SECTION II

ELECTRICAL POWER AND ENERGY—AN ANALYSIS
OF THE FUTURE DEMAND AND SUPPLY

By

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Predicted Demand and Commissioning of Generating Plant:

1. The prediction of electrical power and energy generation requirements over a medium term or long term period can only be done on an approximate basis in the present context. The change of Government priorities since 1977 will have a marked impact on the electricity demand, and the exact trend with regard to the demand rise has not yet been fully established. For the purpose of this paper, therefore, the actual past rate of average growth over a period of 30 years has been taken as a basis for medium and long term estimation. This in essence is a time-trend basis prediction, it is used here in the absence of reliable indices needed for more sophisticated predictions over a long term. The actual demand growth may vary widely from this depending on the Investment Transition Zone (ITZ) and other industrial growth, construction, development and settlement requirements for Mahaweli etc.). Please see Annex I for references further details on energy growth and prediction by different techniques.

2. Based on the above estimated forecast of power and energy generation requirements, the period from 1979-1983 is likely to experience shortages of hydro energy, particularly if the inflow of water to relevant catchment areas turns out to be below average. In particular the gravity of shortage will increase towards 1983, and if Samanala Weva or Victoria is not commissioned by this year, the shortages may reach very serious proportions. Please see Annex II for "Generating Plant Power and Energy Capabilities" and Figure 2.

3. Figures 1(a) and 1(b) and Table I illustrate that the power and energy from the accelerated Mahaweli programme will not be excessive and is in reality quite modest. It would just about match the requirements of demand and if any delays occur in the plant commissioning power and energy availability shortages are likely to occur. It would be further observed that rapid commissioning of all plants envisaged under the accelerated Mahaweli programme, including Kehimale is necessary, in order to avoid hydro-power shortages. Early commissioning of Samanala Weva Power Plant would also be necessary as indicated in Figure 2.

Total Potential of Hydro-Power and Predicted Demand:

4. The total resources in Sri Lanka of large scale hydro-power and energy estimated as available and usable, even if developed in an optimum manner is very limited: this will only be sufficient to meet the power and energy demands for about another 12-15 years. Please see Annex III ref. power and energy potential. There are no known coal, oil, gas or similar resources in Sri Lanka. The wind and solar energies are of such a dilute form that it would not be realistic to depend on such sources for bulk energy because of the vast capital cost that would be required to collect and harness such energies and the resulting cost per Kwh. unit of electricity. If is however necessary to engage in experimental generation from these sources, to carry out Research and Development and gain experience for the sake of the future—as initiated by the CEB. program at Puttikoppa. The requirement of developing the limited resources of hydro-power and energy schemes in an optimum manner cannot therefore be over-emphasized. The hydro-schemes must be developed without allowing undue compromises that are wasteful on the development of hydro power and energy, because the resulting energy loss due to an improper judgement or a poor design would be an annually recurring feature.

5. In the above context the development of the Mahaweli River plays a very important role because the power and energy that could be obtained from Mahaweli accounts for about 60% of the total that could be developed in Sri Lanka. Because the Kelani Ganga hydro power has to a large extent been already developed, the Mahaweli Ganga accounts for more than 70% of the total hydro power and energy yet available for development in the country. Therefore, in the development of the Mahaweli Ganga, all necessary steps should be taken for proper designs so that power and energy development aspects are properly weighted.

Prof. K. K. Y. W. Perera, BSc(Eng.), MSc, PhD, CEng, MIEE, MIEEE(USA), FIE(SL)—having graduated with First Class Honours in Electrical Engineering from the University of Ceylon, Colombo, and subsequently joined the Department of Government Electrical Undertakings and worked as an Engineer from the year 1955 to 1968. During this period he was also a Visiting Lecturer at the University of Ceylon, as well as at the Institute of Technical Education, Katubedda, and the College of Technology, Katubedda. Since 1969 he has been the first Professor of Electronic Engineering at the Katubedda Campus. From 1972 to 1974 he was the first Dean of the Faculty of Engineering and Architecture of the University of Sri Lanka, Katubedda Campus. In 1974 he was the President of the University of Sri Lanka, Katubedda Campus. In 1974 he was appointed as the first Chairman of the National Engineering Research and Development Centre which post he held till 1977. From June 1977 to date he has been the Chairman of the Ceylon Electricity Board. He has been a Member of Council and a very active Member of many of the Committees of this Institution and is Examiner for the Professional Review.
CEB MEDIUM TERM PEAK POWER DEMAND

