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UNITED NATIONS CONFERENCE ON NEW AND RENEWABLE SOURCES OF ENERGY

NAIROBI, 1981

NATIONAL PAPER

SRI LANKA

C O N T E N T S

CHAPTER I

INTRODUCTION

1. "Any plan for the utilization of an underdeveloped area must first ensure an adequate supply of power. An under - planning of the power requirements must be avoided in any case, since this would result in a throttling of the entire industrial development. It is preferable to err on the side of an over production of electrical power since the capital investment in plants for producing power is usually small compared with the capital investment in industries needed to consume the same amount of power".

So stated Dr. Homi J. Bhabha the late Indian Scientist in his invited address as Chief Guest at the Thirteenth Annual Session of the Ceylon Association for the Advancement of Science (now Sri Lanka Association for the Advancement of Science) in December 1957 at Colombo.

2. The steep increase in the price of oil since 1973 has compelled every country to evolve its own energy strategy. Sources of energy alternative to oil are being carefully evaluated and explored. In Sri Lanka the availability of hydro resources has to a large extent inhibited the immediate exploitation of the other alternatives. Nevertheless, electricity generation from non hydro resources would be needed in the 1980's to meet the emerging gap between electricity demand and supply. It is therefore necessary to examine the new and renewable energy resources that may be relevant to Sri Lanka.

3. Energy is most definitely a central component of any nation's development strategy, confirms Enrique V Iglesias, the Secretary General of the Conference on New and Renewable Energy Resources in his message in April 1981.

4. As much as 34% of the Investments in the Five Year Investment Programme (1981 - 1985) of the present government, is in the Energy Sector. The net import of petroleum products in 1980 constituted as much as 36% of the total exports of the country during that year although this met only 27% of the country's total energy needs. 73% of the total energy needs came from the renewable energy resources. With the liberalization policies adapted by the Government since 1977, the demand for energy, both petroleum and electricity, has been rising very dramatically. The cost of net petroleum imports during the period 1981 - 1985 is expected to be in the region of (US $ 3500 millions) Rs. 60,000 million. Hydro electric supply would have to be supplemented by thermal electric sources to bridge the gap between electricity demand

and supply - a gap that has already emerged and will widen very rapidly towards the end of the century.

5. It is therefore imparative that the remaining hydro resources would have to exploited in full pricing policies and conservation of oil through pricing and use would have to be introduced, a planned reafforestation programme has to commence without delay and the renewable energy resources have to be exploited. The role the renewable energy resources could play should be primarily assessed by monitoring these sources - solar, wind and biomass - throughout the country. At present there is no systematic monitoring of these sources. Efficient domestic stoves should be marketed. The use of fluorescent lights should be encouraged. Transport consumes 50% of imported oil. Consumption of oil in transport warrants the improvement of the Railways and shift from roadways to railways in the mass transportation of goods and people. In order to meet the energy needs of the decades 1981 - 1990, 1991 - 2000, 2001 - 2010, each of which is slightly different in nature, measures have to be taken simultaneously and immediately in order to avert series impediments to development programmes.

6. All these are tasks, the importance of which has been fully appreciated by the government and programmes prepared or being prepared to implement them. The establishment of the Natural Resources Energy and Science Authority, which is to be very shortly constituted by the President of Sri Lanka, and directly responsible to him, as well as the recent take over by the President himself of the portfolio of Power & Energy will be the start of an intensive and co-ordinated Energy Development programme in Sri Lanka.

CHAPTER II

THE ENERGY SCENE IN SRI LANKA

7. Sri Lanka has an area of around 65,600 square kilometers. The annual rainfall varies from below 100 cms in the dry zones in the North West and South East sections of the island to 500 cms at certain places in the North Western slopes of the hills. The relative humidity varies generally from about 70% during day to about 90 - 95% at night. The country is blessed with sunshine throughout the year with an average solar insolation of about 5 Kwh per square meter per day.

8. The population of Sri Lanka stands at 14.86 million as of March 1981. The average rate of growth over the last 10 years has been 1.7 per cent per annum. About 76 per cent of the population live in the rural areas, where the main activity is agriculture. The per capita GNP in 1979 was Rs. 3,424 (US $ 220) at current prices.

9. The year 1977 saw a rather dramatic change in the economic policy reflecting the liberalised policies of the United National Party Government which took office in 1977 under the leadership of His Excellency Mr. J.R. Jayewardene. The economy recorded a growth rate of 8.2% in 1978 although the growth rate fell in 1979 to 6.2% and in 1980 to 5.6%. Domestic savings reached 15% of GNP in 1978 and 1979, well above previous levels. Private and public investments grew rapidly bringing the total investment to 20% of GNP in 1978 and 25% in 1979. The Government enbarked on three major new programmes which are lead projects in the five year rolling public investment programme between 1980 and 1985. These are -

(a) The Accelerated Mahaweli Ganga Development Programme for hydropower, irrigation and land development, self sufficiency in food, human settlement and employment

(b) The Greater Colombo Economic Commission for Industrial Development and 'Export' Productivity and

(c) The islandwide housing development programme commencing with the massive Urban Development Programme around Colombo City.

10. The total energy consumption in Sri Lanka in 1979 was estimated at 3.5 million tonnes of oil equivalent of which 60% came from fuelwood and agricultural residues 27% from petroleum products and 13% from Hydro electricity. Reliable estimates indicates that of the 60% of non commercial energy

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a. 3 GWh electrical energy has been taken as equivalent to 1,000 tonnes of oil equivalent (t.o.e.)

consumption almost two thirds come from fuelwood while a third come from the agricultural residues.

11. The sectoral composition of energy consumption expressed as a percentage of oil equivalent was as follows (Ref. 1)

Table 1

	Total Energy	Commercial Energy	Petroleum Products	Electricity	Fuelwood & Agricultural Residues
Domestic	52.9	22.4	23.8	21.6	74.0
Transport	13.4	32.8	50.5	-	-
Industrial	29.2	34.0	19.0	67.1	25.9
Losses	4.5	10.8	6.7	11.3	-

12. The principal sources of energy in the Sri Lanka economy are oil, electricity and relatively small quantities of coal. In certain small industries like brick and tile making, smoked rubber, dessicated coconut and coconut oil production and in curing of tobacco as well as in the domestic sector, traditional fuels like fuelwood and agricultural waste such as bagasse are also used.

13. Tables 2 and 3 below set out details of commercial and noncommercial energy consumption during the period 1960 - 1979 in original units as well as in tonnes of oil equivalent. (Ref. 1)

Table 2 (In original units)

	1960	1965	1970	1975	1979
Coal ('000 Tonnes)	256.5	147.5	19.5	7.0	0
Petroleum Products ('000 Tonnes)	535	630	893	964	980
Hydro-electricity (Gwh)	262	365	740	1078	1461
Fuelwood & Agricultural Residues ('000 Tonnes)	3940	4276	4161	5029	5221

b. 1.6 tonnes coal has been taken as 1 t.o.e.

c. 1 tonne fuelwood has been taken as 0.42 t.o.e.

Table 3 (In 1000 Tonnes of Oil Equivalent)

	1960	1965	1970	1975	1979
Coal	160	92	12	4	0
Petroleum Products	535	620	893	964	980
Hydro Electricity	87	122	247	359	487
Fuelwood & Agricultural Residues	1655	1796	1756	2112	2187

14. There has been a gradual phasing out of the use of coal from 20.5% of commercial energy use in 1960 to almost zero in 1979. The percentage use of hydro electricity in total commercial energy consumption has steadily increased from 11.1% of total commercial energy demand in 1960 to 33.4% in 1979. The percentage use of Petroleum products in total commercial energy consumption has remained at about 70% during 1960 - 1979 with the highest recorded (80.5%) in 1973. Fuelwood and agricultural residues have remained a major non commercial source of energy providing almost 60% of total energy consumption in the period 1960 - 1979, almost two thirds of which was contributed by Fuelwood.

Figure 1 (next page) indicates the total energy consumption in Sri Lanka during the period 1960 - 1979.

15. Following the acceleration in economic activity in all sectors of the economy, and relaxation of import control on vehicles and electrical appliances, the demand for energy, both petroleum based and electrical has grown rapidly during the last two years. There is however very little scope for reducing the country's dependance on imported petroleum during the medium term.

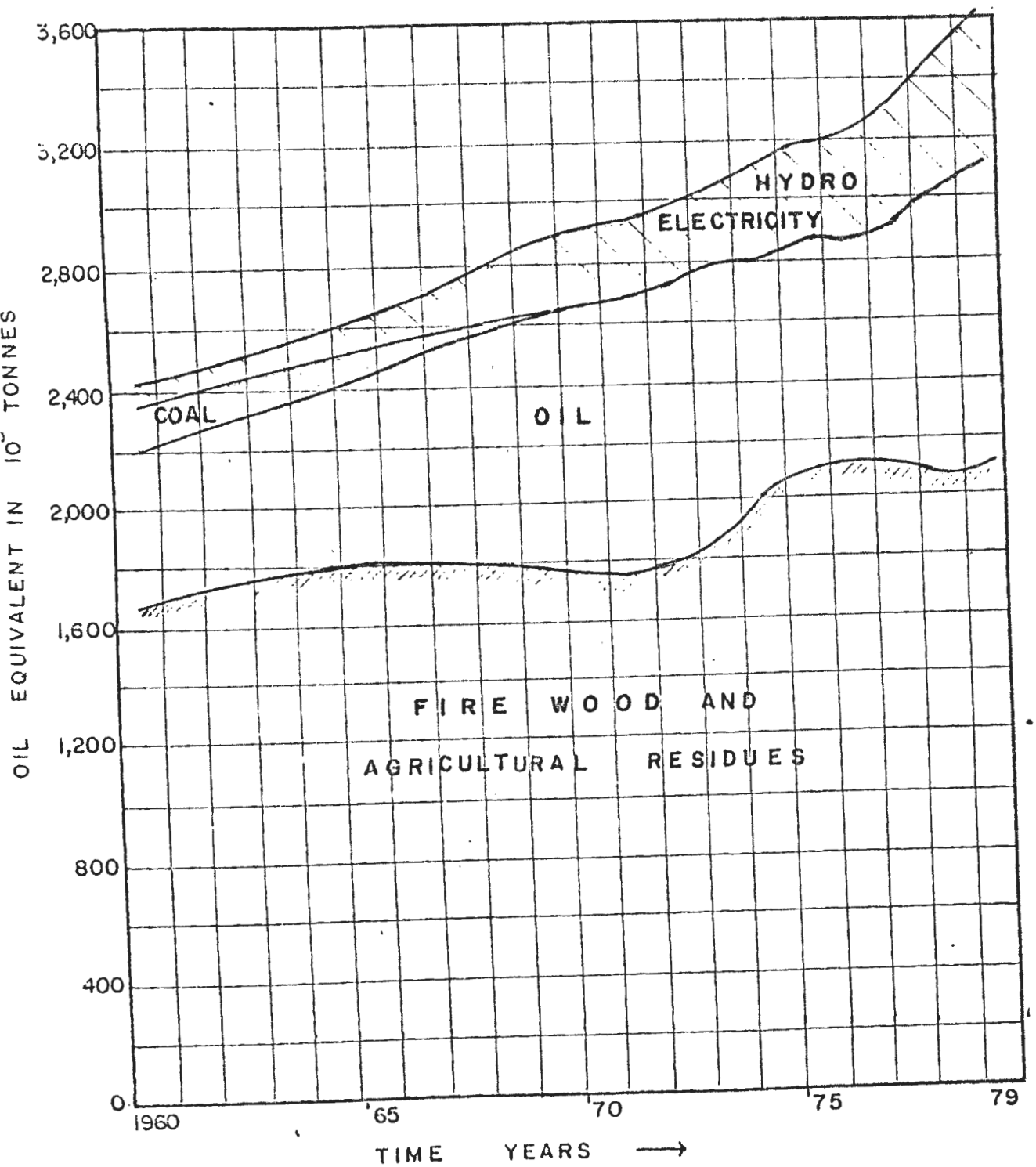
16. Electrical Energy Consumption Pattern

In 1979, 1525 Gwh of electrical energy was generated and the peak demand was 328.9 MW. The per capital consumption of electrical energy was 89.6 Kwh for 1979. In 1980, 1666 Gwh of electrical energy was generated and the peak demand was 368.5 MW.

17. Electricity serves only 11% of the households and 8% of the villages. About a quarter(350 MW, 1,600 Gwh)of the hydro electric potential has already been harnessed and plans are in progress for the harnessing of about another quarter (600 MW, 1,500 Gwh) under the Accelerated Mahaweli Development Programme. The remaining half (1,000 MW, 3,200 Gwh) is to be exploited in quick succession in the 1990's. Thermal Power Generation will still become necessary to supplement hydro resources to meet the widening gap between electricity demand and supply. Steam Plants with an effective capacity of 40 MW and diesel plants with an effective capacity of 10 MW have been installed. Last year 3 gas turbines of 60 MW capacity were installed and this year another

TOTAL ENERGY CONSUMPTION

IN SRI LANKA



3 Gas turbines of 60 MW capacity are being installed. These plants use expensive diesel fuel. The next thermal additions are expected to use furnace oil.

18. Table 4 Annual Growth Rate of Electricity Sales 1960 - 1979

Period	Annual Growth rate on Electricity Sales Total (%)	Domestic Sector	Industrial Sector
1960 - 65	10.3	10.1	10.5
1965 - 70	13.5	7.4	15.5
1970 - 75	8.2	7.9	8.5
1976	3.1	7.7	0.6
1977	4.4	8.6	3.1
1978	11.6	10.1	12.1
1979	11.6	16.3	10.2
1960 - 79	10.0	8.9	10.4

19. As much as 98.3% of electricity generated in the five years 1975 - 1979, was from hydro electricity. This percentage dropped to 88.7% in the year 1980. The share of thermal power generation is expected to rise in the 1980's.

20. It is thus seen that 73% of the energy consumption in 1979 was from the renewable energy resources while 27% came from petroleum products. The cost of the latter was 36% of the total exports in that year.

Little can be done to replace the 13% of total energy (or 50% of Petroleum Products) consumed in the transport sector unless the railways are properly managed although there could be considerable replacement in the 14% of total energy (in the form of petroleum products) consumed in the domestic and industrial sectors by the renewable energy resources.

The increase in demand for total energy should therefore be met by increasing the efficiencies in utilising the renewable energy sources, and systematically replacing petroleum use in the domestic and industrial sectors by the renewable energy resources.

21. INSTITUTIONAL ARRANGEMENTS

The Ceylon Electricity Board is the Authority for the generation, transmission and distribution of electricity in the island. The Ceylon Petroleum Corporation is responsible for importing, refining and distributing petroleum products in Sri Lanka. The Department of Conservation of Forests is responsible for the Management of the Forests while the harvesting of timber

is the responsibility of the State Timber Corporation. The UNDP sponsored Development Planning Unit in the Ministry of Finance and Planning had initiated some exercises towards the development of an energy policy in Sri Lanka. Some important issues on Energy were discussed at a well attended Seminar on 'Towards an Energy Policy in Sri Lanka' in November 1977 jointly sponsored by the Development Planning Unit in the Ministry of Finance and Planning and the Ceylon Electricity Board. Largely as a result of these recommendations the Cabinet appointed a Committee to report on steps to be taken to meet the short and long term energy needs of the country. Consequent to the recommendations of the Cabinet appointed Committee, the Cabinet has approved the establishment of a Natural Resources, Energy and Science Authority which is to be very shortly constituted by the President of Sri Lanka, and directly responsible to him. This Authority, which will absorb the present National Science Council of Sri Lanka, as well as the recent take over by the President himself of the Portfolio of Power and Energy will be the start of an intensive and coordinated Energy Development Programme In Sri Lanka.

22. ENERGY DEMAND PROJECTIONS

The projections for electrical power and energy demand is regularly updated by the Ceylon Electricity Board. The rapid increase in the electricity demand after the UNP government took office in 1977 has lead to electricity demand projections being revised almost monthly.

Table 6 indicates the electricity demand projections as of June 1981 (Ref. 2)

Year	1979	1981	1983	1985	1990
Total Generation (Gwh)	1526	2140	2712	3529	5399
Hydro Generation (Gwh)	1461	1550	1750	2507	3534
Thermal Generation (Gwh)	63	590	962	1022	1865
Maximum Demand (MW)	328.9	452	573	744	1139
Hydro Capability (MW)	313	353	383	623	925

It is clear that along with the commissioning of newer hydro electric projects, large additions of thermal electric sources would be needed to meet the rising demand for electricity.

CHAPTER III

RURAL ENERGY ISSUES

23. The sectorwise consumption of fuel in the rural sector had been analysed in the Socio Economic Survey of 1969 - 1970.

The survey reveals the pattern of fuel use as follows : -

Table 7

	Number of Households using fuel for Cooking		Lighting	
	In '000	%	In '000	%
Electricity	0.0	0.0	48.69	2.9
Gas	0.0	0.0	1.93	0.1
Kerosene	29.25	1.9	1451.63	96.7
Fuelwood	1472.84	97.9	4.33	0.3
Others	2.31	0.2	0.48	0.0

We observe that the major fuel for lighting is kerosene and for cooking it is firewood.

24. Although the Ceylon Electricity Board has been actively persuing the electrification of the rural sector through the rural electrification programme, the total number of households using electricity remain very low. Only 1915 villages out of a total of 23,617 villages have access to the electricity grid. This constitutes 8% of the villages. However 122 out of 195 urban centres (63%) have access to electricity. 5% of the rural population have access to electricity.

25. The Ceylon Electricity Board electrifies about 200 - 300 villages a year catering to about 10,000 rural households. Against this spread of electrification over 30,000 new households come into existence each year due to population increase. The major hinderence to Rural Electrification schemes is that it has been impossible to find any scheme giving an overall return of more than 4 - 5% (Ref. 3) Although the financial return due to high cost of construction is no more than 4.5%, the social benefits that are given to the rural sector in the process has encouraged the government to provide electricity to as many villages as permitted. Rural electrification programmes are financed by a Government grant, the decentralized budget as well as by the Ceylon Electricity Board.

26. A Bank's loan scheme has now been introduced to assist these who are unable to meet the initial capital investment required for electrical installations in their households. The current proposals for rural electrification are in the region of Rs. 500 million but same have been phased out of the 1981 budget due to financial restrictions. