be built into the integrated rural development (IRD) programme should be explored, e.g. the scope for developing non-agricultural demand through the establishment of village, cottage and small scale industries. This work should be carried out in consultation with the concerned District Industries Centres and other Central and State agencies. The SEBs, in coordination with Development Commissioners and IRD officers should identify the appropriate banks and work with them in working up these projects so that project appraisal and sanction can be expedited. The REC can, for the time being, assist the SEBs in formulating and getting sanctions for these projects but in the long term, the specialised R.E. groups that the Committee has recommended in the Chapter on 'Organisation and Management' should take over this work.

Distributive justice

6.76 Vigorous efforts require to be made by SEBs and State Governments to correct the skewed flow of benefits to rural consumers. The Committee recognises that this distortion is not confined to the rural electrification programmes but applies to the many schemes and plans which are intended to benefit the rural poor. The Committee would urge that the measures which have been suggested from time to time to ensure that the poorer farmer gets his fair share of RE be vigorously implemented. The State Governments should in consultation with the SEBs and REC simplify the procedure for issuing guarantees for Bank loans and getting clearances from the Ground Water Boards. The possibility of mobile units comprising all the officers connected with sanctioning of loans, touring villages and processing applications on the spot could be explored so that the small farmer gets a single point service and is not forced to go from one office to another.

6.77 To overcome the initial hurdle of the cost of bringing power to a household the REC should consider financing programmes of electrification of households with very easy repayment terms only to the poorer sections of the village community. Some States such as Karnataka have begun schemes of giving one light point per household as a subsidy to really poor households and this could be extended to other States.

Micro and Mini Hydel schemes

6.78 The Committee is of the view that State Electricity Boards and even the CEA in pursuit of large and prestigious, long gestation hydel projects have failed to take full advantage of the potential of mini and micro hydel schemes which are particularly suited to meet the demands of rural areas without investment in long and costly H.T. transmission systems. Special emphasis on identification and execution of these schemes will not only provide power quickly but, when all other economic costs are taken into account, may do it cheaper than conventional stations.

6.79 The quantum and quality of rural power are particularly suited to what can be produced by non-conventional energy sources like biogas, energy plantations, photovoltaic cells, windmills in coastal areas and so on. In far flung sparsely populated villages in States like Rajasthan and Madhya Pradesh and in the hill areas, they could even at existing levels of technology compete with conventional power for peak loads like lighting in rural areas. Ultimately, say in 10 years, there is every reason to believe that such systems will compete favourably with power from conventional sources in many rural areas.

Tariffs

6.80 The Committee in its Chapter on 'Finance, Financial Management and Tariffs' has suggested guidelines for fixation of tariffs including agricultural tariffs. As mentioned earlier the benefit: cost ratio of an electric pump set to the farmer is so high, whether measured in terms of increased agricultural output or savings in relation to diesel pump sets, that there appears to be no economic justification for giving any subsidy at all to power used in agriculture. Such subsidies as are available should go as capital subsidies to small and marginal farmers to help them over the problem of getting enough money to get loans for a pump set or for electrifying the households of the lower income group in villages and slums, as mentioned in the previous paragraph.

6.81 Likewise the system of flat tariff should be given up and metering of supplies reintroduced. The Committee cannot accept administrative inconvenience and theft as a rationale for flat tariffs and has suggested later how these problems could be dealt with.

6.82 The Committee was greatly handicapped in its examination of the rural electrification system because of the absence of a sound data base. SEBs and REC should set up sound information system to assist in the planning and monitoring of RE schemes. The Committee would also recommend that the National Sample Survey should consider including in its survey some of the vital information such as pattern of ownership of electrified tubewells. use of diesel sets etc. The PEO could be asked to do a study on the flow of benefits of RE in a representative sample of States.

Technical Improvements

6.83 Reference has been made to the fact that besides shortages of power, the quality of the rural power supply suffers on account of the poor planning, execution and maintenance of the distribution system. Steps to correct these must be taken by the State Electricity Boards. For instance studies in Andhra Pradesh have shown that the adoption of small size distribution transformers deserves serious consideration. Similarly greater use of capacitors would improve the power factor and increase the capacity of the system to service more consumers.

6.84 Much power and scarce resources are wasted as mentioned earlier because farmers are induced to buy substandard and oversized pumps. The SEBs and the REC both should have field level technical advisory bodies who should advise not only farmers but also lending institutions who help fund such purchases. The Indian Standard Institution needs to prescribe minimum specifications and standards of performance and only pump sets conforming to these specifications should be eligible for institutionalised funding.

Rural Electrification Corporation and other financial institutions

6.85 In order to ensure that the skewed flow of funds from the financial institutions to the States is corrected, the REC should pay special attention to developing project formulation and implementation capability in the less developed States like Bihar, Assam and Orissa.

6.86 The Rural Electrification Corporation should expand its role into funding micro and mini hydel schemes and setting up demonstration units and pilot plants to promote the growth of unconventional renewable energy resources.

6.87 Special schemes for accelerating the growth of household electrification with special reference to the economically weaker sections of the rural population should be devised.

6.88 Other financial institutions involved in funding RE programmes should also make efforts to see that funds flow preferentially to the less developed States in order to prevent growth of regional imbalances.

Organisational and other changes

6.89 Given the size of even the present RE programme, the widespread criticism of the quality of service that it provides, the rapid growth that is required of it in the future and most important of all the crucial role it will play in our long term socio-economic goals, the organisation for planning, executing and monitoring the performance of RE programme in SEBs will need to be much stronger than it is today. Specialised RE groups will need to be set up at the sub-divisional, divisional, zonal and Board level to implement the constructional aspects of the programme. The manner in which the RE organisation in the SEBs can be strengthened has been dealt with in the Chapter on Organisation and Management.

6.90 The SEBs should progressively extricate themselves from operating and servicing the RE system, however on the basis of their present performance, it cannot be recommended that only rural electricity co-operatives should take over these functions from the SEBs. While they must be given every encouragement to grow, it would be a mistake to put all ones eggs into this basket. The Committee, therefore, recommends that the system of 'agents', referred to in the 'Organisation and Management' Chapter, require to be tried out on a large enough scale in different regions to get a reliable feed back. Continuing efforts are necessary to see that the lowest cost system for providing electricity to rural areas on a dependable basis is developed. The Committee is convinced that operating the RE system solely through expanding the staff of SEBs, on account of their high costs and lack of close involvement with the village community, will make the programme increasingly unviable and retard its progress. The SEBs instead should stimulate the setting up of such decentralised bodies for servicing the rural consumer and assist and oversee and monitor their operations and provide training inputs.

6.91 The financial institutions in the rural areas and agencies set up to help the small entrepreneurs such as the District Industries Centres and Small Industries Service Institutes should provide the training and such capital as is required by the RE 'agents' to get started.

CHAPTER VII

ORGANISATION AND MANAGEMENT

PRESENT ORGANISATION STRUCTURE

Historical Background

7.1 The subject of electricity is included in the Concurrent List under the Indian Constitution with responsibilities both at the Centre and the States. However, the electricity supply industry has been governed mainly by the Central legislation and policy in this field.

7.2 The legislative measures taken in 1948 to organise the industry and the Industrial Policy Resolution of 1956 have primarily guided the organisational structure of the industry to its present pattern.

7.3 Prior to 1948, the Central and the Provincial (State) Governments concerned themselves with only the regulatory aspects, leaving the organisation structure to the evolutionary process which had begun through the entrepreneurial efforts of private companies, local bodies and State Governments. Though the first attempt to legislate in the field of electricity was made as early as 1887 with the specific intent of providing safety to personnel and property, a comprehensive piece of legislation, namely, the Indian Electricity Act was introduced only in 1910. The Act provided for issue of licences for establishment of electricity undertakings and concerned itself with the regulatory and safety aspects. The general administration of the 1910 Act and grant of licences were left mainly in the hands of the Provincial (State) Governments. This Act has been modified from time to time and is in force now.

7.4 In the '40s, the power supply industry was mainly in the private sector. Some enterprising municipalities and Provincial Governments had also entered the field. A few progressive Provincial Governments had set up hydro-electric plants and associated grid systems to supply power to extensive areas within their purview. There were numerous undertakings, the bulk of them concentrated in the urban areas with each having its own independent system to supply power in its area of jurisdiction. There was little co-ordination or co-operation among them as their areas of activities were isolated and often located far apart. This led to a growing public concern over the haphazard growth of the industry and the recognition of the need for giving the industry a proper organisation structure to enable it to develop in the overall national interest consistent with the advancement of the technology. The importance of extending power supply to all the areas, particularly to rural areas, and the promotional efforts required to achieve this welfare objective came to be recognised. The advantages of unification of the industry through a grid system to make power supply more economic and reliable were also recognised. It was in this context that separate comprehensive legislation outside the purview of the 1910 Act was conceived at the time of independence to provide the electricity supply industry with an organisation structure for the State owned Sector.

State Electricity Boards (SEBs)

7.5 The Electricity (Supply) Act, 1948 aimed at rationalisation of production and supply of electricity and generally for taking measures conducive to power development in the Provinces (States) of the country. It provided for the creation of State Electricity Boards (SEBs) charged with 'the duty of promoting co-ordinated development of generation, supply and distribution of electricity within the State in the most efficient and economic manner, with particular reference to such development in areas not for the time being served or adequately served by any licensee'. It also envisaged creation of the Central Electricity Authority (CEA) with the responsibility 'inter-alia' of developing a sound, adequate and uniform national power policy and co-ordinating the activities of the various planning agencies. Nationalisation of the power supply industry was not an objective of this legislation though under it, the SEBs could establish power supply facilities to pursue the objective of promotion of power development in the States. The Industrial Policy Resolution of 1956 reserved generation and distribution of electricity almost exclusively to the State Sector and this led to the gradual nationalisation of the power supply industry.

Central Electricity Authority (CEA)

7.6 The Central Electricity Authority was established as a part-time body in 1951. Most of its functions as a Central co-ordinating body were being discharged by the Central Water and Power Commission (Power Wing). In 1974, when the Central Water and Power Commission was bifurcated as a consequence of the bifurcation of Departments of Irrigation and Power, the Central Electricity Authority formally became a full-time body.

7.7 There was initial reluctance at the State level to create State Electricity Boards, particularly in those States where there were strong Departmental organisations responsible for electricity. Gradually, however, Electricity Boards got established in all the States by the late fifties. In a few States which got their statehood only recently, Boards have not been set up and electricity supply in those States is the responsibility o: departmental organisations.

7.8 The Electricity (Supply) Act of 1948 did not specifically confine the responsibility for expansion or setting up new State owned power supply facilities to the State Electricity Boards. Several States in which development of hydro-electric projects was undertaken through the State Electricity Departments, maintained the status quo without transferring this responsibility to the State Electricity Boards. Even today, there are a few State where development of hydro-electric projects and construction of hydro-electric power plants are left in the charge of either the irrigation department or a separate hydro organisation under the Government. However, after construction of the project the operation of the plants is generally entrusted to the State Electricity Boards.

Private and Public Sector

7.9 The Industrial Policy Resolution of 1956 reserved the expansion of power supply facilities to the State Sector. In several States, licensees already engaged in generation and distribution of power supply were allowed to continue in business so long as the licences were valid. There are still a few private licensees continuing in the business although most of the licensees have been nationalised. There are today three utilities in the private sector which are engaged in power generation. These are the Tata Electric Company and the Calcutta and Ahmedabad Electric Supply Companies.

Central Public Sector Corporations

7.10 In 1976, the Electricity (Supply) Act was amended to provide for the establishment of generation companies by the Central and the State Governments. Two Central generation companies, the National Thermal Power Corporation (NTPC) and the National Hydro-Electric Power Corporation (NHPC), one Centrally owned regional generation company (North-Eastern Electric Power Corporation—NEEPCO) and one State generation company (Mysore Power Corporation) have been established so far. A consultancy organisation, the Water and Power Development (Consultancy) Services (India) Ltd. (WAPCOS), was established in 1969, to give advice mainly on the construction of hydel projects, dams and irrigation canals.

Regional Electricity Boards (REBs)

7.11 During the '60s, the advantage of integration of power systems at the regional level and the limitation of a State as a spatial unit for power planning and operation was recognised. To promote a regional approach to power development, the country was divided into five regions and Regional Electricity Boards (REBs) as associations of the constituent State Electricity Boards and other power organisations were created through Central Government resolutions. The REBs are charged with the responsibility of co-ordinating the operation of the power supply industry in the five regions.

Nuclear Power Stations

7.12 Under the Atomic Energy Act of 1962, the responsibility for nuclear power development is vested with the Central Government. While the function of establishing nuclear power plants is being discharged directly by Department of Atomic Energy, the operation of the plants is entrusted to the Atomic Power Authority which was created as a constituent unit of the Department of Atomic Energy.

Joint Sector Projects

7.13 The Damodar Valley Corporation, established in 1948 by an Act of the Parliament, is responsible for unified development of the Damodar Valley, including irrigation, flood control and power generation and supply in the valley area. Two Corporations one in the State Sector and the other in the Central Sector (Durgapur Project Ltd. and Neyveli Lignite Corporation) were allowed to set up large thermal power plants as a part of their other activities and were permitted to sell power in bulk. These are also in existence. There have also been several instances where two or more States have got together and set up jointly thermal and hydel projects. Examples of this are the Bhakra-Beas, Tungabhadra, Satpura and Machkund projects. In these cases, where one State has a predominant share, the management of the power station is vested in the SEB of that State. Where the shares are roughly equal as in the case of Bhakra and the Beas Sutlej Link, the chief executive of the project by the mutual consent of the States is appointed by the Central Government.

Complexity of the Structure

7.14 From the foregoing, it can be seen that today the power supply industry has a complex organisation structure. The major responsibility for power generation and supply presently rests with the State Governments with the State Electricity Boards playing the key role in most of the States. In a few States, the responsibility is not so clear because of the existence of other organisations. The main concern at the regional level is to bring about co-ordination and integrated operation of the constituent power systems. The main functions at the Central level are formulation of overall power policies, planning, co-ordination and consultancy inputs though in the last few years, the Central Government is increasingly involving itself in establishing generation facilities and supplementing the efforts at the State level.

7.15 The correlation between the pattern of ownership and the share of the generation and distribution systems is shown in Table 7.1 below for 1978-79.

TABLE 7·1

Ownershipwise share of installed generating capacity

Owner	Share of installed generating capacity in MW	Per-cent	Typical Projects
1	2	3	4
A. Autonomous Corporations/Boards.			
(i) Individual States/ U.Ts.	19445	72·8	Projects run by State Electricity Boards and Power Corporations and Delhi Electric Supply Undertaking.
(ii) Groups of States	2261	8·5	Bhakra, Beas-Sutlej Link, Tungabhadra, Machkund, Rihand.
(iii) Centre and States	1421	5·3	D.V.C., Regional Load Despatch Stations.
(iv) Centre . .	1216	4·5	NTPC, NHPC, NLC.
(v) Municipal Corporations.	276	1·1	Bombay Electric Supply Undertaking (BEST), Transmission and Distribution only.
(vi) Public Ltd. Companies.	1389	5·2	Tata Power, Calcutta Electric Supply, Ahmedabad Electricity Supply and a few Transmission and Distribution companies.
B. Departmental Undertakings			
(i) States . .	44	0·2	Projects run by Govt. Department of Nagaland, Arunachal Pradesh.
(ii) Centre . .	640	2·4	Nuclear, Thermal Plants.

From this Table it is clear that as far as current ıpacities are concerned, the SEBs are the organiıtions that really matter, although in certain lates, organisations like Bhakra, DVC, Neyveli nd Rajasthan Atomic Power Station do make a gnificant difference to the power position in the reas they serve.

ore of the Structure

.16 The Central Electricity Authority, the .egional Electricty Boards and the State Electriity Boards today constitute the core of the orgaisation structure. The performance of the ıdustry depends mainly on the efficient and ffective functioning of these organisations. They re described in more detail in the following aragraphs.

:entral Electricity Authority (CEA)

'.17 The Central Electricity Authority is a :atutory body set up under the provisions of the :lectricity (Supply) Act, 1948. Its Chairman .nd Members are appointed by the Government ɟ India. It reports to the Department of Power n the Ministry of Energy. The CEA's principal statutory responsibilities are the development of a national power policy, formulation of plans for power development and co-ordination of power generation and transmission programmes. As a part of its power policy and plan formulation function, the CEA is required to techno-economically appraise power projects to ensure that they are consistent with the national power policy for optimum development of power resources.

7.18 The responsibilities of the CEA have been progressively enlarged to include aspects such as providing advice to State Governments, SEBs, and other organisations on optimal utilisation of available facilities, providing assistance for timely completion of power schemes; making arrangements for manpower training for manning the power supply industry; investigation of generation and transmission projects; promoting research in matters relating to the power supply industry; monitoring the progess of power projects under implementation and the performance of the existing power system. The Chairman of the CEA is also the ex-officio Chairman of the Power Survey Committee which prepares forecasts of the likely growth in demand for power by consumers and States and for which the Secretariat is provided by the CEA. In addition, the CEA discharges the functions which devolved on it from its predecessor organisation, the Central Water & Power Commission (Power Wing).

Consultancy Services

7.19 The CEA has a Consultancy Wing which provides design and engineering services in the fields of hydro and thermal power plants and power systems to SEBs and public sector corporations, more or less on a time cost basis.

Badarpur Thermal Power Station

7.20 The CEA was responsible for the construction and for some years for the operation of the Badarpur Thermal Power Station which had earlier been entrusted to the CW&PC (Power Wing). The management of the plant has recently been transferred to the National Thermal Power Corporation (NTPC).

Organisation Structure

7.21 The CEA has at present a Chairman and five full-time Members. It has a supporting staff consisting mainly of qualified and trained engineers. The work of the CEA is functionally divided amongst the following six Wings :

	Dealing with all matters connected with—
1. Thermal Wing	— Thermal power projects.
2. Hydro Wing	— Hydro-electric projects.
3. Power Systems Wing.	— Transmission, distribution and other matters dealing with the totality of the power system.
4. Operation & Monitoring Wing.	— Monitoring of performance of thermal and hydel power stations and power availability.
5. Economic & Commercial Wing.	— Economic and commercial aspects.
6. Planning Wing	— Planning for power development in its totality.

7.22 Each Wing of the CEA is under the charge of a Member except the Planning Wing which is directly under the charge of the Chairman who is assisted by a Chief Engineer. All the wings function independently and co-ordination among them is brought about mainly by Chairman. The Statute provides that the CEA can have not more than 14 Members of whom not more than eight can be full-time Members.

Regional Electricity Boards (REBs)

7.23 The country has been divided into five regions of contiguous States for promoting power development on a regional basis and regional integration of power systems to pave the way ultimately for a unified national grid. The composition of the regions is shown in appendix 7.1 Section II—(Regional level organisation) Institutional arrangements outside the purview of the Central or State Statutes were considered to be necessary at the regional level mainly to integrate the operation of the constituent State power systems. It was in this context that Regional Electricity Boards were created by Government Resolutions in 1964. The Regional Electricity Boards are comprised of Members representing the constituent Electricity Boards and power supply organisations backed by a full-time secretariat. The Boards are part-time bodies having a part-time Chairman. One of the Members of the Board in rotation acts as Chairman for a period of one year. The Secretariat is headed by a Secretary who is also a member of the Board. The Secretariat is administratively under the control of the Central Electricity Authority. Nominees of CEA and Planning Commission attend the meetings of the REBs.

7.24 The Secretariat of the REBs are accountable to the CEA administratively and to the Boards functionally. They are concerned with the day-to-day integrated operations of regional power systems. The establishment and operation of Regional Load Despatch Stations comes under the REBs. The technical and commercial arrangements for integrated operation are organised through standing operational committees with representation from the constituents. The Boards meet regularly to decide on policy issues and give policy guidelines. The Regional Boards function in an advisory capacity and their advise is not binding on the individual constituents. The Boards do not have a corporate status. Neither have they been given statutory recognition and assigned statutory responsibilities though they have been in existence for more than fifteen years.

7.25 The REBs are in practice not cohesive and effective bodies and there is much scope for improving their contribution to the optimal performance of regional power systems.

State Electricity Boards (SEBs)

7.26 With the growth of the power system, the State Electricity Boards have enlarged over time and are today the most important operating part of the power industry. Boards are in existence in all the States except Nagaland, Manipur, Tripura and Sikkim. The Electricity (Supply) Act provides for the Boards to consist of not less than three and not more than seven members to be appointed by the State Government. Their tenure is also specified. There is no indication in the Act as to how many of the Members should be full-time. The qualifications for three Members are broadly prescribed and one of them is to be appointed as Chairman.

7.27 In practice, most of the SEBs have a full-time Chairman and two full-time Members, one to look after technical matters (Member, Technical) and the other to look after financial aspects and accounts (Member, Accounts or Finance). Some of the larger Boards have a Member in charge of generation and a Member in charge of transmission instead of one Member (Technical). There are also a few Boards with a separate Member to look after administration.

7.28 Each SEB also has a Secretary who is appointed by the Board, with the approval of the State Government. In a few Boards, the Secretary also is a Member of the Board.

7.29 The SEBs can decide on their internal organisation. The functions, duties and responsibilities relating to construction of power plants; operation of the power plants and power systems; transmission and distribution, and supply of electricity to ultimate consumers are distributed among several Chief Engineers. The work and responsibilities below Chief Engineers are distributed among circles under Superintending Engineers, Divisions under Executive Engineers and Sub-divisions under Assistant Engineers. The unit of management which is in direct contact with the ultimate consumers is the Division or the Sub-division. The Accounts/Finance wing of the SEBs also has a similar hierarchical system. Since the structures of Boards vary widely, it is not possible to show a typical chart of the organisation structure of an SEB.

7.30 The SEBs have a cadre of engineers, operators and technicians. The Engineers cadre in some Boards is a common one and in a few cases there are two cadres, one for generation and the other for transmission and distribution. The Boards do not have separate cadres for finance, personnel or commercial affairs and these aspects are dealt with by the staff belonging to the technical cadres.

7.31 The SEBs are envisaged to function as autonomous bodies and the Act provides for the State Governments to give directions, if necessary, on matters of policy to guide the Board's functioning.

Department of Atomic Energy (DAE)

7.32 This is a departmentally run organisation but with considerably greater operating autonomy in practice than even public sector corporations. This is historically the result of strong personalities with direct access and accountability to the

Prime Minister having sought and got the kind of freedom of action that development in a highly sophisticated and increasingly sensitive field demands.

7.33 The department operates in a highly self contained way in as much as it is responsible for designing, erecting, commissioning and operating nuclear power plants. Much of the equipment it needs is manufactured to its specifications under the close supervision of the scientists and engineers of the DAE. The DAE has also built and operates its own fuel fabricating plant, its heavy water plants and its fuel disposal units. The R&D back up for the nuclear power programme comes largely from the Bhabha Atomic Research Centre at Trombay.

7.34 Currently, the DAE has two plants in operation—Tarapore and Rajasthan Atomic Power Station-I (RAPP-I). RAPP-II is ready for commissioning but awaiting heavy water supplies. The indigenous programme for producing heavy water is several years behind schedule. Each of these plants has a rated capacity of 210 MW. Four more plants are under construction, two in Madras (MAPP-I and II) and two in Narora in U.P. (NAPP-I and II).

Performance of the Power Industry

7.35 One of the major targets of criticism today and for some years now has been the inefficiency of the State Electricity Boards and other State owned utilities, especially their inability to put up and operate power generating and distribution systems efficiently; to respond to the needs of the consumer; and to equip themselves to handle the commercial, financial and personnel management aspects of large public utilities. Because of their large share of the power supply industry the criticism is mainly directed at the State Electricity Boards.

7.36 The State Electricity Boards were created with the specific purpose of integrating the power supply system in the States and planning their development at a time when the power supply industry was in more or less the early stages of development. The Boards were given the mandate and the necessary autonomy and authority, (the degree of which varied from State to State), to discharge this responsibility. By and large, they have fulfilled this preliminary objective of integrating power supply systems in their own States, but they are not adequately organised to handle the tasks that face them today much less those that will face them tomorrow.

ORGANISATIONAL AND MANAGERIAL WEAKNESSES

State Electricity Boards

7.37 The major problem areas are inordinate delay in the commissioning of the power projects, the poor utilisation of power plant capacity and heavy financial losses. Although these are partly the result of factors outside the control of the Boards, they cannot but reflect on the quality of their management. During the last few years, their performance has on the whole deteriorated. In personnel terms, the reason is not far to seek. The Boards have not been exposed to modern management systems and an achievement oriented and commercial culture. Apart from salary considerations, they do not provide the kind of environment required to attract and retain young and enterprising engineers and experts in other disciplines. The industry has been and is even today slow and insensitive in responding to the general public's expectations of a power supply of reasonable quality and reliability and also to consumer complaints. There is a general tendency among the staff to exploit conditions created by their position of a monopoly in power supply in a period of power shortages.

Technological Sophistication

7.38 The fact is that the power supply industry has gone well beyond the co-ordinational and promotional role which the Boards were originally set up to perform in the early stages of the development of the power industry. Today the development and operation of the power supply industry is a very large and highly complex activity demanding a mastery over changing technological financial, commercial and personnel challenges of an increasingly sophisticated nature. It must however be recognised that despite the internal and external constraints they have had to work under, a few SEBs have performed reasonably well in the past but even they are now beginning to falter.

Departmental Origins and Growth

7.39 The deficiencies and inadequacies in the functioning of most of the SEBs stem to a considerable extent from their origins. The SEBs were formed initially from the Government Electricity Departments and they have inherited the staff as well as the culture, methods and procedures of departmental working. The departmental ethos and style of functioning are not compatible with the efficient operation of a modern utility as it is slow in responding to changing managerial challenges. The size and sophistication of operation of the SEBs in terms of power supply facilities, area and consumers served, employees, capital employed and revenue collected have grown enormously and some of the SEBs may have even reached the limit of size required for efficient functioning. This raises the question of whether the time has not come to hive off the functions especially on the distribution side which absorbs the largest number of employees.

Appointment of Top Management

7.40 One of the major weaknesses in the SEBs is its personnel policies. Typical of this are the procedures that are being followed for the appointment of the top management team i.e. Chairman and Members of the Board, the terms of their appointment and the extent of involvement in their day-to-day functioning of State politicians and officials. The appointments to the Board follow procedures which are not uniform and give scope for patronage.

7.41 It is necessary that the qualifications for appointments to the Board should be more clearly defined and there should be procedures for selection which are both uniform and capable of finding suitable people for these very critical posts. The Committee finds it difficult to endorse the position prevailing in some States who have laid it down that the Chairman of the Board has to be an Engineer. The Chairman's job has much wider dimensions than the purely technical and a good manager from any discipline should be eligible for becoming the Chief Executive as is the case with a large number of public and private sector organisations.

Insecurity of top management

7.42 Another source of weakness is the insecurity of the Chairman and full-time Members of the Board. The average tenure of a Chairman in some Boards is about 9 months. Changes of Board Members can take place depending upon the equations that exist between the Minister in charge of Power, the senior officials of the State Government and the Chairman and Members of the Board. Increasingly there appears to be a tendency in some States to politicise these appointments.

7.43 As a result, the top management of the SEBs, with some honourable exceptions, is generally not able to provide the kind of leadership required to run the industry efficiently. Secondly, there is no clear allocation of functions and effective delegation and exercise of responsibilities, and most of the powers are concentrated in the Board. As a consequence, the top executives (the Chief Engineers and Superintending Engineers) generally cannot function effectively even when they want to. In some cases, however, where powers are delegated it is noticed that the concerned officers try to evade responsibility and wait for directions from the Board so as to 'play safe'. This is because where delegated powers have been exercised and bona fide mistakes have taken place, as they occasionally must, witch hunts and interminable enquiries have been started tending to dampen all initiative and enterprise.

Absence of non-technical staff inputs

7.44 All the non-technical inputs required by multi-functional organisations to operate efficiently and viably namely finance, project appraisal materials management, personnel, planning and forecasting, economic and statistical analysis and even some technical inputs like industrial engineering and operations research are all either weak or non-existent. Despite the fact that many public and private sector companies have demonstrated the importance of such inputs the Boards with a few exceptions remain isolated from the changes that are taking place around them.

Separation of cadres

7.45 The bulk of the staff in the State Electricity Boards is deployed in discharging the distribution and commercial functions. The staff employed in the generation and bulk transmission functions is relatively small but has to be well qualified and trained to deal with the highly sophisticated power generation technologies. On the other hand, the staff to be deployed on sub-transmission and distribution requires a different kind of technological expertise namely to plan and put up a complex T&D system and run it well. They also need to have skills which enable them to manage a large body of staff, many of them dispersed over wide areas, to deal with consumer complaints; to ensure that bills are promptly sent and dues recovered on time; to plan growth so that the load does not go beyond availability and that T&D losses (including thefts) are minimised. It would be essential, therefore, from the management point of view to ensure that the personnel in charge of the generation and bulk transmission and those responsible for the distribution and the commercial functions are recognised by all concerned as requiring very different skills, experience and training and should thus belong to separate cadres in the Board.

Quality of Management

7.46 State Electricity Boards are facing a growing problem of attracting and holding really bright young officers, typically graduates of the Indian Institutes of Technology, Indian Institutes of Management, the top students from good engineering colleges and so on. The problem is particularly acute when it comes to officers who have to work in projects in inaccessible and under developed areas either on construction or generation. The attraction of urban life and consumer contact in a sellers' market appears to be irresistible so that such talent as there is on the generation side is anxious to switch to distribution. While the quality of the intake is not improving, the task of running the power system is becoming increasingly technologically sophisticated and automated. Both generation and H.T. transmission systems are likely to need fewer but technically superior people. The problem of what to do with the older type of manager, which advancing technology has left behind, will become increasingly serious.

Autonomy of SEBs

7.47 The SEBs were conceived as semi-autonomous organisations with the State Governments confining themselves to the appointment of the 'Shareholders' representatives' namely the Chairman and Members of the Board and giving written directions on major policy issues. The day-to-day management was to be left to the Chief Executives—the Chairman and fulltime Members. The Committee notes from its discussions with the agencies concerned that in practice the SEBs do not have the kind of autonomy that many public sector corporations in the Central Government enjoy, and there is a considerable intervention in their day-to-day operations. These stem from certain special features of the power supply industry which attract political and bureaucratic attention and patronage.

7.48 The industry is highly capital intensive and its expansion accounts for a significant share of the State's plan expenditure. Establishment of power stations involves large blocks of expenditure and consequently is an important economic activity, providing direct, secondary and tertiary employment. The location of a power generation project in a specific area is thus considered a symbol of progress and considerable prestige is attached to it. As a result, within the States the various districts and regions vie with each other for location of projects in their jurisdiction and sometimes techno-economic assessments take a back seat.

Political Pressures

7.49 Constraints on resources, both financial and physical, in extending electricity to rural areas and also giving connections to the ever growing numbers of urban consumers has brought about a situation in which political and bureaucratic cliques which lobby on behalf of individuals and specific consumer groups and localities are bound to flourish.

7.50 The absence of rational guidelines and policies for tariff fixation has been referred to in the chapter on 'Finance, Financial Management and Tariffs'. Tariff fixation thus creates political pressures to favour certain sections of the community which have political leverage. Similarly the implementation of power projects requires purchases and contracts involving large sums of money. This also attracts political and bureaucratic patronage. Another important source of patronage in the SEBs is recruitment of staff and their posting in cities which have good facilities for health, education and entertainment. There is very little realisation at political levels in many States that interference in recruitment, postings and transfers seriously undermines the efficiency of management and thus adversely affects the operation of the industry and with it, the growth of the entire economy.

7.51 It must be accepted that the operations of the State Electricity Boards are so large, so all pervasive and so critical to the day to day activities of the State, that interaction in their day-to-day functioning with the political system cannot be completely avoided in a democratic parliamentary system with the Government accountable to the legislature. The goal should be to minimise it to a level which does not significantly affect the efficient operation of the industry. The elimination of power shortages itself will help to reduce such interference but some other statutory measures may also be required.

Multiplicity of Organisations at State Level

7.52 While in some States, the SEB is solely incharge of all activities connected with power, in others the responsibility is distributed among more than one organisation. In some States, where such division of responsibility exists, this has adversely affected the power supply. For example in States where hydro-electric power developmental has been entrusted jointly to a departmental organisation, such as the Irrigation Department and the SEB, the result has been difficulty in pin pointing accountability for results leading to delays in completion of projects. This has been one of the causes of slowing down of investments in hydro-electric power projects, and a shift to large scale investments in thermal plants.

State and Central organisations dealing with Power

7.53 Statutorily, the State Electricity Boards have been vested with the ultimate responsibility for power supply in their States, but the responsibility for formulation of national power policies and power programmes and clearance of projects, are vested with the Central Electricity Authority. Under the central planning process, the Planning Commission integrates the power programme into the overall programme of national economic development. Thus, for the healthy growth of the power sector and to formulate agreed policies and programmes, close and constant interaction among the SEBs, other State power generating and distribution agencies, the CEA and the Planning Commission is necessary.

Central Electricity Authority

7.54 While the advisory role envisaged for the CEA in power development under the statute is all pervasive, its direct executive powers are limited. Specifically they are limited to giving technical clearance for projects costing more than Rs. 1 crore, an essential step in the implementation process. It also helps to clear cases requiring the concurrence of Central Ministries. At one time, it used to run the Thermal Plant at Badarpur but that has now become a part of the NTPC.

7.55 The CEA, if it is to play the role envisaged for it, has to do so very largely by the quality of the advice it gives and the respect in which it is held by the various executive agencies in the Central and State Governments. Operationally it has a major part to play in the overall planning process because the Chairman of the CEA is the Chairman of the group which carries out the Annual Power Surveys these are key documents in the formulation of the annual, 5-year and long-term Plans of the States and the Centre.

7.56 By carrying out detailed investigations and studies, it is in a position to influence the power sector in a wide variety of ways such as methodology of demand forecasting and planning, project formulation and implementation systems and improvements in operation and maintenance, tariff and financial policies, research and development, personnel policies and organisation structures and so on.

7.57 It appears to be the general impression that in the past the CEA has not adequately fulfilled the role cast for it and there is reason to believe that it has been seen by some SEBs and other bodies connected with the power sector as something of a hurdle to be negotiated in the process of getting clearance of projects but whose assistance is required in dealing with other Central agencies. This is somewhat unfair in the sense that the CEA or its forerunner, the CW&PC, has carried out surveys of hydro resources which have been the basis of the hydel projects that are being executed today. Similarly, studies carried out on location of pit head stations has helped in formulating thermal projects. Many of its members have headed committees which have helped to identify weaknesses in project formulation, implementation and operation.

7.58 The CEA has recently begun to make efforts to strengthen its staff and widen its sphere of influence and has set up a good system for monitoring the performance of thermal generating stations. It has however a long way to go before it can be said to be playing the kind of critical role that it was set up to perform. It is hams'rung by the rigidities of the Governmental procedure in filling posts, sanctioning studies and is finding it difficult to get good men either permanently or on deputation. In short, as matters stand today, there are, largely on account of the past shortcomings of the CEA, no well conceived, coherent, comprehensive and agreed policies for the development of the power industry in all its aspects.

Consultancy Services

7.59 The desirability of the Central Electricity Authority continuing to provide technical consultancy services while it has been vested with the statutory responsibility has been questioned. The CEA as a statutory authority is required to approve on behalf of Government the design and various other technical details of a power project. It is therefore hardly likely to take a detached view of the designs produced by its own staff. On the other hand, the design and consultancy function does provide scope for CEA personnel to acquire practical experience in the various aspects of designing power projects and helps the CEA in performing its functions more effectively and purposefully. Some way of dealing with this conflict has to be found.

Regional Electricity Boards (REBs)

7.60 The least effective of the three core bodies are the Regional Electricity Boards. While some inter-State despatch of power does take place, the possibilities of optimising the system so that capacity utilisation is increased and power shortages eased, are considerable. The main reason for this is that REBs today are non-statutory bodies and have no executive powers to ensure that such optimisation programmes, where they have been developed, are implemented. They do serve a useful purpose by creating a forum for bringing together the heads of the various utilities operating in a region and exchanging information but beyond this, they cannot go.

Department of Atomic Energy (DAE)

7.61 Although the performance of RAPP-I has not been up to expectations, the causes are not at all within the control of the DAE. On the whole, the DAE's performance in the field of power projects has not been unsatisfactory. An analysis of its operations appears in the Chapters on 'Operation & Maintenance', and "Project Formulation & Implementation'. The changes that may be required if it is to implement the much larger programme of nuclear power envisaged are discussed later.

RECOMMENDATIONS

Need for reorganisation

Central Generation

7.62 In a federal system with the subject of electricity in the Concurrent List, any change in the basic organisation structure of the power supply industry could be considered only after defining clearly the basic objectives of power development and establishing the inadequacies of the existing structures in achieving these objectives. The primary objective of the power development programme must be to provide adequate power supply to all consumers at the lowest possible price. Toward this end the Committee, in the Chapter on 'Power Planning', has highlighted the need to set up and operate power generating and transmission facilities as a part of an integrated regional/national grid and has recommended that Central generation should play a much greater role than it has done in the past so that by 2000 A.D. it owns and operates at least 45% of the total generation capacity. The Committee has also proposed that all the high tension (220 KV and above) transmission lines and their associated substations which are required to ensure the equitable and optimal flow of power through and between regions should be owned and operated by the Centre as soon as possible.

MACRO-LEVEL ORGANISATIONAL CHANGES

7.63 The recommended organisational changes and structures for the industry in so far as they concern the Centre and the States flow from these two basic objectives namely that the Centre should put up the bulk of the new generation capacity in future and that it should own and operate the high tension lines and their associated sub-stations so as to be able to control the generation from the various stations in the regions and regulate the inter-State flow of power. The existing generation capacity and the transmission and distribution system not connected with the inter-State flow of power should, in the Committee's view, continue to remain under the State Electricity Boards. In addition, some new generation capacity could come up in certain States either put by the State itself or jointly owned by two or more States.

7.64 The only alternative ownership pattern which has been seriously considered in the 'Power Planning' Chapter is that of all new generation together with HT transmission to the extent outlined above, should be put up by the Central Government. The only difference this would make to the organisation structure discussed below is the discontinuance of the construction wing in charge of setting up generation projects in some SEBs.

Regional Electricity Generation Corporations (REGCs)

Alternative structures

7.65 There are three possible organisational structures under both these ownership patterns. The first is a single large all-India corporation owning all the new projects to be set up in the country, both hydel and thermal, by the Central Government. A variation of this, more in line with the current position, would be two all-India Corporations, one for hydel and one for thermal projects. A second alternative, with similar variations for thermal and hydel projects, is regional corporations—North, East, South, West and North-East. The North-East Corporation is already in existence. A third alternative is the creation of Central power corporations in each State.

7.66 From a purely theoretical point of view, the first alternative serves best the purpose of creating and operating an integrated all-India grid. However, over-centralisation of authority in a vast monolithic organisation is likely, in our environment, to lead to sluggish responses to managerial and technological challenges, delay in decision making, tendency to even greater bureaucratisation and a loss of personal rapport between the various tiers of the hierarchy.

7.67. The third alternative—Centrally-owned Corporations in each State merely substitutes the SEBs by centrally-owned corporations and defeats the purpose of creating an effective regional and national grid and can be discarded. The Committee would recommend, therefore, the second alternative of regional corporations embracing both thermal and hydel projects to be termed Regional Electricity Generating Corporations (REGCs) as it combines many of the merits of the first alternative without creating an unmanageably large structure. It would also dovetail in well with the new responsibilities proposed to be entrusted to the Regional Electricity Authorities. The NTPC and NHPC should, if this recommendation is accepted, therefore, cease to exist in their present forms and their staff and officers will form the nucleus of the 4 regional corporations (excluding NEEPCO).

Regional Level Organisations

Regional Electricity Authority (REA)

7.68 The inability of the Reigonal Electricity Boards (REBs) to exercise effective control over the generating units and transmission lines in the region and optimise the generation and transmission system has been referred to earlier. If the integration of power systems in each region is to be brought about in a purposeful way, it is necessary to create in each region a full-time regional body with statutory powers and responsibilities to plan the development of and operate the power systems in the most efficient and economical manner and exchange power between different power systems in the overall regional interest.

7.69 The Committee, therefore, recommends that full-time Regional Electricity Authorities (REAs) in the five regions of the country should be constituted by statutes and they should replace the REBs and be vested with a much wider range of responsibilities and functions. They should own and operate the regional load despatch centres, the relevant state and inter-State transmission lines and their associated substations, purchase and sell power in bulk from all stations in the region (including nuclear) so that they can exercise effective control over the generation and movement of power in the entire region. Without such powers it would be impossible, for example, to ensure that power generated outside States like Punjab and Haryana in super thermal stations and meant for them actually reaches them. The REAs would be administratively and functionally responsible to the CEA

Role of the Central Electricity Authority

7.70. The Central Electricity Authority (CEA) should continue as the premier national body for policy making, planning and co-ordination in the field of power development. With the setting up of the REAs which would report to it, its ability to influence the planning, construction and operations of the power system will be greatly enhanced. Some of the functions it should concentrate on have been dealt with in para 7.56. It should thus continue to be involved in techno-economic appraisal of power projects, evolving planning methodologies, monitoring and evaluation of project implementation, financial performance of all the power supply organisations, standardisation of designs, checking of power plant designs, arranging for key materials, setting up training facilities and overseeing their performance, advising utilities on tariff and personnel policies, technological developments and so on. In fact, throughout this report, it will be observed that the onus of getting many of the recommendations made by the committee implemented will rest largely with the CEA.

7.71. The CEA should not, however, be involved in consultancy functions, as at present, because this is incompatible with its stature as a policy making and regulatory body. The function of the CEA should thus be more or less that of a review consultant who gives an expert second opinion on the recommendations prepared by the prime consultant. The system and procedures for such approval should be carefully evolved in such a manner that it does not in any way result in delays. One of the major tasks of the CEA should also be to help upgrade the expertise and standards of consultancy organisations in India, which it cannot do if it is one such consultant itself. The CEA should also certify consultancy organisation as being equipped to undertake the assignments they are quoting for.

CEA as the Secretariat of the Ministry

7.72. There is a school of thought which feels that the CEA should be organised on the pattern of the Railway Board, that there should be no separate secretariat for the Department of Power and that the CEA should itself function as the secretariat. The Committee does not subscribe to this view. The CEA was set up as an expert body and its role and functions have been described in detail above. Unlike the Railways, the Central Government does not own all the assets in the power industry nor is there a proposal that it should do so. The CEA's role therefore must continue to be largely advisory except for the new recommendation of this Committee that it should be given administrative responsibility for the development and operation of the REAs.

7.73 The Department of Power has a very different role to play in ensuring 'inter-alia' that there is close co-ordination of the various bodies within the power sector and between the power sector and other sectors of the economy both in the Centre and the States. It must provide these links both at the political and the official levels. It must also ensure that regulations made under the Electricity Supply Act are enforced and that the supply of key inputs to the power industry which fall within the purview of other Ministries such as Coal, Railways, Heavy Engineering, Economic Affairs and Directorate General of Technical Development are maintained. It has to assist the Minister in dealing with Parliament, Cabinet as well as with other countries on policy issues connected with power. These are not functions which expert professional bodies are best suited to undertake as they call more for political and administrative rather than technical judgements. It has to be kept in mind that the CEA has to deal with both the Centre and the States and its professional advice would be more readily acceptable if the political aura that surrounds a Ministry of the Central Government is not injected into what is and should remain a professionally expert and objective body.

Power Design and Consultancy Corporation (PDCC)

7.74 While the Committee recommends that the CEA should divert itself of its consultancy role, a Power Design and Consultancy Corporation (PDCC) should be set up administratively under the Department of Power with the specialist design groups in the CEA as its nucleus and appropriately strengthening it. In course of time, as it establishes itself, it should take over the consultancy functions of WAPCOS and CWC in regard to hydel projects.

7.75 This Corporation should operate on commercial lines competing with organisations in the private sector. Other public sector corporations such as the NTPC and the NHPC are building up gradually design organisations of their own. BHEL has also built up an organisations for providing design and consultancy services. A multiplicity of public sector organisations in the field will merely dissipate and diffuse the limited talent in the country and would be a retrograde trend. Moreover a consultancy organisation should be independent of the manufacturers and the users so that objectivity can be maintained. While there should thus be a competent and effective consultancy organisation in the public sector, the tendency for it to become monopolistic should be resisted and a market share of 50% as a limit may be considered. There are three or four private sector organisations which are beginning to develop expertise of a reasonable order and they should not be discouraged. The CEA must ensure that there is a fair and healthy competition between them. Since MECON, a public sector company, and DASTURCO, a private sector company have both managed to co-exist in the field of steel plants consultancy; there seems no good reason why a similar arrangement cannot be worked out for the power sector.

T&D Consultancy Services

7.76 A distinctive role that the PDCC can take on is offering specialised consultancy services in the field of transmission and distribution. This is also becoming an extremely complex field where optimisation of design requires a high degree of expertise in various branches of engineering as well as systems studies requiring sophisticated software to be developed.

7.77 In short, the PDCC should have three consultancy wings, thermal, hydel, and transmission and distribution and should be able to offer complete turnkey consultancy services in these fields. The Committee feels that, if it is developed properly, the opportunities for this corporation in the export market are immense.

Quality Control/Assurance

7.78 A second and important role it could take on is providing a total quality control service for its clients. Many consultancy organisations elsewhere provide this service and local private sector consultancy organisations also have entered this field. Private sector firms however operate under a handicap in as much as most of major suppliers of power utility equipment are large public sector undertakings whom they cannot afford to alienate.

Another public sector corporation such as the proposed PDCC should however suffer from no such inhibitions and once the manner in which such quality control functions are to be exercised is established the private sector agencies can also function more effectively. The PDCC should undertake to inspect and test any equipment on behalf of its clients to ensure that it conforms to specifications. Quality control and inspection and testing of sophisticated power plant equipment is already a highly complex and specialised function and is becoming increasingly more so. It would be unnecessary and redundant for each utility to build up the required level of expertise for inspecting equipment supplied to it by manufacturers, both indigenous and foreign. The consultancy organisations quality control wing should be able to do so on their behalf at much lesser cost and more efficiently.

Nuclear Power

7.79 The responsibility for nuclear power development should continue to vest in the Department of Atomic Energy as at present. However, co-ordination between CEA and the Department of Atomic Energy in deciding on the future role of nuclear power development needs to be strengthened.

Public Sector Corporation for Nuclear Power

7.80 It has been recommended by the Working Group on Energy Policy—a recommendation endorsed by this Committee—that by 2000 AD India should have a nuclear generation capacity of at least 5000 MW as compared to the 1600 MW sanctioned so far. Given the lead time for putting up nuclear plants, this will require an addition of 3400 MW to be sanctioned by the year 1992. In short, on an average each year from now on, about 300 MW of capacity will need to be sanctioned. The question will then arise whether such a large programme with major financial and commercial dimensions should continue to be run as a Government Department. The Committee would recommend that consideration be given to the setting up of a Nuclear Power Corporation under the Department of Atomic Energy which can operate as a fully commercial organisation with a separate balance sheet and profit and loss account. At the moment, services supplied by BARC and other departmental specialist groups to sustain the power stations do not get separately costed blurring the economic viability of the projects. If a corporation is created, it should get charged and pay for all the services it gets from outside. As it will presumably be a viable corporation it should not be dependent entirely on budgetary support for its expansion programmes and ought to be able to go to lending institutions, both foreign and local, for the capital it requires.

Other Power generating agencies

Joint State/Centre agencies

7.81 The developmental activities of the DVC in the areas of flood control and irrigation have tapered off and DVC's main activity presently is power supply in the DVC area. There is no special merit in DVC continuing to be responsible for power supply in the valley area after the creation of an REGC in the Eastern region and it is recommended that DVC's power activities could gradually be absorbed into the REGC after paying the two States—West Bengal and Bihar—fair compensation for their shares.

Bhakra Beas Management Board (BBMB) and Tungabhadra Board (TB)

7.82 The BBMB and TB were created for the management and operation of inter-State multipurpose river valley projects. They could continue to exist as at present. The operation of their projects could be co-ordinated with the regional and State projects by the local Regional Electricity Authority. Neyveli Lignite Corporation was created for unified development of Neyveli Lignite Deposits. It owns and operates a 600 MW power plant and is presently establishing a new 630 MW power plant under the expansion programme. Since its operations depend intimately on the progress of the mining activities, it should continue as at present to be a part of the Department of Coal.

Multiplicity of agencies in States

7.83 Presently, there are several States in which government departments are still responsible for hydro development especially where multipurpose projects are involved. Multiplicity of organisations at the State level and a dilution of accountability for performance have led to some of the present ills in hydel development. The Committee recommends that in hydel stations, all assets including and upstream of the dam and power house should be transferred to SEB except any irrigation channels. The down stream irrigation facilities could continue to be owned and run departmentally. Releases of water can be decided by a Committee on which the Member (Generation) of the SEB, the Chief Engineer of the irrigation department and a senior officer of the State Government should be members. Where ongoing projects are involved, they could be allowed to be completed and then transferred to the SEBs on the basis outlined above. All new multi-purpose projects upstream of the dam and the power houses should be executed by the SEBs and for executing the civil works of these projects, engineers from the Irrigation Department should be sent on deputation to the SEBs. The present practice of executing hydel projects partly by SEBs and partly through irrigation departments should be discontinued as this clearly leads to a diffusion of accountability. The Committee has observed the advantages of such unified control in the speed with which the Beas-Sutlej Link Projects were completed when they came under the control of a single Chief Executive.

North-Eastern States

7.84 In the North-Eastern Region, only Assam and Meghalaya have SEBs. The other States have not set up Boards and are managing their power supply departmentally. The main reason for this is that the power supply industry in these States is still in the formative stage and establishment of Boards would not be commercially viable propositions. There is however considerable potential for setting up mini and micro hydels and the Committee is of the view that if Boards were constituted in these States and dedicated and enterprising engineers encouraged to use their ingenuity and initiative to develop these resources, considerable progress in power development to meet local requirements could be made. They should however not make the same mistakes as the SEBs in regard to managerial styles, procedures and should get away from bureaucratic systems. The North-Eastern Council (NEC), and the State Boards should look on such projects as their legitimate areas of concern. Large hydel and thermal projects running into Rs. 15 crores or more should be left to a Central organisation as they would be basically catering to the demands of other regions. The only exception to this would be the Assam State Electricity Board which has a sizeable grid. Currently, however, the Committee feels that there is something of a bias in the NEC to take on large prestigious thermal and hydel projects for beyond the resource base of the North-Eastern States and the NEC put together.

Union Territories (UTs)

7.85 The Union Territories in the country are in a different position with respect to power supply. The Electricity (Supply) Act does not make any specific provision regarding the organisational structure for the power industry in the Union Territories. In Delhi, the Delhi Electric Supply Undertaking (DESU) created under the Delhi Corporation Act is responsible for power supply. Distribution is shared between DESU, the New Delhi Municipal Committee and Cantonment authorities. In other UTs there are Government departments looking after the power supply. Since the UTs of Goa and Pondicherry buy and sell considerable quantities of power, there is a good case for setting them up as autonomous Boards with, of course, a much less elaborate structure than the Board of a large State. Delhi on account of its multiplicity of regulating and controlling bodies does not allow a ready solution to the question of the optimal structure of the power supply system. While the accounting and other functional aspects of Delhi Electric Supply Undertaking (DESU) certainly call for urgent attention and there is a case for greater delegation of powers to the General Manager, the status quo can be maintained till the ultimate political and administrative structure of the Union Territory has been decided.

7.86 The various organisations and their functions as they exist at present and as envisaged by the Committee at the various levels are given in Appendix—7.1 page. The internal structuring of each organisation is dealt with in succeeding sections of this Chapter. Chart 7.1 page shows the administrative, ownership, co-ordination, regulatory, advisory, financing and commercial linkages among the various organisations.

INTERNAL RESTRUCTURING

7.87 The major principles that the Committee recommends should be followed in restructuring the various bodies connected with the power supply industry are applicable to all large complex, multi-unit and widely dispersed production and sales organisations. That they require to be mentioned here is merely because of the fact that many of them are disregarded in practice. Special mention may be made of—

(i) Organisational clarity

7.88 Absence of a clear demarcation of responsibilities, functions and powers of different individuals makes accountability for results diffused. The precise roles of Members, Chief Engineers and less senior officers are blurred. Typical of this is the case of multi-purpose projects where there is often no single individual who can be held responsible for performance.

(ii) Spans of control

7.89 Reasonable spans of control should be adopted. These should vary between 3 and 10 and not, as at present, sometimes exceeding 20 or going down to a 1 over 1 relationship making one of the two posts redundant.

(iii) Staff functions

7.90 Elevation of important staff functions *e.g.* personnel, commercial, management services to levels either at Member/Director level or one level below is urgently required. Most State Electricity Boards today tend to relegate these functions, all of which should operate near if not at Board level, to relatively junior positions. This accounts for the very primitive levels of financial, commercial and personnel management competence that obtains in most Boards and which, perhaps more than the purely technical side, is probably responsible for the indifferent performance of many Boards.

(iv) Staff and line functions

7.91 There is a need for a clear differentiation of responsibilities between line and staff jobs. The tendency for accountants at Board or near Board level to get mixed up with the day-to-day exercise of authority which should be left to the concerned officers in the field *i.e.* at the divisional or sub-divisional level has to be resisted.

7.92 There should be, especially in large Boards, separate cadres for the large numbers of employees engaged in specialised functions *e.g.* generation and EHV transmission, distribution, construction, finance, commercial, personnel, etc. Keeping this general principle in mind, typical organisational structures for the Central, State and regional bodies have been recommended. They will need to be modified and adapted to the special circumstances of each Board depending upon its size, present and future goals, historical development etc. The viability of some of the non-technical cadres will increase as the function gets developed to appropriate levels. The main features of these structures are described below.

State Electricity Boards (SEBs) and Regional Electricity Generating Corporations (REGCs)

7.93 A common organisation structure is recommended for SEBs and REGCs except for one important difference—namely that the SEBs will need a strong distribution group with commercial skills to ensure that rural electrification, customer service, regular collection of bills, tariff policies, load growth forecasting etc. get the attention they deserve. Such a function is not required by the REGCs. A typical structure for the top Board is shown in Chart 7.2 and the staffing pattern below them is shown in Charts 7.3 to 7.7.

Board level

7.94 For a medium to large SEB, there should be normally six full-time Members plus a full-time Chairman. In addition, there could be up to five part-time Members. As the Electricity (Supply) Act limits the number of Members to seven, the Act will have to be suitably amended to allow this.

7.95 The Chairman's main role should be to co-ordinate the work of the 6 full-time Members, set objectives and targets and provide the link between the Board/Corporation and the shareholders *viz.* either the State or Central Governments. He should be assisted in this task by a number of staff groups for functions like corporate planning, management services, safety, ecology etc. which will also service other Directors/Members. The Committee has drawn attention to the need to evolve tight norms of performance to ensure that projects are optimally located and objectively appraised, that the estimates made of cost and time are realistic and that data on the pattern and quantum of demand growth is carefully analysed. For each of these functions and for corporate planning, specialist groups have been recommended providing staff support to the Chairman. The corporate planning heads in the SEBs and REGC will need to work very closely with the planning group in the REA which will ultimately evolve the least cost solutions to meeting the future power demands.

Directors/Members

7.96 The structures proposed for the various Directors/Members also draw a clear distinction between line and staff functions. Staff support at this level has been proposed in critical areas not required at the Board level. For example, to help the Director/Member (Generation), deal with the problems faced by existing plants, a specialist group termed 'engineering services' has been recommended. Similarly, for large stations, planning and scheduling of generation and transmission and monitoring and evaluating their performance requires the full-time attention of specialist group. In view of the importance of rural electrification, a Chief Engineer to plan, monitor and guide all RE activities under the control of the Member (T&D) has been recommended.

7.97 The various General Managers, who constitute the core of the line management, should have their own line and staff groups. Functional guidance to these staff groups should be provided by the corresponding Members/Directors on the Board.

7.98 Similarly for the Director/Member (Construction), a number of key staff inputs such as engineering services, contracting services etc. have been recommended to assist the operating groups under the project managers. The structure proposed for the Member (Personnel) and Member (Finance) is conventional and does not call for comment.

7.99 The Committee would recommend a more decentralised structure for the Member (Distribution and Commercial) especially in the case of large Boards with a widely dispersed network. For these, it is recommended that for each zone, General Managers (GMs) be appointed who should be delegated wide powers to be held fully accountable for the physical, financial and other targets set for the zone, to act as profit centres *i.e.* buying power in bulk and selling it to consumers and rendering periodic profit and loss accounts. They will also be responsible for construction of distribution systems and for executing RE programmes in their zone. The various staff functional heads under the GMs will administratively be responsible to him but functionally to the concerned Board member as in the case of other divisions. Directly under each GM, there should be a senior officer responsible for rural electrification. The GMs in turn should delegate their powers widely to divisional and sub-divisional managers so that each of them can be held accountable for meeting pre-set physical and financial targets.

7.100 The Committee, in the Chapter on 'Rural Electrification', has drawn attention to the fact that rural electrification projects leave a lot to be desired when it comes to design and execution. Although the intervention of the REC has done a good deal to bring a degree of rationality and discipline into RE programmes, much remains to be done. The creation of the post of an officer under the GM who will be responsible for the sound design and construction of RE schemes would enable accountability for performance to be pinpointed. He will be functionally accountable to the Chief Engineer (RE) in the Board's office. The line management structure shown under the GMs—the Divisional Managers and Assistant Managers also reflect the role of the staff and line managers and the need to give special attention to rural electrification.

Part-time Members—SEBs

7.101 Of the 5 part-time Members of the SEBs, the Committee would recommend that two should be nominees of the State Government preferably one from the Department of Power and the other from Finance. One of the other Members should be the Member (Planning and Operations) of the concerned REA and the other two should be outsiders preferably people of high professional standing who could contribute in areas where the Board is weak *e.g.* finance and personnel. The Committee would strongly recommend against the appointment of political personalities on the Board and the Act should be modified to bar the appointment of sitting MLAs and MPs on the Boards of SEBs as has been done in the case of Central Government undertakings. All State Legislatures can have Consultative Committees for their Departments of Power and such interaction as is necessary between the SEB, the Department and the MLAs should take place in the forum of these Consultative Committees.

Management Information Systems

7.102 One of the Weakest areas in all the functional groups is the near absence of sound management information system (MIS) on the basis of which timely corrective action can be taken. This is as true of the operational areas like generation and construction as it is in the accounts and personnel fields. The Committee would recommend that the Boards should seek the advice of consultants who have specialised in developing MIS and set up a group to implement it. It is not that enough information today is not being collected, in fact there is often far too much for far too many people. But as in many such cases, it lies undigested and unused. The role of the MIS experts should be to refine and prune the information formats till only what is truly important for achieving the objectives of the organisation is produced and sent only to those who need it for taking action.

Regional Electricity Generating Corporations (REGCs)

7.103 The organisation structure of the REGCs should be similar to the SEBs except that the Member for distribution is not needed. One of the ex-officio part-time Members in the case of the REGCs should be the Planning and Operation Member of the REA and the others, as in the case of SEBs, should be eminent professional men in the fields where REGCs feel the need for expert advice.

Rural Electrification

7.104 The Committee has considered in depth the question of what organisation structure should be adopted for the rural electrification programme, on which there will be increasing emphasis in future. The consensus of views received by the Committee is that at present generally the quality of service is unsatisfactory—frequent and unplanned interruptions in supply, sharp fluctuations in voltage and frequency causing damage to equipment and delays in carrying out repairs. There is thus a high degree of consumer dissatisfaction with rural power supplies and presents one of the practical, as opposed to the 'political', obstacles to an increase in the present highly subsidised rural tariffs. The Committee feels that if there was a rostered but dependable and steady power supply for 4 to 6 hours per day to rural consumers for pumping water, agriculturists would be prepared to pay more. If this were not so, the switch back from electrical sets to diesel pumps that is taking place in some States cannot be explained.

7.105 From the SEBs point of view, rural electrification presents a difficult problem in logistics and control. Several studies show that except where there is a high concentration of pump sets, the cost of maintaining, repairing, metering and billing rural consumers at the salary levels of SEB staff is many times higher than the revenue collected from the consumers. To reduce the cost of meter reading, several Electricity Boards have adopted a flat tariff based on the horse power of the pump set. This, as has been pointed out in the Chapter on 'Finance, Financial Management and Tariffs', is a highly retrograde step and would encourage the wasteful use of power where it is available. In areas where power is not available, it represents a grossly unfair impost on the farmers.

7.106 The causes of the poor quality of rural supply are only partly due to inadequate generation and badly designed and built RE systems. It is in part due to the lack of proper maintenance from the LT end onwards. Steps to ensure that loads in excess of generation capacity are not taken on and that RE systems are properly designed and constructed have been dealt with elsewhere. These tasks will necessarily have to be done by the SEBs or by well-run electricity co-operatives. There are, however, other alternatives to the SEB staff undertaking maintenance, repair, servicing, billing and collection which, if adopted, could greatly reduce the operating costs of the RE programme and help to keep rural tariffs from rising sharply.

7.107 The first option which has been tried in some States is rural electricity co-operatives where a block or a group of villages form a co-operative, buy L. T. power in bulk and look after its distribution to the consumers. They also carry out maintenance and repairs to the system, attend to faults, meter supplies, bill and collect dues. Because the co-operative can employ local labour, it is in a position to keep a tight control on costs. Where the co-operatives ran well, thefts and tampering with meters began to come down because of community pressure and the quality of service has apparently improved to satisfactory levels.

7.108 The experience of many States, however, appears to be that co-operatives except in a few cases have not been satisfactorily managed and in some cases have made the problems worse rather than better. This judgmement is not based on the financial viability of the co-operative where, even if they run at a loss, their costs are likely to be no higher than the SEBs. The problem appears to be more in areas like failure to collect dues, vested interests favouring certain groups in allocating the available power and so on. While co-operatives represent theoretically the best solution and should be encouraged where they show signs of working, alternative ways of servicing the rural consumer at low cost need to be tried out. The Committee would recommend that the concept of an 'agent' viz. an entrepreneur who buys power and sells it at a predetermined commission to consumers should be tried out. These agents would serve a group of say 2 to 5 villages depending on their size and geographical spread. They would also attend to minor repairs of the system e.g. replacement of fuses, repairing broken wires, switches, insulators, joints and other simple faults. Preference could be given to unemployed electrical engineering graduates and diploma holders. They would need to be put through a short training period of practical training in the technical and commercial aspects of the job. This experiment has been tried with some success in the case of petrol stations, LPG distribution agents, Post Offices, etc. and could be extended to RE also.

Regional Electricity Authorities (REAs)

7.109 The role of the REAs has been dealt with in the Chapter on 'Power Planning'. In many ways, the REAs, if run well, will become the lynch pins around which the future of the country's power programme will develop. It is therefore of the greatest importance that, besides being given statutory powers and status, they should be manned, right from the start, by able and dedicated people. Statuswise, the Chairman of REAs should be only next to the Chairman, CEA in the Central hierarchy of the power system.

7.110 The Regional Electricity Authority should have a Chairman and four full-time Members all appointed by the Central Government. The distribution of duties amongst the four Members and the Chairman has been shown in Chart 7.8.

7.111. The Board should have as part-time Members, the chief executives of the constitutent SEBs and REGCs because their co-operation is essential to the smooth working of the REAs. It is they who will have to face the problems of load management at the EHV level and should have the right to express their point of view. The expectation is that, given the right choice of Chairman and Members, inter-State disputes on allocation and movement of power or quantum and prices will not escalate beyond the REA level. If it does so, the CEA should be considered to be the final appellate authority and disputes should be made non-justiciable by statute as otherwise stay orders and other legal devices could render the REAs completely ineffective.

Inter-agency co-operation

7.112. In each region, there will be a number of bodies performing similar or complementary functions for power supply such as the SEBs, REGCs, REAs, nuclear power stations and private sector utilities. To avoid these organisations working at cross-purposes, it is important that they keep in close touch with one another and some institutionalisation of these contacts is considered to be desirable. At the Chairman/Chief Executive level, the periodic meetings of the REAs does provide such a forum but these formal meetings should be preceded by informal meetings where common problems can be discussed. In addition, periodic meetings of the heads of functional groups e.g. generations, distribution, finance and accounts and, in particular personnel, of the various power supply organisations should be organised by the REA at least once a quarter.

7.113. A regular bulletin in English and the regional languages should be published by the REA giving factual details of the current power situation and future prospects. Details of planned and actual generation, power cuts in force, tariff rates and other information of interest to the public should not be withheld. The monthly report put out by the CEA could serve as a good model.

Central Electricity Authority

7.114. In the overall structure of the power supply industry, the Central Electricity Authority (CEA) would continue to be the premier technical body and be the focal point for evolving the national power policy, formulation and co-ordination of power programmes at the national level, progressing power development and ensuring efficient operation and functioning of the power supply industry. The internal structure of the CEA will have to be re-organised to enable it to discharge its functions and responsibilities efficiently. A major addition to its ability to plan and implement the power programme is the creation of five Regional Electricity Authorities who should be functionally and administratively responsible to the CEA. The Committee would recommend the continuation of all 5 Members and their current allocation of duties except the Member for 'Operation Monitoring'. With the creation of 5 REAs, detailed information should be flowing in daily from all agencies connected with power generation and supply through the REAs to the Board and putting together these five reports could be left to the Member (Systems) in the CEA. Besides, as far as they are concerned, Members in charge of the hydel and thermal divisions should in any case be fully aware of what is going on in their respective fields.

7.115. The Committee would however recommend the creation of three new posts—Member (Planning), Member (Research & Development—R&D) and Member (Personnel) as these are all grossly neglected areas and they need the concentrated full-time attention of someone of the status of a Member. The 5 Chairmen of the REAs should be ex-officio part-time Members of the CEA. The proposed structure of the CEA is shown in Chart 7.9. The functions of the proposed three new Members are indicated briefly below.

Member (Planning)

7.116 The job of planning is one of the most crucial in the CEA and requires a full-time Member to be in charge of it, as in the case of REAs. It should not be thrust on the Chairman as at present because he has many other co-ordinating and boundary functions to perform.

Member (R&D) and Member (Personnel)

7.117 The main task of the Member (R&D) would be to stimulate, co-ordinate and fund research on all aspects of the power supply industry especially those to which reference has been made in the Chapter on 'Research and Development'. Perhaps even more serious than any other shortcoming is the lack of attention to the development of human resources and the absence of personnel policies designed to attract and retain competent personnel. One of the CEA's biggest problems in the personnel field is its own inasmuch as it cannot always attract the best talent, sometimes even at Member level.

Change in the role of the CEA

7.118 It must be recognised that if the recommendation of the Committee on the role of REAs is accepted, there will be a qualitative change in the role of the CEA in the sense that much of the routine work of data collection, monitoring of generation and inter-State transmission and also the preperation of surveys, regional plans for generation and T&D will be done by the REAs. Even the inclusion of a project by the REA in a region will imply that at least the preliminary screening of the project has been done.

7.119 The CEA will however be called upon to perform many more jobs which will require high levels of intellectual inputs. One of its first tasks would be to set up and get the REAs off to a good start because they will represent the field units of the CEA. It is the efficient performance of the REAs that will determine the CEA's capability to bring about a radical improvement in the power scene and plan soundly for its future development.

7.120 Many tasks it has not yet fully faced up to, all calling for high levels of expertise, will be thrust upon it, such as promoting conservation and load management, improving the quality standards of equipment, standardising equipment, reviewing principles of inter-State sale of power, interacting with the proposed Bureau of Electricity Costs and Prices and high level R&D Councils etc., suggesting tariff policies and persuading States not to compete with each other in lowering tariffs for industry. It would need to analyse the forecasts of demand emanating from the REAs, and formulate regional and national plans on this basis.

7.121 The CEA will have to study the personnel problems of the utilities including their recruitment, training and promotion policies; pay scales; inter-agency mobility; industrial relations problems and come up with recommendations. It will need to review the working of such of the modified/new organisation structures proposed in this Report as are set up and make fresh recommendations on the basis of such reviews. R&D has taken a back seat for so long that it will be a major challenge to revive it. All this and many more difficult tasks, several of which have been referred to elsewhere in the Report, will fall to the lot of the CEA. This will call for a totally different structure for the CEA compared to the present. The great majority would be top specialists in their own field and would need little or no staff assistance. The organisation chart will be, in fact, an inverted pyramid below this level.

7.122 The detailed functional distribution of responsibilities of the CEA Members is shown in Appendix—7.2. Job specifications for these posts should be drawn up on this basis for carrying out selections to these posts.

Levels of Posts

7.123 One of the reasons why the CEA has not been as effective as it could be is the gap between the posts of Members and the next level below. With a few exceptions, most of the functional heads below the Member are at the level of Directors in the Government. A few posts do exist at the Deputy Chief and Chief Engineer level but they have not been effectively used. The level of a Director in the governmental milieu is not high enough for him to speak with authority on his functional field when dealing with Members of SEBs, Chief Engineers and other senior officers in the Ministries of the Central and State Governments and in various Corporations and Boards of the utilities. Such interaction, in an effective way, is vital to the success of the CEA. In view of this, the Committee recommends that there should be at least two Chief Engineers under each Member looking after the major areas of responsibility and the rest could report directly to the Member.

7.124 There has been a tendency to involve the Chairman and Members of the CEA in every conceivable Board and Technical Committee. These responsibilities take away so much of their time that they find it difficult to get on with their substantive jobs. The offices of the Chairman and the Members of the CEA are very senior level positions and representations of the CEA at their level in various Boards and Committees should be done selectively. In most cases, it may be appropriate to depute the Chief Engineers, who are functional heads, to represent the CEA.

Communication gaps, mobility and pay scales

7.125 There is at present very little mobility between the State Electricity Boards, other operating utilities and the CEA. One of the problems has been the lower scales of pay and relatively fewer facilities in the CEA as compared to the Boards. Conditions in organisations like the NTPC and the NHPC are even better. The CEA and the proposed REAs will not be effective if their personnel cannot be given experience in operating jobs in the field. It is only when they have functioned as field managers and they have understood the realities of planning, constructing and operating a power system that they will be listened to with respect when they return to the REA or CEA. Given the present disparity in conditions of services, however, very few of the personnel of the NTPC, NHPC or SEBs would wish to work for the CEA. As a result, only a fraction of the posts in the CEA reserved for deputationists have been filled and the position is deteriorating.

7.126 The Committee has referred to the character of the CEA changing to one which largely consists of highly qualified and specialised engineers and professional staff such as accountants, economists and statisticians. The routine work will increasingly be done by the REAs. Under the circumstances, the Committee recommends that there should be no fresh recruitment to the CEA except at the clerical and class V level. The supervisors' cadre in the CEA, originally created for operating power stations has no relevance even in the current set-up and should be abolished. These employees of the CEA should be absorbed in the REGCs, PDCC or the SEBs which have field jobs or operational plants.

7.127 All fresh recruitment of officers should henceforth be done by the REAs and the bulk of the CEA posts should be filled by deputationists from the REAs. Provision should be made for direct initial recruitment on a limited basis of specialists like economists, personnel managers, research scientists, financial experts, operation research specialists etc. Till such time as the REAs come into existence and are capable of providing officers for the CEA, vacancies should be filled either by promotion or by deputationists from SEBs and NTPC, or by direct recruitment.

7.128 The Committee recommends that in order to attract able officers from the SEBs and later on from the REAs and REGCs to the CEA, both on deputation and absorption, the terms and conditions of service of CEA officers should be substantially improved. For this, delinking of the CEA and the REA pay scales from the other Central technical services is necessary. Taking into account that the REAs and particularly the CEA in its new role will be a high level organisation contributing to policy making at the national level such differentiation would be fully justified.

Power Design and Consultancy Corporation (PDCC)

7.129 The role of the PDCC has been discussed earlier. The ultimate structure proposed for it is shown in Appendix—7.1. In the initial stages, only the Chief Executive and the Finance Director should be Directors and the rest General Managers. In consultancy organisations, there is a tendency for an overlap between project and functional hierarchies with the risk of the wires getting crossed, conflicting orders being issued and accountability getting diffused. Organisations like EIL and MECON have to a large extent overcome this problem and it is suggested that the structures and lines of command developed by these two organisations should be adopted to its own circumstances by the PDCC.

PERSONNEL POLICIES

Management Styles

7.130 Restructuring and reorganising the various bodies concerned with the power industry as suggested will merely set the framework for allowing them to function as cohesive and efficient organisations but by itself this will not change the attitude and culture of the organisation. This can only happen if the top leadership of the various bodies like SEBs, REGCs and REAs is manned by men of ability and standing and their autonomy is respected by the State and Central Governments.

7.131 The concentration of authority in the Board, the reluctance of Managers to exercise such powers as they have been given for fear of making mistakes and suffering retribution, prolonged paper bound procedures the preoccupation with trifling issues while major discussions and policies languish, these are some of the more glaring weaknesses of the general run of the SEBs, though here again there are Boards which work in a much more professional way. The contrast between the managerial styles of the SEBs, with a few notable exceptions, and the CEA on the one hand and the NTPC on the other, highlights the need for a change in the culture.

7.132 In the case of the CEA, the various Members are still physically located in different buildings making it difficult for them to consult and interact with each other informally which is the very essence of a team operation. As Members of a Board, a Member has to wear two hats, one as the head of his division and the other as a Member of the top team. It is the second which in organisations like SEBs and the CEA is rarely worn. As a result, bickering which begins at the top percolates right down to the bottom.

Promotional Policies

7.133 Another feature of an efficient managerial system is the promotional policy. Here again the Government culture and the rigid service rules make promotion on merit as opposed to seniority extremely difficult. Yet without such a promotional policy, all training programmes which work best when there is a carrot of a promotion at the end of it, tend to be exercises in futility. If promotions are going to go by seniority and performance is secondary, much of the incentive to strive harder and earn promotions is lost. The Committee is strongly of the view that there is need for an immediate review of appraisal systems and promotional policies at all levels in the Boards and in the CEA itself and such a study should be entrusted to a reputed consultancy organisation. This subject has been touched upon later. In short, unless persons of outstanding ability, who do exist in all organisations, are spotted and given promotion without undue regard to their seniority, it would be futile to expect such bodies to function efficiently, regardless of the way they are structured or organised.

Selection and Tenure of Chairman and Board Members

7.134 As has been emphasized earlier, the success of the utility industry will, in the last analysis, depend upon the people who are running it. Of these, the most crucial are the Chairman and full-time Members of Boards/Authorities as they will set the tone for the rest of the organisation and it will be their responsibility to see that the staffing of these bodies is done properly.

7.135 The present system of selection of Board Members of SEBs is not formalised and is generally done by the Chief Minister/Power Minister in consultation, where thought fit, with the senior officials of the secretariat such as the Chief Secretary. The tenure of Board Members is also uncertain and appointments are often made till "further orders". Neither of these practices is designed to spot talent or to give any talent that exists at this level the kind of environment it needs to flourish. The UPSC is responsible for selecting the Chairman and Members of the CEA.

7.136 For the public sector corporations the NHPC, NTPC, NEC and REC, an institutionalised mechanism—the Public Enterprises Selection Board (PESB)—has been set up to select Chairman/Managing Directors/full-time Directors. The Committee believes that the methods and principles on which the PESB works is sound and that it has generally succeeded in finding the best talent available for the jobs it has been asked to fill. The strength of the PESB procedure lies in the fact that Government have made it a rule that only names recommended by the PESB can be considered for appointment to the top posts. While the Government is free to reject all names and call for more, it cannot, by a self denying convention, substitute them by people of its own choice except in very exceptional cases. This has prevented a good deal of lobbying and jockeying that otherwise precedes appointments to these posts. Since the PESB has consisted of persons who have been in top management positions in a variety of large organisations and usually have nothing more to aspire to in the public sector, their assessments tend to be unbiased and as merit based as any such system can be.

Exchange of Personnel between State and Central Power Bodies

7.137 The Committee is of the view that the present, almost watertight compartments between the NTPC, the SEBs and the CEA in terms of interchange of personnel, is one of the major factors in inhibiting the exchange of knowledge and experience necessary for the integrated and efficient development of the power sector. If there is to be one day a national grid, then a structure should be created which allows such interchanges to take place freely. One pre-requisite for this would be to have in the core and at the apex of all these bodies, people who have generally similar qualifications, experience and background.

Job Specifications

7.138 Job specifications will need to be formally drawn up for short listing people for the selection to the level of Chief Executives/Directors of Corporations/Members. It is recommended that the specifications should above all stress managerial qualities, the record of performance and integrity rather than any specific experience or qualifications. Narrow specialists are distinctly unsuitable for these posts as the major function of people at these levels is to manage people, plan, organise, evaluate and enthuse rather than enter deeply into technical details.

Selection of Chairman and Members of CEA and REAs

7.139 The Committee would recommend that the conventions, procedures and guidelines adopted by the Public Enterprises Selection Board (PESB) in selecting people for top level appointments in Central Public Sector Corporations should be adopted for the CEA, REAs, REGCs. and SEBs. This will promote and facilitate the mobility of management between these agencies referred to above. For the Chairman CEA, the Selection Board could consist of the Chairman PESB, the Secretary Department of Power and two or three distinguished professional people drawn from the IITs and the IIMs or from the services provided they have some experience either of the power industry or of top management. For the Chairman of the REAs, the Committee should consist of Secretary Power, Chairman CEA, a Member of the PESB and one or two eminent professional people, as has been suggested for the selection of Chairman of the CEA, but preferably at least one of them should belong to the region in which the Chairman of the REA will operate. For the Members of the CEA, the Committee would comprise the Secretary Department of Power, the Chairman CEA, one PESB Member and two co-opted Members with special knowledge of the field in which the Member is expected to operate. Similarly for Members of the REA, the Chairman CEA, the Chairman of the REA, the appropriate CEA Member and two co-opted Members could form the Selection Board. In order for this to be possible, exemption of the CEA and REAs from the UPSC's selection procedures should be obtained in view of the highly specialised nature of the work these bodies will be taking on.

7.140 Just as in the case of the PESB, some general guidelines on selection can be given to the Selection Boards namely that candidates internal to the organisation if suitable should be given preference, but failing that, the selection field, in the case of Board Members of the CEA can be extended to the REAs, the SEBs or public sector corporations in the utilities field, or the public sector as a whole in that order. The concept of a pool from which top management of these organisations can be drawn has been referred to later. It is only if no suitable talent is available within this field should the open market be explored. The Committee would, however, warn against diluting the standards of suitability to make room for internal candidates. In order to establish this, the first selection should not be confined to internal candidates only and for comparison purposes, some external candidates should also be interviewed. Selections should be on the basis of thorough interviews and not on the basis of confidential records only.

Chairman and Members of SEBs

7.141 Applying the principles, concepts and procedures outlined above, a similar system should be adopted for selecting the Chairman and Board Members of the SEB. The Selection Committee for the Chairman of the SEB should consist of—

(i) The Chief Secretary to the State Government as Chairman.

(ii) The Chairman of the CEA.

(iii) A Member of the Public Enterprises Selection Board.

(iv) Two co-opted Members.

The co-opted Members should be as far as possible top professional people from industry, academics or commerce. A panel of 2 or 3 names should be recommended to the State Government for final selection of Chairman. The Government may reject all the names but it cannot substitute them by people of its own choice. As mentioned earlier, this practice is being followed in the case of the public sector corporations under the Central Government and by and large, it has resulted in keeping nepotism and favouritism out of top level appointments.

7.142 The selection committee for SEB Members should consist of—

(i) The Chief Secretary to the State Government as Chairman.

(ii) The Chairman of the CEA.

(iii) A Member of the PESB.

(iv) The Chairman of the SEB.

(v) One co-opted member specialised in the relevant discipline.

7.143 In order to ensure that this procedure is followed and in view of the crucial role the Board Members will play in the efficient operation of the power sector, it is suggested that this method of selection may be incorporated into the Electricity Act. This is recommended because there are strong vested interests who would like to see that the powers of patronage enjoyed by the Board today are exercised in their favour.

Tenure of Board Members

7.144 The Chairman and the Members of the Board should have a tenure of 3-5 years, preferably 5 years, so that the Board can follow through to full implementation of the policies and strategies that it has decided to adopt. The Chairman and Board Members can thus be made accountable for the results achieved. To maintain continuity of management at the top level, Members of the Board should not all retire at the same time and some phasing of the dates of appointment of Board Members would be necessary.

Termination of Contract of Board Members

7.145 The demoralisation and insecurity prevailing in some SEBs at Board level has greatly weakened the top management. The Committee feels therefore that some safeguards should be provided to avoid them becoming the victims of political squabbles and vendettas. The Committee, therefore, recommends that the amended statute should provide for the Government to consult the Selection Committee which selected the candidate before taking steps to remove a Chairman or a Board Member before his term of office expires. If there is disagreement, then the Government must have the right, if it still wishes to do so, to remove the Chairman or a Member but it will have to table its reasons for so doing at the next session of the State Assembly.

Other Personnel Policies

7.146 The Committee has had occasion to refer elsewhere to the weakness, if not near absence, of the personnel function in most of the State Electricity Boards and organisations like the CEA. Little serious thought has been given to problems and policies of organisation, recruitment, selection and training, appraisal and promotion or to management development and career planning, job enrichment, productivity, terms and conditions of service, perquisites, welfare facilities, discipline and industrial relations, and the role of unions and various staff and professional associations.

7.147 The subject is so wide that carrying out an in-depth study of it and making detailed recommendations covering all the organisations is beyond the capacity of this Committee in the time frame given to it. However, these problems are not unique to the power industry and the Committee is of the view that once the various organisations at the Central, regional and State level are led by people of the requisite calibre, and the relationships between the SEB's and the State Government are such has to enable the SEB to function with the requisite autonomy, these problems will automatically get examined and resolved. One of the purposes of recommending a full time Member of the CEA to look after the personnel function is to ensure that the various power utility bodies do take steps to set up properly staffed personnel departments and address themselves to the solution of personnel problems.

7.148 There are, however, a few important aspects of the personnel function which the Committee suggests is given special emphasis.

Manpower Planning

7.149 Projections should be made for the next ten years about the quantum and the nature of work to be performed by each organisation. Based on the work norms and the workload, forecasts should be made for the manpower requirements on a yearly basis, for the next decade. After matching the requirements with the available work force, including the potential that will be created after proper training inputs have been provided, a list of manpower requirements should be prepared (by skill and grade) with reference to a time frame. This assessment should then form the basis for future recruitment policies and training inputs and should be updated from year to year.

Training

7.150 Based on this manpower plan and the existing talent and potential, each of the organisations in the power industry should identify the training requirements at the skilled manpower, supervisor (non-managerial), and managerial level. Based on this, training programmes should be drawn up making the maximum use of existing institutions.

7.151 Broadly, training programmes would fall into two categories, an induction training programme which begins as soon as the employee joins the organisation and post employment programmes. The induction programme should essentially be familiarisation programmes to be undertaken during the probationary period and besides imparting knowledge, should be used to identify aptitudes and weed out unsuitable entrants. Training programmes for operating engineers and supervisors have been dealt with in the Chapter on 'Operation and Maintenance'.

7.152 In order to provide these training inputs on the scale and quality required, it will be necessary for the various organisations to create additional facilities for training. These will need to be supplemented based on the demand for training inputs that emerges from the study referred to in paras 7.150 and 7.151 and to which reference has been made in para 4.55 in the Chapter on 'Operation and Maintenance'. Depending upon the level of worker, supervisor or manager to be trained and the extent of specialisation of the inputs, the facilities could be at the State, regional or national level. The Committee would, however, like to stress its conviction that the best supervisory training inputs are provided on the job under the watchful eye of competent officers who are not afraid of delegating tasks and powers. One of the major areas on which managers should be judged for taking on more senior positions is their success in training people so that their own work becomes less routine bound and they have time to plan ahead and apply creative inputs into tackling problems.

7.153 A second point that the Committee would like to emphasize is the low priority that is attached to the training function at present. The tendency is to 'dump' managers who have proved to be unsuitable in other jobs, to take charge of the training programme and facilities. As a result, they are often a frustrated lot and it is difficult to see how they can bring a dynamic outlook towards the training function or inspire trainees with enthusiasm and confidence. Nothing could be more demoralising than this to able young people on the threshold of a career and in fact such training programmes could become almost counter productive. Training managers should be drawn from the better managers and should have an aptitude for training. They should not be left there too long. In order to attract good staff, they can be given a generous training allowance.

7.154 Likewise, there is also a tendency only to spare the redundant or less able employees for training courses in case, by letting the abler ones go, the performance of the unit suffers. Here again, steps must be taken by top management to see that training is provided not merely as a chore to be carried out but as a means of equipping promising employees to function better and propose them for more senior positions.

Attracting managerial talent

7.155 There has been a general complaint from the State Electricity Boards and the Central Electricity Authority that they have not been able to attract and hold bright young managers. Reference to this has been made in para 7.46. Significantly, no such complaint has come from the two Central public sector corporations—NTPC or NHPC. In terms of pay, there is little to choose between some of the larger Boards and these corporations. It would appear that these corporations offer an environment in which the younger managers besides getting job satisfaction feel that merit will eventually be recognised and that they can move on to what is sometimes termed the "fast track", to positions of higher status and responsibility. It should be the aim of all the utility organisations to attract and train such talent so that by the mid or late forties they can become Board Members. This will enable them to have at least a five year term as Member and the ablest one could function as Chairman for another 5 years. Without this kind of continuity of management, accountability for results cannot be achieved.

7.156 Much of the rationale for creating autonomous bodies such as the NTPC or SEBs is based on the assumption that the top management will have the freedom to ensure that the really able and high potential managers get accelerated promotion, that the mediocre or incompetent can be put on a shelf or persuaded to leave, and that normal governmental type cadre service rules which are heavily weighted towards seniority do not apply.

Appraisal Systems

7.157 An essential pre-requisite for this is sound performance appraisal systems based on three principles as follows :

(a) Assessment where possible to be made against predetermined objectives which are designed to 'stretch' the officer concerned.

(b) Assessments to be carried out not merely by the reporting officer but by a group of equally senior officers with whom the employee has come into contact during his work. This task of multiple assessments would be facilitated if employees in addition to their normal duties are assigned to special task forces to tackle specific problems in the plant or organisation. The officers in charge of these task forces will thus also have an opportunity to assess and report on their subordinates. While therefore the view of the officer directly in charge of an individual will be the one to which the greatest weight is attached, it could be tempered or re-inforced by the views of other senior officers the individual has come in contact with. The objective of all this is to ensure that when merit leads to supercession of senior candidates, the basis of assessment is not only manifestly fair and objective as it can be but is seen to be so. Without this the dissatisfaction and unrest of those who have been superceded would be difficult to control.

(c) Training programmes as far as possible should be directly linked to the career plan of the employee. Training programmes will become really successful if it is seen that acquitting oneself well opens the doors to promotion. Equally nothing is more frustrating than what often happens today — people are trained in one skill and on completing their training, put on a task where this knowledge or experience is irrelevant.

Fixation of Work Norms

7.158 The Committee has commented on the fact that most SEBs are heavily over-staffed and this has seriously undermined their viability. Advantage should be taken of the rapid growth of the power sector to absorb, by retraining where necessary, the surplus staff either in the SEBs themselves or in the REAs and REGCs. In order to do this, it is necessary to establish, through industrial engineering studies and comparisons with efficient Boards and other utility companies in India and outside, the appropriate staffing levels and fix work norms for different tasks. The annual overhaul of a boiler for instance takes anywhere between two months to three months in SEBs when the prescribed period is five weeks and is done in three weeks in a private sector captive utility. While some variation depending upon the extent of repairs necessary is understandable, this order of variation for a planned shut down does not appear to be justified.

7.159 In order to establish these norms and identify the surplus, the Committee would recommend that the CEA sets up task forces with specialists drawn from all its divisions and including Members of the SEBs and generating companies. The involvement of the SEBs is crucial and the Committee would recommend that these task forces be headed by SEB representatives drawn from the more efficient Boards. They could also make use of the services of specialised agencies like the National Productivity Council or National Institute of Training in Industrial Engineering (NITIE) or of private agenciese specialising in industrial engineering. In view of the urgency of this task, the task forces should set themselves the objective of producing these norms and quantifying surpluses within a year.

Hiring of work charge/Casual Labour

7.160 It has been observed that most of the unskilled employees in the SEBs join as work charge/casual/temporary labour on construction projects. Progressively, through the pressures of political influence and trade unions, they become regular employees of the SEBs even though there is no work for them. Moreover, this work force is not willing to move to new projects at other sites and becomes a permanent burden on power stations. The Committee would, therefore, reiterate that the employment of casual labour departmentally should be totally banned. It would be advisable to use contractors or preferably genuine labour co-operatives for periodic or 'ad hoc' work requiring manpower in excess of what can be absorbed after the construction phase of the project is over.

Relationship between utility companies and their owners

7.161 The Committee is aware of the difficulties in trying to reduce to paper the relationship that ought to exist between Governments and SEBs, nevertheless this relationship is so critical to the success of the SEB that in a report of this kind, some reference to it cannot be avoided. It is hoped that the measures recommended in the Chapter on 'Finance, Financial Management and Tariffs' will ultimately give SEBs some degree of financial independence. In theory, under the Act, the Government has the right only to issue policy directives and to appoint and remove Chairman and Members of the Board. It is not even required to accord sanction to major capital projects and in theory, a Board can go ahead with them provided the approval of the Central Government has been obtained and there are funds at its disposal.

7.162 In practice, the nexus is far closer but unstructured. Through informal means, Ministers, Members of Parliament and Assemblies and senior Government officials influence selections, transfers, promotions, award of contracts, choice of sites for new stations, areas to be electrified, new connections to be given, allotment of power during shortage, industrial relations problems and so on. The extent to which this takes place varies from State to State and significantly, there appears to be some positive correlation between the performance of a Board and the extent to which it is allowed to work free of external pressures of this kind.

7.163 The Committee is of the view that there is a role for Government vis-a-vis the SEB which goes beyond that laid down in the Electricity Act, and this role should be clearly defined in the Act. Thus the Government should—

(a) appoint the Chairman and Board Members according to the procedure prescribed earlier and leave all lower level appointments to the Board ;

(b) approve all capital expenditure exceeding Rs. 1 crore (for smaller Boards, the limit could be lower);

(c) discuss and approve the annual revenue and expenditure budget and the long-term, 5-year and annual Plans of the Board which should be set out in terms of physical and financial targets and any policy or other implications implicit in these plans e.g. loans from Government and financial institutions, tariff policies, pay revision, growth of power connections (areas to be electrified etc.) should be clearly spelt out. It is important that in presenting these Plans, SEBs take a realistic view of their capabilities.

7.164 The SEB should submit quarterly, on an agreed proforma, key information regarding the actual physical and financial progress in the implementation of the Plan and the financial performance in relation to the budget. As long as there are no major departures or serious shortfalls, the Board (which has two senior Government officials on it) should be left alone to get on with the job and in particular on matters like contracts, transfers and promotions there should be no interference whatsoever except for the Government to satisfy itself that the procedures laid down are fair and equitable. In particular, the Governments' tendency to step in directly (when union negotiations threaten to create problems should be resisted. If the State Government has any policy issues which it would like the Board to implement e.g. subsidies to certain categories of consumers, these should be made specific and conveyed as written orders to the Board. The role of the two Government nominees on the Board should be to represent the broader view point of Government to the Board and likewise to ensure that the Board's plans and policies are explained to Government. They should not, as is sometimes the case, use their position as spokesman of the Government to direct the Board on what is to be done on matters which fall within the sphere of responsibility of the Board.

7.165 It has to be conceded that to some extent, intervention by Government in the Board's affairs is a matter of cause and effect and that Boards which perform badly invite public criticism forcing Government to intervene. However, this does not condone the state of affairs which exists in some Boards and requires, for instance, that even routine transfers of junior engineers need formal or informal Government clearance.

Delegation of Powers

7.166 Most of the SEBs have published documents setting out the powers, generally in terms of money that has been delegated to employees at various levels. These should be updated regularly in the light of inflationary trends and a conscious policy adopted to delegate more and more powers. Once the annual revenue budgets are approved, the department/division/area heads should be authorised to spend money on approved projects within the budget limit. For revenue expenditure over the budgeted amount, they must approach the Board through their superiors. Limits of capital expenditure that can be incurred by the Department/division/area without the Boards' approval will need to be specified. A purchase sub-committee of the Board should select and award work to contractors. Only in the case of contracts above a certain value, should the decision of the sub-committee need to be approved by the concerned Member or for larger contracts by the full Board. The General Managers/Chief Engineers/Superintending Engineers should be delegated enough powers to perform their functions without going to the Board for sanctions on a routine basis. This should cover powers to reward/punish, recruit and transfer subject to some minimum safeguards against victimisation or favouritism.

7.167 The manner in which all these powers are being exercised should be the subject of periodic surprise audits and as long as no 'mala fides' are seen, no enquiries or 'witch hunts' should be started for occasional errors of commission or omission.

Management services

7.168 The systems and procedures adopted by the SEBs specially in the areas such as materials management, financial accounting operation research are based on the procedures of a Government department. A complete overhauling and streamlining of existing systems is required to minimise delay and effort. It is recommended that the Management Services Division, proposed to be set up in the SEBs, should undertake this exercise as soon as possible and here again, the service of outside consultants could be sought.

ALL INDIA SERVICE OF POWER ENGINEERS

Present career avenues and career prospects

7.169 Presently, each State Electricity Board has a cadre of Power Engineers. The recruitment to them is generally at the lowest level and the posts at higher levels are filled by promotion based on merit-cum-seniority. There is no provision for lateral entry at higher levels into the Boards' cadres.

7.170 There is a Central Power Engineering Service (CPES) under the Central Government in which all the engineering posts of the CEA and the Regional Electricity Boards are included. Officers of this service are recruited both directly and by deputation from State Electricity Boards and State Governments. There is quota for both direct recruits and deputationists at all levels up to the level of Chief Engineer. The quota at present is 25% for deputationists up to the level of Deputy Chief Engineer and 50% at the level of Chief Engineer. The posts of Members and Chairman in the CEA are open to both the Central and State cadres and there is no quota system. The direct recruitment to the CPES is at the level of Assistant Director and this is done partly through the Engineering Services Competitive Examination held by UPSC and partly by promotion of officers occupying lower levels of posts in the CEA. There is a provision for lateral entry to the higher levels of the service through open advertisements.

7.171 Some of the State Governments which have the responsibility for development of hydro projects under the departmental set-up, have departmental cadres to man the posts in the departmental set-up.

7.172 The NTPC and the NHPC are forming cadres of their own. They are presently recruiting engineering and other personnel at all levels by deputation and their subsequent absorption. They also recruit executive trainees in different disciplines annually to build internally a cadre of trained managers.

All India Service of Power Engineers

7.173 Strong representations have been received by the Committee from several quarters on the need to create an All India Service of Power Engineers to staff all organisations dealing with power—CEA, SEBs and NHPC, NTPC etc. It is claimed that this will provide the power engineers the autonomy, status, security and mobility that is needed to attract talent to the industry and retain it and also help the integration of the power industry into a regional and a national grid. About the objectives of the proposal, there can be no two opinions—they are obviously desirable and the only question that arises is how best to achieve them. Job security at levels other than at the Chairman/Member level, for which the Committee had made recommendations in para 7.136 and which will provide some safeguards if accepted, is not a serious problem. The existing cadre service rules give ample, perhaps excessive, protection and security to employees to the point where even deserved punishment is difficult to met out. Status 'per se' is difficult to define and compare and is often more related to the stature and public image of the organisation than to belonging to a particular cadre.

7.174 The most important issue is what is the best organisation structure for achieving the objectives of the power programme? There appears to be gèneral agreement that autonomous corporations such as the NTPC and NHPC give the maximum freedom for management to act, get results and create an environment which attracts the best management talent. It also can create the internal culture which enables bright and able managers to rise fast in the hierarchy with seniority a secondary consideration. Looking ahead and assuming that the Committee's recommendations in this regard are accepted, the fastest growing groups in the generation sector will be the REGC's because the major share of new generation projects will be executed by them. They should, in the Committee's view, be set up as autonomous corporations like the NTPC or NHPC. It is clear therefore that any all-India cadre which is thought of, whether for power engineers or, as is done in the railways, for such major functions as civil and mechanical engineering, accounts, personnel, tariffs etc., will have to be compatible with the autonomy of the REGCs. While the all-India cadre concept has much to command it, the autonomy of REGCs, and the operation of an all-India cadre are not fully compatible, especially when it comes to promotions, transfers, training, where there can be conflicts between cadre controlling authorities and the corporation. This, historically, was one of the reasons why the Indian Management Pool (IMP), which sought to encadre Central Public Sector managers, had to be given up. The same situation will arise, mutatis mutandis, with State Electricity Boards and REGCs.

7.175 The CEA and the REAs, as long as they are regulatory bodies acting on behalf of Government, should, in the Committee's view, continue as departmental organisations. Their officers will thus be Government servants and not employees of a corporation and their terms and conditions of service will be different. A common cadre for corporations with different owners and Government agencies appears, therefore, to bristle with difficulties.

7.176 While the Committee therefore finds it difficult to support the concept of an all-India cadre/cadres for the power industry in its entirety, there are many desirable features of such a cadre which can be built into the recommended structure. The first is a common entrance examination to be conducted say by the CEA or the UPSC for the entry at the Class I level to all the Central, Regional and State bodies, i.e. REGCs, REAs, SEBs, PDCC etc. in the power utility industry. The successful candidates will be free to join any of the organisations depending upon the vacancies and their position in the examination.

7.177 From the successful candidates, each State could be required to take a minimum of 40% of candidates from outside the State in the case of SEBs and outside the region in the case of REAs. To ensure that this happens, suitable amendments will need to be made in the Electricity (Supply) Act. A second provision could be that 50% of the posts of the CEA and REAs at various levels should be filled by officers on deputation from the SEBs or REGCs or other utility companies. In order to facilitate this, it will be necessary as mentioned earlier, to re-examine the terms and conditions of service of the CEA and REAs so that they are able to attract able deputationists. Likewise, it should be mandatory that an equivalent number of posts in the SEBs and REGCs of comparable seniority should be manned by officers on deputation from the CEA and REAs.

7.178 Thirdly, for ensuring mobility and quality at senior levels, it is recommended that an all-India Pool or Panel of senior Managers in the power industry (equivalent to the posts of Superintending Engineers and above) in all disciplines viz., generation transmission, finance, personnel be formed. This pool should, as far as possible, be the exclusive source for filling the posts of the levels of Chief Engineers, Members/Directors and Chairman in the various organisations although the final decisions on who shall be selected must remain that of the organisation. Only in exceptional cases should people from outside the power system be inducted. As for instance where the cadre is yet not large enough to attract the best talent such as in finance, personnel, material management and so on but even here the attempt must be to build such specialist cadres within each organisation especially the larger ones.

7.179 Selection to this all-India pool should be done by a Standing Empanelment Committee composed of the Chairman, CEA, as Chairman, one Chaiman each of an REGC, an REA and an SEB to be nominated by the Department of Power on two-year terms together with two eminent specialists drawn from the relevant discipline. The selection should be done on the basis of proper interviews and not merely a perusal of C.Rs. The basis of selection should be merit, seniority being given very little weightage. Unless this is done, it will be difficult to appoint officers to posts of Members or Chairman at an age which will give them a full 5-year term. Once an officer has been empanelled, the Standing Committee should receive regular reports on his performance so that if his performance is sub-standard, he can be disempanelled also.

7.180 The Committee believes that most, if not all, of the benefits of an all-India cadre of Power Engineers without its limitations will be achieved if these three recommendations are adopted. The very act of creation and staffing the proposed REGCs and REAs will entail induction of a substantial number of engineers and other professional managers from the SEBs and the CEA, as there is hardly any other source from which experienced people can be drawn. This will be a major step in the direction of greater integration, personnel-wise of the power industry.

7.181 One of the factors underlying the demand for an All-India Service of Power Engineers is uniformity of pay and service conditions, presumably levelling up to the highest emoluments offered by any Board. The Committee feels that although there is no basic rationale for a wide difference in pay between people who are doing similar jobs in different places, this problem is not confined to SEBs alone. The Committee would, however, recommend that the CEA sets out broad guidelines for categorising posts and fixing the minimum terms and conditions of pay of all grades of employees in the power industry, standardisation of recruitment rules and promotional policies in the same way as the Bureau of Public Enterprises seeks to do for the Central Public Sector Corporations.

7.182 As regards the autonomy of the Boards, the Committee feels that if a State or Central Government is determined to encroach on the autonomy of the public sector corporations, an all-India service is no protection. The Government, which represents the owners of the assets, namely, the elected representatives and ultimately the people of India, must have over-riding powers if it is to be accountable to the people. The only deterrent to such encroachment is a Board of competent and upright managers whose public image and performance give them some immunity. It would also be wrong to assume that all Boards are subject to this kind of encroachment on their autonomy. Some are indeed extremely well-run and do indeed enjoy considerable autonomy and independence.

CONSUMER RELATIONS

7.183 The vital role that electricity plays in the lives of its consumers requires that the utility companies keep in close touch with them so that there is a clear understanding of each other's problems and means of solving them, to the extent possible, can be devised. The dissatisfaction of the public with Electricity Boards is widespread and ranges from complaints about reliability and quality of supply, tariffs, indifference to consumer complaints, safety hazards, corruption, damage to equipment and so on.

7.184 Sections 16 and 17 of the Electricity (Supply) Act of 1948 provide for the constitution of State Electricity Consultative Councils (SECCs) and Local Advisory Committees (LACs) in each State. The State Electricity Consultative Council consists, apart from the Members of the Board and the representatives of the electricity supply industry within the State, of representatives of commerce, industry, transport, agriculture and other interests including consumers of electricity. The Chairman of the SEB is the ex-officio Chairman of the Consultative Committee. The main functions of the Council are to advise the Board on major questions of policy and major schemes and review its performance. The functions of the Local Advisory Committees are also recommendatory in nature and the Chairman of the Board is its ex-officio Chairman.

7.185 The consensus seems to be that neither the SECCs nor the LACs have been of much assistance in bridging the communication gap and finding solutions to problems and some change in the way these Councils and Boards are structured seems to be necessary. However, it should be clearly recognised that when demand for power is in excess of supply, as it has been for a decade or more, power cuts, rostering of loads, breakdowns and fluctuations in the quality of supply cannot be avoided altogether. To expect such Councils to help overcome shortages and do effectively with complaints in these circumstances is obviously futile.

7.186 There are however some areas in which such Councils can play a useful role—firstly in giving the Board and Government a first hand and formal feed back of attitudes of consumer to the management of load-shedding the quality of supply, safety regulations, problems in getting connections and so on. They would also provide a good opportunity to discuss the possibilities of flattening the load curve so that plant utilisation can go up. A second area in which such a dialogue would be useful is the general area of tariffs where different points of view including the Board's could be heard.

7.187 To make these SECCs and LACs more effective, the Committee recommends that they should be supported by an independent secretariat funded by the State Government and functioning directly under the Chief Secretary for SECCs and the Collector for LACs. The intention would be to ensure that there are no 'self-defence' biases built into the way information on the various issues that come before the SECCs and LACs is compiled and analysed and that genuine complaints and grievances do get properly discussed on the basis of dependable facts. In addition, a wider range of consumer interest involving representatives of recognised consumer protection groups could be nominated to these two bodies. The secretariat should ensure that meetings take place regularly and the background data and agenda are prepared with the intention of getting balanced discussions on issues of interest to the consumer.

Quality and coverage

7.188 It has to be accepted that there is and will be for sometime a trade off between excellence in the quality of supply and the number of consumers who have access to electricity. It is quite feasible to ensure a thoroughly reliable and high quality of supply if there are sharp restrictions placed on the growth of the connected load and which will in effect mean a reduction in capacity utilisation. This is tantamount to freezing the position in favour of those who have access to power today and against those who do not, although as tax payers, many of the 'have-nots' may have contributed to the growth of capacity. A difficult middle line will have to be so drawn that quality of the power supply to consumers does not fall below reasonable limits but permits the maximum number of users to have the advantages of supply.

7.189 There are a few industrial consumers to whom interruption-free supply ranging within very narrow limits of frequency and voltage is essential. For them, special circuits (and tariffs which reflect this) or captive power generation may have to be considered. The vocal lobby of domestic urban consumers and industrial employees who are inconvenienced by staggered holidays and second shift working are not our most under-privileged groups, except perhaps for slum dwellers and some inconvenience to them may have to be accepted for some time.

Rating Committees

7.190 Acceptance of limitations on the quality and dependability of supply should not be construed as an attempt to condone the present levels of inefficiency of some of the Boards in generating and distributing power. Corrective measures for this have already been recommended including a suggestion that tariffs should be based on reasonable norms of performance and costs and not on actuals. The setting up of a Bureau of Electricity Costs and Prices will help establish these norms and lay down detailed guidelines for fixing tariffs. In view of this, suggestions like Rating Committees suggested by some consumer groups are not considered to be necessary.

Tribunals

7.191 In the Indian environment, tribunals for resolving disputes between consumers and the SEBs are not recommended. There are courts of law where disputes on contractual and other matters can be settled and tribunals only for one particular type of utility do not appear to be justified.

Right to Information

7.192 One area in which there is certainly need for a basic change in approach is the public's right to information about the operations and plans of the SEB. It is understood that Boards and Governments are reluctant to part with this information. The Boards should publish sufficient detailed information for an outsider to understand what is happening. Information on tariff structures (with rebates if any and why), details of production costs, revenues, fixed charges, future plans for generation, T&D, capacity utilisation, forced and planned outages, power restrictions, losses and so on should be published monthly. Some of these statistics are already being published by the CEA and more will be produced by the proposed REAs. There are obviously a few areas of information, say in relation to bids for projects, which it would not be in the public interest to disclose but the purpose of withholding information should not be to shield the Board from an informed look into the way it is being run. The SECCs and LACs might be asked to draw up proformae on the basis of which the Boards could consider disclosing information to the public. In order to avoid needless and time consuming clerical work, the information should be limited to the minimum, which the public needs, to get a clear picture of the performance and plans of the Board.

Consumer Counselling

7.193 A great deal of irritation and resentment is caused by consumers not knowing how to go about getting connections, or details of tariffs, safety regulations and other information which is relevant to their needs. The Committee recommends that a Consumer Counselling counter should be set up at all divisional and sub-divisional offices and the SEBs should print simple booklets in regional languages giving all this information. Considerable annoyance is caused by consumers paying deposits for connections and not getting them for a year or more despite periodic assurances to the contrary. In the Chapter on 'Power Planning', the need to limit load growth to the available power has been emphasised. Deposits should then be taken only when it is clear that the financial resources/power available will be sufficient to meet these demands within the next 6 months.

Penalties for damages caused to consumers

7.194 The Committee has given consideration to the plea that the SEBs should pay compensation to consumers who suffer loss due to failure or deterioration in the quality of power supply. It is urged that this would lead to the Boards being less casual in switching off consumers or allowing frequencies and voltages to fluctuate. While this is, on the face of it, a reasonable suggestion and there are similar penalties levied and paid by utility companies in the developed world, the Committee feels that its application to the Indian situation today and for some time may create more problems than it solves. Given that for some years some sacrifice in quality may have to be accepted as the price for increasing coverage, the first thing an SEB would do if such penalties become legally payable would be to build safeguards against such damages into all contracts it signs, knowing that if these are not acceptable there are no alternative sources to which consumers can turn. Particularly for major consumers operating continuous plants where the damage due to power interruption or fluctuation is likely to be very severe, the better alternative as mentioned earlier would be to have where possible separate circuits or captive generation. For the rest, close co-operation and consultation rather than confrontation with the SEBs may prove to be more productive.

CHAPTER VIII

RESEARCH AND DEVELOPMENT

INTRODUCTION

8.1 In no other vital sector of the Indian economy is so little research and development being done as in the power sector. In an industry which currently spends over Rs. 3000 crores per year, the total research effort in 1976-77 amounted to less than Rs. 15 crores. Of this, nearly Rs. 14 crores was done by private and public sector manufacturers and less than Rs. 1 crore by the utility companies. It is obvious that the totality of R&D is small in relation to the task and that, in the utilities *'per se'*, the R&D effort is negligible.

8.2 It is not as if the Government is not aware of the importance of R&D in this sphere. There have been several groups and Committees some exclusively set up for examining the question of R&D in the power sector e.g.

(a) The Task Force on R&D related to the Electrical Industry and Power Systems (1973) under the Chairmanship of Prof. C. S. Jha.

(b) Group on the Fuel and Power Sector of the National Committee on Science and Technology (1974).

R&D in power and energy has also been dealt with as part of the Reports of :

(c) Fuel Policy Committee (1974)

(d) The Development Council for Heavy Electrical Industries (1977) and

(e) Working Groups on Electrical Power Equipment Industry (1978, 1979).

8.3 Despite this, there are no visible signs of speeding up of the R&D tempo by the utilities although the equipment manufacturers are slowly picking up momentum.

8.4 The Task Force set up under Prof. Jha submitted its Report in August, 1973 and its major recommendations were as follows :—

8.5 There should be National Product Development Programmes and National Research Projects fully supported by the Government in respect of the development of large power equipment. The development of 500 MW generating plant was to be regarded as the most important Product Development Programme to be undertaken during the Fifth Plan.

8.6 The existing R&D institutes should be expanded to their optimum size consistent with the tasks allotted to them. Their activities should be geared for more active R&D back-up for the Power sector.

8.7 Facilities should be created in the areas of direct energy conversion, steam turbine and large electrical machine development, superconducting phenomenon and its applications, AC/DC high voltage transmission and studies in the operation and control of interconnected power systems. As far as possible, the newly identified facilities should be organised at the existing research institutes and new organisations/institutes should be created only when absolutely necessary.

8.8 Regional Research Institutes attached to the Regional Electricity Boards should be established for investigations into the planning, operation, maintenance and research problems common to the regional power network.

8.9 The major manufacturers of electrical equipment, in the private as well as public sector should be required to set up R&D centres/complexes commensurate with their manufacturing capacities and financial operations.

8.10 Development Centres for the needs of the small and medium scale industry should be established on a regional basis preferably sponsored by the Development Commissioners for Small Scale Industries.

8.11 A Power Technology Development Board should be created with the responsibility for identifying national R&D project areas. It will be the highest Government authority to evaluate and draft the R&D programmes and nominate institutions to whom the work is to be allotted. While it will not oversee the day-to-day working of the R&D projects, it will generally be responsible for monitoring the R&D work in the country and evaluate and control the major projects allotted to the different organisations.

8.12 An 'R&D Cess' on a percentage of the output of the electrical manufacturing industry and on the sale of power by the State Electricity Boards should be charged to generate resources for the R&D programmes of the power sector.

8.13 Urgent attention must be paid to the proper training of a sufficient number of research personnel; otherwise much of the expenditure is likely to be wasted.

8.14 A financial outlay of Rs. 150 Crores is considered essential for implementing the programmes identified by the Task Force. Suitable provisions centrally or Ministrywise, may be made.

8.15 The Report of the Task Force was submitted to the Planning Commission. Though no formal action appears to have been taken, certain results such as the formation of a CSIR Committee on 'Electrical Engineering Research' have taken place.

The recommendations of the Development Council for Heavy Electrical Industries submitted in 1977 are summarised below :—

8.16 A Central Technology Development Panel be established for the electrical industry as a Standing Committee of the Development Council for Heavy Electrical Industries, with the responsibility of advising and assisting in the co-ordination of specified aspects of technology development in particular, the establishment and operation of the Data Banks, training and development of personnel, enlargement and specialisation of R&D centres into "Centres of Excellence", creation of additional regional R&D centres and studies on futurology.

8.17 Adequate Data Bank facilities be set up for receiving, abstracting, collating and disseminating information on the results of current research programmes, within and outside the country, of relevance to the electrical industry. The Data Bank should be responsible for maintaining up-to-date information on R&D facilities and specialised talent available at various centres.

8.18 Conditions be created for free movement of research workers between technical wings to Government, industry, research centres and institutions of learning in India and abroad in order to promote interaction among them. In addition, a programme for periodical interchange of technical personnel among these bodies be prepared and implemented.

8.19 Suitable guidelines or checklists for transfer of technology be evolved for cases of both imported and indigenous technology, covering the whole technology package from design through production and marketing to satisfactory customer service, and ensuring appropriate linkages to reduce the risk element to the recipient.

8.20 Urgent steps be taken to strengthen existing R&D centres like CPRI, BHEL Hyderabad, ERDA and inhouse R&D centres, and to build and equip new R&D and testing laboratories at appropriate regional centres, to cope with the upsurge in demand for such facilities.

8.21 A co-ordinated plan be drawn up for the training and development of the research and development manpower required starting from the recommendations of the Working Groups set up by the Council so that the requirements of research workers in appropriate disciplines are fulfilled. As successful research depends largely on the quality of research leaders and research workers, the academic institutions should evolve and continuously review methods to identify talent and provide them with opportunities for training and development both within and outside.

8.22 Additionally, the Development Council for Heavy Electrical Industries (DCHEI) gave some typical projects for development which need national support. The details of the projects which have been identified by DCHEI were tabulated in the DCHEI report. This tabulation prepared by a very large number of specialists and experts, deals essentially with details like priorities, funding, choice of institutions etc. The DCHEI has recently been reconstituted an follow-up action by the Ministry of Industry on the above recommendations of the DCHEI is understood to be under consideration.

CURRENT STATUS OF R&D IN THE POWER INDUSTRY

Utilities Sector

State Electricity Boards

8.23 Several Electricity Boards have R&D Cells devoted to investigations into certain specific problems, development of improved systems, or evaluation of certain practices, etc. largely in relation to projects financed by the CBIP. It is observed that although certain studies have been made and new systems developed, the R&D cells have not been able to address themselves effectively to most of the burning problems faced by the Electricity Boards e.g. boiler tube failures, erosion of parts like I.D. fans, mills & grinders, poor water treatment, vibration problems etc. It is obvious that the R&D effort such as it is, is not related to the priority areas.

Research & Development by Equipment manufacturers

8.24 Apart from BHEL who spent Rs. 9.85 crores on R&D in 1979-80, there are 78 companies in the public and private sectors who have their own R&D facilities. Their expenditure on R&D is estimated at about Rs. 4 crores/annum. In addition, a co-operative sector research and testing facility called Electrical Research and Development Association ERDA has recently been set up under the aegis of the CSIR and the Indian Electrical Manufacturers Association.

Academic Institutions

8.25 Research and Development facilities available at the IITs, Universities and other academic institutions are primarily used for the education and training of engineering students. There is also certain amount of utilisation of the facilities at these institutes for developmental work for industries and utilities. A list of R&D activities being carried out in academic institutions is shown in Appendix 8-1. In general, it will be observed that the projects undertaken at such institutions tend to relate more to advanced concepts and technology rather than to the "grass roots" problems faced by the power industry in India.

Other Research Institutions

8.26 The Central Power Research Institute (CPRI) has been assigned the major role in R&D in the power sector by the Ministry of Energy. Its current R&D activities are largely in the field of materials and equipment for HV and EHV (AC) system and its main thrust is in the area of testing and certification of high voltage transmission equipment.

8.27 The Central Board of Irrigation and Power (CBIP) has been entrusted with the task of co-ordinating research on power undertaken in the country at the various Research Institutes of State Governments, State Electricity Boards and the Central Government as also that which is carried out at the various institutions of engineering education. The funds required for carrying out research studies are made available by the Government of India as Grants-in-aid. These are released to the respective research units after appraisal and approval of the CBIP.

Linkages and Co-ordination

8.28 The research and development activities related to the power sector are spread over diverse organisations. The broad classification of the research agencies and organisations are as follows :—

- Ministry of Energy—Department of Power—CPRI, CBIP.
- Ministry of Steel & Mines and Deptt. of Coal—CFRI, CMPDI, CMRI, NML.
- Department of Science & Technology—CSIR Laboratories, Electrical Research & Development Association (ERDA).
- Atomic Energy—BARC, RRC.
- Utilities—Research groups in State Electricity Boards, Licensees, Statutory Corporations, Private Sector Licensees.
- Ministry of Industry—Research groups in the Private Sector and Public Sector (BHEL, ILK, Keltron).
- Educational Institutions—IITs, IISc, Engineering Colleges etc.
- Department of Supplies—National Test House.

8.29 Although there have been some efforts to co-ordinate various activities, an integrated approach to problems, policies and programmes for R&D in the power sector is conspicuous by its absence. Recommendations of earlier Committees to rectify this situation have not been implemented. Different organisations tend to work in isolation from one another mainly because they are responsible to different authorities such as different Ministries of the Central and State Governments, State Electricity Boards, Public Sector manufacturing units and Private Sector organisations and associations. This has not been conducive to the optimal utilisation of the available physical resources and talent, much less to the accelerated pace of the R&D effort required to enable it to measure up to the challenges of the future.

Testing and Certification

8.30 At present facilities for testing and certification are available only at CPRI, Bangalore and the High Voltage Switchgear Testing Laboratory at Bhopal. These cover facilities for testing—

(a) L.T. Switchgear.
(b) Cables & Capacitors with Partial Discharge Detection facilities etc.
(c) High Voltage equipment.
(d) Electronic system and Instrumentation.
(e) Insulating Materials.
(f) Chemical properties with facilities for Liquid Dielectrics.
(g) Domestic Appliances.
(h) Vibration (for Transmission Lines).
(i) Prototype Tower Testing.
(j) High Voltage Switchgear Testing.

8.31 Facilities available at a number of educational institutions can also be used for a limited volume and range of tests. A number of organisations are using these facilities for carrying out test of equipment and components. The utilisation of the test facilities in educational institutions is not very high because, it is claimed these institutions are basically interested in academic work.

Import of Technology

8.32 In a developing country, the technology imports are generally via the manufacturing sector rather than directly to the utilities themselves. The available technologies within this industry thus control the design and performance of power systems. An examination of the technological capabilities of the various units of the electrical engineering industry indicates that a large proportion of them have started with collaboration agreements, with organisations abroad, for manufacture of a range of products. Sometimes, in the case of medium and small scale industries, agreements cover only one or two components of limited specification or performance capacity. There are very few truly indigenous R&D products in the utility industry that one can point to. It must thus be accepted that for, at least some years, if the power industry is to remain modern, efficient and economic and be able to compete in the international market, it will have to rely heavily on imported technology. Many of our designs of turbo alternators, large motors and switchgear have already become obsolescent. The immediate task is to create a solid R&D base which can absorb this technology and which perhaps in a decade or so could begin to become contemporary with the developed world in at least a few areas.

Information and Documentation

8.33 The library and information bureau of the Central Board of Irrigation and Power is the main source of documentation facilities in the field of Irrigation and Power Engineering. It regularly receives technical enquiries on specific problems in the field. Among its other activities, the Library and Information Bureau prepares abstracts of books, articles, reports and conference proceedings and distributes them to all its members. The Indian National Committee of the World Energy Conference has a programme of interacting internationally in the field of energy information and documentation. The Tata Energy Research Institute is also doing useful work in the area of documentation. Some manufacturers have House Journals or other publications covering new developments essentially related to their own business. A few regular commercial publications have also started.

RECOMMENDATIONS

Utilities

8.34 As pointed out in the Chapter on 'Operation and Maintenance', the scope of "grass roots R&D" i.e. research on the day-to-day problems of operation and maintenance, especially of thermal power plants is itself an enormous task and one in which the pay back is immediate and extremely high. A day's reduction in the forced outage of thermal plants in a year would generate revenues of the order of Rs. 8 crores*. Likewise, a 1% reduction in T&D losses would produce revenue earnings of the order of Rs. 22 crores*. Given these orders of savings, the question that needs to be answered is why are utilities and other bodies so disinclined to invest in R&D.

8.35 The Committee attributes this to a combination of factors—

(a) Absence of R & D personnel of the right calibre and background at sufficiently senior positions in the management.

(b) Funds allotted by utilities and R&D are negligible and largely confined to the assistance received from the CBIP. Even these are not always fully spent. The priority attached to research is low compared to generation and T&D.

(c) Inhouse facilities in utilities laboratories to support R&D are practically non-existent.

(d) Lack of linkages with other scientific institutions in similar and allied fields.

8.36 The Committee is of the view that the prevailing situation is not a consequence of any conscious resistance by utilities, particularly SEBs, towards R&D but of a lack of what may be termed an 'R&D' culture. The operational environment especially its overwhelming concentration on current problems and traditional methods of dealing with them has so far not permitted utility leadership to seriously explore the R&D route towards solutions of its problems. It is also likely that middle and senior level engineers, not having been exposed to an R&D atmosphere during their formative phase, do not intuitively think of it in operational situations. The Committee believes that correction of this attitudinal constraint is perhaps more important than any other more specific remedial measures if R&D is to take firm root in the utility industry.

In order to correct this, the Committee would recommend that—

R&D Group in the CEA

8.37 There should be a Member (Research) in the CEA on whom the principal individual responsibility for rejuvenating and accelerating the R&D effort in power utility organisations in India will lie. He would function through a National Council on R&D in Power, reference to which will be made later. Under him he should have senior officers of the requisite competence, and dedication specialising in the various areas of R&D activity. Neither the Member (R&D) nor his staff should be chosen simply because they are judges to be the best scientists in the field. The qualities they need is the ability to gauge the capacities and special strengths of different institutions doing R&D, understand the weaknesses in the training and orientation of research Scientists and have the capacity to organise, coordinate, help set goals and monitor progress. Their first job would be to draw up a comprehensive 'grass roots' R&D programme including projects which have been referred to later in this Chapter and move away from long range R&D.

Its second major task would be to promote the 3-tier testing facilities referred to later and be responsible for coordinating and monitoring the progress of the standardisation programme referred to in the chapter on 'Project Formulation and Implementation'.

R&D in SEBs

8.38 Similarly in all State Electricity Boards a carefully selected officer of the rank of Chief Engineer should be put full time in charge of the R&D division and he should be given an appropriate staff. In many SEBs, there is overstaffing at these levels and surpluses can be suitably re-deployed but strictly subject to men of the requisite aptitude and dedication to R&D being available. Whether the division is manned by fresh recruits or people transferred from other sections, they must be carefully selected and trained and be given a status which fully recognises their special abilities and knowledge.

8.39 Each SEB ought to aim at an R&D revenue expenditure equal to about 0.5% of its turnover and the creation of assets annually of roughly the same order. However, the pace at which this should be done will depend on the calibre of the people chosen for the Division and the support of the Board. Special care should be taken to keep the normal bureaucratic formalities and procedures out of this research group even if special dispensation has to be given.

8.40 The Board should identify precisely which are the operational areas which are responsible for the maximum number of forced and partial outages and losses in T&D and set up multi-disciplinary task forces headed by the Chief Engineer (R&D) and comprised of officers/engineers from the operating units to arrive at a solution by a given date. They should report periodically to the Board on progress. It is only when the Board is seen to be taking a keen interest in the activities of the R&D groups that the culture of R&D will begin to develop.

*These figures pertain to the year 1977-78.

8.41 The procedure for sanctioning funds should be greatly simplified. Once the yearly budget and projects of the Division are approved after due scrutiny, the Chief Engineer, which an Accounts Officer attached to him and administratively under his control, should be permitted to spend the money. The Accounts Officer should also have some exposure to the workings of research departments. Only major capital expenditure should require Board approval. Accountability should be for results and not only for vouchers showing where the money was spent.

Academic Institutions

8.42 Academic and research institutions should evolve a series of basic training and refresher courses especially tailored for R&D personnel in the manufacturing and utilities sectors. The scheme of Centres of Excellence should be introduced at a few academic institutions. Each such Centre should focus on a major technological or scientific area and should have seconded to them R&D personnel from utilities, and organisations manufacturing power plant equipment.

Manufacturing Units

8.43 Although there is considerably greater activity in the R&D field in the manufacturing sector as compared to utilities, it is largely confined to the organised large scale sector. R&D in this sector has been influenced by the technological collaborations, both inherited and negotiated, which form the basis of the present industry. The commercial aspects of collaborations have not infrequently prevailed over their suitability for Indian needs. Design criteria and specifications, to which much of the equipment is built, are imperfectly matched to local operating duties and environmental conditions, causing breakdowns even when a product is made to design. This had led the Committee to recommend in para 4.28 that where major manufacturers of power equipment sign collaboration contracts, especially where they are in a monopolistic situation, representatives of the users should also be consulted and a mechanism for ensuring this has been suggested.

8.44 Reference has also been made to other reasons for improving communications between the manufacturing and utility sectors as well as governmental agencies like the C.E.A. It is quite apparent that failures of equipment in the field are rarely communicated to the manufacturers in sufficient detail to trigger-off corrective action. Similarly, utilities are often unaware of latest product and process improvements.

8.45 The Committee has also stressed the need for manufacturers not only to respond to the field performance of their equipment but also to strengthen the quality assurance procedures used for testing raw materials, components and stage manufacture of their products. Standards covering limits of variance in, say, purity of metals have yet to be established.

8.46 It is suggested that an expert group be appointed to enquire into why despite the substantial fiscal and other concessions offered and the size of the market, the pace of inhouse R&D has been generally rather halting amongst the large scale manufacturing sector with the exception of BHEL and one or two other units. The fact is that and there is considerable reliance on imported technology even in improving the performance of relatively simple equipment like small motors, transformers, switchgear, relays, insulation etc.

Small Scale Sector

8.47 Although substantial development and growth has taken place in the electrical industry in the small scale sector it still suffers from a variety of shortcomings such as lack of standardisation, inability to attain desired quality levels in certain specific areas and technological obsolescence. In order to improve the quality of the products in the small scale sector and to enable it to keep pace with the latest trends of development in technology, it is necessary to provide assistance to the existing units particularly in standardising and improving the designs of their products, material conservation, prototype development and creating sophisticated common testing facilities. In providing some of these inputs, particularly to small units, the proposed Electrical Research and Development Association in Baroda could play a vital role. The CEA, the ISI and the local SEB should directly or through the local Small Industries Service Institutes (SISI)s and other state level promotional bodies take it upon themselves to see that the quality, technology and productivity of the small scale sector improves and products are made to uniformly high standards.

8.48 Some of the specific areas where this kind of assistance would be generally required are given below :—

(i) Improving efficiency levels of motors to 70-75% by specifying and standardising designs, process technology including designs of tools, jigs & fixtures and material specifications.

(ii) Switch-over to technology for production of electric motors from Class A type insulation to Class B type and further to F type insulation.

(iii) Standardisation of improved designs for transformers, simple relays and other electrical devices.

(iv) Provision, of common testing facilities within easy access where in addition diagnostic studies can be made and corrective measures suggested for raw materials, components and finished products.

(v) Stocking scarce raw materials of the requisite specifications.

(vi) Design and proto-type development of miniature and micro switches including tools and fixtures etc.

The progress in this direction will be accelerated if the I.S.I. were to prescribe designs and testing methods and conformance to these specifications linked to the eligibility of the manufacturer to tender for all supplies bought by utilities. Similarly loans from public financial institutions and State Governments should be given only to those who buy products which have been so designed and tested.

Testing

8.49 Although testing equipment is not strictly an R&D sanction, it creates an excellent base on which to build an R&D organisation. The Committee recommends that starting with the CPRI as the apex body, a three tiered laboratory structure should be created. The CPRI itself will do only such testing as requires extremely capital intensive facilities which will serve the country as a whole. It would also maintain the master standards against which the 2nd tier laboratories instruments will be checked. The 2nd tier should consist of zonal laboratories set up by the Central Government which will carry out a much wider range of less sophisticated tests on behalf of all the manufacturing units and the utilities in the region. At the base of the pyramid, on the quality of which the superstructure will depend, are the laboratories in the utility companies and the manufacturing organisations who would do the routine testing as well as the day-to-day 'trouble shooting' R&D. Industrial estates and other areas of concentration of small scale industries who also put up such laboratories as a common facility would be a part of this 3rd tier.

8.50 Close interaction between these tiers and the States and regional level institutions e.g. engineering colleges and IITs is envisaged so that the theoretical basis in which testing and R&D are done in the utilities is continually reinforced. At the same time, the transplantation of pilot plant work done in laboratories to the field —a major constraint today, will become much smoother. At the core of the concept of this entire structure is the mobility of people between and within tiers and between this structure and the various academic and research institutions here and abroad. Pay structures and allowances will have to be so devised to allow this mobility to be generated and this is a subject to which the proposed Member (R&D) and Member (Personnel) in the CEA must give serious consideration.

Apex Body for R&D in Power

8.51 The Committee found a broad consensus amongst research workers in this field that the absence of an apex body at the Centre to oversee R&D activities is one of the major causes for our very halting progress. It has, therefore, proposed the creation of National Council for R&D in Power in the Ministry of Energy. The Council should evolve a national R&D policy in this field, formulate strategies and programmes to accord with national power plans, allocate R&D tasks to designated organisations and monitor and coordinate their implementation.

Functioning of the Council

8.52 The Council should function through eight Standing Committees each of which would relate to a specified sector or area. These eight are—

(a) Testing, Certification and Standardisation.
(b) Product, Process and Technology Development.
(c) R&D Training and Manpower development.
(d) Generation.
(e) Power Systems.
(f) Non-conventional energy resources.
(g) Conservation technologies.
(h) Information, documentation and dissemination.

8.53 The task of each Committee would be to select problems of importance to the power sector particularly those in which India has a distinctive interest and in which acquisition of knowledge or know how from outside would be difficult or impossible. The attempt should be to focus all available facilities, manpower and financial resources on such carefully chosen problems so that dissipation of effort and resources subcritically over a multiplicity of projects is avoided.

Typical of the problems and tasks that could be undertaken in each of these areas are—

8.54 Setting up a system to monitor the progress of the proposed 3-tier testing organisation and providing assistance to the small scale sector as outlined in para 8.49.

8.55 Detailed investigation of the causes of breakdowns of thermal power generating equipment by setting up multi-disciplinary, multi-institutional task forces to tackle each of these causes e.g. study of mechanical, metallurgical, erosion and corrosion failures and the relevance of capacity ratings under Indian conditions.

8.56 Surveys of R&D personnel in different organisations; identification of disciplinary weaknesses and gaps; measures for training in institutions in India and abroad; exchange of scientists; pay scales; facilities and status of scientists; setting up of Centres of Excellence.

8.57 Coal washing; fluidised-bed boilers for burning high ash coals, middlings and rejects; pumping coal by pipe lines; improved crushers and pulverizers; reduction of oil support, sturdier F.D., P.A. and I.D. fans; increasing reliability of instrumentation systems; improved techniques for installation of plant.

8.58 DC & EHV transmission systems; multi voltage multi circuit towers; high tensile steel/aluminium towers; low cost circuit breakers with earth leakage protection and auto reclosing features; ripple or wave-form switching arrangements for load management, self protected low loss, low cost distribution transformers, LT conductors with light insulation; reliable communication systems with field and mobile units.

8.59 Trial installations with varying mixes of biogas, solar and wind energy sources; small prime movers for agriculture and rural industry motive power applications, photo voltaic systems, energy plantations, blue green algae, ocean thermal gradient systems, solar ponds, experimental megawatt solar thermal plant, organic wastes into liquid fuels; fast breeder reactors, nuclear fusion.

8.60 Waste heat recovery and combined cycle systems, higher efficiency motors and transformers, reduction in losses in T&D systems, higher efficiency arc furnaces and electrolytic and electro thermal plants, fixation of norms for power consumption in different industries.

8.61 Collection, storage, abstracting and disseminating information on R&D in power and providing ready access to scientific activity in all fields relating to power. All Class I and diploma holders in the utilities should receive a copy of a monthly bulletin highlighting the national and international developments in the power sector. Copies of information/documentation on R&D received by Government agencies from sources outside India should be channelled through this Standing Committee.

8.62 The Chairman of this Committee would be the Secretary, Department of Power if he happens to be a 'technocrat' with the requisite technical background and experience. Otherwise the Chairman, C.E.A. could be the Chairman of the Committee but in any case he should be a Member. The other members would consist of the 8 Chairmen of the Standing Committees and in addition the Secretaries to the Departments of Science & Technology and Electronics, D.G.T.D., Directors of BARC, CFRI, CPRI, ERDA and the Chairman, Indian Electrical Manufacturers Association should be Members. If the Solar Energy Commission referred to later is constituted, a representative of this Commission should be brought on to the Council. Representatives of the Finance Ministry and Planning Commission should also be members of the Council. A Committee like this could ensure that all aspects of R&D in the power sector are taken note of, that gaps in which India ought to mount an effort are identified, unintentional duplication of research activities avoided and the programme given real impetus. The Member (R&D) of the CEA should be the ex-officio Member Secretary of this Council and his senior officers, Members Secretaries of the various Standing Committees.

8.63 This Committee would be the official high level channel for dealing with international organisations on R&D in the power sector.

Alternative Energy Sources

8.64 The Committee believes that the potential in India for application of renewable/solar energy resources to the development of agricultural and rural electrification is immense. It can also help to substantially reduce the fossil fuel consumption of medium and large scale industries. These applications become increasingly attractive as coal and oil prices go up and electrification has to be extended to increasingly remote and sparsely populated villages. The demand of power in the rural areas is for small quantities at special times of the day and the year and at relatively low voltage and quantities. These specifications correspond to precisely the kind of power, that renewable energy sources like biogas driven generators, windmills or photovoltaic cells, are capable of producing.

Solar Energy Commission

8.65 Efforts at developing non-conventional renewable energy have been going on for a number of years but the totality of the results achieved so far have been somewhat disappointing. The Committee found that the principal weaknesses in the rapid development of non-conventional renewable energy sources were:

(a) Lack of the capability to test promising new concepts and devices in the field and getting detailed operational feed back;

(b) Failure to examine the socio-economic implications of systems and devices;

(c) Lack of organisations who are able to get prototype and pilot plants engineers for production on a large scale;

(d) Lack of adequate exchange of information between various research groups and field workers;

(e) Slow evaluation and release of funds including foreign exchange for organisations which are doing promising work.

8.66 The Department of Science and Technology is doing admirable work in this field but it has a very wide range of responsibilities and can devote only a limited amount of high level attention to this area. Individual States or agencies like the Gujarat Energy Development Agency have taken the initiative to set up energy plantations and initiated work in solar and biomass systems but they do not function as a part of an integrated national R&D effort.

8.67 In order to give this vital programme the impetus it needs, the Committee recommends the setting up of a high level Solar Energy Commission on the same lines as the Electronic Commission. Its role should be to fund programmes of R&D in solar energy systems (including bio-gas, wind and tidal energy systems), identify gaps in research activity as also in scale up and transfer mechanisms, collect and disseminate information and recommend incentives for adoption of solar devices by industry and agriculture. It should be accountable to the nation for ensuring that the renewable energy resources programme gets the support and coordinated inputs required to ensure that the immense potential that these energy sources have for India are speedily exploited.

Magnetohydrodynamics

8.68 The area of magnetohydrodynamics namely the direct conversion of thermal energy into electricity is relatively new. This technology which is capable of raising thermal efficiencies of boiler plants from the present 30 to 40% to over 50% has made little progress outside the USA and USSR. India has a modest MHD programme in progress beginning with the establishment of a 5 MW pilot plant. Before further large scale R&D commitments are made, the Committee would recommend that the economic viability of this technology needs to be clearly and unambiguously established.

R&D activities in the field of nuclear power

8.69 The research and development activities in the field of nuclear power are carried out primarily at the Bhabha Atomic Research Centre (BARC) at Trombay and in respect of fast breeder reactors at the Reactor Research Centre (RRC) at Kalpakkam. Inhouse capability exists for resolving most of the current problems in the nuclear power field. Participation of other institutions like various IIT's, Indian Institute of Science, Bangalore, specialised laboratories and industries is also obtained wherever necessary.

8.70 At BARC, extensive facilities exist for engineering research and development of supporting services for almost all aspects of nuclear power plant operations, including nuclear fuel management, hazards evaluation and safety analysis. BARC is also the training ground for the majority of personnel, both scientists and engineers required for the Indian nuclear power programme. Four research reactors are in operation at BARC and a 100 MW thermal research reactor is under construction. It will enable material testing and fuel development for advanced thermal reactors. It will also produce radioisotopes of high specific activities.

8.71 A major step in the direction of computer control of a nuclear reactor is the development at BARC of a computer-based control system for automatically operating fuelling machines of the pressurised heavy water type of reactors in operation and under construction at Rajasthan, Kalpakkam and Narora.

8.72 The Fast Breeder Test Reactor (FBTR) being built at RRC, Kalpakkam is designed on the same lines as the Rapsodie-Fortissinic reactor in France, but unlike the latter it will generate approximately 14 MW of electric power. The FBTR is a sodium-cooled fast breeder reactor using plutonium-uranium fuel. It will serve as a facility for developing improved fuels having high specific power and better breeding ratios and for research on materials and component development for fast reactors.

8.73 Studies are in progress regarding the feasibility of using thorium, of which large deposits exist in India, in the existing heavy water reactors. This will also provide an alternative to the fast breeder reactor route in case the breeder development gets delayed for any reason. Work related to U233 separation is also in hand. While technology for fabrication of enriched uranium fuel elements has been well established, developmental work for fabrication of the thorium plus U233 fuel and plutonium mixed oxide fuel is also being carried out.

8.74 Work of nuclear fuel management is carried out departmentally for reactors through the use of computer codes and plant data. The recent uncertainty of supplies of enriched uranium from USA for TAPS has put severe constraints on fuel management options. Consequently, the Department of Atomic Energy has carried out studies and devised strategies to utilise the existing stock of enriched uranium fuel optimally and alternative like the use of mixed oxide fuel consisting of uranium and plutonium are being studied.

8.75 Certain problems like corrosion of materials due to flowing fluids have specially grave consequences in nuclear power plants because of the fact that in a nuclear power plant corrosion products act as carriers of radioactivity to other parts of the system. This makes maintenance work more difficult. Hence, research work is being directed towards understanding the mechanism of corrosion and to devise satisfactory ways of reducing corrosion. Considerable expertise has thus been developed at BARC in the field of power reactor water chemistry. The expertise developed has been made available to thermal power stations also but the interaction between the two needs to be strengthened.

8.76 Another significant development required for smooth and satisfactory operation of nuclear power plants is the setting up of mock-up facilities for training personnel to do complex operational jobs. Mock-up of tasks to be performed in radiation zones facilitates conservation of man-rems by increasing the output that personnel working in these zones can do in a given time before they run any risk of over exposure to radiation. A nuclear power plant simulator is also being set up for training/re-training of operating Engineers/Technicians.

8.77 The R&D work in the nuclear field is and has been getting all the financial inputs it has needed and the Committee recommends that the policy be continued as it is a vital prong of a multipronged strategy aimed at meeting the country's long term power and energy needs.

Fusion

8.78 Limitless power will only be possible when man learns to harness fusion energy i.e. energy released when certain nuclear particles fuse together. Commercial reactors based on fusion energy are atleast 2 if not 3 decades away unless there is a dramatic break-through. Before embarking on a major programme of fusion research, a programme which would stretch the resources of even the developed world countries if it is tackled in a way needed to get results in the foreseeable future, the possibility of doing joint research in this area with groups in Europe and the Comecon countries needs to be explored. India may have to consider doing sufficient R&D work in this field to get an entry into these 'clubs' on the basis that it has something to contribute. A comprehensive literature survey covering the 'State of the art' should be prepared and strategies for entering this field considered, together with their short and long term financial and technological implications.

CHAPTER IX

SHORT-TERM MEASURES TO ALLEVIATE POWER SHORTAGES

9.1 The Committee has recommended a number of measures which if implemented would give the country a steady and dependable power supply at the minimum cost. However, some of these recommendations involve basic changes in the structures, management procedures, and policies of the power utility industry and would only show significant results after 3 to 4 years. The Committee has, therefore, thought it desirable to list separately those recommendations which could produce results in the next 1-3 years to alleviate the power shortage. It has also added a number of recommendations of a stop-gap nature.

Improving performance of existing thermal stations

9.2 In the last three years capacity utilisation of thermal plants has fallen from 56% in 1976-77 to 45%. Measures to restore performance to 1976-77 levels and higher in the next year or two are listed below.

Overhauling and rectification schedules

9.3 All major thermal plants should be asked to prepare in the next 3 months a detailed programme for thoroughly overhauling and rectifying their equipment and carrying out any vital modifications. The major causes of poor performance should be identified and a list of the spares, sub-assemblies and replacement units required should be compiled, ordered and utilised not only during the annual planned maintenance shutdowns but also where possible during week-end shutdowns. Replacements could include the substitution of undercapacities ancillary equipment by equipment which could enable the plant to operate at full capacity e.g. boiler feed pumps, forced draft and induced draft fans, water treatment plant, air ejectors, condensers, crushers and mills, improvements in materials of construction especially for components subject to erosion, conveyors for manually removing stone and shale from coal, etc.

9.4 In this task the utilities should, especially in the case of a few of the chronically poor performances, associate themselves with competent Indian as well as, if necessary, foreign consultancy firms. These activities should be fully programmed on PERT charts prepared after a careful and realistic appraisal of the time required for various activities and monitored jointly by the CEA and the Boards of the utilities each month.

Supplies of spares and assemblies

9.5 All spares components, sub-assemblies etc. required for this programme, which are to be procured from local manufacturers such as BHEL, ILK, AVB should be given the highest priority even at the cost of the manufacturers rescheduling deliveries of equipment for new plant. Similarly all imported spares should be ordered, on a crash basis if necessary to suit the PERT, short circuiting normal purchase procedures e.g. indigenous availability scrutiny. Air freighting can be carried out if it means reducing the time of the shut-down. Insurance and emergency spares should also be ordered at the same time.

Training programmes

9.6 The facilities of the 4 regional training institutes are under-utilised. They should be fully and rapidly used to give tailor-made training courses at different levels from plant operators and maintenance staff to station managers on the operation and maintenance of thermal units of different capacities and makes. The intention would be for the CEA to pool the experience of all the field level personnel in each make of equipment and from their experience develop manuals of operation and maintenance systems for each type of boiler and turbogenerator and arrange training, in both the theoretical and practical aspects of thermal plant operation & maintenance for various levels of plant personnel. Such an exchange of information will also enable the spares lists referred to in the previous paragraph to be made more comprehensive and realistic.

Coal-rail power co-ordination

9.7 An improvement in the quality and stocks of coal at the power plants would immediately reflect on the performance of the power plants. To still the infighting within Government departments, the Committee would suggest that the Government appoints a full time group consisting of a Director of Coal India, an officer of the rank of Chief Operating Superintendent of the Railways and a Chief Engineer from the thermal wing of the CEA. This group should as a team spend its time continuously visiting the coal fields and power plants and send in fortnightly joint, agreed and factual weekly reports to the proposed High Level Committee referred to later on the following items for each of the country's major thermal plants.

9.8 (i) Planned and actual receipts of coal at each power house as measured jointly by the power house and coal company representatives.

(ii) Stocks of usable and substandard coal at each power house.

(iii) Major causes of difference between planned and actual receipts.

(iv) Wagons detained in collieries and power houses beyond normal discharging time—area-wise for collieries and in each power station.

(v) Coal moved to power houses by trucks divided into movements which can only be done by trucks and movements due to non-availability of wagons.

(vi) Remedial measures planned.

9.9 In order to reduce the proportion shale and stones in coal which are the primary cause of damage to the power plant equipment, the Committee would recommend the immediate setting up of picking band conveyers for hand picking stones and shale either at the coal mines or in the power plants. The coal companies have for some years past been proposing to set up crushers and mechanical deshaling equipment (as opposed to proper washeries) which would substantially mitigate this problem. Action in this regard should be expedited. If imports of equipment are needed to hasten action, these should be freely permitted.

Inter-State Transmission lines

9.10 Surpluses of power when they are available, are not being fully used because of delays in the construction of inter-State lines and the less than optimal use of the existing ones because of the lack of an agency which could effectively regulate power flows and maximise generation. The Committee's recommendation of setting up statutory Regional Electricity Authorities as described in the Chapter on 'Organisation and Management' should be implemented expeditiously and the task of setting up inter-State lines and controlling power flows should be entrusted to them.

Selection of Chairmen and Board Members and other organisational changes

9.11 The appointment of able and dedicated officers to the Boards of the SEBs together with the protection for them that has been recommended in the Chapter on 'Organisation and Management' should progressively tone up the performance of many of the utilities. The procedure, therefore, outlined for selecting such officers in the report should be implemented as early as possible. The separation of generation and distribution cadres, the grant of special allowances to staff working in remote places, the decentralisation of authority for distribution and the strengthening of the CEA should be given high priority.

Industrial relations

9.12 The Committee is of the view that the law and order situation in some states and the disturbed industrial relations prevailing in many SEBs and in organisations such as the railways and coal mines especially in the eastern region is one of the major cause of the current power shortage in the country. Besides bringing in good management and ensuring that it has the full support of the State Government, action at the political level is necessary to restore law and order, bring back discipline and allow firm action to be taken against go slows, slackness and negligence at all levels including management.

Gas Turbines

9.13 Although gas turbines have no place at all in the long term scenario for power development, the current shortages today are so high that the Committee would recommend the immediate importation of 500 to 600 MW of gas turbines and their installation in the next 9 months for the following purposes :

(i) Steel plants .	. about 200 MW
(ii) Coal mines .	. 100 MW — 150 MW
(iii) Fertilizer factories.	100 MW — 150 MW
(iv) Cement .	. 100 MW

9.14 The main purpose of these turbines would be to supplement power to these industries in order to increase production and reduce the imports of these commodities. The foreign exchange so saved will more than offset the expenditure on imports of fuel/diesel oil. The allocation of gas turbines to the specific plants in these industries should be done by the High Level Committee referred to later in consultation with the Secretaries of the 4 concerned Ministries. These gas turbines should obviously only be run when they are actually going to augment production i.e. when there are no other constraints such as coal, transport, feedstock, industrial relations problems etc. It should also be ensured that this power is in fact supplemental and does not lead to diversion of the power currently supplied to these industries to other purposes.

Power allocation and demand management

9.15 There is no clear cut national policy on rationing power in times of shortages in a way which causes the least socio-economic dislocation. It is recommended that the Planning Commission in consultation with the concerned Ministries and State Governments draws up a list of priorities. Typically, highly power-intensive industries like mini steel and alloy steel plants. non-ferrous metal smelters, calcium carbide and other electro-thermal processes have high power : output and power : employment ratios. Their output can be curtailed and the power saved diverted to the maximum production of essential commodities which would help to curb inflation and increase employment. Power intensive products can if the need arises be imported. One test that could be applied would be to calculate whether it would be cheaper in foreign exchange terms to import such products or import the diesel oil required to generate power via turbines to operate these industries.

9.16 Load staggering for industries and agriculture is still not adopted in many states thus leading to avoidable additions to peak demand. The Committee would recommend the introduction of peak and non-peak tariffs for major power consuming industries as soon as time-differentiating meters can be obtained and installed. This will help flatten the load curve and improve capacity utilisation. The CEA should also study the various measures taken by states to reduce peak demands and take steps to ensure that those which are effective are adopted by all States.

Transmission and Distribution

9.17 Immediate attention to the installation of capacitors on distribution system with low power factors would improve the capacity utilisation of the generation and transmission system. The system of flat rates for pumps currently in operation in various SEBs leads to wastage of power and should be rapidly substituted by meters.

Conservation

9.18 The Committee feels that there is a strong case for a substantial upward revision in tariff especially for industrial and agricultural consumers. Such a step will not only help to raise much needed resources for the utilities but induce consumers to invest in measures which conserve the use of power. Conservation can be further hastened by a mix of fiscal and financial incentives and disincentives. Based on existing technologies, norms of consumption can be worked out by independent expert bodies like the proposed Bureau of Electricity Costs and Prices for different industries. Organisations which perform better than these norms could be given some tax relief and those who exceed them should be subject to penal power tariffs. Likewise capital subsidies or accelerated depreciation can be considered for investment which lead to economies in the use of power.

9.19 Restrictions should be placed on the production and sale of low-efficiency motors and transformers. These can be implemented through a system of compulsory testing and certification as well as by confining institutional credit to consumers who buy equipment which conforms to the prescribed standards.

9.20 A start should be made on encouraging the use of non-conventional renewable energy resources by giving incentives for replacing conventional power operated equipment by equipment operating on biogas, solar and wind powered systems.

IMPLEMENTATION

A high level Committee should be set up by the Central Government to draw up a time bound plan of action in all these areas in consultation with the SEBs, other utilities and State Governments and to monitor its implementation. The Committee should be chaired by Secretary, Department of Power and should have on it Secretaries of the following Departments/Ministries—Railways (Member Traffic), Heavy Industries, Coal, Labour and Home. The Chairman, CEA and Adviser (Energy), Planning Commission should also be members and the Member (Thermal), CEA be the Member-Secretary. This Committee should report fortnightly on progress to the Cabinet Committee on Infrastructure, in particular drawing attention to where action is required at the political level e.g. concerned Ministries/Chief Ministers in States. Trade Unions etc.

Members

Sd/-
(N. B. PRASAD)

Sd-/
(N. TATA RAO)

Sd/-
(R. N. BHARGAVA)

Sd/-
(J. M. PATNAIK)

Sd/-
(V. N. KOTHARI)

Sd-/
(S. N. ROY)

Sd/-
(K. V. RAGHAVAN)

Sd-/
(J. C. SHAH)

Sd-/
(K. M. CHINNAPPA)

Sd-/
(C. MUTHUSAMI GOUNDER)

Sd/-
(S. RAMESH)
Secretary

Sd/-
(V. G. RAJADHYAKSHA)
Chairman

SUMMARY OF RECOMMENDATIONS

PLANNING FOR POWER DEVELOPMENT

DEMAND FORECASTING

		Para
Long term forecasts		
1.	Plans for the development of the power industry should have a 15-20 year time-frame and the 5-year Plans should be built into this plan so as to optimise the mix of generating sources i.e. thermal, hydel and nuclear.	2.23
2.	Such plans should be based on long term demand forecasts evolved by adopting a scenario approach which takes into account changing patterns of connected loads, the trends within different categories of consumers. the relationship between the GDP and demand for power and the progress achieved in demand management and conservation.	2.24
3.	This exercise should be carried out every three years by a Committee headed by a suitably senior officer or by a Member of the Planning Commission together with representatives of the related sectors of the Central Government such as Department of Power, Coal, Industries, Agriculture and Railways.	2.29
Annual and Medium term forecasts		
4.	Annual and Medium term forecasts (5-10 years) which quantify the national demand, for both peak and energy, that can be met from year to year should be prepared annually by a Standing Committee consisting of the Chairman, CEA, 5 Chairmen of the proposed REAs, 4 Chairmen of SEBs nominated by the Central Government and Advisers for Energy, Resources and Perspective Planning in the Planning Commission. These forecasts should replace the current system of Annual Power Surveys.	2.30
State-wise Forecasts		
5.	These forecasts should indicate the increased demand that it will be possible to meet in each State taking into account 'inter alia' the State's on contribution to power generation, its share of Central power, historical growth rates which should take into account socio-economic objectives such as redressing regional imbalances. These allocations should receive the endorsement of the Planning Commission, the Central Cabinet and the National Development Council.	2.31
6.	The plans for load growth in each State should be restricted to this additional capacity.	2.32
7.	In order to optimally utilise the available power load planning cells should be set up in each SEB. The growth and variability of the agricultural load will have to be given special weightage. These cells should work in close coordination with the planning groups in the REA and the CEA.	2.35, 2.41
Load Management & Conservation		
8.	For the industrial load, all States should adopt such measures as staggering off-days, high peak hour tariffs, timing of annual shut-downs for overhaul of major consuming industries so as to reduce seasonal and daily peak demand and flatten the load curve.	2.45
9.	An estimated 20% reduction in power usage in industry is feasible by adopting a wide range of conservation measures. Such savings should be encouraged by using a mix of fiscal incentives and penal tariffs.	2.46, 2.47
10.	In agriculture, rostering of loads, use of properly sized and efficient pumpsets, elimination of flat rate tariffs, and installation of efficient transformers and capacitors would reduce losses, conserve power and reduce peak demands.	2.49, 2.50, 2.51
11.	A Committee should be set up to examine ways of curbing the growing energy demands of commercial offices and hotels. Appropriate peak hour pricing of domestic and commercial power and enforcement of minimum standards of efficiency of domestic and office power consuming equipment would assist demand management and help conservation.	2.43, 2.53

		Para
12.	Power Conservation Committees should be set up in each State to draw up time bound programmes and set physical goals.	2.55
13.	For each of the major industries the concerned Development Councils should set up task forces on conservation to quantify the targets that each type of industry should aim at and suggest measures for achieving them.	2.55

CAPACITY PLANNING

Role of Central Generation and Transmission

14.	In order to minimise costs, additions to power generating and transmission capacity should be planned on a region-wise rather than a State-wise basis.	2.78
15.	To achieve this the Centre's role in power generation will need to be enlarged so as to achieve ownership of at least 45% of all generation capacity by 2000 A.D.	2.79
16.	The Centre should forthwith take steps to acquire the ownership of such EHV transmission lines and sub-stations as would enable it to operate the regional grid optimally.	2.80
17.	The nuclear power programme should be accelerated to attain an installed capacity of 5000 MW by 2000 A.D.	2.83

Organisational Changes

18.	To implement this enhanced role proposed for the Central Government two groups of bodies, the Regional Electricity Generating Corporations and the Regional Electricity Authorities should be set up.	2.84, 2.85

Centre-State Financial Transfers

19.	The increased investment by the Central Government in power generation will require a review of the Plan assistance to the States. This should be carried out by the Planning Commission.	2.86

Gestation periods of power project

20.	A 2 year period should be allowed for formulating thermal and nuclear projects inclusive of the time required for the issue of Government sanction.	2.91
21.	The construction and commissioning period of thermal and nuclear projects could be assumed to be 5 and 7 years respectively for planning purposes and between 9 to 11 years for hydel projects (inclusive of time for preparing the detailed project report).	2.92
22.	A thermal project should be assumed to be 'stabilised' i.e. available for operating at 80% plant availability 12 months after it has successfully completed its guarantee tests.	2.93
23.	The present practice of planning capacity to meet peak loads should continue.	2.94
24.	87.5% of hydel capacity, 64% of stabilised thermal capacity and 65 to 75% of nuclear capacity may be taken as being available for meeting peak loads. Thermal plants in the Eastern Region can be assumed to contribute at 59% of their rated capacity for peaking purposes.	2.95, 2.96, 2.98
25.	For energy availability calculations stabilised thermal plants should be assumed to have an all-India average plant load factor of 58%. The factors will vary from region to region.	2.101
26.	All hydel stations should in future be designed for meeting either diurnal and or seasonal peak loads and should be based on a 40% plant load factor.	2.102
27.	The C.E.A. should carry out a study on derating and retirement of old units, till then the current figure of 0.5% of installed capacity being phased out every year can be assumed for planning purposes.	2.104
28.	In place of the present deterministic approach to capacity planning, probability techniques should be used.	2.105

Para

29. Captive generation should be encouraged in the case of total energy systems and permitted in the case of highly power sensitive units like steel or artificial fibre plants, large scale consumers like aluminium and for collieries, based on using washery rejects. 2.107, 2.108, 2.109, 2.110

Private Sector Utilities

30. The present policy of permitting growth of private sector utilities only on a selective case by case basis should not be disturbed. 2.111

Transmission and Distribution (T&D)

31. Investment in T&D will need to be stepped up to take care of the backlog of the past and to restore the balance between generation and T&D capacities. 2.116

32. Generation capacity planning must be fully integrated with T&D planning so that both are optimised as a system. 2.121

33. System studies should be carried out to optimise planning of the T&D network and the software required for this will need to be developed on a continuing basis. These studies should be undertaken for rural electrification system as well as for urban complexes. 2.122, 2.123, 2.130

34. Adequate provision should be made for providing reactive compensation on transmission lines to reduce power losses. 2.124

35. Monitoring and information systems on the construction and operation of transmission system should be developed for the Central and State Governments by the CEA in the same way as has been done for the thermal generating units. 2.128

36. The planning groups in the CEA, and the SEBs should equip themselves to undertake systems studies. 2.131

37. Electricity Boards should install sufficient meters to enable an energy audit to be carried out and to monitor losses. 2.135

38. Priority should be given to reduction of both transmission and distribution losses over increases in generation capacity. 2.137

39. Diversion of agreed plan funds by SEBs/State Governments to other purposes should lead to a corresponding cuts in Central plan assistance. 2.139

40. As a guideline to capacity planning the following assumptions can be made regarding trends in T&D losses.

	Percentage of Loss
By 1982/83	18
1987/88	17
1992/93	16
2000/01	15

PROJECT FORMULATION

General

1. In order to prepare an optimal regional plan the Regional Electricity Authorities should have a shelf of detailed project reports (DPRs) of potential hydel, thermal and nuclear projects from which to choose. 3.18

2. Responsibility for funding and preparing DPRs for thermal and nuclear projects should be that of the owning and operating agencies but for major hydel projects the appropriate REA should provide funds. 3.19, 3.23

Major hydel projects

3. Project investment capabilities in the SEBs and organisation like WAPCOs should be strengthened and they should be provided with the latest equipment required for site investigation. 3.24

4 The output of engineering geologists will have to be increased. 3.24

5. To bring competent personnel into project investigation and motivate them, they should be given special allowances, improved welfare facilities and provided with full logistic support including helicopters and good telecommunication facilities. 3.27

		Para
6.	Investment decisions on hydel and other projects should be taken after evaluating all options based on DPRs, in relation to the region's long-term plan.	3.29
7.	The practice of estimating project costs at current prices should continue but the effect of inflation should be quantified when comparing actuals with estimates.	3.30
Small Hydel Projects		
8.	Micro hydels should be developed for meeting the power requirements of sparsely populated areas far away from major power projects.	3.31
9.	Measures for reducing the cost of small hydels should be examined.	3.32
10.	Separate divisions should be set up for concentrating on small hydel projects in those SEBs which have the potential for them.	3.34
Thermal Projects		
11.	A project should be regarded as complete only when it has satisfactorily completed the contractual period of operation at full load and is ready for commercial operation.	3.36
12.	While a period of 5 years has been recommended as the time that should be allowed for planning purposes for completing construction and commissioning of the thermal stations, SEB's should attempt to finish the job in 4 years or less.	3.37
13.	A 15-year coal production plan should be drawn up and linkages established from mining areas to power plants, building in some flexibility in the power plants to take care of unforeseen changes of linkages with specific mines.	3.39 3.40
Nuclear Projects		
14.	A separate corporation for the manufacture and supply of heavy water should be formed.	3.50
Transmission and Distribution (T&D)		
15.	Improvement of the data base for formulating T&D projects should be given high priority and specialised consultancy services should be sought for this purpose.	3.51

STANDARDIZATION

Thermal Stations		
16.	Standard lay-outs and schemes for 200/210 MW BHEL sets, sent to utility companies by BHEL, should be used for formulating new projects using this size of set.	3.57
17.	Similar standardisation should be carried out in regard to KWU designs of turbo generators, AVB boilers and instrumentation system in consultation with the manufacturers.	3.57 3.58
18.	Feed back systems should be set up to report regularly on field experience on such standard layouts and designs so that they can be continuously updated and at the same time advantage taken of new technological developments.	3.59
Hydel Stations		
19.	Standard modules for ancillary and auxiliary systems should be prepared by the CEA and CWC.	3.60
20.	Standard designs for low head bulb type turbines should be prepared.	3.61
21.	Civil foundations, structures and generating plant for installation in seismic zones are specialised areas of standardisation to which attention should be given.	3.62
Transmission and Distribution systems		
22.	Standards developed by the CEA for 400 KVA systems covering specifications and design parameters for sub-station equipment and line material should be adopted by SEBs and manufacturers.	3.63
23.	Similar standards should be developed for sub-station layouts, transmission line clearances, transmission line towers, protection schemes and instrumentation and accessories especially those made by small scale industries.	3.64

Para

24. Practices in regard to stub setting, tower erection, stringing conductors should be standardised. 3.64

Responsibility for Standardisation

25. The CEA should assume responsibility for drawing up and implementing a time bound programme in the field of standardisation and also for updating standards to keep pace with the advance of technology. 3.65 3.66

Appraisal

26. Preliminary appraisal of detailed project reports (DPRs) submitted by utilities should be carried out by the REAs. Final appraisal and sanction should continue to be done by the CEA and the Planning Commission. 3.67

PROJECT IMPLEMENTATION

27. Time consuming procedures for dealing with sanctions and inputs into projects which involve external agencies in the State and the Centre should be streamlined, substituting where possible decisions across the table for correspondence and file notings. The costs of delay in decision making should be quantified and conveyed to all internal and external agencies concerned with implementation of the Project. 3.69

28. The DPR should specify the requirements of staff and approval of the DPR should automatically be construed as sanction for the staff. 3.71

29 Inter-State water disputes if not resolved amongst the concerned States in 3 months, should, by law, be referred to an arbitrator to be appointed by the Central Government who should be required to submit his award in 3 months. Such an award should be made non-justiciable. 3.74

30. As an alternative the possibility of river and lake waters being declared a Central subject under a constitutional amendment may be given serious consideration. 3.74

31. Properly prepared resource based PERT charts should be made a pre-condition to the approval of DPRs and should be used as operating instruments for realistically scheduling projects and then keeping them on target. 3.76

32. The full cost of rehabilitation of displaced persons should be treated as a part of the project cost and the responsibility for rehabilitating displaced people in suitable productive and remunerative occupations should be taken on by the project authorities who should have a fully staffed multi-disciplinary cell for this purpose. 3.78

33. Except for providing overall supervision, co-ordination and checking the quality of work done, the owners of utilities should leave the execution of the projects entirely to contractors and undertake no work departmentally. 3.80

34. The CEA and CWC should encourage contractors who work on power projects to use time saving techniques and should help them in training their staff in the theory and practice of modern project construction techniques. 3.82

35. Work on detailed designs and engineering should be done in advance of the project being sanctioned to save time. 3.83

36. Tenders should only be invited from contractors who have proven capability and equipment and even in these cases the acceptance of lowest tender should not be mandatory. 3.84

37. Shortages of construction materials should be anticipated and stocks built up in good time. Special cells for planning the ordering and follow-up of contracted supplies should be set up. 3.85

38. State Governments should ensure that there is a regular flow of funds as planned in the Annual Plans from the State Governments to the State Electricity Boards. 3.86

39. The Railways should augment their stock of heavy duty wagons particularly in the 90 tonne to 130 tonne range. 3.87

40. A group should be set up to examine the clearance procedures required to be followed by SEBs and P&T for erecting transmission lines which run close to P&T lines and make recommendations both on expediting such clearances and on the equitable sharing of costs that are incurred in relocating P&T lines. 3.88

Para

EQUIPMENT FOR THE POWER INDUSTRY

Hydro-electric projects

41. Imports of large hydel turbo-generators should be permitted well in time if the gap between demand and indigenous supply cannot be bridged. An early decision should be taken on augmenting hydel plant manufacturnig capacity. 3.91

42. The number and technological capabilities of manufacturers of small hydel sets should be augmented. 3.93

43. For building low head bulb type turbines foreign collaboration should be permitted and specialised units set up for manufacturing these machines. 3.94

Thermal Plants

44. Manufacturers, especially local ones, must be made to give the highest priority to spares, components and sub-assemblies required to maximise utilisation of existing capacity even at the risk of loss of production of complete equipment. 3.99

45. The additional capacity that will be required to implement the larger power programme of the next two decades should be set up outside BHEL to encourage competition. If this cannot be done then BHEL should administratively move to the Deptt. of Power. 3.101, 3.102, 3.103

46. The indigenous capacity for manufacturing pressure parts for boilers and boiler auxiliaries, as also for manufacturing coal and ash handling plant, coal crushers and pulverizers will have to be augmented. 3.104, 3.105

Transmission and Distribution Equipment

47. Critical equipment which is not produced in adequate quantities and quality e.g. sophisticated protection systems and reactive power compensation equipment, should be freely imported. 3.108

48. The capacity for manufacturing transmission line towers will need to be augmented and this should be done largely through the small scale sector. 3.109

49. There is need for substantial improvement in the quality of equipment like distribution and power transformers, LT and HT capacitors, switches, circuit-breakers and fuses. CEA, ISI and SEBs should provide technical assistance to manufacturers in ensuring that equipment is produced to meet the approved standards. 3.110

50. Additional capacity will need to be created to meet the requirements of such items as H.T. insulators and ACSR conductors. 200 KVA and 400 KVA bushings and insulators and data acquisition and control equipment will need to be imported till such time as indigenous capacity comes on stream. 3.111 to 3.114

51. Steps should be taken by the manufacturers to ensure that equipment is supplied according to the agreed and predetermined sequence. 3.115

Quality Control

52. Bought out equipment must be carefully quality controlled by the main manufacturer. If it does not meet the specifications, imports by the main manufacturer should be permitted. 3.117

53. Hydel units should be fully assembled in the shop before despatch to the project site. 3.119

54. The quality of instrumentation and auxiliary control equipment like conductors, relays, switches etc. procured from indigenous sources needs to be improved. 3.120, 3.121

55. The quality assurance systems of the main manufacturers also requires substantial upgradation as also those of the utilities. 3.123

56. The proposed Power Design & Consultancy Corporation (PDCC) should set up a quality control wing to carry out quality control of equipment on behalf of the owners. 3.125

Consultancy Services

57. A new publie sector organisation, the Project Design & Consultancy Corporation, should be set up with the nucleus being provided by the staff of the CEA and CWC presently engaged in this work. With this the CEA and CWC should progressively give up consultancy services beginning with thermal projects and eventually hydel projects. 3.129

Para

58. The Water and Power Development (Consultancy) Services (India) Ltd. (WAPCOS) should become a part of the PDCC and help to equip it to provide full consultancy on hydel projects. 3.131

59. The expertise available in IITs and other academic institutions should be sought on solving complex problems relating to design of load despatch centres and 'on-line' computer systems. 3.133

60. Consultancy services should cover the entire spectrum of project formulation and implementation activities. 3.137

61. Selection of consultants should not be done simply on a 'lowest tender' basis. Minimum fees should be prescribed and choice of consultants governed by quality of advice and services offered. 3.138

62. Manufacturers of equipment should not be awarded turnkey jobs for complete power plants. 3.139

63. The owner must assume final responsibility for the performance of the contract and develop sufficient inhouse capability to assess the quality of the work done by his consultants. 3.140

OPERATION AND MAINTENANCE (O & M)

Plant availability and load factors

1. Plant availability for operating thermal units should be assumed to be 80% on an average. 4.6

2. Plant load factors of 58% should be considered as the norm for the system. 4.7

Interaction between utility companies and equipment manufacturers

3. A Committee should be set up composed of Member (Thermal), CEA as Chairman and senior representatives of utilities and manufacturers as Members to advise on, modifications to be made in existing equipment and evaluating new designs of equipment to be manufactured in the country. 4.28

4. Manufacturers should prepare expeditiously comprehensive manuals for erection, operation and maintenance of their equipment for use by various levels of plant personnel. 4.29

Maintenance Measures

The recommendations of Reports of earlier Committees e.g. the Kulkarni Committee and the VGB Committee should be vigorously and meticulously implemented. 4.39

6. While maintaining the improvement in the time schedules for planned maintenance the quality of the work done requires to be improved. 4.40

7. Short outages, especially at week-ends, should be planned to enable relatively minor problems like steam leaks to be attended to. 4.41

8. Detailed data about forced outages during the proceeding years should be analysed to enable an effective planned maintenance programme to be formulated by the plant authorities. 4.42

9. The CEA should take follow-up action to find out the efficacy of the preventive maintenance manual prepared by BHEL. 4.43

10. SEBs should establish independent, internal, multi-disciplinary audit groups to report independently to the Chief Executive on the quality and comprehensiveness of the planned maintenance operations. 4.44

11. Specialised maintenance task forces should be set up at all power stations and be given rigorous training in maintenance systems. 4.45

12. The CEA should arrange exchange visits between engineers, specialists and skilled workmen of different plants using similar equipment or coal. Comprehensive reports on maintenance activities and problems should be prepared and widely circulated in the CEA, and all utilities in the country down to the shop floor. 4.46

Spares

13. For equipment which is becoming obsolete, either life time spares should be ordered out or, if the numbers are large and there is adequate time, organisations like BHEL or ILK could make these items themselves or assist local manufacturers in producing them. 4.48

		Para
14.	Local manufacturers of equipment must take the full responsibility for timely availability of spares both local and imported. Manufacture of spares should receive priority over main equipment.	4.49
15.	Utilities should give manufacturers the lead times specified when ordering spares.	4.50
16.	A common pool of major spares should be formed for equipment of similar design and capacity and the CEA, with the help of utilities and manufacturers, should take steps to organise their production.	4.51
17.	Project authorities should provide at least 3% of the equipment cost for the supply of start-up and essential spares in the project proposal and these should be ordered along with main equipment.	4.52

Training of Operation & Maintenance Personnel

18.	A special group should be appointed by the Department of Power to study the shortcomings in the operations of the four regional Power Station Personnel Training Institutes and recommend measures for using them fully.	4.57
19.	Additional training institutes to cater to the expected gap between demand and supply of engineers, technicians and operators should be started.	4.58
20.	Special training courses for maintenance personnel at the officer level should be started using the resources of regional engineering colleges. Consultancy inputs should be sought from IITs for drawing up the curricula in specialised areas.	4.60
21.	Operator/technician training courses should be augmented to cater to training staff for maintenance work. Training schools for this purpose should be set up by the larger SEBs for themselves or if available local ITI's can be used. In the case of smaller Boards two or three of them could get together to start up such schools.	4.61
22.	Short term courses in specific areas e.g. power station chemistry, maintenance planning techniques, currently being conducted by the CEA, should be held more frequently.	4.62
23.	SEBs and other utility operators should train personnel for 1½ years prior to their being required for operating a plant by being taught theoretical principles and then given practical training in the manufacturer's works and his test facilities and in such operating stations as are using his equipment.	4.63
24.	Persons so trained should, when they return, be put on jobs for which they have been trained and not disturbed for at least five years.	4.63
25.	Several more simulator training centres need to be established.	4.64
26.	The coordination and follow up of training activity for trainees in SEBs and other utilities should be the responsibility of training officers in each plant. Trainees should be given a mix of theoretical and practical training, if possible, on redundant plant.	4.65, 4.66
27.	The CEA and REA should assume the responsibility for arranging tests for operators of power plant and issuing certificates of competency on a national basis. A similar practice should be adopted with regard to maintenance personnel. Only such certified personnel should be permitted to operate and maintain power plants.	4.67

Industrial relations and staffing

28.	State Governments should take firm action in backing the top management of the SEBs in dealing with tactics like go-slows and curbing, indiscipline, corruption and inter-union rivalries which affect the smooth and efficient operation of the plant.	4.68
29.	The management should take the initiative in evolving a more participative approach to problem solving, setting up objective mechanisms for awarding rewards and penalties and creating an 'esprit de corps'.	4.68
30.	Fresh recruitment should be stopped till wastage, separations or growth absorbs the surplus staff as worked out according to the norms prescribed by the Power Economy Committee (1971) up dated for the new plants. These norms should be reviewed from time to time to take into account technological changes.	4.69

		Para
31.	Incentives should be given to O&M staff for exceeding pre-set norms of plant availability.	4.69

Partial unavailability

32.	About 1000 M. W. of existing capacity is unavailable in some of the newer plants due to defects which can be rectified quickly and with marginal investments. Steps should be immediately taken to bring this capacity back on stream using the assistance of consultants and manufacturers.	4.76, 4.77
33.	Another 1285 M. W. can be added to capacity by removing constraints which will take somewhat longer to remove and similar measures in this regard should be taken expeditiously.	4.79, 4.80

Coal

34.	Coal washeries for up-grading coal should be put up if found economically viable and should be accompanied by the setting up of pit head power plants to make use of washery rejects.	4.83
35.	Collieries should blend coal at the loading points, start putting up mechanical shale separating units, crush coal to the correct size and in the meantime set up facilities for manually removing shale and stones.	4.85
36.	Station authorities should monitor coal despatches and they together with representatives of coal companies should jointly check receipts of coal for quality and quantity at the power stations.	4.85
37.	Stations which have mechanical coal blending facilities should accumulate stocks of coal till these facilities can be utilised. Stations without blending facilities should try using bull-dozers to even out fluctuations in quality between different deliveries.	4.86
38.	The systems and techniques adopted by the Renusagar Thermal Power Station for dealing with the coal problem should be emulated.	4.87
39.	Future power stations should be designed to burn high ash coals and made as flexible as possible.	4.88
40.	To build up coal stocks greater attention should be paid to using unit trains, sea and water transport. Pipe-line transport should be tried out on an experimental basis.	4.90

Rehabilitation and Replacement of Old Plants

41.	Plants which have been derated but can be restored to full capacity because of deficiencies which can be corrected should be attended to expeditiously. Multi-disciplinary groups should be put on this task including the manufacturer's representatives.	4.92
42.	Units which are uneconomical to run should be replaced. CEA should estimate the extent of such replacements over the next 5 years and allow for them in planning additions to capacity.	4.93, 4.94

Research and Development

43.	'Grass roots' R&D intended to deal with the day to day practical problems of thermal power plants operation should be undertaken in close collaboration with academic and research institutions like the IITs.	4.96

Hydel Plants

44.	Although hydel plants have generally caused less problems than thermal units the quality control in the case of indigenous equipment especially with respect to welding, lubrication, insulation and cooling systems requires to be improved.	4.99
45.	Specialised training is also required to be given to hydel plant operators.	4.100

Nuclear Plants

46.	Many of the operation and maintenance procedures and practices adopted by nuclear power stations including the training of personnel, standards of house keeping are sound and can be applied to thermal stations. The Department of Atomic Energy should help to set up the necessary training inputs.	4.104

Para

47. There should be an independent body, outside the Department of Atomic Energy, to lay down and monitor observance of minimum standards for siting, design, construction, operation, maintenance and safety of nuclear power plants on the lines of the Nuclear Regulatory Commission.

Transmission and Distribution

48. T&D losses should be reduced by metering power flows at all stages of voltage change from generation down to LT distribution, identifying sections where excessive losses are occurring and taking corrective action. Divisional and assistant engineers should be held accountable for losses in excess of predetermined norms and vigilance squads set up to detect thefts of power and equipment. 4.111

49. The other recommendations of the Power Economy Committee 1971 for improving the T&D system also require to be expeditiously implemented. The CEA and REAs should initiate and coordinate action in this regard. 4.115

Management Information Systems (MIS) and Data Base

50. The MIS introduced for thermal generation system should be extended to the T&D and hydel generation system also. 4.119

51. Data acquisition systems should become a compulsory part of all power plant equipment so as to strengthen the data base. 4.120

Measures to ensure implementation of recommendations

52. A Standing Committee of top level officers of utilities responsible for operations and maintenance of power systems should be constituted and meetings convened at regular intervals to review progress, exchange information, carry out joint studies etc. 4.121

53. The CEA should extend the coverage of information published to include data on other parameters of plant efficiency, T&D losses, water levels in lakes, tariffs etc. 4.122

54. The CEA, the Finance Ministry and The Planning Commission should make grant of central assistance, clearance of projects conditional on satisfactory progress being made in implementing such of these recommendations as are accepted by Government. 4.124

Take over of Power Stations/State Electricity Boards by the Central Government

55. Only if a State Government requests that a power stations or a State Electricity Board should be run by the Centre, should the Centre accept, subject to its capability of providing the requisite level of managerial inputs. 4.125

FINANCE, FINANCIAL MANAGEMENT AND TARIFFS

Finance

1. Over the longer term the utility companies should aim at generating internally about 50% of the resources they need for their expansion. 5.5

Financial Management

2. The objectives of tariff and financial policies should be clearly set out and incorporated in the Electricity Act. 5.47

3. The rate of return, to be calculated according to a recommended methodology should be 15% on the assumption that the average rate of interest on loans to the SEB is 7%. If the borrowing rate is increased the return should go up correspondingly. 5.52

4. Interest on works-in-progress should be debited to the revenue account and not capitalised. 5.54

5. Government should lend to SEBs at ½% above the rate at which they themselves borrow loans from the open market maturing over periods of 10-12 years. 5.55

6. The contingent interest liabilities of Boards should be converted into interest bearing loans. 5.56

7. The present provisions for depreciation should be examined in depth by a Committee to be set up by the CEA. 5.57

Para

8. Electricity duties charged by State Governments should not be included in the calculation of the rate of return of SEBs. 5.58

9. The question of merging the excise duty on electricity with tariffs should be referred to the next Finance Commission. 5.59

10. Electricity Boards should be statutorily exempted from income-tax. 5.61

Principles of Tariff Structure

11. No single class of consumers should be charged by the SEB a rate less than the 'cost' of providing them this power, i.e. at most the 15% rate of return could be waived. 5.65

12. If the State Government feels that a particular consumer group needs special subsidies which require the SEB to sell power below cost, specific written instructions should be issued to the Board and a subsidy equivalent to the loss that the Board will suffer given to the Board and provided for as a separate item in the State Budget. 5.66

13. Groups which could qualify for such subsidies are small and marginal farmers, landless labourers and slum dwellers. 5.67

14. Subsidies for electrifying remote, sparsely populated areas should be gradually tapered off as demand picks up. Steps should be taken to see that subsidies do actually reach the intended beneficiaries. 5.67, 5.68

15. Peak hour tariffs should reflect the cost of incremental additions to capacity. 5.69(a)

16. The capacity of the consumer to pay should be taken into accounting fixing tariffs. 5.69(b)

17. For bulk consumers who take loads of 1 MW and above time differentiating meters should be provided. 5.70

18. Domestic and commercial consumers should be charged inverted block tariffs, i.e. rates should increase as the quantum of power taken increases. 5.71

19. Tariffs should encourage conservation by being raised to levels at which investment and effort in conservation become economically worthwhile. 5.72

20. Agriculturists and rural consumers as a class do not need subsidies and subsidies should be confined to the rural and urban poor. 5.73

21. There is no case for subsidising power intensive industries and they should be charged at least the full cost of power plus the prescribed return. 5.75

22. Interstate competition by States to attract new industries to their States by offering concessional tariffs should cease. No subsidies should be given to industries except as a special subvention from the State Government to the Board and voted through the budget. 5.77

23. Tariff rates required to earn the specified rate of return should be based on the Boards reaching prescribed minimum norms of technical and commercial efficiency. 5.78

24. To prescribe such norms a Bureau of Electricity Costs and Prices (BECP) should be set up as statutory body. Its Role should be advisory. 5.79

25. The BECP should also advise SEBs on tariff policies. 5.80

26. Flat rate tariffs should be discontinued and replaced by metered supplies. 5.81

27. The Commercial wings of the SEBs will need to be greatly strengthened. 5.82

28. The CEA should evolve detailed guide lines and proformae on how the accounts of the SEBs and utility companies should be kept and compliance with these ensured by making suitable changes in the Electricity Act. 5.83

Inter-state Tariffs

29. All bulk power bought and sold by a State should be through the proposed Regional Electricity Authorities and there should be no bilateral exchanges of power between States. 5.88

Para

30. Uniform, rational and equitable tariff policies for inter-State exchange of power should be evolved which will encourage inter-State power flows. 5.89 to 5.93

Power from Centrally-owned generation stations

31. Allocation of power from Central Stations whether thermal, hydel or nuclear should be made on the basis of the total pool of Central power in each region and not from each station. 5.95

32. Central power should be sold at a uniform price throughout the country to SEBs. Prices should be based on a 15% return on capital employed as in the case of SEBs subject to the same conditions of minimum performance norms being achieved. 5.96

Private Sector Utilities

33. Subject to their achieving the prescribed minimum norms private sector utilities should be allowed to charge tariffs on the same basis as applicable to other goods and services which are sold at administered prices i.e. a 12-14% return after tax on share-holders' funds. 5.97, 5.98

RURAL ELECTRIFICATION

Planning and Project Formulation

1. Given the rising trend of petroleum prices the growth of rural electrification should be based on the assumption that there will be no addition to the number of diesel sets beyond 1990 and that by 2000 AD all pumpsets will work on conventionally generated power or non-conventional renewable energy resources. 6.71

2. By 1994-95 all villages in the nation should be targetted to be electrified. Simultaneously household electrification should be given much higher priority to improve the quality of life and save kerosene. The goal should be to electrify all households by 2000 AD. 6.72

3. Rural electrification schemes should be formulated as a part of a total distribution system and not in isolation and optimisation studies should be carried out to minimise investment. 6.73

4. Load growth should not be permitted to grow beyond levels which cannot be adequately serviced. 6.74

5. Rural electrification programmes should be developed on a block by block basis and besides covering agricultural pumpsets and household lighting should be-dovetailed into the integrated rural development plants covering village, cottage and small scale industries. 6.75

Street Lighting

6. Street lighting dues can be paid directly to SEBs, agents or rural cooperative and deducted from the grants paid by the State Government to the concerned local bodies. 6.41

7. In planning and implementing rural electrification programmes special care must be taken to see that the smaller farmers share fully in the benefits. 6.76

8. Procedures for issuing of bank guarantees, clearances from Ground Water Boards etc. should be simplified and mobile units set up for providing a single point clearance of all formalities required to sanction loans to small farmers. 6.76

9. Schemes such as giving a light point free to small farmers and landless labourers as is done in Karnataka should be introduced by other States. 6.77

10. Special emphasis should be given to the development of micro and mini-hydel generation schemes. These and non-conventional energy sources should be developed in rural areas where distance and load densities make conventional RE systems uneconomic. 6.78

Data Base

11. The data base on all matters concerning RE should be greatly improved. The SEBs, and REC should set up systems which report relevant information regularly and key information on RE should be included in the National Sample Surveys. PEO and the REC should carry out studies on the flow of benefits of RE schemes to different income groups in rural areas. 6.82

Technical Modifications

		Para
12.	Special programmes should be implemented to improve the quality of supply to rural consumers by provision of capacitors, small size distribution transformers etc.	6.83
13.	The ISI should prescribe minimum standards of efficiency for pumpsets and SEBs and REC should have field level technical advisory bodies to see that farmers are properly advised on sizes and types of set. Banks and other institutions should give loans for purchasing only such pumpsets as conform to these minimum standards.	6.84

Rural Electrification Corporation and other Financial Institutions

14.	The REC should arrange special courses and training programmes for improving the project formulation and implementation capabilities of the less developed States.	6.85
15.	The REC should fund schemes for micro/mini hydels and pilot demonstration schemes for development of non-conventional renewable energy resources.	6.86
16.	The REC should develop schemes for encouraging household electrification.	6.87
17.	The REC should not fund system improvement schemes. These should be funded by the SEBs themselves except where modifications to REC schemes have to be made on account of unforeseen factors.	6.55
18.	Other financial institutions should also devote more attention to helping backward States to absorb more loan funds for rural electrification.	6.88

Organisation

19.	Specialised RE groups should be set up at subdivisional, divisional, zonal and Board levels by SEBs to ensure that RE gets concentrated attention.	6.89
20.	Financial institutions in the rural areas as well as agencies set up to help the small entrepreneur such as District Industries Centres and Small Industries Service Institutes should provide the training input and seed money to get RE 'agents' started in business.	6.90, 6.91

ORGANISATION AND MANAGEMENT

Structural Changes

1.	To implement the recommendation that 45% of total generation should be in the Central Sector by 2000 A.D., five Regional Electricity Generating Corporations (REGCs) should be set up to construct and operate Centrally owned thermal and hydel plants.	7.67
2.	To plan the development of the regional grid and operate it in an integrated way, Regional Electricity Authorities (REAs) should be set up as statutory bodies. The REAs should be administratively under the CEA.	7.69
3.	The CEA should give up consultancy work and concentrate on the policy, planning, managerial, personnel, research, commercial, financial and coordination requirements of the power industry. It should help the growth of consultants in the public and private sector, improve their technical and professional skills by organising training inputs and certify their suitability to bid for consultancy assignments. It should function as an appellate body in case of disputes.	7.70, 7.71 & 3.131
4.	The CEA should not function as the Secretariat of the Deptt. of Power.	7.72
5.	A full fledged public sector consultancy organisation should be formed—the Power Design and Consultancy Corporation (PDCC)—to take over the consultancy work currently being done by the CEA and later on by CWC and WAPCOS.	7.74
6.	The PDCC should be equipped to provide the full range of consultancy services required by thermal and hydel plants and the T&D system. It should also undertake quality control of equipment on behalf of owners of the utilities.	7.74 to 7.78
7.	Steps should be taken to prevent the PDCC from monopolising all work in these fields.	7.75

		Para
8.	A Nuclear Power Corporation should be set up to construct and operate nuclear power stations.	7.80
9.	The DVC should be merged with the regional REGC after paying West Bengal and Bihar compensation for their shares.	7.81
10.	SEBs and not Government Departments should be responsible for constructing and operating all civil and mechanical facilities on hydel/multipurpose projects up stream of the power house and the dam except those only required for the irrigation system.	7.83
11.	Those States which have departmentally run power systems should set up autonomous electricity boards.	7.84
12.	The North Eastern States and the North Eastern Council (NEC) with the exception of Assam, should concentrate on mini and micro hydel projects, leaving large projects to the local REGC.	7.84
13.	The Union Territories of Goa and Pondicherry should also set up their own Boards.	7.85
Internal Structuring of Organisations in the Power Industry		
14.	Restructuring should be aimed at a clear demarcation of responsibilities and powers of individuals so that centres of accountability can be identified, ensuring reasonable spans of control, and elevation of important staff functions like personnel, commercial, management services to Member/Director level or one level below.	7.87 to 7.90
15.	Staff and line functions should be clearly distinguished.	7.91
16.	Cadres should be created for a wide range of technical and non-technical functions.	7.92
State Electricity Boards		
17.	The larger SEBs should have a full-time Chairman and 6 full-time and 5 part-time members and the Electricity Act should be suitably modified to allow this.	7.94
18.	The Chairman, Members and General Managers should have staff groups to assist them in selected areas where specialised inputs are required.	7.95 to 7.98
19.	The distribution function should be highly decentralised with the General Managers in charge of zones being treated as profit centres and they in turn delegating powers to divisional and sub-divisional managers who would be held accountable for results.	7.99
20.	The RE programme should be supported by specialised staff at levels from the Board down to the zones, divisions and sub-divisions.	7.100
21.	Of the part-time Members on the SEBs, two should be Government representatives, one should be the Member in charge of planning and operations the concerned REA and two should be eminent professionals in areas where the Board needs advice.	7.101
22.	Boards should develop sound management information systems based on advice from specialised consultants.	7.102
Regional Electricity Generating Corporations		
23.	The structure of the Boards of the REGCs should be similar to the SEBs except that a Member for distribution is not needed.	7.103
24.	The operations and planning Member of the REA should be an ex-officio part-time member of the Board. Two other distinguished professionals should be appointed as part-time Members.	7.103
Rural Electrification		
25.	Where they are seen to be working satisfactorily, rural cooperatives should be set up for the bulk purchase and sale of power and operation maintenance of the rural electrification system.	7.108

		Para
26.	Where they are not successful the experiment of appointing entrepreneurs as 'agents' for a few villages who do the same work as RE cooperatives on a smaller scale, under the supervision of the SEBs should be tried out.	7.108, 6.90

Regional Electricity Authorities

27.	The REA should have a Chairman and 4 full-time Members, all appointed by the Central Government.	7.110
28.	The REA should have the Chief Executives of all the SEBs, REGC and any other utilities in the region as its part-time Members.	7.111
29.	Regular regional meetings of the various functional heads of the REGC, the REA, the SEBs and any other utility in the region should be organised by the concerned REA Member to exchange information and discuss policies and problems.	7.112
30.	The REA should publish a regular bulletin, on the lines of the monthly review published by the CEA dealing in depth with various aspects of the operation and future prospects of the regional power system.	7.113
31.	In case of disputes between constituent utilities of the REA on issues like power flows, tariffs, power planning the final appellate authority by statute should be the CEA. Such disputes should be made non-justiciable.	7.113

Central Electricity Authority (CEA)

32.	The CEA should have a Chairman and 8 full-time Members. The existing post of Member (Operations and Monitoring) should be abolished and posts for Members in charge of Planning, Personnel and Research and Development created. The 5 Chairmen of the REAs should be part-time Members of the CEA.	7.114, 7.115
33.	To meet the new challenges that will face it the CEA will need to induct a large number of high level specialists and relatively few supporting staff.	7.121
34.	Each Member should be assisted by at least two Chief Engineers.	7.123
35.	There should be no fresh recruitment to permanent posts by the CEA except at the clerical/class IV level. The senior posts should be filled as a rule, either by internal promotion or by deputationists from the SEBs, REGCs and REAs except in the case of a few specialised disciplines like finance and personnel where direct recruitment should be permitted.	7.126
36.	Other than the above, all fresh recruitment to the REA/CEA cadre should be done in the REAs.	7.127
37.	The terms and conditions of service of the REA and CEA officers should be delinked from those of other central technical services and substantially improved.	7.128

PERSONNEL POLICIES

38.	Managers should be encouraged to exercise delegated authority, streamline cumbersome procedures, and reduce paper work so as to get quick results.	7.131
39.	The appraisal and promotional policies of all the public sector and Government agencies dealing with power have to be modified to bring in much greater emphasis on promotion based on merit.	7.133, 7.157
40.	In order to encourage mobility between organisations like CEA, REAs, REGCs, and SEBs they should be staffed by officers with broadly similar experience, qualification and back-grounds.	7.137
41	The job specification drawn up for top posts in these organisations should lay stress on managerial qualities rather than on narrow specialisation.	7.138

Selection of Chairman and Members of REA & CEA

42.	The guidelines and conventions regarding filling of post in central public sector companies adopted by the Public Enterprises Selection Board (PESB) should be adopted for filling up top level posts in the CEA, REAs, REGC's and SEB's.	7.139 & 7.140
43.	The Selection Boards for the posts of Chairmen and Members of the CEA and REAs should be as suggested in para 7.139.	7.139

Selection of Chairmen and Members of SEBs

44. Similar procedures and conventions should be followed in filling up the posts of Chairmen and Members of SEBs and the Selection Boards should be established as recommended in para 7.141 & 7.142. 7.140 to 7.142

45. These changes in the selection procedures for the SEBs should be incorporated into the Electricity Act. 7.143

46. The tenure of the Chairman and Members of the Board should be at least 3 and preferably 5 years. 7.144

47. If the State Government wishes to terminate the appointment of a full-time Member or Chairman of an SEB before he completes his term of office, the Government should consult the appropriate Selection Committee. In case there is a difference of view the reasons for such termination should be tabled on the floor of the Legislature. 7.145

Manpower Planning

48. Recruitment and training inputs into the power industry should be prepared on the basis of a 10 year man-power plan updated from year to year. 7.149

Training

49. Substantial augmentation of training facilities at all levels will be required if the training inputs required are to be satisfactorily met. 7.152

50. Training managers should not be people who are considered unsuitable for appointments elsewhere but should be drawn from amongst the abler managers. They should be given a special training and allowances so as to attract good men. 7.153

51. The brighter and more promising officers should be sent to training programmes and where possible as a preparation for promotion to more senior positions. 7.154

Fixation of work norms

52. The extent of over-staffing of SEBs should be quantified by establishing work norms in consultation with expert bodies such as the National Productivity Council or the National Institute of Training in Industrial Engineering. 7.159

Relationship between Governments and their utilities

54. The role of Government vis-a-vis the Board's of utilities should be clearly defined and should be confined to appointments of Chairmen and Board Members, approval of capital expenditure over certain limits, approval of annual budgets in physical and financial terms and annual and long-term plans. 7.163

55. Government should receive periodic reports on progress in relation to budget and plans and intervene only when there are major departures. Policy directives in regard to subsidies, allocations of power etc. should be communicated as written instructions.

56. Government nominees should not look upon themselves as spokesmen of Government when they sit as Board Members of SEBs. 7.164

Delegation of Powers

57. Power should be delegated to the extent possible retaining just sufficient checks to ensure there is no misuse. Unless there is a clear 'prima facie' case of 'malafides' occasional errors of judgment should not lead to managers who exercise such powers being penalised. 7.166, 7.167

Materials Management

58. The materials management system of the utilities especially the SEBs requires to be completely overhauled and for this purpose the services of specialised consultants should be sought. 7.168

All India Service of Power Engineers

59. The concept of an All-India Service of Power Engineers should not be accepted in its entirety. 7.176

60. There should be a common entrance exam at the Class I level for all utilities and the REA's at the State, Regional and National level. 7.176

61. A minimum of 40% of the successful candidates should be taken from outside the State in the case of SEBs and outside the region in the case of REAs. 7.177

Selection of Chairmen and Members of SEBs

44. Similar procedures and conventions should be followed in filling up the posts of Chairmen and Members of SEBs and the Selection Boards should be established as recommended in para 7.141 & 7.142. 7.140 to 7.142

45. These changes in the selection procedures for the SEBs should be incorporated into the Electricity Act. 7.143

46. The tenure of the Chairman and Members of the Board should be at least 3 and preferably 5 years. 7.144

47. If the State Government wishes to terminate the appointment of a full-time Member or Chairman of an SEB before he completes his term of office, the Government should consult the appropriate Selection Committee. In case there is a difference of view the reasons for such termination should be tabled on the floor of the Legislature. 7.145

Manpower Planning

48. Recruitment and training inputs into the power industry should be prepared on the basis of a 10 year man-power plan updated from year to year. 7.149

Training

49. Substantial augmentation of training facilities at all levels will be required if the training inputs required are to be satisfactorily met. 7.152

50. Training managers should not be people who are considered unsuitable for appointments elsewhere but should be drawn from amongst the abler managers. They should be given a special training and allowances so as to attract good men. 7.153

51. The brighter and more promising officers should be sent to training programmes and where possible as a preparation for promotion to more senior positions. 7.154

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61. A minimum of 40% of the successful candidates should be taken from outside the State in the case of SEBs and outside the region in the case of REAs. 7.177

62. An All-India pool of senior managers should be formed on the basis of selection from officers at the level of Superintending Engineers and above. This pool should be the normal source of filling posts of Chief Engineers, Members, Directors and Chairmen of SEB's, CEA, REAs and REGC's. 7.178

63. Selection of this pool should be done by a Standing Empanelment Committee. 7.179

64. The CEA should fix guidelines for categorising posts, lay down minimum terms and conditions of pay, perquisites and other facilities and standardise recruitment rules and promotional policies. 7.181

Consumer Relations

64. The State Electricity Consultative Councils (SECCs) and the Local Advisory Committees should be serviced by independent full-time Secretariats responsible to the Chief Secretary and the local District Collector respectively. 7.187

65. A wider range of consumer protection interests could be nominated to the Council. 7.187

66. In a situation of resource scarcity there has to be a trade-off between a higher quality of service to existing consumers and non-consumers getting access to power.

67. Rating Committees and Tribunals for settling disputes between consumers and SEB's are not recommended. 7.190, 7.191

68. SEBs and utilities should publish detailed information required to keep consumers fully informed about their performance, progress and future prospects. The proformae for this could be produced by SECC and LACs. 7.192

69. Consumer counselling counters should be set up at divisional and sub-divisional offices and printed booklets published on the procedures for getting connections and information on tariffs, safety regulations etc. 7.193

70. Payment of compensation by SEBs to consumers who suffer losses due to failure or poor quality of power supply is not considered to be a practical proposition. 7.194

RESEARCH AND DEVELOPMENT

State Electricity Boards

1. The absence of an 'R&D culture' in SEBs is the biggest obstacle to faster progress in the growth and utilisation of research and development inputs in the power industry and steps must be taken to bring about a basic attitudinal change. 8.36

2. A Member in charge of R&D should be appointed in the CEA and supported by senior officers in charge of major areas of R&D activity. 8.37, 7.115

3. Each SEB should have a full-time Chief Engineer (CE) as head of the R&D Division and he should be assisted by a carefully selected, full-time, multi-disciplinary group of scientists and technologists. Where possible this team should be composed of people already within the undertaking and their special skills and knowledge should be appropriately reflected in their status. 8.38

4. SEBs should eventually aim at spending about 1% of their turnover equally on building up facilities and on research staff. 8.39

5. Efforts should be first concentrated on solving problems which are responsible for the current low levels of efficiency of thermal plants and reducing high T&D losses. 8.40

6. Procedures for sanctioning funds and facilities should be simplified and authority delegated to the CE and his accounts officer to spend money within the sanctioned budget on approved projects. 8.41

7. Academic and research institutions should evolve a series of basic training and refresher courses for R&D personnel. 8.42

8. A few academic institutions should be developed as centres of excellence, each in a different scientific and technological area. 8.42

Manufacturing Units

9. An expert group should be set up to examine how the pace of in-house R&D in the large scale manufacturing sector can be speeded up. 8.46

Para

10. The small scale sector should be assisted in improving the quality and reliability of its products. The areas of assistance could include provision of improved standard designs for products such as motors, transformers, relays and help in designing production tools, and fixtures, products like micro switches and improvements in insulation systems. 8.47, 8.48

11. Testing facilities for the large, medium and especially the small scale manufacturing sector need to be augmented and improved. A three-tier testing organisation under the CPRI should be set up, the 2nd tier comprising centrally funded regional laboratories and the third 'grass roots' tier consisting of testing laboratories in SEBs large and medium scale corporations and industrial estates which serve a group of small scale industries making products, components and equipment for the power sector. 8.49

12. There should be close interaction between these 'grass roots' laboratories and the next tier of the structure and with the local, State and regional level engineering and research institutions by inter-change of personnel within and between tiers. 8.50

Apex body for R&D in Power

13. To evolve policies, strategies and plans for R&D in the power industry and to co-ordinate them, an apex body to be termed the National Council for R&D on power should be set up. 8.51

14. The Council should function through eight Standing Committees for each of the following subjects :—
    (a) Testing, certification and standardisation;
    (b) Product, process and technology development;
    (c) R&D training and man-power development;
    (d) Generation;
    (e) Power systems;
    (f) Non-conventional energy sources;
    (g) Conservation technologies;
    (h) Information/documentation. 8.52

15. The areas on which R&D effort should be focussed are those in which India has a distinctive interest and/or where external knowhow is not available. 8.53

16. The Council should consist of the Secretary, Department of Power, Government of India or the Chairman, CEA, as Chairman. The Members should be the Secretaries of the Departments of Electronics, Science and Technology, the Chairmen of the 8 Standing Committees, the Director General, Technical Development, other eminent people connected with different aspects of the power sector and representatives of the Ministry of Finance and Planning Commission. The Member (R&D) of the CEA should be the Council's Member-Secretary. 8.62

17. This Committee would be the high level channel of communication in R&D on power between India and other countries. 8.63

Alternative Energy Sources

Solar Energy

18. Solar energy sources (inclusive of windmills) need to be developed rapidly because of the high potential for developing them in India and the nature of the demand for power and energy especially in the rural areas. 8.64

19. To promote rapid development of solar energy, a Solar Energy Commission on the lines of the Electronic Commission should be set up. 8.67

Magneto-hydro Dynamics (MHD)

20. Subject to the preliminary trials establishing its commercial/economic viability, the MHD programme for direct conversion of heat into power should continue. 8.68

Nuclear Power

21. Work on improving the performance of the pressurised heavy water reactors and the development of fast breeder reactors should continue. 8.77

Fusion

22. A "State of the Art" survey should be carried out and the long and short-term, technological and financial implications of alternative strategies for entering into fusion R&D should be worked out. 8.78

APPENDIX 1

Statement indicating the membership and the Terms of Reference of the Panels of the Committee on Power

Panel I—Power Planning

Membership	*Terms of Reference*
Convenor Dr. N. B. Prasad, Secretary, Deptt. of Power *Members* 1. Sh. T. R. Satish Chandran, Advisor (Energy), Planning Commission. 2. Smt. Otima Bordia Joint Secretary, Department of Power. 3. Sh. A. N. Singh, Member (H. E.), Central Electricity, Authority. 4. Shri H. R. Kulkarni, Member (Thermal), Central Electricity, Authority, 5. Dr. M. R. Srinivasan, Director (Power Project Engineering), Atomic Energy Commission. 6. Shri B. V. Chitnis, Director, Engineering Tata Consulting Engineers. 7. Shri T. S. Madan, Chairman, Punjab State Electricity Board. 8. Shri V. S. Shevde, Chief Engineer, Maharashtra State Electricity Board. 9. Dr. S. K. Mukherjee, Indian Institute of Management, Ahmedabad. 10. Dr. V. Ranganathan, Indian Institute of Management, Bangalore. *Panel Secretary* Shri Sudhakar Rao, Under Secretary, Committee on Power. *Senior Research Officer* Shri J. N. Maggo. *Research Officer* Shri Raj Kumar.	To evaluate the methodology adopted for the present power surveys and demand forecasts being made by the Central Electricity Authority; examine the introduction of concepts of energy management in the power industry; critically examine the thermal-hydel-nuclear mix for power development in the national and regional contexts and the time frame in which such plan are made examine other aspects of power planning including institutional changes, inter-state linkages in power, the role of Central generation and Regional Electricity Boards, and the problems of funding the massive investments in the power sector; also study the need for and policy regarding captive power generation.

Panel II—Project Formulation & Implementation

Membership	*Terms of Reference*
Convenor Shri S. N. Roy, Chairman, Central Electricity Authority. *Memebers* 1. Sh. N. Tata Rao, Chairman, Andhra Pradesh, State Electricity Board.	To review the approach by the State and Central Organ sations in formulating projects, examine the procedure and evaluation criteria adopted by the CEA for appro ving them; examine the need and scope for standardi sation of project designs especially in thermal and transmission projects; examine the procedures/agencies for implementation of major projects with a view to reducing/eliminating the delays and cost overruns, identify the more common constraints in executicn and

Membership

2. Sh. S. P. Manaktala, General Manager and Director, Tata Electric Company.
3. Sh. N. G. K. Murti, Consulting Engineer, Bombay.
4. Sh. T. K. Srinivasan, Member (PS), Central Electricity Authority.
5. Sh. D. Jayachandran, General Manager, BHEL (Seamless Steel Tube Plan Unit).
6. Sh. D. V. Kapur, Chairman, National Thermal Power Corporation.

Member Secretary

Shri P. Achyutham, Chief Engineer (Hydro), Central Electricity Authority.

Terms of Reference

propose measures to remove them including training in project implementation and monitoring systems and availability of power equipment for generation, transmission and distribution; also study the institutional/organisational framework in this regard.

Panel III—Operation and Maintenance

Membership

Convenor

Shri K. M. Chinnappa, Managing Director, Tata Electric Company.

Members

1. Sh. J. M. Patnaik, Chairman, Orissa State Electricity Board.
2. Sh. Ramanuja Rai, Chief Engineer (O & M) Damodar Valley Corporation.
3. Shri Etty Darwin, Member, Kerala State Electricity Board.
4. Sh. R. N. Ghosh, Deputy General Manager (OS), National Thermal Power Corporation Limited.
5. Sh. D. J. Ramrakhiani, Member, Madhya Pradesh Electricity Board.
6. Sh. N. C. Basru Member (Operations), Central Electricity Authority.
7. Sh. S. S. Das Gupta, Chairman, West Bengal State Electricity Board.
8. Dr. K. R. Pandit, Chief Engineer, Tata Electric Companies.

Panel Secretary

Sh. J. K. Sharma, Sr. Management Consultant, Ministry of Energy.

Research Officer

Shri R. A. Sharma

To review the operational efficiency (including outages, renovation schemes and maintenance standards of present equipment) of power stations and the state grides, and suggest ways and means of improvement; suggest methods for the optimum utilisation of present installed capacity including the flattening of the load curve by restructuring demand patterns, incentives etc. identify shortcomings in the training institutions/programmes being provided for power plant operators and evolve appropriate systems of training and staffing norms for operation and maintenance personnel, review of problems and suggestions related to quality and quantity of fuel supply to thermal power stations, review organisation of operation and maintenance in the power stations, examine requirements for integrated operation for improving power systems efficiency, study control and monitoring of environmental impact of power stations and spare parts management/inventory control.

Panel IV—Organisation and management

Membership	*Terms of Reference*
Convenor Shri K. V. Raghavan, Chairman & Managing Director, EIL. *Members* 1. Sh. N. Tata Rao, Chairman, Andhra Pradesh, Electricity Board. 2. Shri B. N. Bose, Member (Generation), Uttar Pradesh State Electricity Board. 3. Dr. M. D. Godbole, Joint Secretary, Deptt. of Economic Affairs. 4. Sh. P. Ramayya, Chief Engineer (General) Karnataka SEB. 5. Shri R. B. Dutt, Chief Electrical Eng., Indian Explosive Ltd. *Panel Secretary* Shri M. K. Sambamurti, Director, Deptt. of Power. *Research Officer* Shri Inderjit Malhotra.	To study the organisation of State Electricity Boards and other Central bodies in Power Sector (including Central Undertakings) and suggest ways and means for increasing their effectiveness/efficiency; also examine the need for creation of new organisations to fill specific gaps; examine the existing legislation with regard to the adequacy of its provisions for the proper organisation of the State Electricity Boards; evaluate the recruitment and selection procedures of these organisations, their training schemes and also the extent of professionalisation achieved so far; evolve the guidelines for the appropriate relationship between Electricity Boards and the State/Central bodies.

Panel V—Finance, Financial management and Tariffs

Membership	
Convenor Prof. V. N. Kothari, Head of the Deptt. of Economics, University of Baroda. *Members* 1. Shri R. N. Bhargava, Chairman, UPSEB. 2. Sh. M. G. Shah, Additional Chief Secretary, Govt. of Gujarat. 3. Shri S. Ramesh, Joint Secretary, Department of Power. 4. Sh. C. Muthusami Gounder, President, Tamil Nadu Agriculturists Association. 5. Sh. Vinay Bharatram, Executive Director, DCM Engineering Products Ltd. 6. Sh. G. Ramachandran, Adviser, Finance & Accounts, Deptt. of Finance & Planning, Govt. of A. P. 7. Prof. Ramesh Gupta, Finance & Accounts Area, IIM, Ahmedabad. *Member Secretary* Shri Arun Bhatnagar, Managing Director, M. P. State Co-operative Marketing Federation Ltd. *Senior Research Officer* Shri G. G. Nair.	To study in depth the financial working of the Electricity Boards and other generation and distribution organisations; study the existing legislative framework to make the Boards financially viable and make recommendations in this regard; examine ways and means of funding the needs of the power sector both at State and Central levels and suggest changes required in this regard: examine procedures for capitalisation of interest charges during construction and principles regarding the depreciation of assets, cost accounting methods and related issues; study the tariff structure in the various States, including matters relating to the concessions given to certain classes of consumers: examine the desirability for adoption of marginal cost pricing in India in the light of experience in other countries; study the problems encountered in inter-state sale of power, and suggest institutional and other changes.

Panel VI—Rural Electrification

Membership

Convenor

Shri R. N. Bhargava,
Chairman, UPSEB.

Members

1. Sh. C. Muthusami Gounder, President, Tamil Nadu Agriculturists Association.
2. Prof. V. N. Kothari, Head of the Deptt. of Economics, University of Baroda.
3. Sh. T. G. K. Charlu, Chairman & Managing, Director REC.
4. Sh. C. Sanjeevi, Member (Technical), Tamil Nadu, SEB, (now retired).
5. Sh. R. G. Deshpande, Director, Agricultural Refinance & Development Corporation.
6. Dr. R. K. Pachhauri, Administrative Staff College, of India, Hyderabad.

Panel Secretary

Shri Ram Kumar,
Director.
Deptt. of Power.

Senior Research Officer

Shri Manohar Lal.

Terms of Reference

To evaluate the progress achieved so far by the rural electrification programme in meeting its stated social and economic objectives and identify the constraints in timely project implementation and efficient operation and manning norms; study the organisations concerned with rural electrification i.e. Electricity Boards, Rural Electrification Corporation etc., the financial working of the organisations; involved in rural electrification suggest ways and means of augmenting the resources. available for the purpose; evolve criteria for distribution of funds to various States for rural electrification programmes keeping in view regional imbalances; examine patterns/procedures for financing capital outlays to rural power consumers and their problems of maintenance of power equipment; study the implications of subsidising extensive rural electrification, especially its implications for the tariff policies to be adopted by the Boards; examines alternative energy systems for motive power in rural areas and suggest policy guidelines.

Panel VII—Research and Development n Power Sector

Membership

Convenor

Shri J. C. Shah, Chairman,
Gujarat Electricity Board.

Members

1. Sh. K. M. Chinnappa, Managing Director, Tata Electric Companies.
2. Dr. C. S. Jha, Senior Professor, Indian Institute of Technology.
3. Dr. J. Gururaja, Director, Deptt. of Science and Technology.
4. Dr. A. Gopalakrishnan, General Manager, BHEL (R & D Work).
5. Sh. S. G. Ramachandra, Kirloskar's Electric Company.
6. Sh. Surendra Mehta, Technical Member, M. P. Electricity Board.
7. Sh. V. R. Narasimhan, Director, Central Power Research Institute.
8. Shri Hari Eswaran, G. M., Eswaran & Sons (P) Ltd.

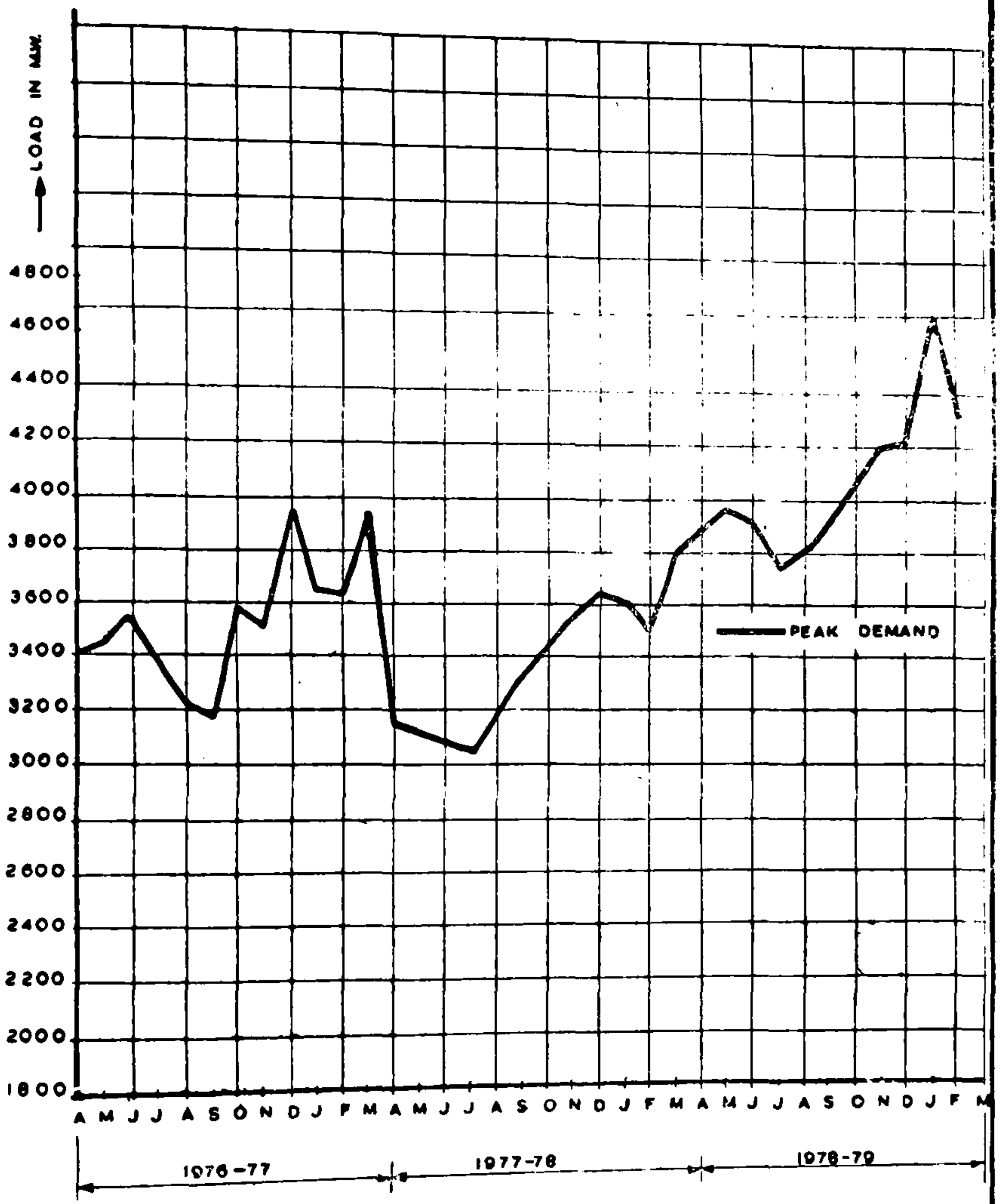
Panel Secretary

Shri J. N. Maggo, Senior Research Officer,
Committee on Power.

To evaluate the present state of R & D in the power industry, make recommendations for the systematic development of R & D work with a view to improve planning techniques, system/station efficiencies and reliability.

ANNEXURE 2·1

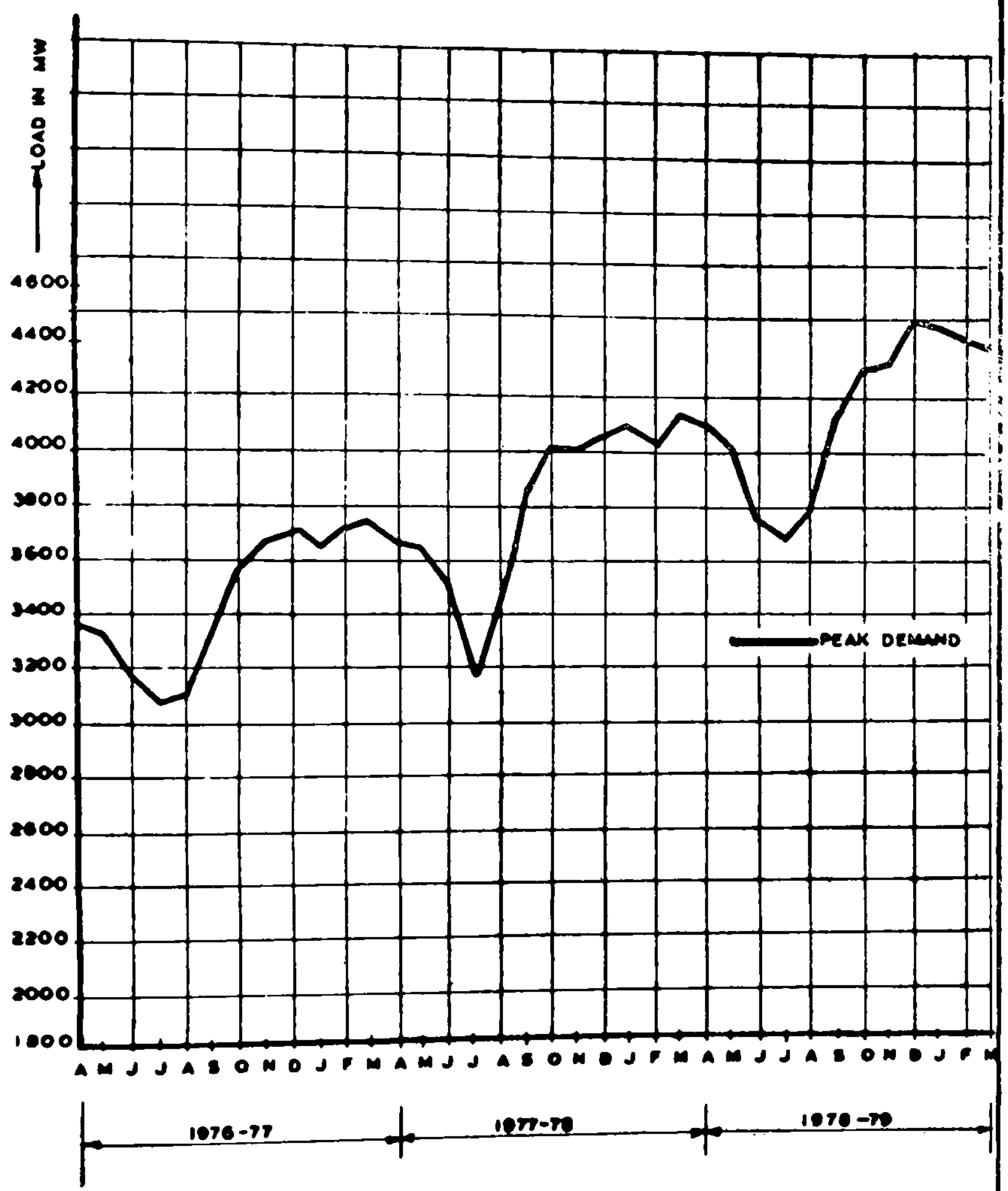
NORTHERN REGION



RAMESH

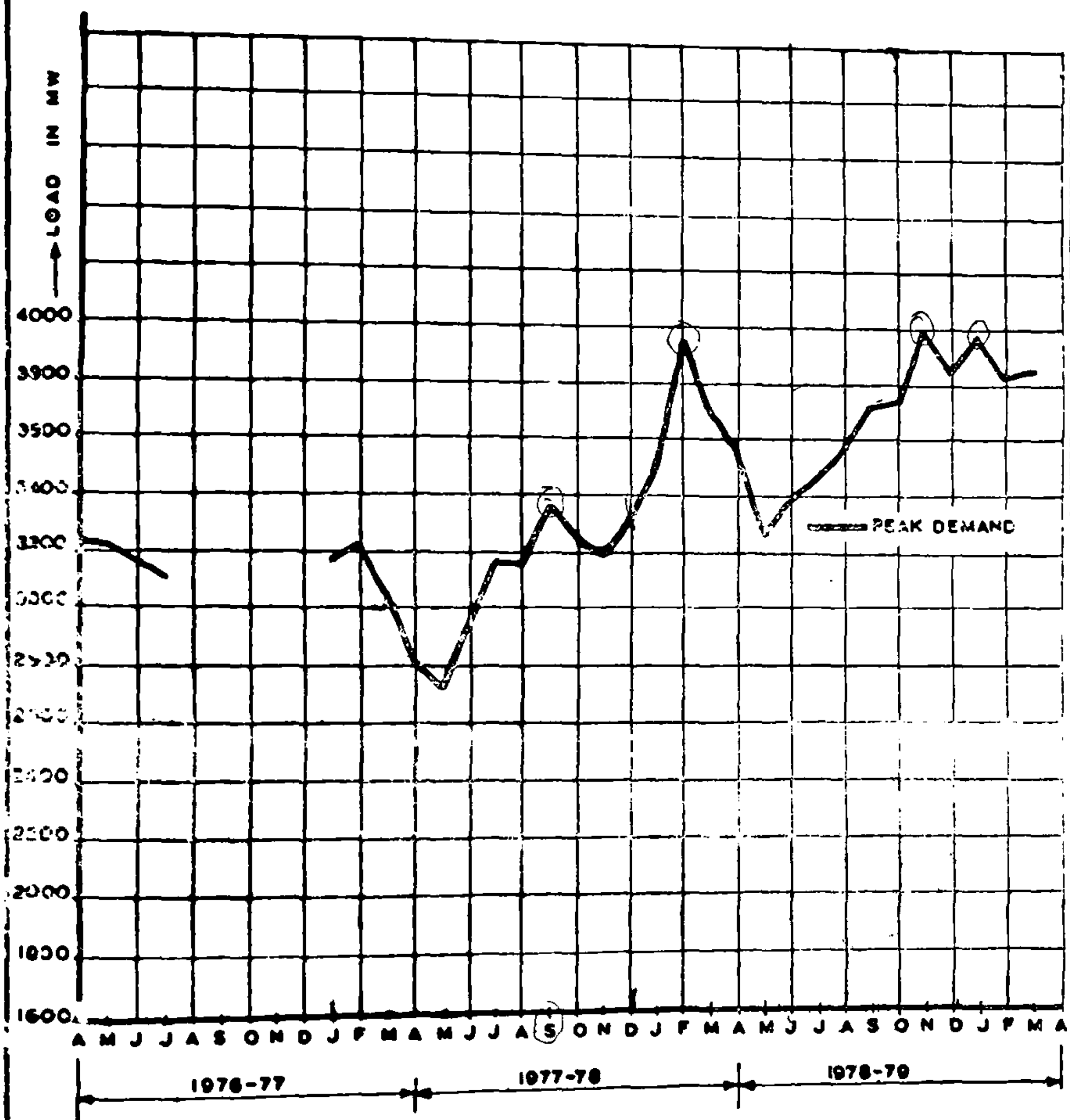
ANNEXURE 8·2

WESTERN REGION



ANNEXURE 2·3

SOUTHERN REGION



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ANNEXURE 2·4

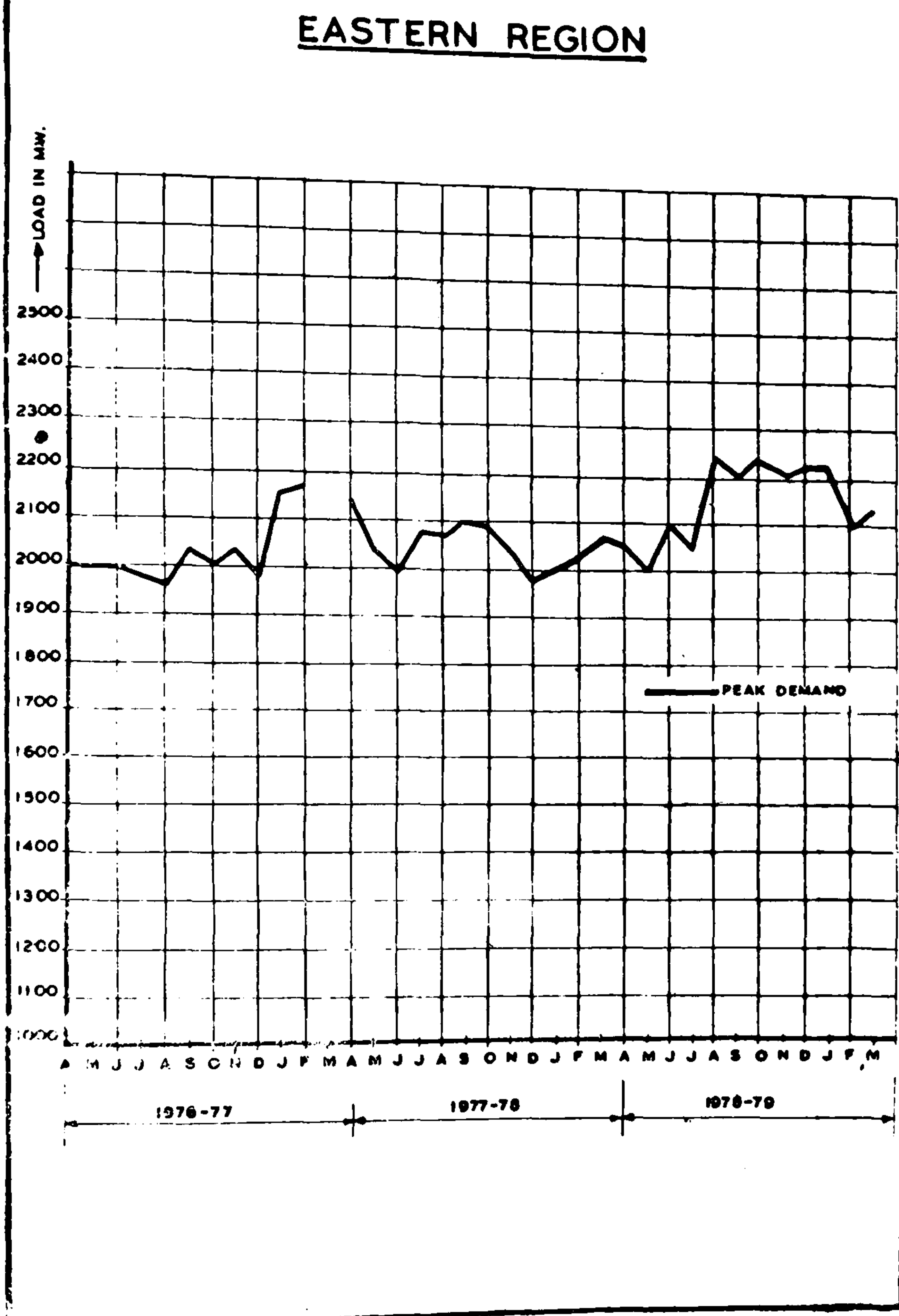

EASTERN REGION
LOAD IN MW.
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
PEAK DEMAND
A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M
1976-77
1977-78
1978-79

TABLE 1

THERMAL POWER PLANT YEARLY OPERATING INDICES FOR SEVEN YEARS 1973-74 TO 1979-80

ALL INDIA & REGION-WISE

ALL INDIA

YEAR	AGGREGATE CAPACITY (MW)	GENERATION (MU)	OPERATING HOURS	PLANNED OUTAGE %	FORCED OUTAGE %	AVAILABILITY %	UN.UTILISED POWER %	PARTIAL UNAVAILTY %	CAP. UTILISATION %
73-74	[illegible]	31665.38	6241	19.91	8.84	71.25	-	20.86	50.39
74-75	8178.5	36455.07	6687	13.19	10.47	76.34	-	23.57	52.77
75-76	9019.5	39708.98	6490	15.84	10.27	73.89	0.09	21.87	51.93
76-77	9898.5	46810.58	6748	9.81	13.16	77.03	7.30	14.45	55.28
77-78	[illegible]	47824.40	6344	13.40	14.18	72.42	5.42	14.29	52.71
78-79	12035.0	47888.00	6220	14.30	14.70	71.00	8.32	16.18	49.80
79-80*	14195.0	53770.30	6055	12.31	18.76	68.93	6.01	17.51	45.41

NORTHERN REGION

YEAR	AGGREGATE CAPACITY (MW)	GENERATION (MU)	OPERATING HOURS	PLANNED OUTAGE %	FORCED OUTAGE %	AVAILABILITY %	UN.UTILISED POWER %	PARTIAL UNAVAILTY %	CAP. UTILISATION %
73-74	1141.5	5305.29	6128	17.16	12.91	69.93	-	11.38	58.55
74-75	1541.5	7218.05	6607	10.07	14.51	75.42	-	18.43	59.99
75-76	1911.5	8779.63	6368	10.85	16.65	72.50	-	16.12	56.38
76-77	2081.5	10517.44	6460	11.57	14.68	73.75	1.83	12.50	59.42
77-78	2308.5	10374.42	5620	16.61	19.23	64.16	0.25	12.51	51.40
78-79	2978.5	10585.22	4977	15.17	25.75	59.08	0.63	13.66	44.79
79-80	3508.5	12276.41	5398	14.97	23.58	61.45	4.42	14.92	42.11

WESTERN REGION

YEAR	AGGREGATE CAPACITY (MW)	GENERATION (MU)	OPERATING HOURS	PLANNED OUTAGE %	FORCED OUTAGE %	AVAILABILITY %	UN.UTILISED POWER %	PARTIAL UNAVAILTY %	CAP. UTILISATION %
73-74	2169.0	11222.44	7115	13.08	5.70	81.22	-	21.84	59.38
74-75	2289.0	12241.96	7343	10.13	6.05	83.82	-	22.29	61.53
75-76	2409.0	13034.42	7101	14.33	4.83	80.84	-	19.09	61.75
76-77	3009.0	14927.60	7068	9.75	9.57	80.68	6.47	16.13	58.08
77-78	3358.5	17219.98	6986	13.20	7.05	79.75	6.91	13.44	59.40
78-79	3878.5	18898.19	6648	12.05	6.68	81.27	6.37	14.02	60.88
79-80	4818.50	21533.90	6675	11.88	12.13	75.99	6.93	15.55	53.51

SOUTHERN REGION

YEAR	AGGREGATE CAPACITY (MW)	GENERATION (MU)	OPERATING HOURS	PLANNED OUTAGE %	FORCED OUTAGE %	AVAILABILITY %	UN.UTILISED POWER %	PARTIAL UNAVAILTY %	CAP. UTILISATION %
73-74	1332.5	5405.52	5818	21.75	11.83	66.42	-	19.86	46.56
74-75	1552.5	5997.55	6743	10.02	13.00	76.98	-	29.15	47.83
75-76	1662.5	6275.55	6404	14.63	12.47	72.90	-	27.44	45.46
76-77	1662.5	8383.89	7019	8.72	11.16	80.12	8.96	14.02	57.14
77-78	1882.5	7411.94	6404	14.29	12.60	73.11	10.55	15.07	47.49
78-79	1882.5	7250.00	5372	14.55	11.21	74.24	12.35	17.92	43.97
79-80	2302.5	7446.41	6403	3.77	12.33	72.90	0.15	24.80	39.98

EASTERN REGION

YEAR	AGGREGATE CAPACITY (MW)	GENERATION (MU)	OPERATING HOURS	PLANNED OUTAGE %	FORCED OUTAGE %	AVAILABILITY %	UN.UTILISED POWER %	PARTIAL UNAVAILTY %	CAP. UTILISATION %
73-74	2645.5	9084.35	5854	24.70	8.47	66.83	-	23.50	43.33
74-75	2765.5	10962.18	6177	19.12	10.37	70.51	-	25.80	44.71
75-76	3005.5	11509.43	6119	20.58	9.76	69.66	-	24.92	44.74
76-77	3115.5	12825.14	6463	9.42	16.80	73.78	10.47	14.60	46.71
77-78	3115.5	12683.81	6011	14.72	16.66	68.62	5.46	16.55	46.61
78-79	3235.5	12943.39	6030	15.45	15.43	69.12	4.48	17.66	46.98
79-80	3465.5	12513.50	5652	12.49	23.16	64.35	5.00	18.15	41.20

NORTH EAST REGION

YEAR	AGGREGATE CAPACITY (MW)	GENERATION (MU)	OPERATING HOURS	PLANNED OUTAGE %	FORCED OUTAGE %	AVAILABILITY %	UN.UTILISED POWER %	PARTIAL UNAVAILTY %	CAP. UTILISATION %
73-74	30.0	47.76	2693	53.87	15.39	30.74	-	12.56	18.18
74-75	30.0	35.56	3956	2.33	52.51	45.16	-	31.63	13.53
75-76	30.0	109.95	5408	36.08	1.44	62.48	-	22.66	39.82
76-77	30.0	156.51	8631	1.47	-	98.53	21.46	17.52	59.55
77-78	30.0	134.25	6754	10.43	12.47	77.10	3.92	19.57	51.61
78-79	60.0	271.57	6063	21.12	9.67	69.21	—	17.54	51.67
79-80*									

NOTE :— * EXCLUDES CHANDRAPUR & NAMRUP POWER STATION (N.E. REGION) FOR WHICH NO OPERATING DATA HAS BEEN RECEIVED.

APPENDIX 1
FIGURE 1

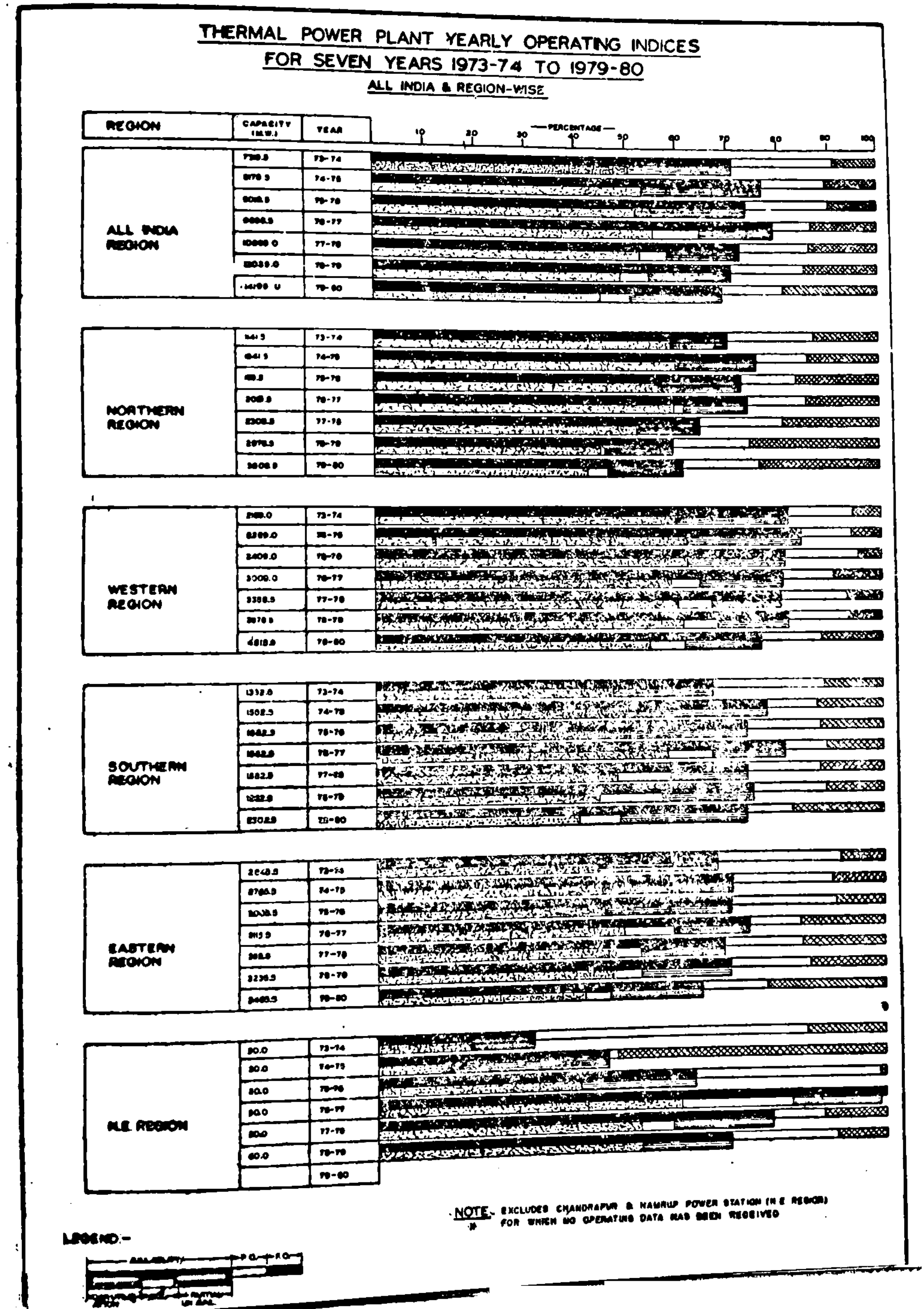


FIGURE 2

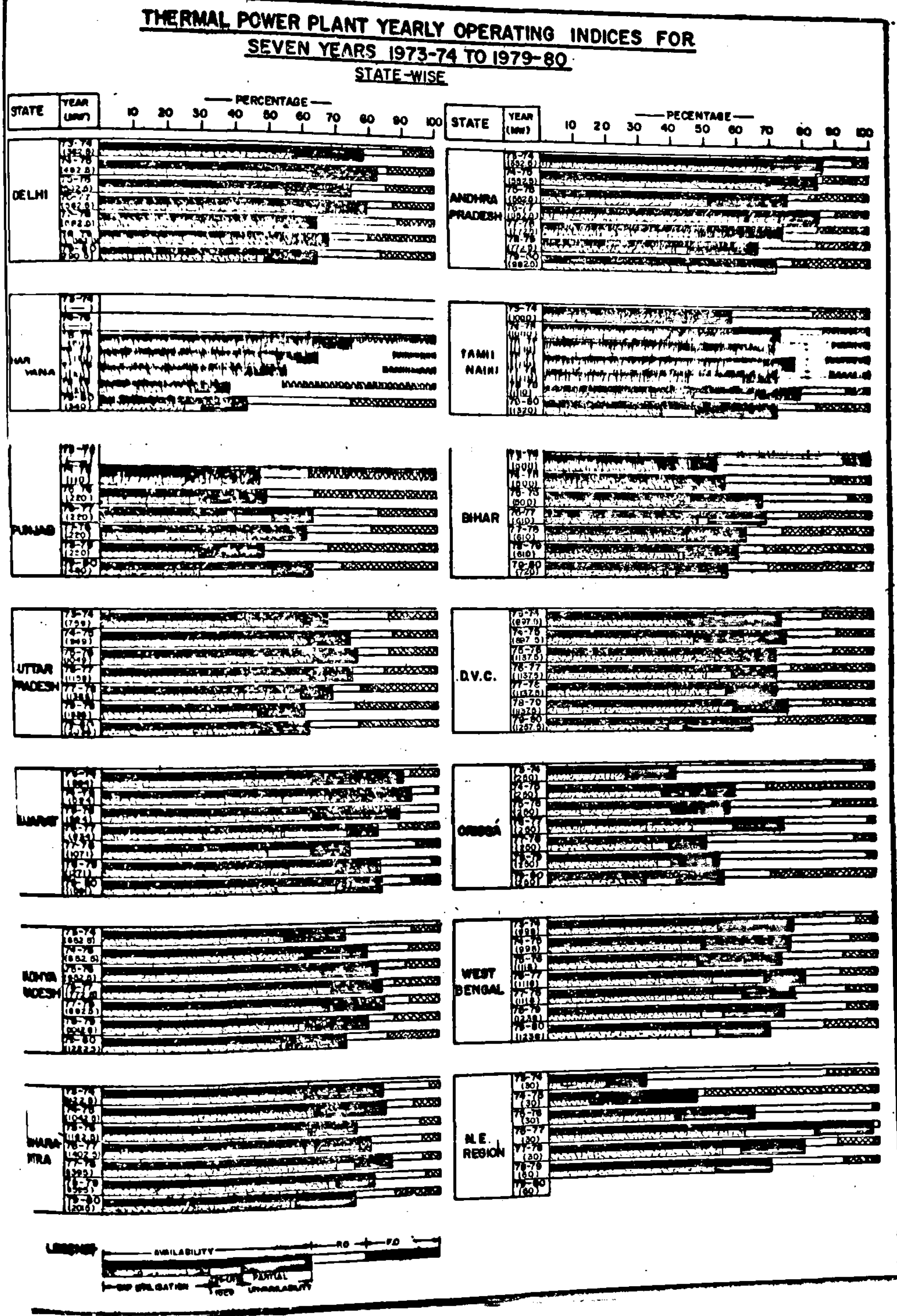

THERMAL POWER PLANT YEARLY OPERATING INDICES FOR
SEVEN YEARS 1973-74 TO 1979-80
STATE-WISE
STATE
YEAR (MW)
PERCENTAGE
10 20 30 40 50 60 70 80 90 100
DELHI
PUNJAB
UTTAR PRADESH
ANDHRA PRADESH
BIHAR
D.V.C.
ORISSA
WEST BENGAL
N.E. REGION
AVAILABILITY
PARTIAL UNAVAILABILITY

TABLE 2

THERMAL POWER PLANT YEARLY OPERATING INDICES FOR SEVEN YEARS 1973-74 TO 1979-80

STATE-WISE

STATE	YEAR	CAPACITY (MW)	GENERATION (MU)	OPERATING HOURS	PLANNED OUTAGE %	FORCED OUTAGE %	AVAILABILITY %	UN-UTILISED POWER %	PARTIAL UN-AVAILABILITY %	CAP. UTILISATION %
DELHI	73-74	382.5	1834.83	6818	13.19	8.98	77.83	—	20.93	57.30
	74-75	482.5	[illegible]	7180	3.50	14.33	83.17	—	[illegible]	[illegible]
	75-76	[illegible]	[illegible]	6401	11.39	14.71	73.90	—	19.77	54.13
	76-77	582.5	3134.70	6024	8.03	12.83	78.04	0.38	[illegible]	[illegible]
	77-78	682.5	2807.61	6581	25.40	10.83	63.71	0.36	6.94	53.72
	78-79	582.5	2898.86	6648	12.07	20.03	67.60	[illegible]	14.38	[illegible]
	79-80	[illegible]	3280.24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HARYANA	73-74	—	—	—	—	—	—	—	—	—
	74-75	—	—	—	—	—	—	—	—	—
	75-76	60.0	189.43	6432	0.80	85.69	—	—	—	—
	76-77	120.0	478.72	6477	24.80	12.58	73.45	—	24.89	48.50
	77-78	120.0	[illegible].20	6429	21.70	14.24	62.82	8.30	11.78	43.38
	78-79	120.0	264.54	3353	15.41	45.85	61.80	0.33	12.20	29.38
	79-80	340.0	470.74	3835	30.80	23.48	30.64	1.04	10.53	27.07
							43.64	0.58	13.07	33.01
PUNJAB	73-74	—	—	—	—	—	—	—	—	—
	74-75	110.0	157.79	4200	13.00	38.45	47.04	—	—	—
	75-76	280.0	410.81	4294	15.69	25.43	49.88	—	22.00	29.83
	76-77	270.0	705.04	5460	20.48	10.80	52.67	11.69	20.13	28.75
	77-78	220.0	1020.74	5009	21.62	20.81	58.08	0.49	11.50	38.80
	78-79	440.0	870.27	3271	19.16	32.03	49.51	1.72	16.04	31.28
	79-80	440.0	1143.00	5530	8.84	28.14	63.02	20.72	18.28	28.53
									12.73	25.37
UTTAR PRADESH	73-74	750.0	3870.38	6808	10.0	14.73	60.27	—	7.14	50.13
	74-75	949.0	4600.04	6460	13.10	13.09	73.75	—	13.90	60.23
	75-76	1049.0	5404.16	6639	10.37	14.10	75.88	—	12.74	[illegible]
	76-77	1129.0	5642.[illegible]	7016	10.31	10.41	74.[illegible]	0.24	15.78	[illegible]
	77-78	1309.0	6356.67	6740	11.85	[illegible]	[illegible]	0.19	17.19	52.19
	78-79	1630.0	6733.40	5161	18.33	24.98	59.80	0.35	15.67	46.67
	79-80	2036.0	7453.51	5298	13.87	22.48	61.59	1.21	15.59	44.79
GUJARAT	73-74	534.0	3183.57	7822	2.60	8.03	80.29	—	20.23	61.08
	74-75	594.0	3446.60	7369	8.87	0.47	91.81	—	25.12	60.10
	75-76	894.0	4214.32	7815	10.24	0.29	83.67	—	27.47	61.48
	76-77	974.0	4878.01	7010	8.41	13.57	60.03	19.23	8.88	51.91
	77-78	1071.0	[illegible]	3237	21.93	7.21	70.38	12.88	[illegible]	48.50
	78-79	1271.0	5410.8	7033	14.00	2.80	83.11	18.35	[illegible]	55.03
	79-80	1361.0	6339.71	7042	11.30	8.39	80.25	18.52	12.00	49.73
MADHYA PRADESH	73-74	692.5	3101.75	6928	20.78	7.00	71.28	—	17.61	51.80
	74-75	682.5	3709.32	6770	13.24	9.38	77.38	—	9.40	67.60
	75-76	682.5	3914.00	7334	6.69	7.34	85.77	—	17.46	60.31
	76-77	772.5	4450.76	7242	3.63	13.70	82.67	0.59	20.76	61.52
	77-78	892.5	4768.74	7102	8.20	9.64	82.10	0.95	13.27	64.80
	78-79	1012.5	5087.06	6710	7.38	13.66	78.98	1.87	18.42	58.69
	79-80	1132.5	5350.72	6393	11.20	[illegible]	[illegible]	1.02	17.70	52.09
MAHARASTRA	73-74	927.5	5008.12	7274	14.33	2.88	83.00	—	23.68	59.21
	74-75	1042.5	5463.04	7522	0.26	7.19	83.59	—	22.44	61.15
	75-76	1182.5	5803.24	6490	20.37	5.78	73.85	—	18.73	50.18
	76-77	1402.5	7108.83	7003	15.25	4.81	79.94	8.17	17.84	50.89
	77-78	1386.5	[illegible].70	7459	9.48	6.37	83.75	5.94	19.10	66.07
	78-79	1508.0	8334.[illegible]	6301	12.60	4.79	81.42	2.49	12.01	66.66
	79-80	2008.0	9434.47	6576	12.29	12.82	74.88	1.44	17.29	56.16
ANDHRA PRADESH	73-74	332.5	2063.81	7590	11.08	2.98	85.90	—	15.47	70.40
	74-75	552.5	2542.61	7440	1.14	13.83	85.03	—	10.69	68.34
	75-76	552.5	2322.68	6687	6.88	17.31	76.13	—	24.13	52.00
	76-77	552.5	2875.88	7507	9.07	9.83	85.70	1.08	[illegible]	61.34
	77-78	772.5	2963.88	6501	10.70	18.09	74.81	0.53	25.58	48.10
	78-79	772.5	2789.30	5802	17.17	18.58	66.25	2.88	22.34	40.83
	79-80	[illegible]	3140.48	6426	4.88	[illegible].18	73.18	8.07	30.47	41.62
TAMIL NADU	73-74	1000.0	3351.71	5250	28.30	14.77	69.93	—	21.33	38.90
	74-75	1000.0	3454.31	6448	12.78	12.69	73.97	—	24.43	39.14
	75-76	1100.0	3752.39	6881	10.97	8.97	71.16	—	[illegible]	41.84
	76-77	1100.0	3408.23	6776	10.83	[illegible]	77.38	12.88	8.42	55.05
	77-78	1100.0	4448.28	6347	16.48	11.08	72.46	16.89	10.04	45.83
	78-79	1110.0	4480.30	5412	12.70	7.47	79.80	18.88	14.64	49.08
	79-80	1230.0	4305.[illegible]	6400	11.34	18.80	72.86	10.20	23.64	[illegible]
BIHAR	73-74	800.0	1879.61	4846	39.93	4.75	55.32	—	17.20	38.03
	74-75	800.0	[illegible].64	6219	32.73	7.60	60.58	—	16.40	43.18
	75-76	800.0	1834.30	[illegible]	26.80	6.07	67.03	—	24.[illegible]	42.22
	76-77	810.0	2172.88	6030	10.37	20.91	68.72	3.80	17.82	47.60
	77-78	810.0	2344.80	5421	[illegible].01	20.11	61.88	0.76	17.24	43.88
	78-79	810.0	2214.27	5118	[illegible].02	32.79	50.19	0.84	[illegible]	41.44
	79-80	720.0	2429.57	5106	[illegible].29	20.38	[illegible].13	2.40	16.74	38.91
D.V.C.	73-74	807.5	3402.64	6383	13.11	14.37	72.52	—	29.34	43.18
	74-75	1017.5	4168.97	6500	18.81	6.41	74.88	—	30.27	46.71
	75-76	1107.5	4488.91	6308	17.30	10.82	71.79	—	24.80	46.89
	76-77	1107.5	5018.54	6294	4.17	23.88	71.85	7.82	13.67	50.38
	77-78	1107.5	4604.75	6197	7.80	21.70	70.74	4.93	16.58	49.29
	78-79	[illegible]	5217.87	6331	10.18	15.30	74.83	4.93	17.27	52.38
	79-80	[illegible]	4480.30	5741	8.11	28.53	63.36	3.80	21.47	40.08
ORRISA	73-74	280.0	346.64	3885	57.29	2.13	40.58	—	10.62	24.06
	74-75	280.0	880.64	5007	9.58	32.24	58.19	—	23.27	34.01
	75-76	280.0	716.32	4923	31.72	18.83	58.05	—	17.91	38.14
	76-77	280.0	981.30	6328	28.22	1.98	72.22	12.84	14.58	44.80
	77-78	250.0	889.08	4122	46.82	8.43	47.05	5.08	11.52	30.55
	78-79	250.0	726.27	4469	45.19	7.41	52.40	3.84	19.38	33.18
	79-80	250.0	697.71	4684	14.48	29.94	65.60	9.08	14.74	31.77
WEST BENGAL	73-74	998.0	4055.20	6581	18.77	9.48	74.78	—	23.34	51.44
	74-75	998.0	4040.89	6589	18.88	7.21	74.83	—	29.97	45.90
	75-76	1118.0	4253.60	6309	18.80	9.60	71.88	—	30.64	45.18
	76-77	1110.0	4072.[illegible]	[illegible]	10.87	10.90	78.44	16.18	13.89	48.42
	77-78	1110.0	4780.08	[illegible]	16.38	8.60	74.98	8.86	17.28	40.04
	78-79	1238.0	4784.[illegible]	6131	18.17	9.16	72.67	8.04	19.03	47.80
	79-80	1238.0	4896.02	6035	16.83	14.64	68.71	8.88	19.23	45.37
NORTH-EASTERN REGION	73-74	40.0	47.78	2693	63.67	15.30	50.74	—	12.08	15.18
	74-75	40.0	86.66	3139	2.39	32.81	45.18	—	31.63	13.53
	75-76	30.0	100.93	3488	36.09	1.44	62.48	—	22.88	40.62
	76-77	30.0	159.81	6831	1.47	—	98.69	21.46	17.02	60.33
	77-78	30.0	134.29	3154	10.44	12.47	77.10	8.42	19.57	51.81
	78-79	80.0	271.37	6582	21.18	9.82	69.21	—	17.54	31.87
	79-80*									

NOTE-* OPERATING DATA HAS NOT BEEN RECEIVED FOR CHANDRAPUR & NAMRUP POWER STATIONS HENCE N.E. REGION OPERATING PERFORMANCE FACTORS ARE NOT INCLUDED

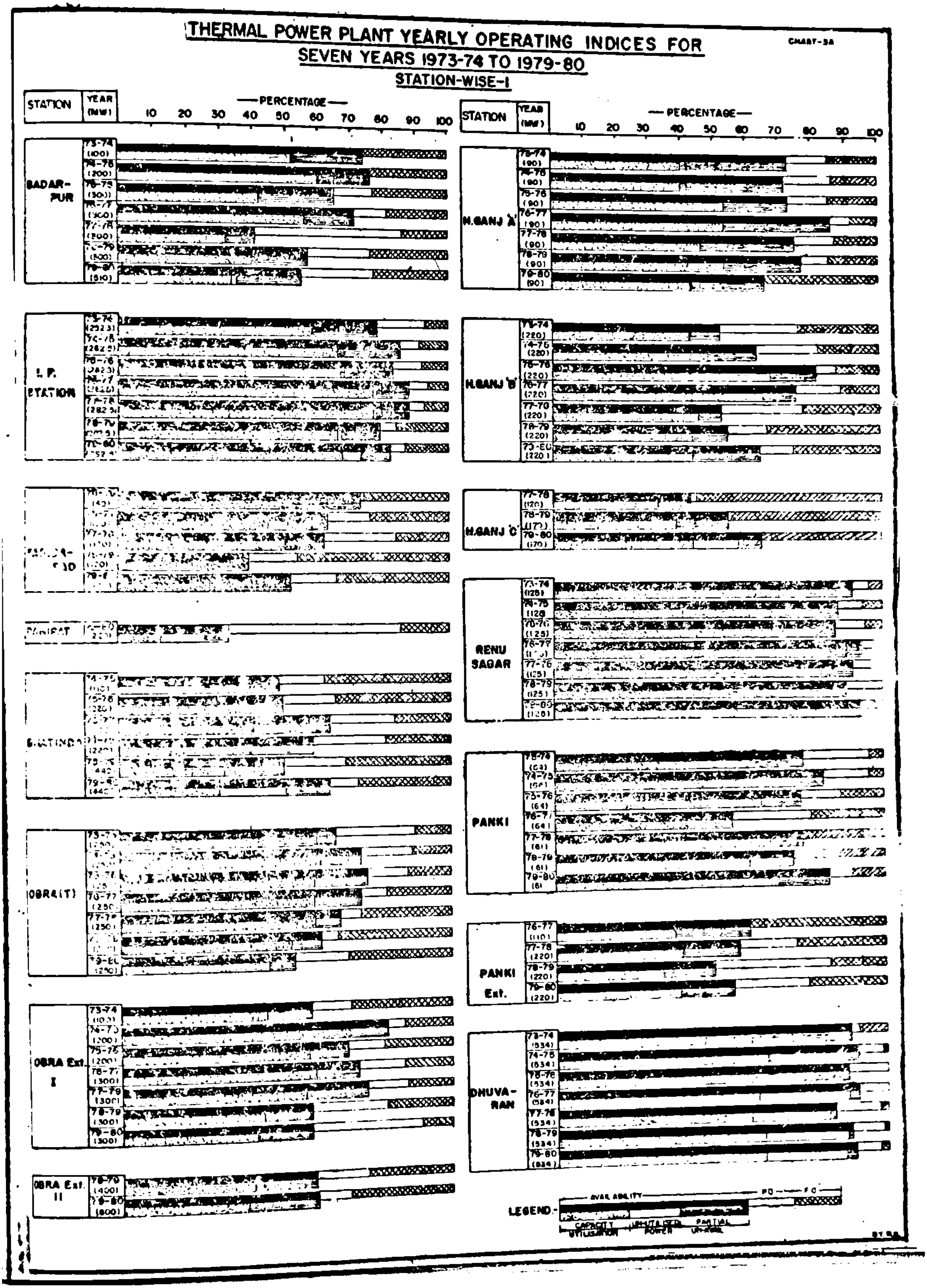

THERMAL POWER PLANT YEARLY OPERATING INDICES FOR SEVEN YEARS 1973-74 TO 1979-80
STATION-WISE-I
CHART-3A
STATION
YEAR (MW)
PERCENTAGE
10 20 30 40 50 60 70 80 90 100
BADAR-PUR
I. P. STATION
PANIPAT
OBRA(T)
OBRA Ext. I
OBRA Ext. II
H.GANJ 'A'
H.GANJ 'B'
H.GANJ 'C'
RENU SAGAR
PANKI
PANKI Ext.
DHUVA-RAN
LEGEND
AVAILABILITY
P.O.
F.O.
CAPACITY UTILISATION
UNUTILISED POWER
PARTIAL UN-AVAIL

CHART-20

THERMAL POWER PLANT YEARLY OPERATING INDICES FOR SEVEN YEARS 1973-74 TO 1979-80

STATION-WISE-I

STATE	STATIONS	YEAR	NO OF UT	CAP. IN (MW)	GENERATION IN (MU)	OPERATING HRS.	PLANNED OUTAGE %	FORCED OUTAGE %	AVAILABILITY %	UN-UTILISED POWER %	PARTIAL UNAVAIL. %	CAPACITY UTILISATION %
DELHI	BADARPUR	73-74	1	100	198.73	6510	–	25.40	74.31	–	22.00	[illegible]
		74-75	2	200	646.88	6019	–	23.58	76.[illegible]	–	10.66	30.73
		75-76	3	300	1100.73	6700	51.31	21.60	84.00	–	33.12	41.77
		76-77	3	300	1401.60	6204	9.72	13.46	70.03	–	[illegible]	[illegible]
		77-78	3	300	830.41	3551	44.84	14.62	40.94	0.01	[illegible]	[illegible]
		78-79	3	300	1056.08	5074	18.84	24.11	67.85	0.07	[illegible]	[illegible]
		79-80	4	810	1632.33	4674	22.48	22.08	50.40	0.36	18.[illegible]	40.76
		80-81								0.08	20.37	30.20
	I.P. STATION	73-74	5	282.5	1438.20	6963	10.14	6.9	78.35	–	20.83	59.[illegible]
		74-75	5	282.5	1633.40	7460	5.45	9.10	86.30	–	19.30	66.00
		75-76	5	282.5	1588.50	7332	9.13	7.40	83.47	–	18.81	67.72
		76-77	6	282.5	1662.90	7699	0.23	9.00	87.77	0.48	[illegible]	77.72
		77-78	6	282.5	1666.30	7737	4.07	6.8	90.[illegible]	0.04	10.[illegible]	75.92
		78-79	6	282.5	1840.00	6630	8.19	15.70	77.11	1.04	11.73	64.31
		79-80	5	282.5	1666.81	7170	5.00	13.30	81.70	.64	7.60	66.42
		80-81										
HARYANA	FARIDABAD	75-76	1	60	209.43	8452	0.80	23.66	75.45	–	[illegible]	[illegible]
		76-77	2	120	426.72	5477	20.00	12.52	62.52	6.30	11.70	45.[illegible]
		77-78	2	120	510.20	5499	21.70	16.28	[illegible]	[illegible]	12.[illegible]	49.28
		78-79	2	120	284.34	3293	15.41	45.05	[illegible].64	1.04	10.80	27.07
		79-80	2	120	365.00	4067	14.20	33.50	[illegible].23	—	13.80	34.03
		80-81										
	PANIPAT	79-80	2	220	105.74	2871	52.04	15.16	32.46	11.67	7.[illegible]	12.70
		80-81										
PUNJAB	BHATINDA	74-75	1	110	137.78	[illegible]	19.40	30.40	47.84	–	27.00	[illegible]
		75-76	2	220	416.81	4294	15.65	36.45	46.60	–	[illegible]	24.70
		76-77	2	220	763.04	5400	20.45	16.80	62.67	11.60	11.[illegible]	39.60
		77-78	2	220	800.74	5063	21.02	20.30	58.03	0.40	18.04	41.[illegible]
		78-79	4	440	870.27	3271	19.46	37.09	48.31	1.78	10.30	26.03
		79-80	4	440	1143.00	[illegible]	6.84	30.14	63.03	20.73	12.72	29.57
		80-81										
UTTAR PRADESH	OBRA (T)	73-74	5	250	1300.76	5701	23.66	11.24	65.09	–	[illegible]	59.[illegible]
		74-75	5	250	1301.60	6326	15.64	12.14	72.22	–	12.80	59.[illegible]
		75-76	5	250	1262.60	6439	13.35	12.71	73.94	–	13.83	58.41
		76-77	6	250	1267.90	6267	8.81	19.02	71.77	0.48	13.42	57.92
		77-78	6	250	1274.93	5787	6.11	37.83	56.06	0.16	7.67	58.23
		78-79	6	250	1124.79	5231	9.43	34.06	69.00	0.30	7.00	51.36
		79-80	5	250	970.70	4335	15.87	32.0	52.02	—	7.65	44.17
		80-81										
	OBRA EXTN-I	73-74	1	100	157.59	2000	11.70	30.01	57.53	–	13.92	[illegible]
		74-75	2	200	747.37	6537	3.02	[illegible]	78.87	–	11.87	[illegible]
		75-76	2	200	1147.20	5970	11.90	21.08	66.05	–	12.06	59.67
		76-77	3	300	1510.60	6631	42.34	17.09	70.87	0.35	12.30	57.03
		77-78	3	300	1480.60	6472	10.03	15.70	74.18	0.04	16.70	56.20
		78-79	3	300	1060.08	4975	25.00	[illegible]	60.76	0.05	19.24	41.60
		79-80	3	300	1029.82	3060	33.72	[illegible].05	57.23	—	17.01	40.22
		80-81										
	OBRA Extn.-II	78-79		400	757.82	4405	10.40	33.97	57.53	0.04	16.29	27.50
		79-80		600	1457.78	[illegible]	0.61	[illegible].00	68.87	—	41.70	30.70
		80-81										
	HARDUA GANJ 'A'	73-74	3	90	312.04	6363	12.54	14.95	72.00	–	[illegible]	[illegible]
		74-75	3	90	310.30	6300	15.73	14.43	[illegible]	–	31.30	40.00
		75-76	3	90	334.14	6407	12.09	14.97	72.94	–	30.27	42.67
		76-77	3	90	421.41	7462	0.28	8.18	[illegible].53	–	[illegible]	[illegible].45
		77-78	3	90	365.09	6538	12.60	12.07	[illegible]	–	[illegible]	46.48
		78-79	3	90	415.43	6739	0.28	14.81	78.93	–	[illegible]	[illegible]
		79-80	3	90	340.00	6794	0.32	33.40	[illegible]		[illegible]	43.06
		80-81										
	HARDUA GANJ 'B'	73-74	4	220	914.39	4896	[illegible]	[illegible]	58.47	–	10.23	[illegible]
		74-75	4	220	928.31	5493	[illegible]	18.37	68.70	–	14.34	[illegible]
		75-76	4	220	1290.00	7080	6.03	13.37	80.60	–	13.30	67.34
		76-77	4	220	1310.10	[illegible]	11.80	12.07	76.13	0.07	7.00	67.98
		77-78	4	220	871.39	[illegible]	24.90	[illegible]	[illegible]	–	7.10	45.22
		78-79	4	220	828.1[illegible]	[illegible]	11.74	[illegible]	[illegible]	–	[illegible]	42.87
		79-80	4	220	884.84	5501	0.60	36.40	[illegible]	–	20.06	45.40
		80-81										
	HARDUAGANJ 'C'	77-78	2	120	278.99	[illegible]	1.61	58.65	41.74	–	10.25	[illegible]
		78-79	2	170	313.28	[illegible]	6.32	40.31	54.37	–	18.72	[illegible]
		79-80	2	170	627.18	[illegible]	6.37	33.78	[illegible]	13.40	7.32	[illegible]
		80-81										
	RENUSAGAR	73-74	2	125	1010.00	[illegible]	4.93	4.94	90.[illegible]	–	2.91	[illegible]
		74-75	2	125	892.40	7464	[illegible]	5.78	87.37	–	[illegible]	[illegible]
		75-76	2	125	932.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	–	2.48	[illegible]
		76-77	2	125	1092.07	[illegible]	4.06	1.43	94.40	–	[illegible]	[illegible]
		77-78	2	125	1044.10	7810	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		78-79	2	125	1033.02	7819	6.47	1.27	[illegible]	[illegible]	–	[illegible]
		79-80	2	125	1101.[illegible]	[illegible]	[illegible]	3.20	[illegible]	–	–	[illegible]
		80-81										
	PANKI	73-74	2	64	387.78	[illegible]	18.64	4.49	[illegible]	–	[illegible]	69.17
		74-75	2	64	405.43	7174	13.71	4.40	[illegible]	–	7.10	[illegible]
		75-76	2	64	368.33	[illegible]	11.04	12.79	76.37	–	11.63	[illegible]
		76-77	2	64	228.08	4713	24.04	[illegible]	[illegible]	0.42	13.08	40.32
		77-78	2	64	328.15	6600	–	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		78-79	2	64	[illegible]	6201	[illegible]	14.48	[illegible]	[illegible]	11.43	[illegible]
		79-80	2	64	351.82	[illegible]	7.47	[illegible]	[illegible]	–	[illegible]	[illegible]
		80-81										
	PANKI Extn.	76-77	1	110	114.80	1708	–	[illegible]	[illegible]	–	[illegible]	[illegible]
		77-78	2	220	728.33	4890	[illegible]	[illegible]	[illegible]	0.97	[illegible]	[illegible]
		78-79	2	220	623.38	4469	[illegible]	[illegible]	47.89	1.60	13.70	32.35
		79-80	2	220	720.91	4758	[illegible]	24.07	[illegible]	—	[illegible]	37.77
		80-81										
GUJARAT	DHUVARAN	73-74	6	534	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	–	[illegible]	[illegible]
		74-75	6	534	3018.50	8001	[illegible]	0.51	[illegible]	–	[illegible]	[illegible]
		75-76	6	534	2774.10	7771	11.20	[illegible]	[illegible]	–	[illegible]	[illegible]
		76-77	6	534	2867.60	[illegible]	[illegible]	[illegible]	[illegible]	37.63	[illegible]	[illegible]
		77-78	6	534	2757.20	7401	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		78-79	6	534	[illegible]	[illegible]	[illegible]	1.67	[illegible]	[illegible]	1.06	[illegible]
		79-80	6	534	2984.00	7892	[illegible]	1.50	[illegible]	[illegible]	[illegible]	[illegible]
		80-81										

MANAGEMENT CONSULTANTS MINISTRY OF ENERGY (DEPTT. OF POWER)

THERMAL POWER PLANT YEARLY OPERATING INDICES FOR SEVEN YEARS 1973-74 TO 1979-80

STATION-WISE-2

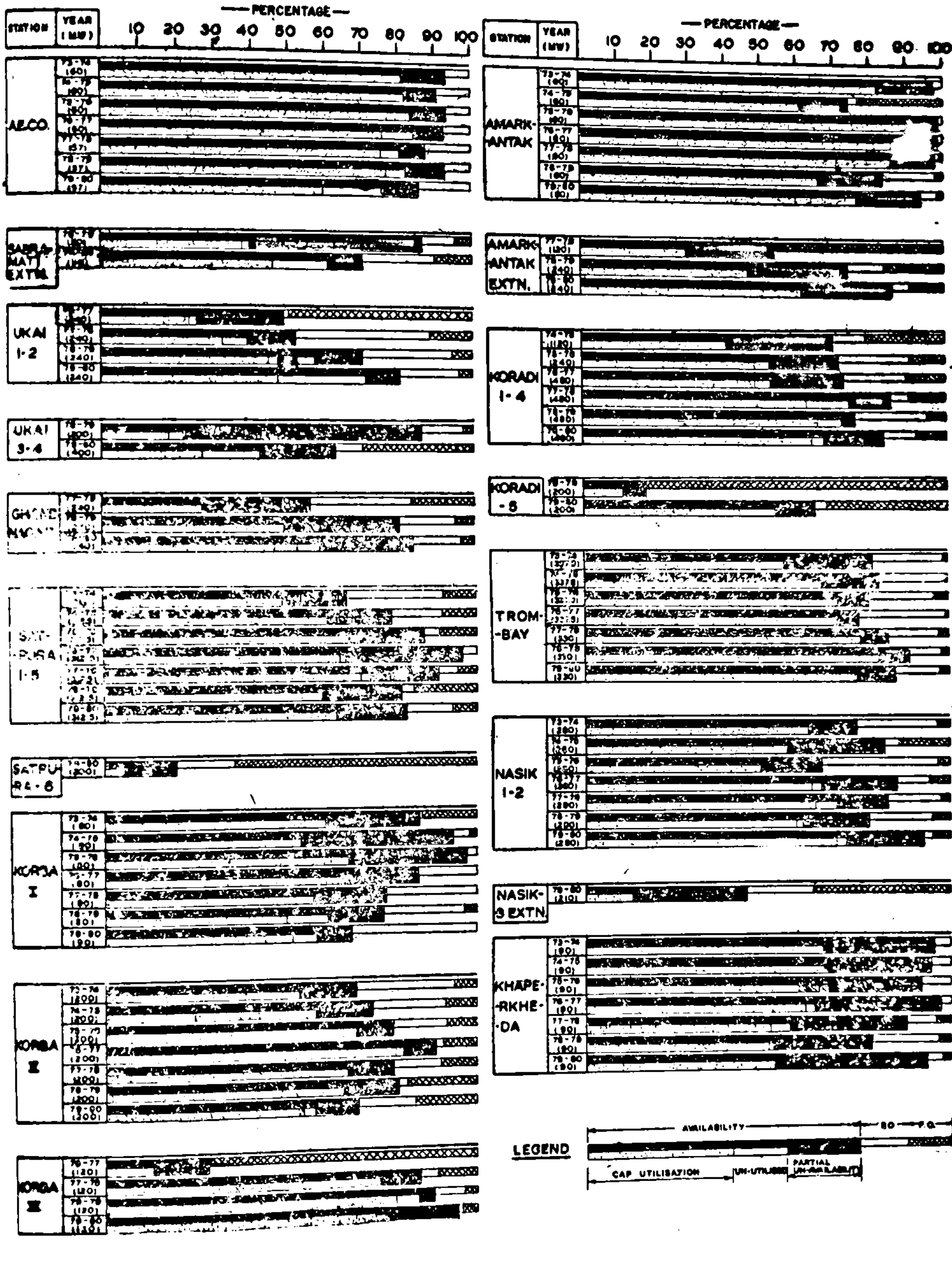
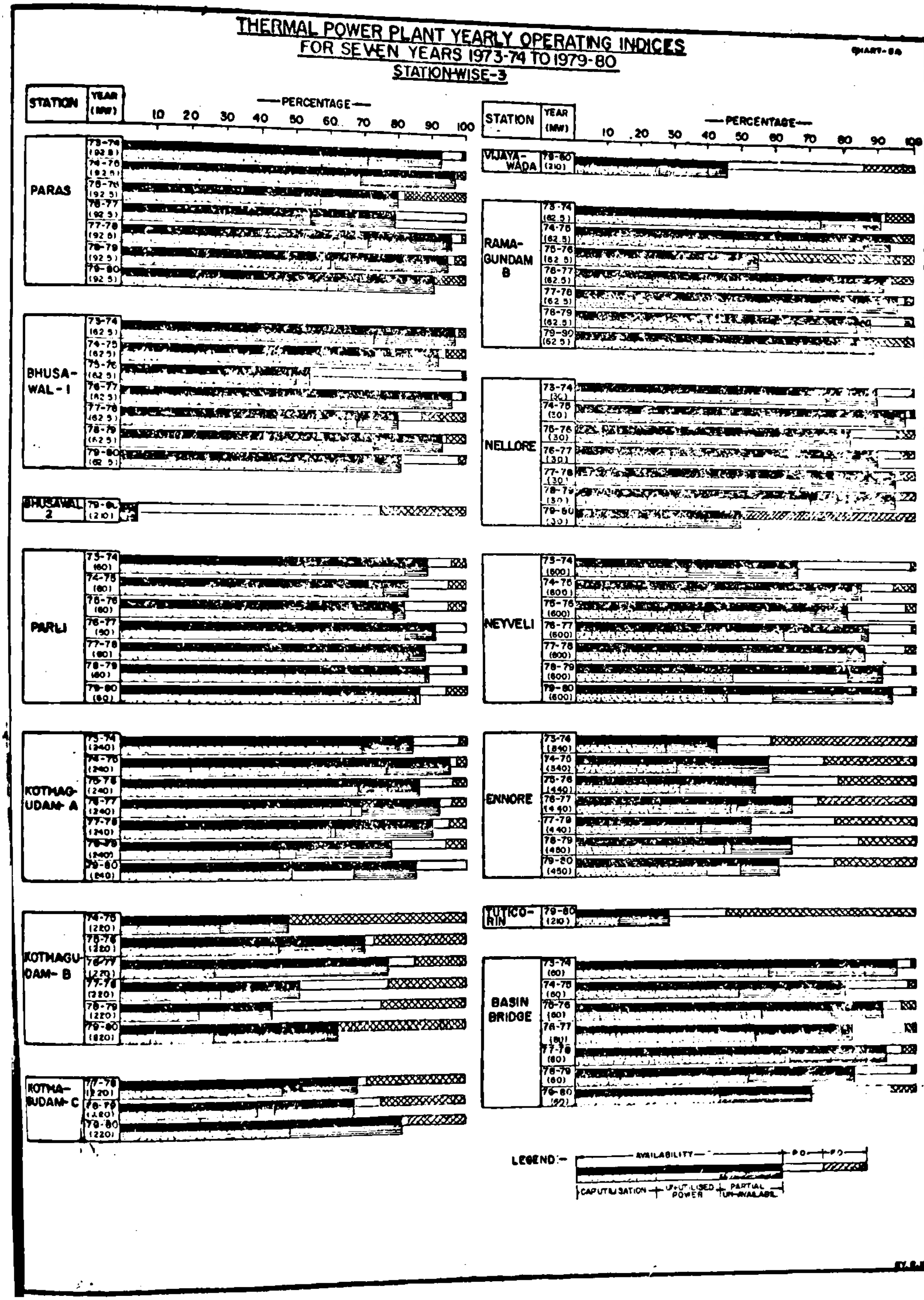


CHART-48

THERMAL POWER PLANT YEARLY OPERATING INDICES FOR SEVEN YEARS 1973-74 TO 1979-80

STATION-WISE-2

STATE	POWER STATION	YEAR	NO. OF UT.	CAPACITY (MW)	GENERATION (MU)	OPERATING HOURS	PLANNED OUTAGE %	FORCED OUTAGE %	AVAILABILITY %	UN-UTILISED POWER %	PARTIAL UN-AVAILABILITY %	CAP. UTILISATION %
GUJARAT	AECQ	73-74	2	60	427.27	8124	8.94	0.32	92.74	-	11.48	81.59
		74-75	2	60	432.10	7984	8.01	0.05	91.14	-	8.95	83.21
		75-76	2	60	440.22	8831	8.71	0.39	93.70	-	10.18	83.63
		76-77	2	60	376.90	8129	7.27	-	92.73	8.43	8.60	78.40
		77-78	2	57	374.10	7984	11.87	0.31	87.78	4.04	7.78	78.06
		78-79	2	57	385.43	7800	6.62	0.24	93.04	8.89	10.82	77.23
		79-80	2	57	[illegible]	7310	14.08	0.41	88.[illegible]	10.98	8.33	59.72
		80-81										
	SABRAMATI EXTN.	78-79	1	110	[illegible]	1332	8.92	2.67	83.81	1.89	47.14	37.99
		79-80	1	110	[illegible]	8113	19.[illegible]	10.59	[illegible]	13.12	3.03	48.90
		80-81										
	UKAI 1-2	76-77	1	[illegible]	[illegible]	[illegible]	1.0[illegible]	50.17	40.80	1.77	84.31	28.71
		77-78	2	240	671.62	[illegible]	30.75	11.05	81.72	3.35	19.12	91.75
		78-79	[illegible]	[illegible]	[illegible]	[illegible]	24.[illegible]	[illegible]	67.59	12.94	13.97	47.59
		79-80	2	240	603.58	[illegible]	[illegible]	3.12	[illegible]	24.09	9.0[illegible]	47.19
		80-81										
	UKAI 3-4 EXTN	78-79	1	200	50.[illegible]	[illegible]	11.51	2.17	86.02	3.70	84.50	17.82
		79-80	[illegible]	[illegible]	724.[illegible]	6500	7.81	[illegible]	82.01	12.92	[illegible]	24.93
		80-81										
	GHANDI NAGAR	77-78	2	240	553.[illegible]	[illegible]	27.43	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		78-79	2	240	1015.86	6060	14.33	3.28	70.08	0.26	31.[illegible]	47.31
		79-80	2	240	1097.58	7227	13.01	3.05	83.41	8.19	28.14	62.09
		80-81										
MADHYA PRADESH	SATPURA 1-5	73-74	5	312.5	1315.00	8720	28.93	[illegible]	69.37	-	17.34	40.63
		74-75	5	312.5	1641.70	6707	13.38	[illegible]	77.[illegible]	-	17.32	59.97
		75-76	5	312.5	1609.40	7051	4.38	0.60	[illegible]	-	10.[illegible]	[illegible]
		76-77	5	312.5	[illegible]	6449	3.69	-	86.48	1.38	33.25	38.64
		77-78	5	[illegible]	1972.00	7430	6.43	[illegible]	[illegible]	[illegible]	18.4[illegible]	66.41
		78-79	5	[illegible]	[illegible]	6990	9.32	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		79-80	5	312.5	1706.98	7132	12.39	[illegible]	[illegible]	-	12.04	62.1[illegible]
		80-81										
	SATPURA-6 EXTN.	79-80	1	200	[illegible]	[illegible]	19.11	[illegible]	19.17	-	19.37	[illegible]
		80-81										
	KORBA-I	73-74	3	60	380.35	[illegible]	[illegible]	17.38	34.82	-	33.20	65.32
		74-75	3	90	337.20	8191	4.43	2.22	63.50	-	41.86	52.24
		75-76	[illegible]	[illegible]	450.17	6583	2.[illegible]	0.60	[illegible]	-	32.20	68.19
		76-77	3	60	444.24	7345	15.89	[illegible]	81.86	0.41	10.09	63.40
		77-78	3	60	390.10	[illegible]	24.71	0.28	75.01	-	13.38	[illegible]
		78-79	3	80	334.97	8569	21.70	3.47	74.74	11.28	19.07	47.70
		79-80	3	60	394.00	8758	34.08	0.48	63.49	6.70	8.50	48.[illegible]
		80-81										
	KORBA-II	73-74	4	200	806.17	6707	28.60	[illegible]	67.18	-	18.49	[illegible]
		74-75	4	200	889.20	6277	19.87	0.43	71.68	-	18.84	[illegible]
		75-76	4	200	1179.10	6766	14.89	[illegible]	77.33	-	10.14	66.[illegible]
		76-77	4	200	1400.[illegible]	7703	[illegible]	[illegible]	[illegible]	-	9.15	79.93
		77-78	4	200	1130.39	6771	13.85	0.84	77.80	0.03	12.73	64.31
		78-79	4	200	1111.60	[illegible]	2.[illegible]	[illegible]	78.[illegible]	-	14.98	[illegible]
		79-80	4	200	911.29	5933	18.04	10.82	67.04	8.14	12.04	[illegible]
		80-81										
	KORBA-III EXTN.	76-77	1	120	133.00	2359	-	73.09	20.92	-	14.77	[illegible]
		77-78	1	120	767.00	7381	4.60	10.75	84.28	-	11.30	72.80
		78-79	1	120	816.09	7728	0.80	[illegible]	[illegible]	0.48	[illegible]	77.33
		79-80	1	120	796.74	8381	1.02	[illegible]	85.19	-	19.[illegible]	75.01
		80-81										
	AMARKANTAK	73-74	2	60	430.33	8574	2.12	-	97.88	-	16.0[illegible]	81.87
		74-75	2	60	320.22	6621	2.30	23.10	74.44	-	13.02	[illegible]
		75-76	2	60	478.10	8739	0.38	0.10	99.44	-	9.10	[illegible]
		76-77	2	60	492.32	8710	0.37	-	99.43	-	10.67	[illegible]
		77-78	2	60	450.84	8090	0.88	0.99	98.06	-	12.34	[illegible]
		78-79	2	60	347.73	7372	13.06	1.66	84.16	-	14.00	[illegible]
		79-80	2	60	401.81	8239	4.86	1.36	93.79	-	17.33	[illegible]
		80-81										
	AMARKANTAK EXTN.	77-78	1	120	178.00	2748	-	45.99	54.01	-	24.86	20.18
		78-79	2	240	[illegible]	2820	10.10	15.80	74.10	0.72	27.12	[illegible]
		79-80	2	240	1285.96	7872	4.86	8.10	86.20	0.14	28.12	61.00
		80-81										
MAHARASHTRA	KORADI 1-4	74-75	1	120	347.35	6096	8.98	21.44	[illegible]	-	[illegible]	33.07
		75-76	2	240	1095.00	6245	19.49	[illegible]	71.11	-	19.12	[illegible]
		76-77	4	480	1804.80	6308	17.94	10.60	72.01	4.32	[illegible]	40.84
		77-78	4	480	[illegible]	7448	8.10	9.88	85.02	11.82	11.18	[illegible]
		78-79	4	480	2739.70	6021	19.31	6.11	75.88	6.70	3.06	[illegible]
		79-80	4	480	[illegible]	7314	8.89	8.09	83.20	5.41	[illegible]	[illegible]
		80-81										
	KORADI-5 EXTN.	78-79	1	200	71.00	193	-	[illegible]	17.74	-	6.91	[illegible]
		79-80	1	200	[illegible]	[illegible]	3.30	12.88	[illegible]	-	11.12	[illegible]
		80-81										
	TROMBAY	73-74	4	337.5	1884.40	[illegible]	19.44	1.01	[illegible]	-	24.71	[illegible]
		74-75	4	337.5	[illegible]	7108	18.50	0.88	61.12	-	16.43	[illegible]
		75-76	4	337.5	2019.60	[illegible]	17.11	4.24	[illegible]	-	[illegible]	[illegible]
		76-77	4	337.5	[illegible]	[illegible]	[illegible]	0.84	76.73	0.42	[illegible]	[illegible]
		77-78	4	330	2105.30	[illegible]	13.58	2.61	[illegible]	0.01	[illegible]	[illegible]
		78-79	4	330	2347.05	[illegible]	[illegible]	1.02	[illegible]	-	[illegible]	[illegible]
		79-80	4	330	[illegible]	7820	11.87	2.52	[illegible]	-	11.50	[illegible]
		80-81										
	NASIK 1-2	73-74	[illegible]	280	1931.70	6000	18.58	[illegible]	75.42	-	14.10	81.29
		74-75	[illegible]	160	[illegible]	[illegible]	4.00	[illegible]	[illegible]	-	[illegible]	[illegible]
		75-76	[illegible]	200	[illegible]	[illegible]	31.32	[illegible]	[illegible]	-	[illegible]	[illegible]
		76-77	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		77-78	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		78-79	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	76.04	-	16.01	[illegible]
		79-80	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2.70	[illegible]	68.67
		80-81										
	NASIK-3 EXTN.	79-80	1	210	271.00	[illegible]	17.97	47.82	44.60	-	48.74	[illegible]
		80-81										
	KHAPERKHEDA	73-74	3	90	[illegible]	8393	4.02	0.17	[illegible]	-	31.09	[illegible]
		74-75	3	90	[illegible]	[illegible]	4.71	[illegible]	[illegible]	-	37.40	[illegible]
		75-76	[illegible]	[illegible]	[illegible]	[illegible]	8.18	[illegible]	91.[illegible]	-	[illegible]	54.09
		76-77	[illegible]	[illegible]	[illegible]	8034	2.34	-	97.70	2.40	[illegible]	[illegible]
		77-78	[illegible]	90	[illegible]	7711	7.64	4.23	[illegible]	8.78	[illegible]	[illegible]
		78-79	[illegible]	90	[illegible]	8860	10.01	3.19	[illegible]	[illegible]	37.60	[illegible]
		79-80	3	[illegible]	409.00	8674	4.01	[illegible]	[illegible]	-	41.01	51.75
		80-81										


THERMAL POWER PLANT YEARLY OPERATING INDICES
FOR SEVEN YEARS 1973-74 TO 1979-80
STATION-WISE-3
STATION
YEAR (MW)
PERCENTAGE
10 20 30 40 50 60 70 80 90 100
PARAS
BHUSAWAL-I
BHUSAWAL 2
PARLI
KOTHAGUDAM-A
KOTHAGUDAM-B
KOTHAGUDAM-C
VIJAYAWADA
RAMAGUNDAM B
NELLORE
NEYVELI
ENNORE
TUTICORIN
BASIN BRIDGE
LEGEND:-
AVAILABILITY
CAP. UTILISATION
UNUTILISED POWER
PARTIAL UN-AVAILABL.

THERMAL POWER PLANT - YEARLY OPERATING INDICES FOR SEVEN YEARS 1973-74 TO 1979-80

CHART-[illegible]

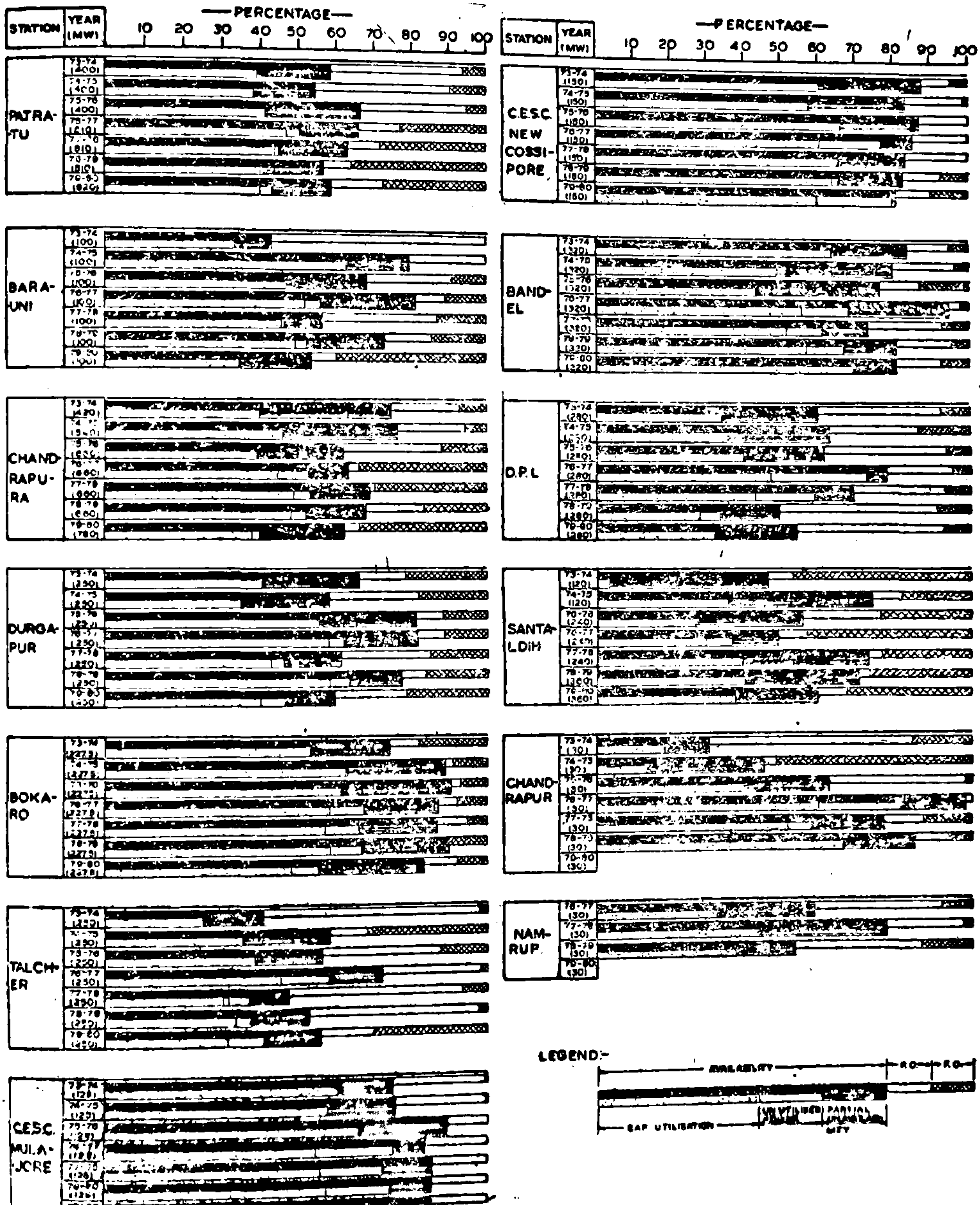
STATION-WISE-3

STATE	POWER STATION	YEAR	NO OF UT.	CAPA-CITY (MW)	GENERA-TION (MU)	OPERA-TING HOUR	PLANNED OUTAGE %	FORCED OUTAGE %	AVAILA-BILTY %	UN-UTIL-ISED %	PARTIAL UN-AVAIL-ABILTY %	CAP.-UTI-LISATION %
MAHARASHTRA	PARAS	73-74	2	92.5	573.07	8182						
		74-75	2	92.5	573.09	8016	8.09	0.31	93.40	-	22.67	70.74
		75-76	2	92.5	466.72	7070	0.47	2.29	97.24	-	27.76	69.28
		76-77	2	92.5	460.06	6955	1.43	18.08	80.49	-	23.05	57.44
		77-78	2	92.5	518.09	8425	20.30	0.10	79.40	1.62	26.26	51.52
		78-79	2	92.5	489.30	8245	2.53	1.29	96.18	7.35	24.90	63.93
		79-80	2	92.5	281.00	7552	2.29	2.07	84.84	0.72	33.73	60.19
		80-81					6.20	8.27	90.33	2.88	28.45	59.20
	BHUSAWAL-1	73-74	1	62.5	408.43	8510						
		74-75	1	62.5	392.00	8091	0.92	1.93	97.15	-	24.01	73.14
		75-76	1	62.5	288.48	4785	2.00	5.64	92.36	-	20.76	71.60
		76-77	1	62.5	463.83	8450	44.23	7.30	54.47	-	5.47	48.90
		77-78	1	62.5	358.29	7003	2.74	0.80	96.46	-	11.73	84.73
		78-79	1	62.5	400.60	8162	6.51	13.25	79.94	2.81	11.60	65.44
		79-80	1	62.5	359.62	7076	1.14	5.69	93.17	-	20.00	73.17
		80-81					17.76	1.89	80.35	-	15.15	65.40
	BHUSAWAL-2	79-80	1	210.0	24.00	210	70.09	25.23	4.68	-	2.35	2.13
		80-81										
	PARLI	73-74	2	60	431.98	7814						
		74-75	2	60	397.58	7230	7.27	2.83	89.20	-	7.16	82.02
		75-76	2	60	414.67	7192	11.64	2.83	82.57	-	6.97	75.82
		76-77	2	60	428.02	7981	11.66	5.03	81.00	-	3.34	78.84
		77-78	2	60	438.01	7725	8.86	—	91.11	0.49	8.01	81.81
		78-79	2	60	463.52	7811	10.80	1.02	86.18	0.11	4.74	83.33
		79-80	2	60	450.70	7374	10.09	0.72	89.17	0.16	0.82	88.19
		80-81					7.88	8.12	86.22	0.37	0.45	85.20
ANDHRA PRADESH	KOTHAGUDAM (A)	73-74	4	240	1457.53	7381	13.93	1.79	84.28	-	14.96	69.30
		74-75	4	240	1605.68	8340	1.92	2.87	95.21	-	19.02	76.19
		75-76	4	240	1216.66	7571	10.22	3.57	86.19	-	28.47	57.72
		76-77	4	240	1394.55	8029	3.88	4.36	91.76	2.28	23.15	66.33
		77-78	4	240	1350.02	7800	4.41	5.41	90.18	1.40	29.08	53.70
		78-79	4	240	947.66	6810	15.83	7.40	77.77	5.04	27.65	45.08
		79-80	4	240	1027.52	7444	0.03	15.23	84.74	17.85	16.00	48.74
		80-81										
	KOTHAGUDAM (B)	74-75	2	220	227.02	4191	—	52.15	47.84	-	19.53	28.31
		75-76	2	220	863.16	6172	3.46	23.24	70.28	-	25.39	44.67
		76-77	2	220	800.18	6714	7.58	15.28	76.64	-	30.50	41.84
		77-78	2	220	533.10	4445	25.72	23.08	51.20	0.08	23.44	27.58
		78-79	2	220	431.05	3784	31.61	25.43	42.98	-	[illegible]	22.37
		79-80	2	220	400.94	5456	—	37.55	62.45	-	36.58	23.87
		80-81										
	KOTHAGUDAM (C)	77-78	2	220	488.05	[illegible]	5.17	26.53	[illegible]	-	[illegible]	45.06
		78-79	2	220	746.79	[illegible]	8.25	24.66	[illegible]	4.75	21.27	[illegible]
		79-80	2	220	[illegible]	7631	2.34	15.93	[illegible]	-	32.41	[illegible]
		80-81										
	VIJAYAWADA	79-80	1	210	196.00	1691	40.40	13.24	46.36	-	20.61	25.75
		80-81										
	RAMAGUDAM (B)	73-74	1	62.5	393.52	7956	0.34	8.54	90.63	-	17.82	73.06
		74-75	1	62.5	468.98	8259	—	5.71	94.32	-	8.63	85.58
		75-76	1	62.5	261.23	4667	—	44.79	55.41	-	3.83	51.55
		76-77	1	62.5	438.82	[illegible]	0.49	[illegible]	91.57	0.07	[illegible]	[illegible]
		77-78	1	62.5	508.18	[illegible]	[illegible]	2.20	[illegible]	-	23.14	[illegible]
		78-79	1	62.5	[illegible]	7712	11.15	2.01	86.04	0.03	3.78	83.75
		79-80	1	62.5	407.32	[illegible]	—	10.09	89.61	0.04	[illegible]	74.33
		80-81										
	NELLORE	73-74	1	30	196.76	7840	9.82	0.69	89.50	-	14.63	74.87
		74-75	1	30	241.13	[illegible]	0.78	1.24	[illegible]	-	0.23	91.75
		75-76	1	30	[illegible]	7141	12.74	[illegible]	[illegible]	-	7.07	[illegible]
		76-77	1	30	194.41	[illegible]	8.73	3.73	[illegible]	1.82	13.04	[illegible]
		77-78	1	30	183.28	6404	1.03	4.17	94.76	-	25.00	69.74
		78-79	1	30	181.10	[illegible]	1.33	[illegible]	90.32	-	[illegible]	68.91
		79-80	1	30	75.58	4282	0.20	[illegible]	[illegible]	-	29.12	28.74
		80-81										
TAMIL-NADU	NEYVELI	73-74	9	600	2275.93	[illegible]	32.01	0.74	65.49	-	25.37	43.08
		74-75	9	600	2268.68	7657	10.69	6.27	82.84	-	39.30	43.54
		75-76	9	600	[illegible]	[illegible]	12.55	4.85	80.39	-	33.03	47.56
		76-77	9	600	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	22.25	[illegible]	[illegible]
		77-78	9	600	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		78-79	9	600	2493.42	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10.19	47.44
		79-80	9	600	[illegible]	7021	4.74	[illegible]	94.45	14.20	[illegible]	[illegible]
		80-81										
	ENNORE	73-74	2	340	775.02	2703	18.58	37.18	42.27	-	[illegible]	[illegible]
		74-75	2	340	915.85	[illegible]	16.74	[illegible]	[illegible]	-	[illegible]	20.70
		75-76	3	450	952.66	[illegible]	[illegible]	[illegible]	[illegible]	-	21.88	[illegible]
		76-77	3	450	1801.38	[illegible]	[illegible]	27.60	64.16	2.11	16.33	45.70
		77-78	3	430	1438.34	4613	[illegible]	[illegible]	51.52	0.38	14.68	38.30
		78-79	3	450	1720.97	[illegible]	19.21	[illegible]	84.40	1.86	16.78	43.60
		79-80	3	450	1547.93	[illegible]	[illegible]	[illegible]	60.15	9.57	[illegible]	39.15
		80-81										
	TUTICORIN	79-80	1	210.0	171.10	1655	16.92	[illegible]	58.77	-	15.91	12.78
		80-81										
	BASIN BRIDGE	73-74	2	60	300.74	[illegible]	3.37	1.70	94.95	-	37.03	[illegible]
		74-75	2	60	[illegible]	[illegible]	[illegible]	1.14	79.83	-	[illegible]	43.10
		75-76	2	60	[illegible]	2069	[illegible]	[illegible]	80.62	-	38.08	53.54
		76-77	2	60	278.66	7147	15.07	2.04	81.58	0.03	28.90	12.64
		77-78	2	60	[illegible]	[illegible]	[illegible]	[illegible]	91.67	0.70	29.26	61.53
		78-79	2	60	[illegible]	7250	[illegible]	1.37	83.13	0.41	34.02	[illegible]
		79-80	2	60	217.35	6105	[illegible]	[illegible]	70.19	1.08	27.64	41.29
		80-81										

THERMAL POWER PLANT YEARLY OPERATING INDICES FOR SEVEN YEARS 1973-74 TO 1979-80

CHART-6A

STATION-WISE - 4



NOTE * EXCLUDES CHANDRAPUR & NAMRUP POWER STATIONS (N.E REGION) FOR WHICH NO OPERATING DATA HAS BEEN RECEIVED.

THERMAL POWER PLANT YEARLY OPERATING INDICES FOR SEVEN YEARS 1973-74 TO 1979-80

STATION-WISE-4

CHART-69

STATE	STATIONS	YEAR	NO. OF UNITS	CAP. IN (MW)	GENERATION IN (MU)	OPERATING HOURS	PLANNED OUTAGE %	FORCED OUTAGE %	AVAILABILITY %	UN-UTILISED POWER %	PARTIAL UN-AVAILABILITY %	CAPACITY UTILISED %
BIHAR	PATRATU	73-74	6	400	1585.30	4627	35.5[illegible]	5.94	58.53	—	19.30	39.23
		74-75	6	400	1142.73	4779	35.87	9.61	54.92	—	16.15	32.37
		75-76	6	400	1254.10	5567	27.67	5.24	66.79	—	25.69	41.10
		76-77	7	510	1716.33	5737	11.06	23.25	65.71	3.47	15.67	46.58
		77-78	7	510	1645.13	5525	8.23	28.87	63.06	0.82	18.60	43.54
		78-79	7	510	1784.74	4917	7.14	38.17	58.49	0.58	15.56	39.95
		79-80	8	620	2138.86	6160	13.19	27.64	58.97	2.87	18.37	39.73
		80-81										
	BARAUNI	73-74	2	100	291.31	3724	57.40	—	42.51	—	9.22	33.28
		74-75	2	100	546.91	6990	20.15	0.02	79.83	—	17.40	62.43
		75-76	2	100	410.20	5974	22.63	9.36	68.01	—	21.32	46.69
		76-77	2	100	454.55	7120	7.74	10.98	81.28	4.11	25.28	51.80
		77-78	2	100	399.74	4899	31.05	13.03	55.92	0.46	9.83	45.63
		78-79	2	100	429.53	6145	12.54	14.54	72.92	2.77	21.12	49.03
		79-80	2	100	290.71	4050	6.69	40.37	52.9[illegible]	—	12.10	[illegible]
		80-81										
D.V.C.	CHANDRAPURA	73-74	3	420	1475.30	6568	13.63	7.72	75.35	—	35.04	39.49
		74-75	4	540	2158.81	6727	17.5[illegible]	5.63	76.79	—	31.16	45.63
		75-76	5	660	2247.34	7425	26.32	11.92	61.76	—	23.50	39.76
		76-77	5	660	2382.29	5559	2.84	34.27	62.89	8.50	9.92	44.66
		77-78	5	660	2824.13	6035	1.32	29.79	63.80	4.25	15.60	49.85
		78-79	5	660	2779.27	5984	15.06	16.63	68.31	3.87	16.37	48.07
		79-80	6	780	2587.39	5443	4.44	33.60	61.96	2.00	22.13	37.77
		80-81										
	DURGAPUR	73-74	3	250	639.28	5795	12.12	21.73	66.15	—	25.33	40.02
		74-75	3	250	737.32	7115	23.62	18.01	58.17	—	23.27	34.80
		75-76	3	250	1217.37	7130	7.37	11.63	81.00	—	25.57	55.43
		76-77	3	250	1277.38	5256	7.21	11.40	81.39	4.15	18.91	59.33
		77-78	3	250	942.50	5523	23.50	15.24	61.26	3.13	15.09	43.04
		78-79	3	250	1273.07	6749	6.41	16.52	77.06	4.99	13.93	53.13
		79-80	3	250	884.09	5232	18.73	21.67	59.58	6.15	13.26	40.17
		80-81										
	BOKARO	73-74	4	227.5	1047.17	6513	7.08	19.57	74.35	—	21.77	[illegible]
		74-75	4	227.5	1242.84	7609	1.92	8.94	89.14	—	26.76	62.36
		75-76	4	227.5	1220.50	7967	2.05	7.25	90.70	—	27.61	61.09
		76-77	4	227.5	1158.67	7853	4.71	7.04	87.35	8.95	20.23	58.14
		77-78	4	227.5	[illegible]	[illegible]	8.1[illegible]	[illegible]	85.53	8.[illegible]	[illegible]	[illegible]
		78-79	4	227.5	1165.53	7878	—	13.07	69.93	7.90	[illegible]	58.48
		79-80	4	227.5	950.72	[illegible]	[illegible]	7.85	[illegible]	7.18	[illegible]	47.76
		80-81										
ORRISA	TALCHER	73-74	4	250	546.84	3573	57.[illegible]	[illegible]	40.50	—	[illegible]	[illegible]
		74-75	4	250	860.[illegible]	[illegible]	[illegible]	[illegible]	58.80	—	[illegible]	[illegible]
		75-76	4	240	[illegible]	4073	[illegible]	[illegible]	[illegible]	—	[illegible]	[illegible]
		76-77	4	250	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		77-78	4	250	669.09	4129	[illegible]	3.24	47.05	9.08	11.82	[illegible]
		78-79	4	250	724.27	4459	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		79-80	4	250	[illegible].71	4104	[illegible]	[illegible]	55.60	9.09	[illegible]	[illegible]
		80-81										
WEST BENGAL	C.E.S.C. (Mulajore)	73-74	5	128	657.57	6004	24.17	0.49	75.30	—	14.98	60.41
		74-75	5	128	664.70	6551	23.15	0.85	75.[illegible]	—	10.60	57.[illegible]
		75-76	5	128	742.62	7853	10.[illegible]	—	[illegible]	—	[illegible]	[illegible]
		76-77	5	128	579.71	[illegible]	15.21	—	63.79	20.00	8.90	54.[illegible]
		77-78	5	[illegible]	[illegible]	[illegible]	14.[illegible]	—	85.[illegible]	10.[illegible]	[illegible]	[illegible]
		78-79	5	128	639.96	7453	14.74	—	85.25	16.67	11.51	[illegible]
		79-80	5	128	[illegible]	[illegible]	14.67	0.21	85.10	7.[illegible]	18.57	[illegible]
		80-81										
	C.E.S.C. (New Cossipore)	73-74	4	150	765.70	7714	7.4[illegible]	[illegible].47	81.[illegible]	—	[illegible].42	[illegible]
		74-75	4	150	782.60	7296	10.[illegible]	[illegible]	81.91	—	25.29	58.0[illegible]
		75-76	4	150	879.78	7625	13.19	—	[illegible]	—	20.[illegible]	56.[illegible]
		76-77	4	150	796.82	7533	14.21	—	85.79	16.00	8.78	61.03
		77-78	4	150	863.91	7329	16.33	—	83.67	0.32	17.64	65.71
		78-79	4	150	839.26	7274	10.02	6.94	83.04	1.64	17.5[illegible]	62.67
		79-80	4	150	704.49	7083	9.29	10.08	80.63	19.34	0.99	60.30
		80-81										
	BANDEL	73-74	4	320	1732.62	7365	10.97	4.96	84.07	—	20.53	61.54
		74-75	4	320	1378.78	7026	16.37	3.43	80.20	—	31.00	49.12
		75-76	4	320	1208.54	6726	10.70	12.73	76.57	—	33.58	42.95
		76-77	4	320	1559.69	8328	2.97	1.98	95.05	12.67	26.75	55.63
		77-78	4	320	1448.50	6404	19.78	7.09	73.13	9.51	11.96	51.66
		78-79	4	320	1594.40	7093	14.92	4.11	80.97	9.98	14.11	56.05
		79-80	4	320	1548.26	7115	13.88	8.29	81.00	14.67	11.25	55.09
		80-81										
	D.P.L.	73-74	5	280	828.20	5243	32.52	7.53	59.65	—	28.07	32.78
		74-75	5	280	804.01	5498	23.74	13.50	62.76	—	27.83	34.93
		75-76	5	280	973.62	5384	32.60	6.11	61.29	—	21.73	39.56
		76-77	5	280	1114.42	6853	17.45	4.55	78.00	25.67	5.49	46.84
		77-78	5	280	1001.81	6069	24.25	6.47	69.28	16.05	10.82	42.41
		78-79	5	280	693.69	4288	42.57	8.49	48.94	4.91	15.7[illegible]	28.28
		79-80	5	280	793.08	4742	39.30	6.71	53.99	—	21.74	32.25
		80-81										
	SANTALDIH	73-74	1	120	31.08	996	6.53	47.36	46.11	—	43.15	2.96
		74-75	1	120	373.00	6513	7.59	10.08	74.35	—	38.88	35.47
		75-76	2	240	458.08	4691	20.33	23.98	55.68	—	29.06	26.62
		76-77	2	240	625.09	4335	7.37	43.26	49.37	7.17	12.47	29.73
		77-78	2	240	848.29	6385	3.82	23.24	73.04	—	[illegible]	[illegible].41
		78-79	3	360	1017.65	6421	2.58	26.81	70.81	—	30.[illegible]	39.[illegible]
		79-80	3	400	1151.72	3090	—	54.47	45.53	—	14.[illegible]	30.96
		80-81										
ASSAM	CHANDRAPUR	73-74	1	30	47.70	3276	53.87	13.30	30.74	—	13.55	16.13
		74-75	1	30	[illegible]	[illegible]	2.35	52.51	45.10	—	31.63	15.53
		75-76	1	30	109.95	[illegible]	30.00	1.44	67.49	—	22.06	[illegible]
		76-77	1	30	130.51	[illegible]	1.47	—	98.53	21.46	17.52	59.25
		77-78	1	30	134.25	5734	10.43	12.47	77.10	5.06	10.57	51.01
		78-79	1	30	174.31	7481	8.54	6.06	85.40	—	19.07	66.33
		* 79-80	1	30								
		80-81										
	NAMRUP	76-77	1	30	84.67	3145	33.72	7.55	58.73	—	26.51	32.22
		77-78	1	30	115.00	6816	20.27	1.92	77.81	—	24.04	43.77
		78-79	1	30	97.26	4644	33.70	13.29	53.01	—	16.00	37.01
		* 79-80	1	30								
		80-81										

NOTE-* EXCLUDES CHANDRAPUR & NAMRUP POWER STATIONS (N.E. REGION) FOR WHICH NO OPERATING DATA HAS BEEN RECEIVED.

APPENDIX 5.1

Comparative performance of the State Electricity Boards in 1977-78 in certain selected areas

Sl. No.	SEBs (including MPC)	Capacity utilisation (Percentages) Thermal %	Capacity utilisation (Percentages) Hydel %	Average tariff revenue per unit sold (Paise per[4] kWh)	Transmission and distribution losses (percentage)	Cost of power purchase (Paise per kWh)	Admn. and establishment charges per unit sent out (Paise per kWh)	O & M charges per unit sent out (Paise per kWh)	Total operating expenses per unit sent out (Paise per[3] kWh	Fixed cost per unit sent out(depreciation + interest accrued (Paise per kWh)	%age of works-in-progress to block capital in the middle of 1978-79 (30-9-78)
1	2	3	4	5	6	7	8	9	10	11	12
1.	Andhra Pradesh	43·7	29·8	29·1	23·2	24·8	6·3	1·9	14·4	10·4	16·9
2.	Assam	47·6	..	28·9	19·5	16·4	6·9	5·5	22·7	13·8	55·1
3.	Bihar	36·5	5·4	28·6	24·4	15·6	NA	1·5	17·0	9·8	23·5
4.	Gujarat	44·7	49·2	25·4	17·6	13·9	2·3	2·7	14·5	7·9	19·1
5.	Haryana	56·9	42·8	23·7	20·9	22·9	5·3	3·0	13.5	11·9	26·4
6.	Himachal Pradesh	..	22·1	23·8	21·6	6·5	5·9	7·9	16·7	15·2	67·5
7.	Jammu & Kashmir	5·5	33·5	15·7	21·0	8·7	NA	6·5	13·0	14·6	48·2
8.	Karnataka	..	29·5	17·9	22·7	5·5	4·6	1·1	10·6	3·7	19·3
9.	Mysore Power Corporation[7]	NA	NA	3·2	..	..	0·6[6]	0·4	1·2	4·6	58·9
10.	Kerala	..	50·5	14·0	11·2	..	5·8	1·6	7·4	6·1	22·1
11.	Madhya Pradesh	50·0	63·2	23·6	18·9	18·6	5·7	1·3	13·1	9·0	34·3
12.	Maharashtra	53·2	60·9	23·3	16·8	NA	3·0	1·5	11·9	4·5	29·1
13.	Meghalaya	11·4	37·5	15·4	NA	..	5·1	2·4	8·0	17·6	34·5
14.	Orissa	29·6	42·3	12·1	14·2	..	3·4	1·3	9·5	6·9	34·0
15.	Punjab	27·5	46·0	17·5	16·8	12·5	4·8	1·4	8·4	11·5	16·0
16.	Rajasthan	56·4	45·3	34·0[1]	23·4	21·2[5]	4·9	3·2[5]	16·5	9·1	13·9
17.	Tamil Nadu	39·2	33·5	26·0	18·6	17·7	5·7	1·7	17·6	6·0	18·2
18.	Uttar Pradesh	39·3	33·8	24·2	20·0	24·2[5]	6·4	2·2	16·7	14·2	30·7
19.	West Bengal	44·1	27·9	24·3	12·8	16·7	7·6[2]	7·6[2]	17·5	9·2	47·2

1 Includes arrear realisation of about 9·4 paise per kWh.

2 Establishment, administration and O & M charges.

3 Includes cost of fuel, cost of power purchases, O & M charges and administration and establishment charges.

4 Excludes subsidy and miscellaneous receipts.

5 Relates to 1978-79.

6 Only generation staffs.

7 The functions of other Boards are performed by two agencies in Karnataka viz. MPC and Karnataka SEB hence figures are not comparable.

Source : For column 2 and 3 data based on General Review—1977-78 (CEA). For other columns information is based on SEBs and CEA booklet of August, 1979 on Performance of SEBs.

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APPENDIX 5.2

Transmission and distribution losses as percentage to net generation including power purchase

(Figures in percentages)

Sl. No.	Electricity Boards	1974-75 (Actuals)	1977-78 (Actuals)	1978-79 (Estimates)
1	2	3	4	5
1.	Andhra Pradesh	24·6	23·2	22·5
2.	Assam*	18·0	19·5	19·4
3.	Bihar**	25·1	24·4	25·0
4.	Gujarat*	20·3	17·6	18·0
5.	Haryana*	18·6	20·9	21·0
6.	Himachal Pradesh*	15·6	21·6	21·9
7.	Jammu & Kashmir**	22·6	21·0	36·0
8.	Karnataka*	16·8	22·7	21·8
9.	Kerala*	16·5	11·2	11·0
10.	Madhya Pradesh**	20·1	18·9	18·0
11.	Maharashtra**	16·1	16·8	17·3
12.	Orissa*	11·1	14·2	13·0
13.	Punjab*	17·8	16·8	18·1
14.	Rajasthan**	24·7	23·4	22·9
15.	Tamil Nadu*	21·4	18·6	19·0
16.	Uttar Pradesh*	22·3	20·0	19·9
17.	West Bengal*	9·2	12·8	11·5

Source.—*Based on the data furnished by the State Electricity Boards to the Committee on Power.

**Based on the data circulated by the CEA, Ministry of Energy in August, 1979 in the document "Financial Performance Review of SEBs during the 5th and 6th Plan period."

APPENDIX 5.3

Tariff guide-lines for different categories of transactions in the Southern, Northern, Eastern and Western Region

Sl. No.	Category of transaction	Recommended Tariff: SREB	NREB	EREB	WREB
1	2	3	4	5	6
1. Short term firm supply					
	Firm assistance in capacity and energy on a non-returnable basis for a period not exceeding one year.	Highest cost of generation and relevant transmission facilities plus an element of profit.	The Tariff should be the highest cost of generation in the supplying system plus a profit element of 10% thereof at the generating station Bus Bar. (This is not applicable to BMB)	Average cost of thermal generation in the supply system (fixed charges plus suitably updated running charges) and transmission cost together with an element of profit which should be a percentage (not exceeding 10%) of the cost of generation and transmission as worked out above. It will be one part tariff *i. e.*, unit rate as would be aggreed upon by the parties concerned.	Pooled cost of generation in the supplying system plus a profit element of 10 % thereof the generating station.
2. Banking Transactions					
	Banking of spill hydro and surplus thermal energy with systems having spare storage capacity in its hydel reservoirs.	(a) *Sharing* (i) In proportion to the percentage deficit in energy in other systems in the region during the period from October to June if the banking system (which generates the spill energy) is not in deficit of energy. (ii) On a mutually agreed basis between the banking and the banker system if the banking system is itself a deficit system. (*b*) *Tariff* i) *Spill Hydro* : Weighted average cost of generation at those stations where spill energy is generated. (ii) *Surplus Thermal* Weighted average cost of the thermal stations in the system supplying off-peak energy.	*Thermal* Fuel cost of generation at the concerned thermal station plus 10 percent. *Hydro* At half the cost of generation at the station where spilling would have otherwise occurred. (No transmission cost be charged while energy is banked; but the transmission cost be charged by the sending system when the banked energy is released).	If the system which generates the surplus energy is itself not in deficit in energy over the year, then the sharing of the banked energy will be among all the other systems in the Region in proportion to their respective percentage deficits. *Tariff* (i) *Spill Hydro* : Half the cost of generation at the station where spill would have otherwise occurred. (ii) *Surplus Thermal* : Average fuel cost of generation at the thermal stations of the system having surplus thermal energy plus 10 per cent. (The transmission cost will be borne by the system which will bank the surplus energy and draw that energy subsequently from the bank).	*Thermal* Fuel cost of generation at th concerned thermal stations be 10 per cent. *Hydro* Half the cost of generation on the station where spill would have otherwise occurred.
3. Peaking Assistance					
	Peaking assistance to a system deficient in capacity.	50 per cent of the annual charges of previous year for the period of peaking (which include interest, depreciation, general reserve, and O & M) at the largest hydro station in the supplying system. The charges shall be worked out	50 per cent of the annual charges per MVA (Annual charges will include interest on capital, O & M, depreciation, general and other reserves provided in the Electricity Supply Act) and a profit element of 30 per cent	If committed assistance is given and taken during peak hours jointly defined and if the energy as received is subsequently returned back within a specified period then 50% of the charges calculated prorata for the period of peaking assistance in the generation system of the assisting party will have to be	50 per cent of the annual charges for MVA (Annual charges include interest on capital, O & M, depreciation, general and other reserves provided in the electricity supply Act). If the assistance is not for the

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		separately for the morning peak (3 hrs.) and evening peak (2 hrs.) based on the maximum demand touched during these hours.	calculated in respect of the generating station concerned in the supplying system. (to be implemented w. e. f. 1-10-75).	paid for by the system receiving the assistance. If the assistance is from the hydel station then the annual charges of all the thermal stations of that system will be considered. The energy received under this assistance shall be returned in kind within the agreed period. If it is not so returned, the energy will have to be paid for at the emergency assistance rate in addition to the demand charge already paid.	whole year, the cost of MVA shall be on prorata basis for the period during which the assistance is availed of. The energy received under this assistance shall be returned in kind within an agreed period. If it is not returned the energy will have to be paid at the emergency assistance rate.
4. Spinning Reserve Assistance					
	Maintaining spinning reserve for system(s) deficient in capacity.	50 per cent of the annual charges of previous year for the spinning period of the largest hydro station in the supplying system. Energy to be normally on a returning basis. If energy is not to be returned, tariff shall be as per short-term supply.	Annual charges for the reserve maintained, based on the latest published accounts, should be shared amongst the beneficiaries including the system maintaining the spinning reserve, in proportion to their peak demands. (In case of BMB only non partners of BMB will have to pay for spinning reserve.)	Excepting OSEB there is hardly any spinning reserve available during peak hours in the Eastern Region. Annual charges for the reserve maintained based on the latest published accounts should be shared by the beneficiaries entering into such transaction, including the system maintaining the spinning reserve. The sharing will be in proportion to the peak demand of each system. This spinning reserve will be a committed provision. The peak hours requirement might also be met as far as possible by (i) utilising captive power available, (ii) Load staggering and (iii) use of under frequency relays for load shedding.	50 percent of the annual charge for the reserve maintenance based on the latest published accounts. The beneficiaries of the system maintaining the spinning reserve share the charges in proportion to their peak demands.
5. Emergency Assistance					
	Assistance during emergencies.	Energy to be returned in kind. If the supplying system is in a position to give energy assistance, the rates shall be as per short-term supply.	Energy to be returned in kind over a period of one month. In case energy is not returned, charges should be as for short-term supply plus 10%. (In respect of supplies from BMB the rate shall be that which is chargeable to its partner States in case of excess drawal over their shares. The present rate is 19 paise per unit).	Such assistance will be availed of only if surplus capacity happens to be available during that time in the neighbouring system. There will be no firm commitment on either side for giving and taking such supply. In the event of such supply availed, attempt will be made to return the units within an agreed period and under agreed conditions. Any unrepaid balance will be paid for at a flat rate to be decided by the EREB. Such rate will be based on the highest incremental cost of generation and transmission of the participating systems together with a small margin for covering contingency and profit.	Energy to be returned in kind over a period of one month. If not returned, it should be charged at short term supply rate. Need to provide a deterrent rate for utilising emergency assistance instead of short-term assistance will be reviewed later based on operating experience.
6. Wheeling of Power					
	Wheeling of power from one system to other through an intermediate system.	Banked energy does not attract wheeling charges but only incremental losses. Any other wheeling of power from one system to another attracts 10 % service charges which is inclusive of transmission losses.	The cost of the transmission system should be worked out taking into account the annual cost of the entire grid comprising substations and lines of 132 KV and above including the portion(s) of interstate line(s) in	Banked energy does not attract wheeling charges but only incremental losses. Any other wheeling of power from one system to another attracts service charges. The exact quantum of the incremental losses and the service charges will have to be worked out by the constituent systems on	The cost of wheeling should be worked out taking into account the annual cost of entire grid comprising of all substations and lines 132 KV and above including inter-State lines in the system

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			that system and the total energy handled in that State (energy generated plus energy imported) and the transmission cost per unit arrived at. The cost shall be worked out on the basis of the latest published figures. In the absence of these figures the transmission cost figure of BMB shall be adopted.	approximate basis. Wheeling charges will always be paid by the system availing of the supply.	and the total energy handled in that State (on generated plus energy imported and the transmission cost per unit arrived at. The cost should be based on latest published figures subject to adjustment taken on actuals. In addition, the wheeling party should be compensated for transmission loss at 4% wheeling charges will be paid by the system, availing the supply.
7. Inadvertant Power Transfer					
Inadvertant and uncontrollable power transfers in the process of integrated operation.	If the deviation from the schedule exceeds 30 MW the following rates shall apply depending on the hours of occurrence of inadvertance (i) *Non-peak hours* : 50% of the charges for peaking assistance. (ii) *Peak hours:* 100% of the charges for peaking assistance. Energy to be adjusted over a period of one month. Balance, if any, shall be charged at the short term supply rate.	Energy should be adjusted as far as possible over a day and the balance, if any, adjusted over a period of one week but in any case not later than a fortnight. Unadjusted energy will be paid for at rate applicable under emergency assistance.	Limit of inadvertant and uncontrollable power transfer in the process of inter-connected operation should be plus 10 MW. Transfer of energy within this limit should be balanced within the month. Any unadjusted balance shall be paid for at the fuel cost of the receiving system. If and when this limit of plus 10 MW is exceeded, then payment will have to be made as follows : (i) For the excess supply occurring during night lean hours, payment will be made at half the fuel cost of the receiving system. (ii) For the excess drawal made during other hours of the day payment will be made at the emergency supply rate. The night lean hours will normally be from 22.00 hrs. to 8.00 hrs. but any modification felt necessary will be made from time to time by the Operating Committee.	The deviation should not exceed 3 MW over scheduled flows. If the deviation exceeds 30 MWs. the energy to be returned as soon as possible over a day for maximum within a week preferably under similar load conditions under which it was received. If they fail to return within a week, it would be charged short term rate.	
8. MVAR Supply					
In case a system is not capable of generating or is in deficit in MVAR capacity or the system conditions so demand that reactive energy has to be imported from other system.			8th of overall rate for short-term supply with a computed p. f. of 0·85 and if the p. f. is less than 0·85, rate will be half the (active) energy rate.		
9. Transmission Losses			Sending party and wheeling party if any shall be compensated for transmission losses to the extent of 4% each.		Sending party should be compensated for transmission losses to the extent of 4% and also for transmission incidence (As mentioned under Item 6 "Wheeling of Power") wherever considered app cab e.

1	2	3	4	5	6
10. Economy Exchange					
	Exchanges under this category are those which arise when the different systems have adequate resources to meet their demands but when such inter-System exchanges result in economy to the system.		Only running cost should enter into such transactions and tariffs should be based on the incremental/decremental cost of the participant systems. The equitable rate would be the average of the two costs.		The tariff in such cases should be the running cost of generation of the supplying system plus half of the saving resulting in purchase of such power by the receiving system.

APPENDIX—7.1

POWER SUPPLY INDUSTRY

Various Organisations Existing and Proposed

Sl. No.	Organisations	Status and structure	Existing functions and responsibilities	Proposed changes/addition in structure and functions
1	2	3	4	5
I. National Level Organisations				
1.	Deptt. of power Govt. of India.	Created in 1974 as a separate Deptt. under the Ministry of Energy. Prior to 1974, matters relating to power were under the purview of Ministry of Irrigation and power.	1. Laying down the national policy for development regulation and conservation of the country's power resources.	1. Formulation of policy guide lines for allocation of power from the Central/regioal power stations to the States and exchange of power from the surplus to the deficit States through REGCs.
		TheDeptt. of Power is administratively headed by a Secretary assisted by 5 Joint Secretaries each in charge of a wing.	2. Formulation and promotion of national programmes in the field of power.	2. Formulation of policy relating to tarifi for bulk supply from (a) Central generation agencies to the Regional Electricity Generation Corporation.
			3. Co-ordination of the development of non-conventional sources of energy for power generation.	(b) Regional Electriicity Generation Corporation to State Electricity Board's and (c) State Electricity Board having surplus Power to Regional Electricity Coporations.
			4. Administration of Electricity Laws.	3. Formulation of Policy and guide lines for Research and Development in the power sector.
			5. Administration of Central level automous/statutory/ Corporate bodies within power sector.	4. Administration of the Proposed Bureau of Electricity of Cost and Prices.
			6. Provisions of linkages between various agencies concerned with power develop ment.	
			7. Co-ordination of negotiations with external financing agencies.	
2.	Central Electricity Authority	Statutary organisation constituted under Section 3 of the Electricity (Supply) Act, 1948. Existed as a part-time body from 1951 to 1974 and most of its functions were being discharged by the Central Water and Power Commission and its predecessor organisations. With the creation of a separate Deptt. of Power and bifurcation of the Central Water Commission and Central Electricity Authority, it functions as a fulltime body from 1974. Administratively the CEA is under the Deptt. of power.	(i) Develop a sound, adequate and uniform national power policy formulated short-term and perspective plans for power development and co-ordinate the activities of the planning agencies in relation to the control and utilisation of national power resources;	1. Addition of Members for thermal and R & D and deletion of Member (Monitoring). 2. Monitoring and evaluating the performance of all national regional and State utilities.
			(ii) Act as arbitrators in matter arising between the State Government or the Board and a licensee or other person as provided in the Act;	3. Arbitration between the States on the disputes arising out of power distribution by the REGCs. 4. Approval of design philosophy and criteria for power projects—standardisation and optimisation.
		Consists of Chairman and five full-time Members. The work is functionally divided among six wings namely— (i) Thermal Wing, (ii) Hydro Wings, (iii) Power System Wing,	(iii) Make public from time to time information secured under the act and to provide for the publication of reports and investigations; (iv) Collect and record the data concerning generation, distribution, and utilisation of power and carry out studies relating to	5. Evolve guidelines for allocation of power from Central Sector power plants and surplus power from State, 6. Evolving guidelines for tariff fixation for bulk buying and selling of power by the REGs

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		(iv) Operation and Monitoring Wing, (v) Economic & Commercial Wing and (vi) Planning Wing. Each wing is under the charge of a Member except the Planning Wing which is directly under the charge of the Chairman assisted by the Chief Engineer.	cost efficiency, losses, benefits and such like matters; (v) Advise any State Govt., Board, Generation, Company or any other agency engaged in generation or supply of electricity on such matters as will enable such Govt., Board, Generating company or any other agency engaged in generation or supply of electricity on such matters as will enable such Government, Board, Generating Company or agency to operate and maintain the power system under its ownership or control in an improved manner and where necessary, in co-ordination with any other agency owning or having the control of another power system; (vi) Promote and assist in the timely completion of schemes sanctioned under Chapter V of the Act; (vii) Make arrangements for advancing the skill of persons in the generation and supply of electricity; (viii) Carry out, or make arrangements for, any investigation for the purpose of generating or transmitting electricity; (ix) Promote research in matters affecting the generation, transmission, and supply of electricity; (x) Advise the Central Government on any matter on which its advice is sought or make recommendation to that Government on any matter, if in the opinion of the Authority, the recommendation would help in improving the generation, distribution and utilisation of electricity; (xi) Discharges such other functions as may be entrusted to it by or under any other law.	as well as for distribution by SEBs to various types of consumers. 7. Personal policies, productivity and manpower planning for the Power industry. 8. Evolving policy guidlines for rural electrification. 9. Evolving of guidelines relating to conservation of electricity.
3.	Department of Atomic Energy	Created in 1954 as a separate Deptt. the Deptt. is administratively headed by Secretary.	To lay down policy relating to production and development of nuclear energy.	
4.	Atomic Energy Commission	Established as a part-time body by a Central Government notification in 1948. The Secretary, Deptt. of Atomic Energy is the Chairman of the Commission. The total number of members shall not be less than three and not more than seven.	Formulating and implementing the policy of the Department of Atomic Energy in all matters concerning atomic energy, establishing nuclear power plants.	
5.	Atomic power Authority (APA)		1. Management of nuclear power station in the operational phase. 2. Bulk sale of power to utilites.	

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Corporations				
6.	National Thermal Power Corporation	Incorporated in November 1975 as a generating company in the Central Sector under the Companies Act, 1956. Managed by a Board of Directors comprising a full-time Chairman-cum-Managing Director and one Director incharge of finance and five part-time directors from the Deptt. of power, CEA, Planning Commission and Deptt. of Heavy Industries. Each project is under the charge of a General Manager and the Corporate Office has the following divisions : Corporate Planning, Finance, Personnel, Technical Services, Project Management, Data Processing and Contract Services.	To Plan, promote and organise Integrated and efficient development of thermal power in all the aspects, including planning, investigation, research, design and preparation of preliminary, feasibility and definite project reports, construction, generation, operation and maintenance of thermal power stations and projects, transmission, distribution and sale of power generated at thermal stations in accordance with the national economic policy and objectives laid down by the Central Government from time to time.	NTPC to be progressively merged into the REGCs with a structure similar to the SEBs.
7.	National Hydro Electric power Corporation	Established in November, 1975 as a generating company under the Companies Act, 1956. Managed by a Board of Direectors comprising a full-time Chairman-cum-Managing Director and a Director (Finance) and five part-time Directors. Each project is under the charge of a General Manager and the Corporate Office and has 7 divisions for finance & accounts, civil engineering, generation, transmission, personnel, cost engineering and systems.	To plan, promote and organise and integrated and efficient development of hydro-electric power in all its aspects including planning, investigation research, design and preparation of preliminary, feasibility and definite project reports, construction generation, operation and maintenance of hydro-electric power stations and projects, transmission, distribution and sale of power generated at hydro-electric stations in accordance with the national economic policy and objectives laid down by the Central Government from time to time.	To be progressively merged into the REGCs.
8.	Rural Electrification Corporation	Established in 1969 as a public sector undertaking. Governed by a Board of Directors consisting of a Chairman-cum-Managing Director, two full-time Directors and six to twelve part-time Directors representing Government interests and non-officials.	Financingl rural electrification schemes and promoting and financingl rural electrification in the country'	1. Monitoring the progress of all ongoing rural electrification schemes. 2. Assisting in the financing of micro and mini hydels. 3. Promoting coöperatives/agents for RE distribution and servicing.
9.	Power design & consultancy Corporation	To be set up as a Centrally owned public sector Corporation managed by a Board ultimately consisting of a Chairman-cum-Managing Director and 6 Directors incharge of Thermal, Hydel and T & D Projects, and Directors for Finance, Personnel and Commercial/Quality assurance.	..	Providing full consultancy services for formulating, designing constructing and commissioniag thermal, hydel and T&D projects. Quality assurance of equipment and construction on behalf of the client.
10.	Nuclear Power corporations.	To be set up as Centrally owned public sector Corporation managed by a full-time Chairman-cum-managing Director with 5 Directors in charge of construction, generation, finance personnel and technical services.	..	Designing, constructing and operating nuclear power stations including waste disposal.
11.	Bureau of Electricity Costs and Prices	To be set up as a statutory body headed by a full-time Chairman with 3 full-time Members in charge of Engineering, finance and economic analysis.	..	To develop norms for the performance of thermal, hydel stations and T&D systems. To examine and advise on tariffs and tariff policies.

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II. Regional Level Organisations				
1.	**Regional Electricity Boards**	Set up as part-time bodies by Central Govt. resolution and function in 5 Regions. The following 5 Regional Electricity Boards exist :	1. To devise integrated operation of the constituent power systems for achieving economic generation and transmission of power in the region.	The REBs should be replaced by statutory bodies called the Regional Electricity Authorities (REAs), whose structure and functions would be responsible for—
		Region — Constituent States/ *Union/Territories*		
		Northern — Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Rajasthan, Uttar Pradesh, Chandigarh and Delhi.	2. To prepare a coordinated overhaul and maintenance schedule for the generating plants. 3. To draw up generation schedule for enabling utilisation of available capacity in each system to the maximum extent.	1. Purchase and sale of bulk power from all utilities in the region. 2. Integrated operation of grid through RLDCs and control over regional generation and ownership of relevant EHV transmission lines.
		Western — Gujarat, Madhya Pradesh, Maharashtra Goa, Daman & Diu, Dadra and Nagar Haveli.		3. Inter-regional power transfers.
		Southern — Andhra Pradesh, Karnataka, Kerala, Tamil Nadu and Pondicherry.	4. To formulate the pricing Policy for sales or exchange of Power from one power system to another.	4. Planning of optimal regional Power development. 5. Preliminary appraisal of DPRs submitted by utilities.
		Eastern — Bihar, Orissa, Sikkim and West Bengal	5. To review the progress of power development schemes in the region.	6. Construction of all inter-State transmission lines.
		North-Eastern — Assam, Manipur, Meghalaya, Nagaland, Tripura, Arunachal Pradesh and Mizoram.		*Structure*—A full-time Chairman and four full-time Members in charge of Planning Operations and construction, Commercial and Finance, Chief executives of all utilities in region will be part-time Members.
		Comprises Chairman of the concered State Electricity Board, representatives of the State Governments/Union Territories as also representatives of the Deptt. of Atomic Energy, Central Electricity Authority and organisations concerned with electricity generation.		
		The Office of Chairman of the Regional Electricity Board is held by rotation by the Chairman of the State Electricity Boards in the Region or by Minister of the constituent States (if they be Member of the Regional Electricity Board) and/or organisation concerned with electricity generation, for a period of one year each. The Board has a full-time Secretariate provided by the Central Government, which is headed by an officer normally of the rank of Chief Engineer and who is also a Member of the Regional Electricity Board (this position variess in respect of North-Eastern Regional Electricity Board where the Secretary is not a member of Regional Electricity Board). Presently the Superintending Engineer posted for the North-Eastern Regional Load Despatch Centre is the incharge of the Regional Electricity Board.		

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2.	Damodar Valley Corporation	Established in 1948 under the DVC Act, 1948, having jurisdiction over Damodar Valley extending over parts of Bihar and West Bengal. The Corporation, which is an autonomous body, has a full-time Chairman and two part time Members (by convention the two part time Members are drawn from constituent States Viz. West Bengal and Bihar) General Manager, Secretary, and financial Adviser assist the Corporation in the performance of defferent functions.	To develop the resources of The Damodar Valley for multi-purpose benefits including irrigation, flood control and power development: the promotion and operation of schemes for the generation, transmission and distribution of electrical energy both Hydro-electric and thermal. it establishes and Operates power generation facilities and distributes power to Bulk consumers in the valley area directly at voltage of 33 KV and above. The responsibility for power supply at voltage lower than 33 KV is vested with the concerned SEBs. The DVC have been historically supplying certain loans outside the valley area, including bulk supply to CESC and TISCO.	The DVC should be taken over by the Proposed REGC in the Eastern Region after compensating Bihar and West Bengal for their share.
3.	Bhakra Beas Management Board.	Bhakra Management Board was set up in Oct., 1967 under Section 79 of the Punjab Re-organisation Act, 1966. The Board has been re-named as Bhakra Beas Management Board in May, 1976 in terms of Section 80(5) of the Punjab Re-organisation Act, 1966, after the transfer to the Board of Some completed components of the Beas Project. The Board acts under the control of the Central Government. The Board consists of a full-time Chairman and two full-time Members and of six part-time Members representing the interests of the participating States and the Central Government. For functional purposes there are two distinct wings of the Board, namely, the irrigation Wing and the Power Wing each headed by a whole time member and the combined finance and accounts organisation for both the Irrigation and power Wings is headed by a financial Advisor and Chief Accounts Officer.	1. Regulation of supply of water to the participating States in accordance with any agreement/ arrangement made between the participating States. 2. Regulation of supply of power generated at the power houses. 3. Administration, maintenance and operation of Bhakra Nangal and Beas Projects and the associated transmission system.	The operation of these projects could be co-ordinated with the regional projects by the REA.
4.	Tungabhadra Board	Constituted in 1953 by the Government of India under Section 66 of the Andhra State Act. The Board functioned at the level of Chief Engineer from October, 1953 to March, 1955 when the Board was reconstituted. As a part-time body it now consists of a Chairman and 3 Members representing the Govt. of India and Govts. of Andhra Pradesh and Karnataka. All important matters are disposed of at the Board meetings. The Board has delegated full discretion to the Chairman to deal with all matters in-between the meetings of the Board.	Managed the multipurpose Tungabhadra project. Generation of electricity in the Turgabhadra Dam and the Hampi Power Stations and its supply in bulk to the Governments of Andhra Pradesh and Karnataka in agreed proportions. The maintenance of the transmission system associated with the project.	Operation of these projects could be co-ordinated with the regional projects by the REA.

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5.	Neyveli Lignite Corporation	Set up in November, 1956 as a company under the Companies Act, 1956. It is a Public Sector Undertaking under the Deptt. of Coal. Managed by a Board of Directors comprising one full-time Chairman and two full-time Directors and 6 part-time Directors representing interests of Govt. of India.	Management of, interalia, the integrated project consisting of the Open Cast Lignite Mine and the 600 MW Thermal Power Station. Presently, the Corporation supplies power only to Tamil Nadu. The Corporation has also been entrusted with the expansion of mining activities through a second mine cut and power generation through a second power station with an initial installation of 600 MW. The power output from the expansion programme now sanctioned will be made available to all the States and Union Territories in the Southern Region.	
6.	North-Eastern Electric Power Corporation (NEEPCO)	Set up in 1976 as a generating company for the North-Eastern Region. It is a Public Sector Undertaking under the control of the Deptt. of Power. Managed by a Board of Directors comprising one full-time Chairman-cum-Managing Director and 12 part-time Directors drawn from the Govt. of India and North-Eastern-States.	1. Development of electric power, in all its aspects in the North Eastern Region. 2. Formulation and recommending to the Central Government, a regional policy for development of electric power in the region. 3. Construction, generation, operation and maintenance of electric power stations and projects, transmission, distribution and sale of electric power.	An REGC in NE Region should be formed with NEEPCO as its nucleus.
7.	Regional Electricity Generating Corporation	To be set up as a Centrally owned public sector Corporation and managed by a Board with a full-time Chairman-cum-Managing Director and 4 full-time Directors in charge of generation and EHV transmission, construction, finance, and personnel. Part-time directors should consist of the Member (Planning) of the local REA and two eminent professional people		Formulating, executing and operating regional power stations. Bulk sale of power to REAs.
III. State Level Organisations				
1.	Departmental Organisations	In all the States and Union Territories, the Gorvernment or Administration has a Departmental set up responsible for power. The Deptt. is normally headed by a Secretary/Chief Engineer and is divided into convenient wings as may be required having regard to the pecularities of each State/Union Territory. Their operations follow departmental procedures.	The Departmental set up deals with the policies and administrative matters and discharges the responsibilities towards legislature. In Punjab, Maharashtra and Orissa, a separate departmental hydel organisation is vested with the responsibility for hydel development and this organisation executes all hydel projects. In Uttar Pradesh hydel development is undertaken jointly by/ the State Irrigation Deptt. and the state Electricity Board. In Andhra Pradesh, while the responsibility for the construction of most of the hydel projects has been taken over by the Board, the Srisailam project is being implemented by a departmental organisation.	1. All UTs should have autonomous Electricity Boards except Delhi where its long term constitutional future is under consideration. 2. Hydel projects upstream of dam and power house should be constructed by SEBs and not departmentally. 3. Existing departmentally run stations should be handed over to SEBs. 4. Role of Government *vis-a vis* SEB should be clearly defined as proposed in Chapter VII. 5. Provision of Secretariat for SECCs and LACs.

1	2	3	4	5
			In the States of Sikkim, Nagaland, Mainpur and Tripura and all the Union Territories except Delhi, Govt. Electricity Departments look after electricity development and operate the power supply industry. In Delhi, Delhi Electric Supply Undertaking (DESU) was constituted in 1957, consequent to the enactment of the Delhi, Municipal Corporation Act, 1957, for the Union Territory of Delhi. DESU which replaced the Delhi State Electricity Board constituted under the Electricity (Supply) Act, 1948, is responsible for the power supply in the Union Territory of Delhi. The Delhi Electric Supply Committee constituted Under the Delhi Municipal Corporation Act, 1957 is responsible for the affairs of DESU. This Committee consists of 7 members — 4 Councillors and Aldermen and 3 Central Government nominees. A full-time General Manager is responsible for the administration and day-to-day operations.	
2.	State Electricity Board	Set up under the Electricity (Supply) Act, 1948. Exists in all States except the States of Sikkim, Nagaland, Manipur and Tripura and the Union Territories. Most of the State Electricity Boards have a Chairman, Member (Technical), Member (Finance), as their full-time top management. Some of the SEBs have Member (Generation) and Member (Transmission) instead of Member (Technical). Most of the Boards have Government officials like Secretary (Finance), Secretary (Planning), etc. as ex-officio Members. Some Boards have non-official part-time Members also mainly with a view to representing consumer interests	In the original Electricity (Supply) Act, 1948 the State Electricity Boards were charged with the general duties of promoting the co-ordinated development of the generation supply and distribution of electricity within the State in the most efficient and economical manner with particular reference to such development in areas not for the time being served or adequately served by any licensee. For discharging its duties, the Board could establish its own generating stations or treat the existing stations/licensees as controlled stations and interconnect generating stations within its jurisdication by the establishment of suitable grid. The powers and the duties of the Board have been modified in the Act to suit the changing conditions. At present, the Boards are charged with the following general duties : (a) to arrange, in coordination with the generating company or generating companies, if any, operating in the State, for the supply of electricity that may be required within the State and for the transmission and distribution of the same in the most efficient and economical manner with particular reference to those areas which are not for the time being supplied or adequately supplied with electricity; (b) to supply electricity as soon as practicable to a licensee or other person requiring such supply if the Board is competent under this Act so to do ;	Board should have a full-time Chairman, 5 full-time Members in charge of generation, construction, distribution and commercial functions finance, personnel and 3-4 part-time Members 2 representing Finance and Power Departments of State Government and two eminent professional people in areas where the SEB is located. Distribution groups headed by Zonal Managers should act as profit centres. Special attention to be given to development of rural electrification and mini/micro hydels. Ownership of EHV lines related to inter-State load despatch and overall control of generation needed to optimise regional operations will pass over to the REAs.

1	2	3	4	5
			(c) to exercise such control in relation to the generation, distribution and utilisation of electricity within the State as is provided for by or under this Act; (d) to collect the data on the demand for, and the use of electricity and to formulate co-ordinated perspective plans, for the generation, transmission and supply of electricity within the State; (e) to prepare and carry out schemes for transmission, distribution and generally for promoting the use of electricity within the State; and (f) to operate the generating stations under its control in co-ordination with other agencies.	
	3. Mysore Power Corporation	Set up by the Govt. of Karnataka as a generating company under the Companies Act, 1956. Managed by a Board of Directors consisting of a part-time Chairman and a full-time Managing Director and other Directors.	To establish and operate power generating projects in Karnataka State.	
	4. Licensees	Holder of a licence issued by a State Government under Section 3 of the Indian Electricity Act, 1910. There are at present 32 licensees of whom the following 3 are engaged in power generation activity:— (1) Calcutta Electric Supply Corporation. (2) The Ahmedabad Electricity Supply Company. (3) The Tata Electric Companies.		
IV Regulatory/Advisory Organisations				
A. National Level				
	1. Central Electricity Board	Statutory organisations constituted under section 36 A of the Indian Electricity Act, 1910. It is a part-time body. The Chairman, Central Electricity Authority is the Chairman of the Central Electricity Board. Chairman of various State Electricity Boards, high ranking officers of the State and Central Governments are members of the Board.	To make rules for regulating the generation, transmission, supply and use of electricity (safety).	Need not be constituted, functions can be better performed by REAs and CEA.
	2. Central Electrical Inspector	Appointed under Section 36 of the Indian Electricity Act, 1910 Director (Commercial), Central Electricity Authority is the Electrical Inspector in respect of the Central Government installations. Ministries of Railways, Defence and Communications (P&T Board) have appointed their own inspectors for their installations.	To carry out the functions envisaged in the Indian Electricity Act, 1910 and the Indian Electricity Rules, 1956.	

1	2	3	4	5
3.	Central Advisory Board	Section 35 of the Indian Electricity Act, 1910 enables the constitution of Board. However, the Board has not been in existence.	To carry out the functions as may be entrusted by the Central Government.	Need not be constituted.
B. State Level				
1.	State Electrical Inspectors	Appointed under Section 36 of the Indian Electricity Act, 1910. Normally an officer of the rank of the Chief Engineer in the State Government.	To carry out the functions envisaged in the Indian Electricity Act, 1910 and Indian Electricity Rules, 1956.	
2.	State Electricity Consultative Council	Constituted under Section 16 of the Electricity (Supply) Act, 1948. The Chairman of the State Electricity Board is the Chairman of the Council and the Council consists of at least 8 members representing the interests of Local Self-Government, Electricity Supply Industry, Commerce, Industry, Transport Agriculture, Electricity Staff and consumers of electricity.	To advice the State Electricity Board on major questions of policies and schemes and also to review the progress and the planning of the State Electricity Board.	Should have a separate full-time Secretariat reporting to Chief Secretary.
3.	State Advisory Board	Constituted under Section 35 of the Indian Electricity Act, 1910. Comprises a Chairman and not less than two other Members.	To carry out the functions as may be entrusted by the State Government.	
4.	Local Advisory Committee	A body constituted under Section 17 of the Electricity (Supply) Act, 1948 The Chairman of the Board or his nominee will be the Chairman of the Committee. The number of members of the Committee is to be decided by the State Government.	To advise the State Electricity Board, if so consulted, on any business coming before the Board.	Should have a full-time Secretariat reporting to local authorities.
5.	Rating Committee	Constituted under Section 57 A of the Electricity (Supply) Act, 1948. Comprises 3 members in the State where State Electricity Board exist of whom, one will be a judicial officer, the second having experience of accounting and financial matters and the third coopted by other members representing the association of licensees or Chamber of Commerce. In other States, it comprises 5 members—3 nominated by the State Government, one by licensees and one by the Association of Licensees or Chamber of Commerce.	To examine the licensee's charges for the Supply of electricity.	Should be replaced by the Bureau of Electricity Costs and Prices to examine costs, fix norms, advice on tariffs. Should report to the Department of Power and function as an advisory body.

APPENDIX 7.3

Functional distribution of responsibilities of the C. E. A. Members

Planning Division

(a) Load forecasting.
(b) Formulation of long-term and perspective plans, for generation, transmission and distribution.
(c) Formulation of Five-Year and Annual Plans for generation, transmission and distribution.
(d) Formulation of rural electrification programme and their co-ordination.
(e) Formulation of Power programmes for Union Territories.
(f) Co-ordination of inputs (equipment, key-materials, manpower), requirements of funds and foreign exchange for the power projects.
(g) Co-ordination of techno-economic appraisal of power projects and project approvals.
(h) Ecology and environment co-ordination.
(i) Conservation and load management.
(j) Allocation of capacity to States.
(k) Analysis of changes in demand patterns.
(l) Policies on captive power plants and private sector utilities.

Hydro-electric Division

(a) Hydro-electric planning and optimisation.
(b) Assessment of hydro-resources-monitoring of project investigation.
(c) Mini and micro hydel development.
(d) Project appraisal.
(e) Hydro-technology development.
(f) Review consultancy of design of hydro-projects—
- Civil designs
- Electrical and mechanical designs
- Protection, instrumentation and control.

(g) Construction monitoring—civil electrical and mechanical and recommending remedial action.
(h) Monitoring performance of hydel stations.
(i) Assessment of requirements of key inputs and funds for hydro-electric prospects.
(j) Fixation of work norms.
(k) Assessment of training inputs and plan for meeting them.

Thermal Division

(a) Planning and optimisation of thermal power development.
(b) Identification of sites for thermal power development and co-ordination with concerned organisation for fuel linkage and other inputs.
(c) Thermal power projects appraisal.
(d) Thermal power technology development.
(e) Review consultancy of design of thermal power plants.
(f) Monitoring construction & operation of plants and recommending remedial action.
(g) Assessment of requirement of key inputs and funds for thermal power projects.
(h) Fixation of work norms.
(i) Evaluation of projects for coal washing and coal transportation.
(j) Assessment of training inputs and programmes for meeting them.

Power Systems Division

(a) Transmission system—planning and optimisation.
(b) Techno-economic aspect of rural electrification.
(c) Project appraisal of projects relating to T&D, substations load despatch stations, rural electrification, etc.
(d) Technology development.
(e) Review consultancy—design of
- EHV lines and sub-stations
- Distribution systems
- Power system project, control and instrumentation.
- Load despatch stations.

(f) Monitoring of construction of transmission lines, substations, load despatch stations, rural electrification projects etc.
(g) Assessment of requirements of key inputs e.g. aluminium, steel etc.
(h) Monitoring of intergrated operation of power systems and inter system transfer of power.
(i) Assessment of needs and plans for manpower training for operation of power systems.
(j) Operation of REA's.
(k) Fixation of work norms.

Economic, Commercial, Legal and Safety Division

(a) Economic evaluation of projects.
(b) Financial monitoring of the power supply industry.
(c) Development of uniform accounting systems and practices.
(d) Tariff formation.
(e) Electricity legislation.
(f) Statistics.
(g) Safety inspection.
(h) Linkage with BECP.

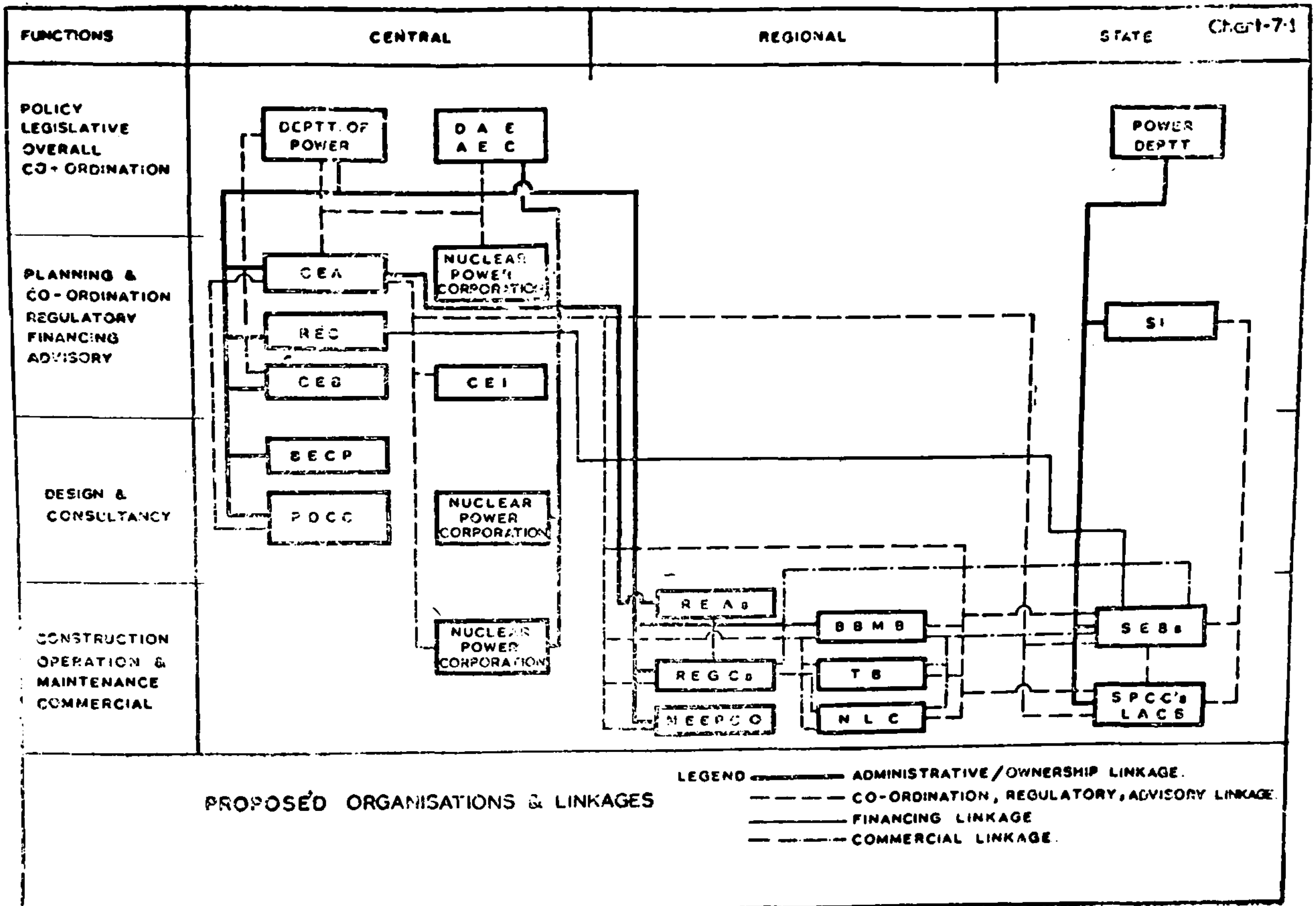
Research & Development Division

(a) Evalaution of on going research programmes.
(b) Promoting and funding 'grass roots' R&D in the power and connected industries.
(c) Testing, Certification & Standardisation.
(d) Conservation strategies.
(e) Evaluation of new products, design changes etc.
(f) New energy sources.
(g) R&D data collection, storage and dissemination.
(h) Promoting growth of research in statistics and identifying gaps.
(i) Secretariat inputs to the National council for R&D in Power.

Personnel Division

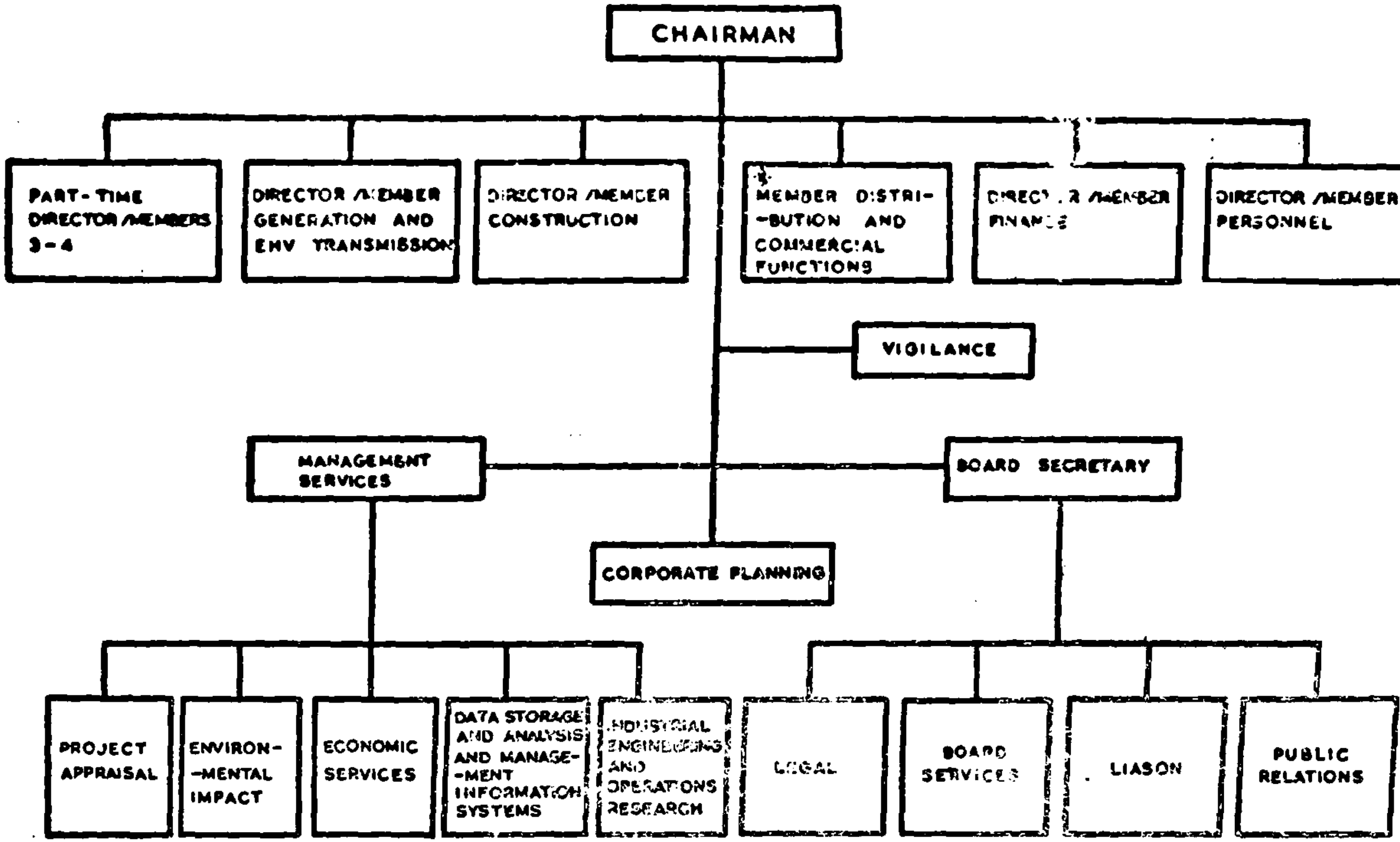
(a) Recruitment selection systems.
(b) Appraisal and promotion systems.
(c) Terms and conditions of service.
(d) Welfare facilities.
(e) Training.
(f) Disciplinary action.
(g) Industrial relations.
(h) Productivity.

Chart-7·1



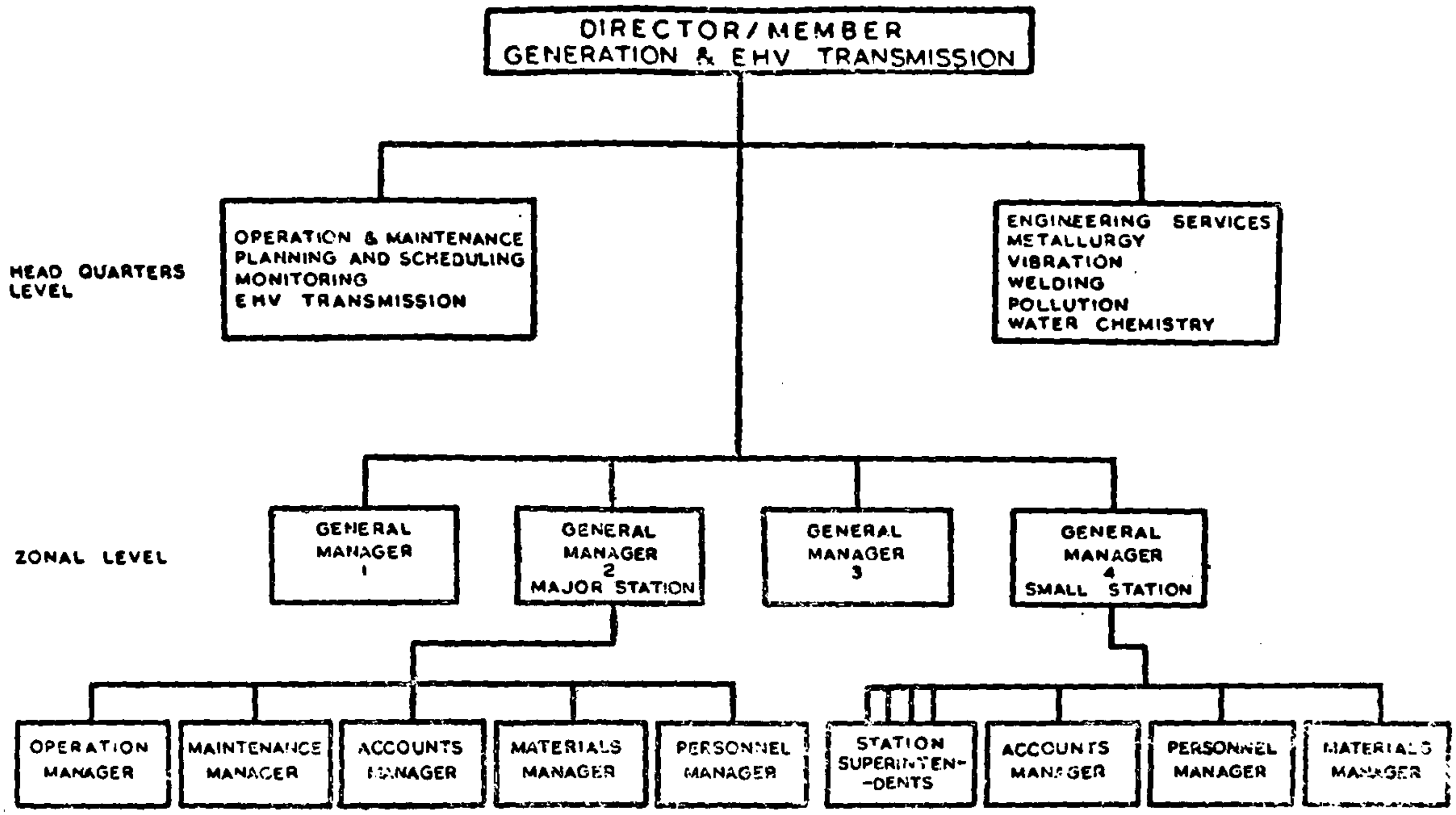
PROPOSED ORGANISATIONS & LINKAGES

Chart - 7.2



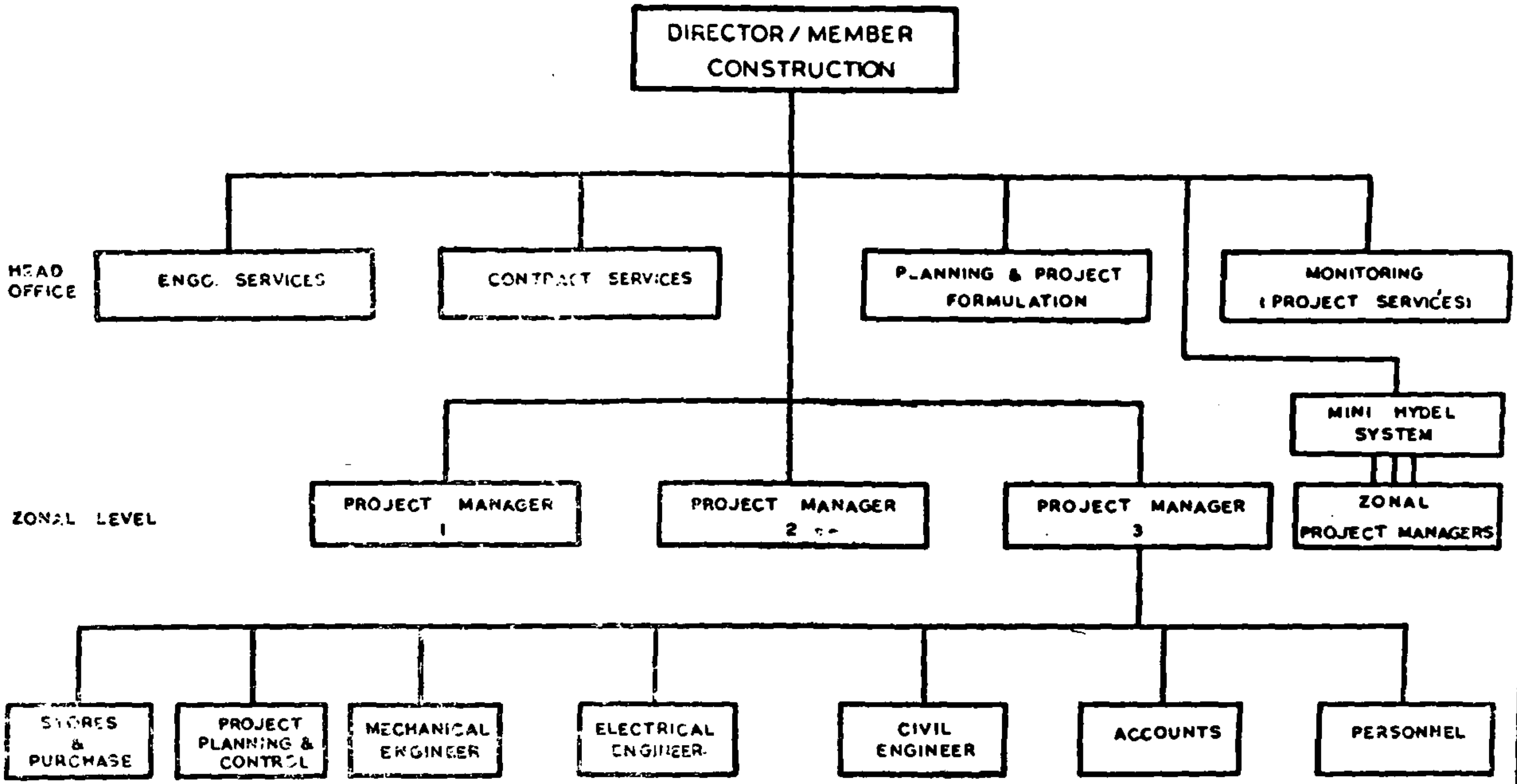
PROPOSED ORGANISATION FOR REGCs/SEBs
*Not required for REGCs

Chart - 7.3



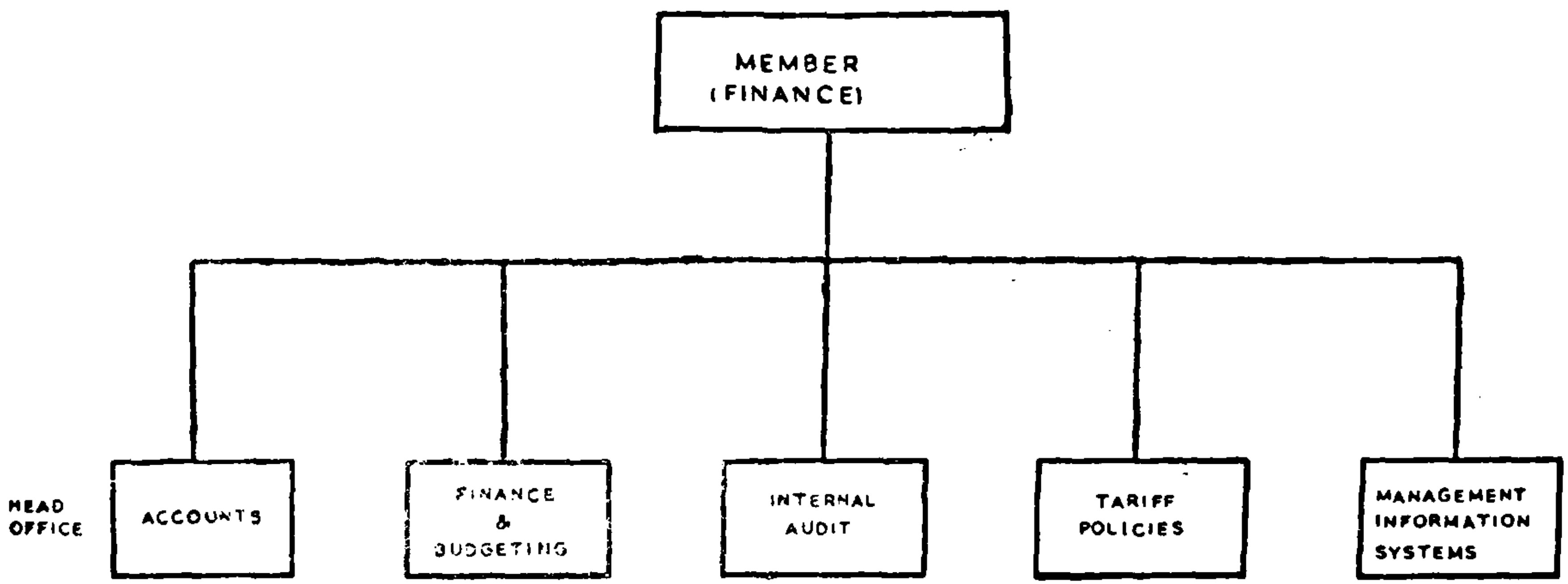
PROPOSED ORGANISATION GENERATION AND EHV TRANSMISSION DIVISION-REGCs/SEBs

Chart -74



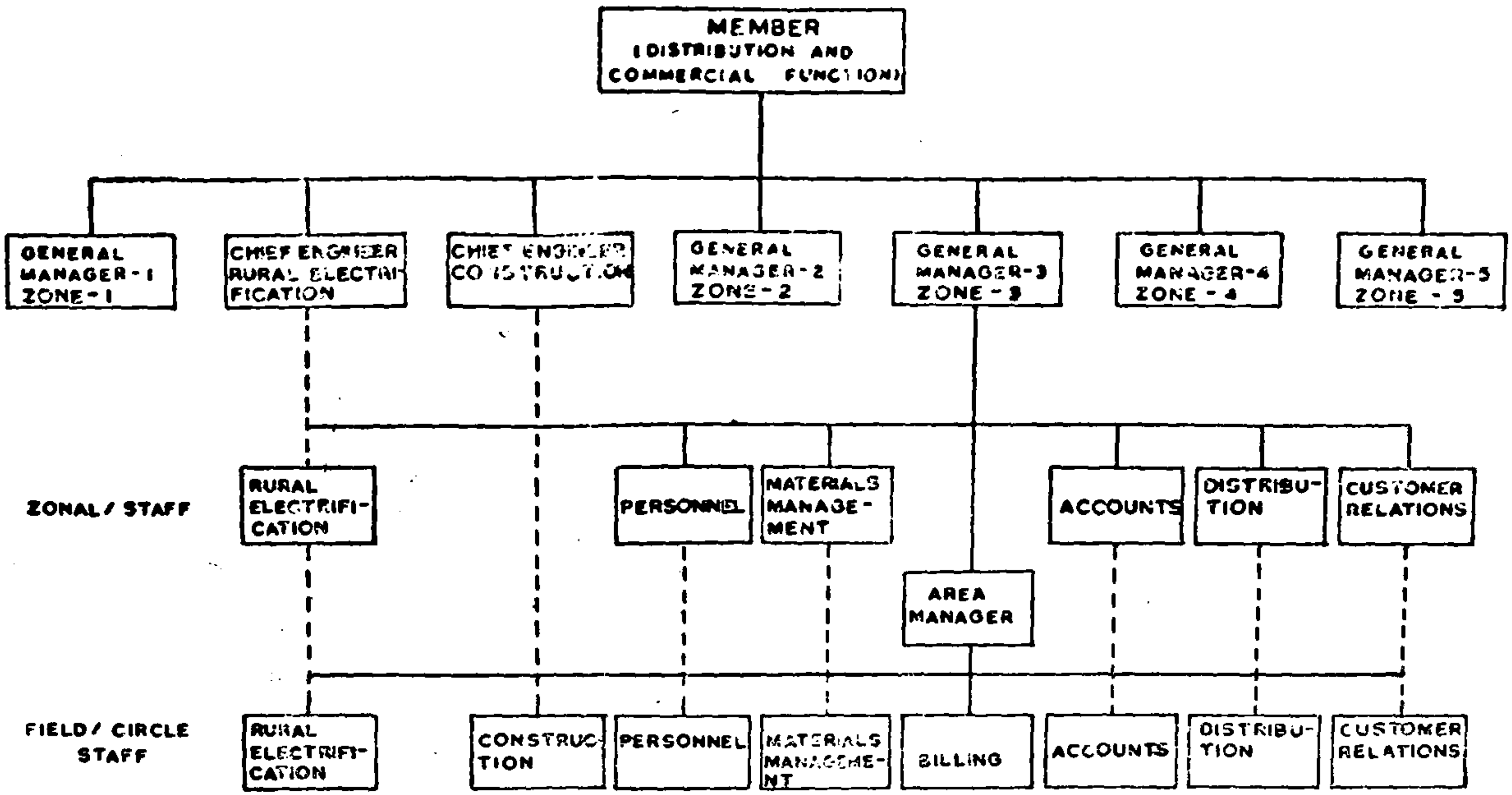
PROPOSED ORGANISATION - CONSTRUCTION DIVISION - REGCs/SEBs

Chart - 7.5



PROPOSED ORGANISATION - FINANCE DIVISION - REGCs/SEBs

Chart-76



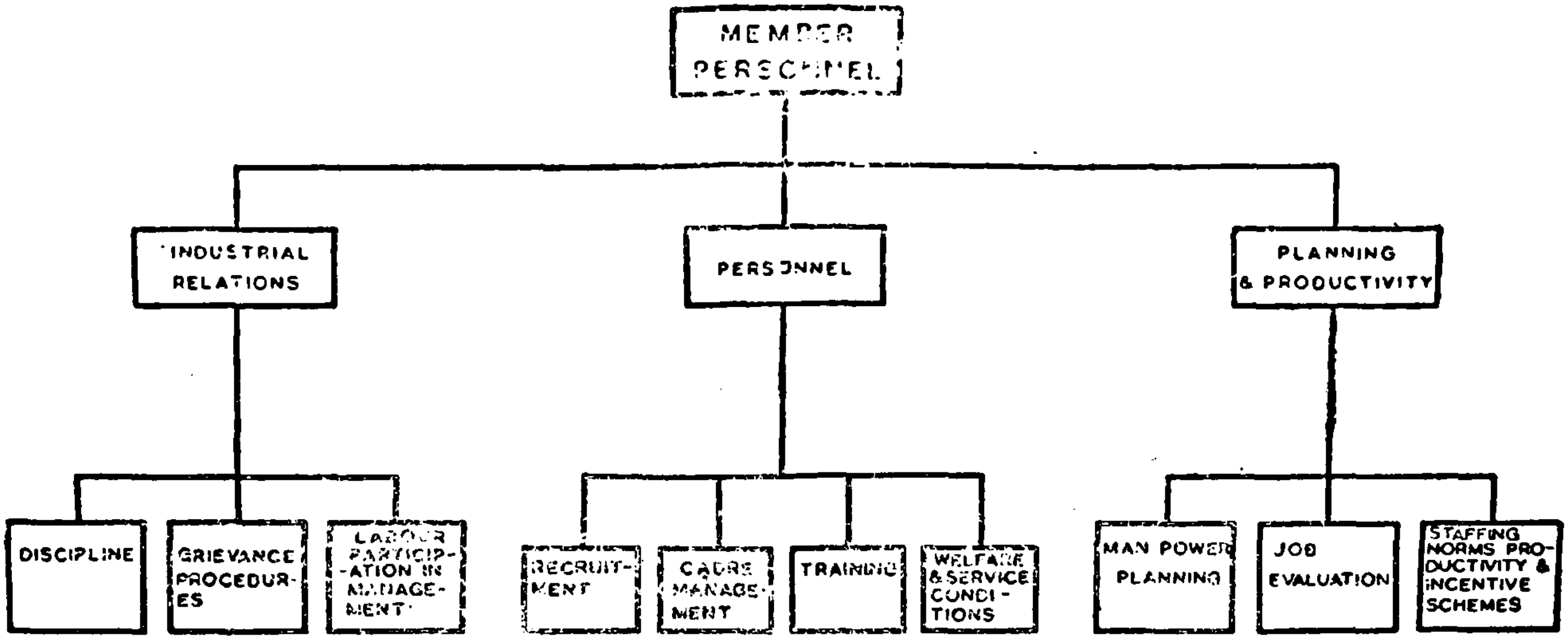
ZONAL ORGANISATION (DISTRIBUTION AND COMMERCIAL) (SEB)
FOR LARGE BOARDS, FOR SMALLER BOARDS THE ZONAL TIER CAN BE DROPPED

LEGEND

——— LINE FUNCTION

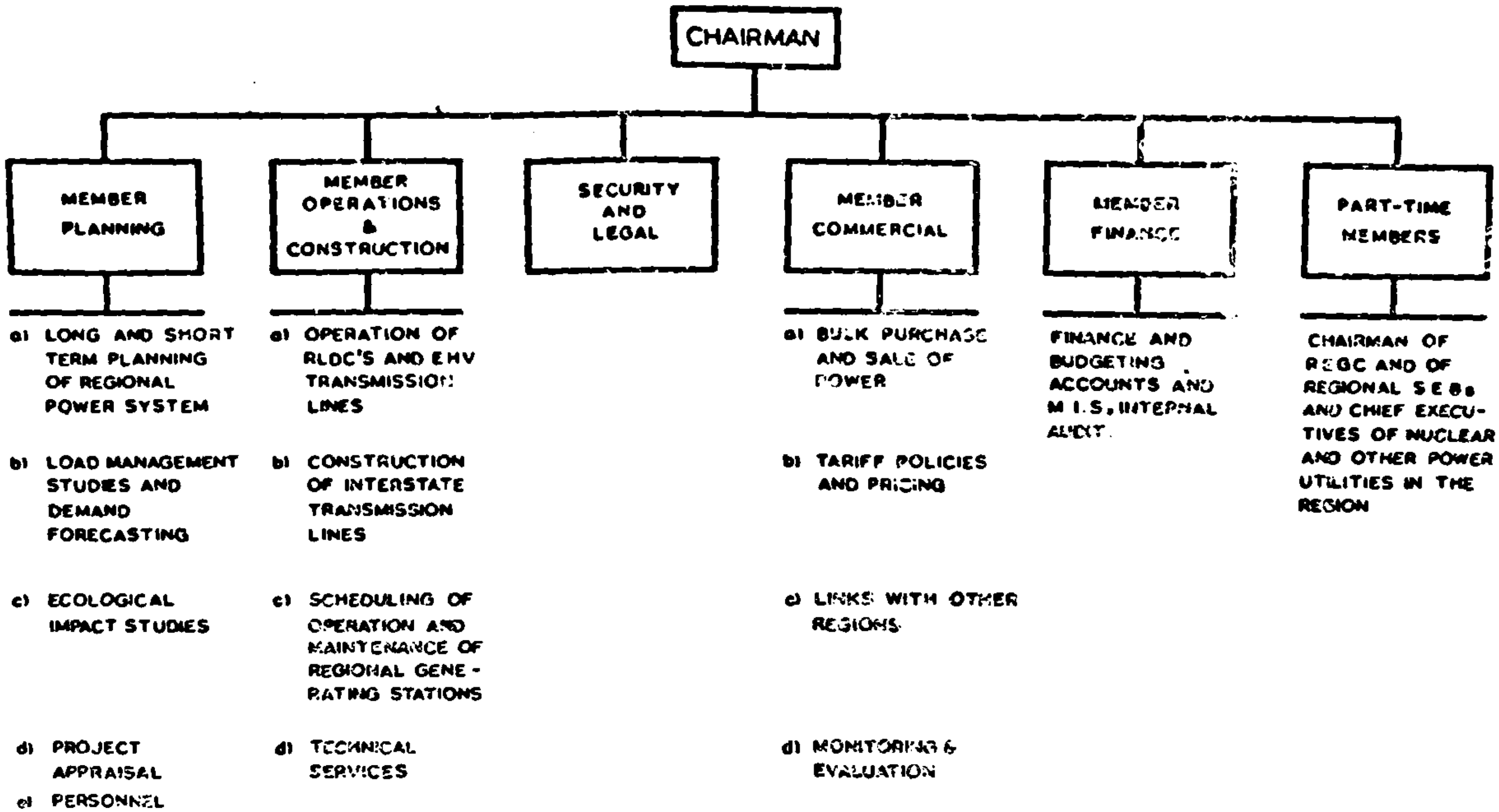
- - - - - - COMMUNICATION LINK

Chart – 7.7

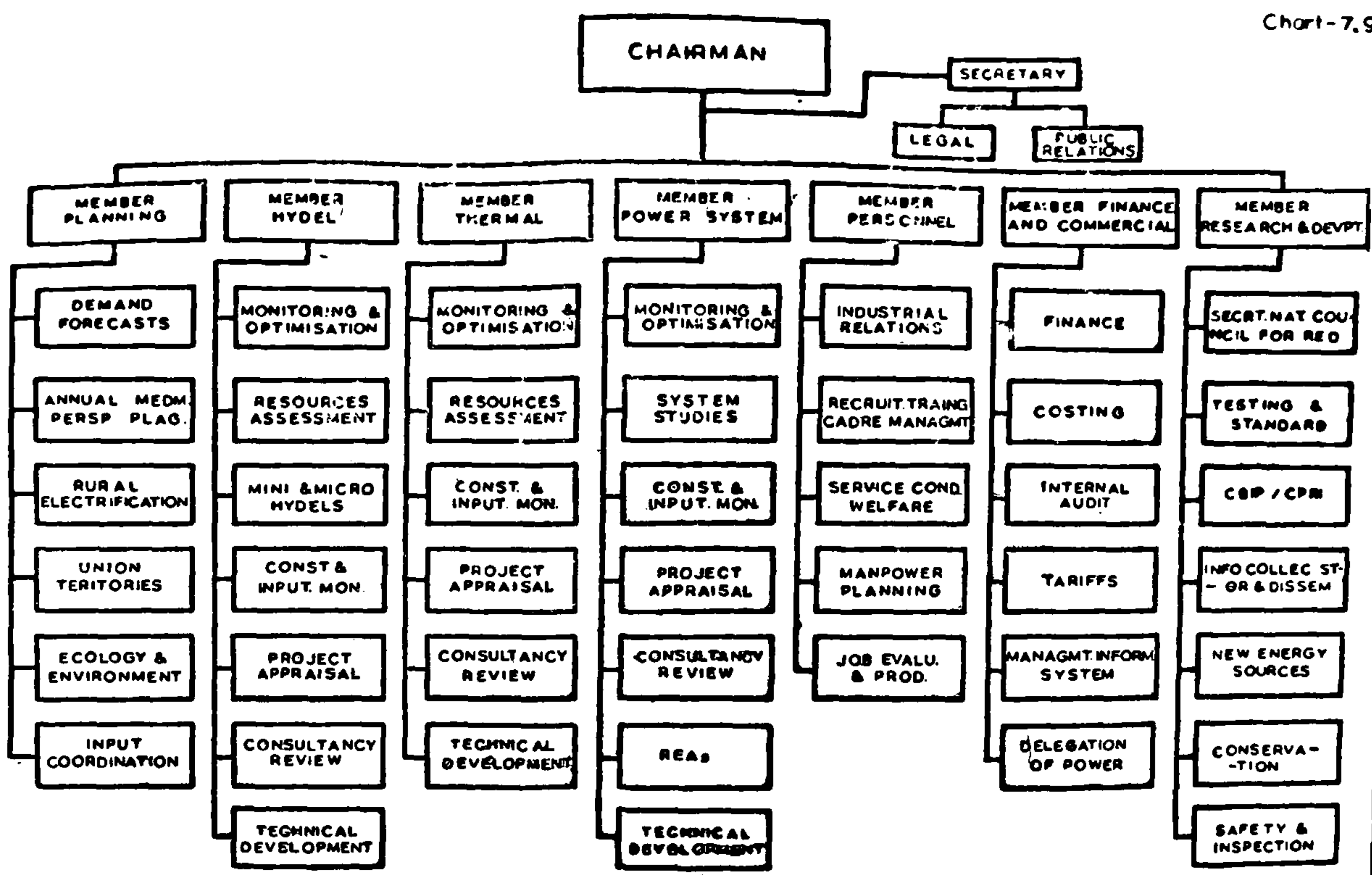


PROPOSED ORGANISATION — PERSONNEL DIVISION REGCs/SEBs

Chart - 7.8



PROPOSED ORGANISATION STRUCTURE OF A REGIONAL ELECTRICITY AUTHORITY



PROPOSED ORGANISATION STRUCTURE CENTRAL ELECTRICITY AUTHORITY

APPENDIX 8.1

List of R&D Activities being carried out at Academic Institutions

I. Indian Institute of Technology, Delhi

1. Optimal hydro-thermal scheduling.
2. Real time simulation and control of power systems including micromachines.
3. Optimal power flow solution using fast decoupled techniques.
4. Torque-slip characteristics of large synchronous machines during a synchrous operation.
5. Suppression of self-excited oscillations in dual excited synchronous machines.
6. Self-excited oscillations of series compensated transmission systems.
7. Automatic generation control of an interconnected power system and state estimation.
8. Constant starting torque of induction motors through rotor impedance control.
9. Voltage fluctuation effect on irrigation pumpsets.
10. Transmission loss minimization.
11. Load frequency control.
12. State space modelling of a series compensated long distance transmission system through Graph theoretic approach.
13. Power systems Dynamic stability.
14. Transmission system transients.
15. Large scale power system modelling.
16. Energy system planning and forecasting studies.
17. Economic load despatch/unit commitment/maintenance scheduling with power system security constraints.
18. Thyristor control of A. C. and D. C. drives.

II. Indian Institute of Technology, Bombay

1. Evaluation of reliability and security of complex power networks.
2. Instability study of thyristor controlled induction motor.
3. Electric arc research.
4. HVDC simulator and studies.
5. Simulator for over voltage in EHV system.
6. Multiloop synthetic testing of ACC circuit breakers.
7. Stability limit of inverter fed induction motor.
8. Control of induction motor using thyristor chopper controlled resistance.
9. Digital simulation for chopper fed DC motors.
10. Speed control of various motors.

III. Indian Institute of Technology, Kharagpur

1. Asymmetrical fault analysis of synchronous generators by d—q—o reference frame.
2. Hydro-thermal load scheduling.
3. Study of corona and radio active interference in EHV lines.
4. Application of diakopties to power system security and monitoring.
5. Analysis of eddy current brakes with nonmagnetic rotor.

IV. Indian Institute of Technology, Madras

1. Development of hardware and software for computer aided power system data processing and control (Hardware-software.)
2. Dynamic and transient stability studies (SW).
3. A synchronous and resynchronisation of synchronous generators (SW).

V. Indian Institute of Technology, Kanpur

1. HVDC simulator.
2. Microprocessors for power systems protection.
3. Real time control of power systems.
4. Stability of large scale power systems.

VI. Baroda University

1. Use of microprocessor for power system protection.
2. Application of minicomputers to power systems problems of monitoring and display.
3. Load flow and dynamic stability.

VII. Punjab Engineering College

1. Problems related to grounding systems.
2. Problems related with interference.

VIII. Banaras Hindu University

1. Static reactive compensators.
2. HVDC model applications.

IX. Regional Engineering College, Warangal

1. Real time computer control of power systems to improve stability.
2. Two-axis excitation system to improve power system stability.
3. Identification techniques applied to p.s. (SW).

X. Indian Institute of Science, Bangalore

1. Static Compensator using 11KV thyristors with optical firing and associated control.
2. Design and development, fabrication of SCR controlled static VAR compensator.

XI. Regional Engineering College, Nagpur

1. Micromachine applications for dynamic and transient stability study.

GLOSSARY OF IMPORTANT TERMS IN POWER ENGINEERING AS USED IN THIS REPORT

Terms dealing with characteristics of a power sytem

1. *Maximum Demand*

   The highest average kilowatts drawn by the system over and 15 or 30 minutes period.

2. *Base Load*

   It is the minimum load over a given period of time.

3. *Load Factor*

   Average load over a period as a proportion of the maximum load over the same period.

4. *System Load Factor*

   Average peak load as a percentage of the maximum peak load.

5. *Diversity Factor*

   The sum of the maximum demands of different consumers as a proportion of the actual maximum simultaneous demand of the system as a whole.

6. *Plant Factor*

   Average load on the generating unit or plant or system as a proportion of the rated capacity of the generating unit or plant or system.

7. *Peaking Capability*

   The capacity that is available from a particular unit to meet the peak demand at any time.

8. *Peaking Capacity*

   The sum of the peaking capabilities of the different power generating units in the system.

9. *Spinning Reserve/Gross Plant Margins*

   The capacity which is running and available on the generating station busbars to meet the variations of load demand or unforeseen outages of machines.

10. *Power Cut*

    Imposition of restriction on Maximum Demand in KW.

11. *Energy Cut*

    Imposition of restriction on energy consumption in KWh.

12. *Derating of Capacity*

    Decrease in the installed/rated capacity of the generating unit due to age or defects in any of its components.

13. *Retirement of Capacity*

    Removal of installed capacity due to over-age or obsolescence.

Terms dealing with equipment/plant used in Power System

14. *Base-Load Station*

    A generating station which is operated for all the 24 hours of the day at the maximum load possible. Thermal and Nuclear stations are best suited to function as base load stations.

15. *Peak Load Station*

    A generating station which is operated for a short time to meet the peak demand. Normally Hydro Stations with storage reservoirs are operated as peaking stations.

16. *Load Despatch Station*

    A control centre from which the generation levels in various power stations are controlled. This enables optimum and economic utilisation of power and energy.

17. *EHV (Extra high voltage) Lines.*

    Lines operating at voltages of 220 KV and above.

18. *LV (Low voltage) Lines*

    Lines operating at 400 V and below.

19. *Major Equipment (Generating Station)*

    The main components of a generating unit, such as: boiler, nuclear reactor, generator, steam turbine, condenser.

20. *Auxiliary Equipment (Generating Station)*

    Accessory equipment necessary for the operation of a generating station. This would include pumps, fans pulverizers etc. etc.

21. *Capital Maintenance*

    Major repairs involving replacement and/or reconditioning of major equipment and its auxiliaries.

22. *Planned Maintenance*

    The repair of a power plant which takes place at a scheduled time each year.

Terms which relate to the efficiency of operation of a power system

23. *Planned Outage Rate*

    The total number of hours in a year the plant was shut down for planned maintenance as a percentage of 8760 (i.e. the total number of hours in a year).

24. *Forced Outage Rate*

The total number of hours in the year the plant was shut down due to breakdowns as a percentage of 8760.

25. *Availability Rates*

The total number of hours in the year the plant was available for generation (i.e. 8760—planned and forced outage hrs) as a proportion of 8760.

26. *Partial Unavailability*

The energy lost during the period the plant was not available for generation at full capacity as a percentage of the energy that could have been produced if the plant had generated at full capacity.

27. *Plant Load Factor/Capacity Utilisation*

Actual energy produced by a plant during a given period as a percentage of the maximum energy that could have been produced had the plant generated at full capacity during the same period.

ABBREVIATIONS

AIMO	—	All India Manufacturers Organisation
APS	—	Annual Power Survey
BARC	—	Bhabha Atomic Research Centre
BBMB	—	Bhakra Beas Management Board
BECP	—	Bureau of Electricity Costs and Prices
BEL	—	Bharat Electronics Limited
BHEL	—	Bharat Heavy Electricals Limited
BICP	—	Bureau of Industrial Costs & Prices
CAG	—	Comptroller & Auditor General of India
CBIP	—	Central Board of Irrigation & Power
CEA	—	Central Electricity Authority
CFRI	—	Central Fuel Research Institute
CMERI	—	Central Mechanical Engineering Research Institute
CMPDI	—	Central Mine Planning & Design Institute
CPES	—	Central Power Engineering Service
CPRI	—	Central Power Research Institute
CSIR	—	Council of Scientific and Industrial Research
DAE	—	Department of Atomic Energy
DESU	—	Delhi Electric Supply Undertaking
DGTD	—	Directorate General of Technical Development
DVC	—	Damodar Valley Corporation
EIL	—	Engineers India Limited
EHV	—	Extra High Voltage
ERDA	—	Electrical Research & Development Association
EREB	—	Eastern Regional Electricity Board
FOR	—	Forced Outage Rate
GDP	—	Gross Domestic Product
GNP	—	Gross National Product
HV	—	High Voltage
ICAR	—	Indian Council of Agricultural Research
IEMA	—	Indian Electrical Manufacturers Association
IIM	—	Indian Institute of Management
IISC	—	Indian Institute of Science, Bangalore
IIT	—	Indian Institute of Technology
ILK	—	Instrumentation Limited, Kota
ISI	—	Indian Standards Institution
ITI	—	Industrial Training Institute
LAC	—	Local Advisory Committee
LDC	—	Load Despatch Centre
LT	—	Low Tension
MIS	—	Management Information System
NEC	—	North-Eastern Council
NEEPCO	—	North-Eastern Electric Power Corporation
NML	—	National Metallurgical Laboratory

NREB	—	Northern Regional Electricity Board
NTPC	—	National Thermal Power Corporation
OLF	—	Optimal Level Forecast
PDCC	—	Power Design and Consultancy Corporation
PEO	—	Programme Evaluation Organisation — Planning Commission
PESB	—	Public Enterprises Selection Board
PIB	—	Public Investment Board
PLF	—	Plant Load Factor
PTCC	—	Power Telecommunication Co-ordination Committee
R&D	—	Research and Development
RAPP	—	Rajasthan Atomic Power Project
RE	—	Rural Electrification
REA	—	Regional Electricity Authority
REB	—	Regional Electricity Board
REC	—	Rural Electrification Corporation
REGC	—	Regional Electricity Generation Corporation
RLDC	—	Regional Load Despatch Centre
RLF	—	Reference Level Forecast
RRC	—	Reactor Research Centre
SEB	—	State Electricity Board
SECC	—	State Electricity Consultative Council
SPA	—	Special Programme in Agriculture
SREB	—	Southern Regional Electricity Board
T&D	—	Transmision and Distribution
TERI	—	Tata Energy Research Institute
UHV Forum	—	Ultra High Voltage Forum.
WGEP	—	Working Group on Energy Policy
WREB	—	Western Regional Electricity Board
WASP	—	Wien Automatic System Planning
WAPCOS	—	Water & Power Development Consultancy Services (India) Ltd.

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