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<td>307</td>
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<td>435</td>
<td>470</td>
<td>506</td>
<td>532</td>
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FIGURE 1(b)

FORECAST OF PEAK POWER DEMAND AND A TENTATIVE PLANT COMMISSIONING PROGRAMME

MAXIMUM DEMAND (MW)

YEAR

ACTUAL PAST VALUES

GENERATION ADDITIONS

(B) Bowlares
(C) Canyon
(V) Low Victoria (UNBP)
(S) Sampaguita
(M) Morogoro
(K) Kalamula

FORECAST

LARGEST UNIT

MICROPOWER UNITS

1000
900
800
700
600
500
400
300
200
100
6. It is important to carry out detailed studies with regard to identifying and designing of power projects in the Mahaweli and other basins. In particular it is suggested that studies be undertaken immediately with regard to identifying of power plants in the Kotmale Oya so that a proper design for optimum utilisation of power and energy could be done. The schemes for study indicated in the UNDP studies include Yoxford Talawakele, Palmerston, Tillicolurty and Agga. The possibility of combining some of these together with other feasible schemes to a single underground station at a site close to Talawakele or elsewhere should be examined.

7. With regard to small hydro power plants from minor rivers, tributaries, canal discharges etc., it is necessary to carry out comprehensive island-wide identification surveys. This would firstly give a reasonable estimate of the total power and energy that could be harnessed. Such studies would further enable the construction of all possible small hydro plants during Nineteen Nineties, when the large economical power plants have been fully harnessed. Pilot scale commissioning of small hydro plants prior to this date is desirable to gain experience in low cost operation and maintenance for this type and size of plant.

Thermal Power Requirements:

8. Since rainfall and river flows are seasonal and subject to droughts, a certain percentage of thermal plant is desirable in conjunction with hydro plants. This enables the raising of the firm energy level that could be obtained from the hydro-thermal system, and thereby increases in practice the extent of energy that could be extracted from the hydro plant itself. In this context it is perhaps advisable to install a medium sized thermal plant in order to firm up the hydro power. Further studies in this regard are necessary.

9. If the development of the Free Trade Zone is very rapid, and the quoted 36 MW requirements were to materialize within 1 to 2 years, it may be necessary to get gas turbines installed on an urgent basis. The Bowatte (40 MW) and Canoya (30 MW) power plants which are expected to be commissioned in 1980 and 1981 will not be able to cope with the energy requirements resulting from such a rapid growth.

Cost of Electricity:

10. Selling price of electricity in Sri Lanka today is amongst the lowest in the world. The electricity tariffs have been held constant since 1973 and do not reflect the cost increases in plant, materials and labour. The sale price of electricity should be realistic and tariffs changed accordingly, as otherwise many industrialists plan for high consumption of this scarce commodity. If the electricity is supplied at below cost values, industrialists would be working on false economic basis and the planning of new projects would be unrealistic. (In fact certain large foreign industrialists have made applications to set up industries on the pre-
Of the costs, about 50% would be foreign in nature, required for repayment of loans and interest, spares etc.

(c) In order that the limited resources of hydro power and energy are used to a maximum and in an optimum manner so that the cost of electricity to industries and other essential purposes are kept low, the planning and exploitation of water resources should be done very carefully with a view to maximising the benefit to cost ratio.

(d) In order to extend the time period that we can manage to meet a large portion of the electricity demand using hydro electric energy, it is now necessary to carry out identification surveys with regard to potential small hydro-power plant locations and parameters. Large scale commissioning of those may become necessary in the Nineteen Nineties. Pilot scale commissioning is now desirable.

(e) In view of the limited hydro electric potential and the expensive nature of future plants, more economic and efficient use of electricity should be resorted to.

(f) Research, development and experimenting with non-conventional energy such as solar, wind and Biogas should be resorted to.

Acknowledgement:

The author wishes to acknowledge with thanks the assistance given by Dr. P. N. Fernando in the preparation of this paper.

References:


Table (1) — Tentative Power and Energy Balance Tabulation (1970 - 1987)

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<td>318</td>
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<td>Power Deficit (MW)</td>
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<th>Samanwella</th>
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<th>Bandarawela</th>
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<td>1680</td>
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<td>1953</td>
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<td>Thermal Energy Requirements (GWH) (Under adverse inflow conditions)</td>
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<td>104</td>
<td>186</td>
<td>337</td>
<td>356</td>
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<td>Thermal Energy Capability (GWH)</td>
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<td>—</td>
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<td>—</td>
<td>87</td>
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*Note:

It is assumed that the Diesel plant in the system are retired and the boilers at the steam plant are replaced or augmented by 1984.
NOTE: The order of plants' commissioning indicated is only tentative and is subject to change after further study.
ANNEX I

ELECTRICAL POWER AND ENERGY DEMAND

Medium Term 1978 - 1982:

The power and energy demand predictions for the period 1978 - 1982 have been made on various basis and assumptions from time to time. The recent predictions are as given below:

(a) Prediction by Mr. T. L. Sankar in September, 1977.

(b) Professor Perera Committee Report 3 on "Power and Energy Requirements of the Ceylon Electricity Board" submitted to the Hon. Minister of Irrigation, Power and Highways in September, 1977.

(c) Mr. T. L. Sankar's prediction given in page 149 of the Final Report 1 of Mr. T. L. Sankar and Mr. G. B. A. Fernando — "Towards and Energy Policy in Sri Lanka" — April 1978.

(d) Prediction by Mr. T. L. Sankar given in the above report in page 107 of the same report.

While the predicted values given in (b) and (c) tally very closely with each other the values given in (a) and (d) differ widely from those given in (b) and (c). The reasons for the difference in predictions and uncertainty involved would be clear from the following:

The rate of growth of electrical power and energy requirements of electricity in different time periods are as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>Peak Power</th>
<th>Energy</th>
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<tr>
<td>1965 - 1969</td>
<td>13%</td>
<td>14%</td>
</tr>
<tr>
<td>1966 - 1985</td>
<td>9%</td>
<td>9%</td>
</tr>
<tr>
<td>1965 - 1970</td>
<td>13%</td>
<td>13%</td>
</tr>
<tr>
<td>1970 - 1976</td>
<td>6.5%</td>
<td>6.5%</td>
</tr>
<tr>
<td>1960 - 1970</td>
<td>10.8%</td>
<td>11%</td>
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</table>

The percentage growth of power and energy during different sub-periods are found to be varied in a wide manner as indicated above. The percentage growth depends on a large number of unpredictable factors such as economic stability, political stability, liberalization policies, revenue from export commodities such as tea, rubber and coconut etc. The method of prediction can be on a time trend basis involving the extrapolation of growth curves of known mathematical formulae or on planned GDP growth rate basis or on econometric models selected on the basis of economic parameters which have a direct correlation with energy consumption. The various techniques which could be used for such forecast are given in reference 2.

The impact on the electricity demand resulting from the change in policies after the change of Government in 1977 have not been stabilised and the uncertainty of predicting electricity even to the medium term period 1978 - 1982 as wide that the U. N. Export Mr. T. L. Sankar too had to revise the prediction estimates three times within a matter of approximately eight months as indicated above.

However uncertain such predictions are, it is necessary for the purposes of planning and decision making to make an estimate of the power and energy growth and demand as best as possible. In this paper the average rates of power and energy demand growth experienced over the last 30 years have been utilised. The energy generation demand projected on this basis coincides with the Prof. Perera Committee Report of September, 1977 when updated to include the requirements of the Free Trade Zone. The Graphs indicating power and energy demand are given in Figures 1 (a) and 1(b). The corresponding values of power and energy balance is given in table 1.

Long Term 1978—1992

Prediction of power and energy on a long term basis to any reasonable degree of accuracy is one of the most difficult tasks. This is more so in the present context of Sri Lanka because over a period of more than 5 years into the future, the parameters of GDP growth etc. are also not available. In this context, for the limited purpose of assessing the available hydro resources vis-a-vis the likely demand in the future, a prediction on a time-trend basis is utilised.

Over a long term period the time-trend method of prediction is not at all satisfactory and the predictions given here should be revised at least annually and adjustments in planning made accordingly. On the time-trend prediction curve appended to this report the values of energy demand computed by other methods, where available, are shown for purposes of comparison.

From the time-trend prediction given in figure 1(a) it would be seen that by the year 1992, the energy demand would have reached the total identified usable energy as indicated in Annex III. Although it may be argued that other unidentified sources of hydro energy may be available, it is very unlikely that large extents of usable hydro energy are yet to be found. Any small hydro power plant potential which may be identified in addition to the above, even if significant of the power angle, would only be small in relation to the large annual increments of energy demand by the year 1992. For instance 100 MW of additional plants installed in 1992 would be insufficient to meet an year's increase of demand.
ANNEX II
GENERATING PLANT POWER AND ENERGY CAPABILITIES

HYDRO PLANTS

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<th>Power Station</th>
<th>Power Capability (MW)</th>
<th>Annual Energy Capability (GWH)</th>
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<tr>
<td>1. Old Laxapana</td>
<td>50</td>
<td>828</td>
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<tr>
<td>2. Inginiyagala</td>
<td>10</td>
<td></td>
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<tr>
<td>3. Udalawala</td>
<td>96</td>
<td></td>
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<tr>
<td>4. Wimalasurendra</td>
<td>50</td>
<td></td>
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<tr>
<td>5. Polpitiya</td>
<td>75</td>
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<td>6. New Laxapana</td>
<td>100</td>
<td>504</td>
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<tr>
<td>7. Ukuwela</td>
<td>38</td>
<td>168</td>
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<td>8. Bowatemo</td>
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<td>198</td>
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<tr>
<td>9. Canyon</td>
<td>30</td>
<td>144</td>
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<td>10. Law Victoria (UNDP)</td>
<td>85</td>
<td>268</td>
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<td>11. Samanalaowa</td>
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THERMAL PLANTS

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<th>Power Capability (MW)</th>
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<tr>
<td>1. Kelanitissa (Steam)</td>
<td>45</td>
<td>250</td>
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<tr>
<td>2. Pettiha (Diesel)</td>
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<td>3. Chunnakam (Diesel)</td>
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ANNEX III
Total Hydro-power and Energy Potential

Comparison with Future Demand

The technically attainable and economically feasible hydro-power resources of Sri Lanka as basically estimated in the 1968 UNDP/FAO Mahaweli Ganga Irrigation and Hydro-power Survey, Volume VII, on "Dams and Hydro Electric Stations," and updated considering recent developments are given below. The estimates are subject to change after further investigations:

$$\text{Scheme} \quad \text{Power (MW)} \quad \text{Annual Energy (GWH)}$$

1. Mahaweli Ganga and Tributaries (Low Victoria—High Randeni-gala basis) \hspace{1cm} 962 \hspace{1cm} 3378
2. Kelani Ganga —
   Old Laxapana \hspace{1cm} 50 \hspace{1cm} 784
   Wimalasurendra \hspace{1cm} 50 \hspace{1cm} 784
   Polpitiya \hspace{1cm} 75
   New Laxapana \hspace{1cm} 100 \hspace{1cm} 504
   Canyon \hspace{1cm} 20 \hspace{1cm} 144
3. Kali Ganga
   Kukula Ganga \hspace{1cm} 105 \hspace{1cm} 456
   Ratnapura \hspace{1cm} 30 \hspace{1cm} 124
4. Walawe Ganga
   Samanalaowa \hspace{1cm} 120 \hspace{1cm} 680
   Uda Walawe \hspace{1cm} 6 \hspace{1cm} 12
5. Jasmin Complex
   Gin Ganga \hspace{1cm} 26 \hspace{1cm} 188
   Nihawala Ganga \hspace{1cm} 26 \hspace{1cm} 188
   Kali Ganga \hspace{1cm} 26 \hspace{1cm} 188
6. Other Rivers including Ingingiyanigala \hspace{1cm} 28 \hspace{1cm} 188
Total \hspace{1cm} 1592 \hspace{1cm} 8229

According to the trend observed in Figure (1a) and Mr. T. L. Sanduk's Report 1 the energy generation demand will reach the above potential in approximately another 12 to 15 years — i.e. by early nineteen. 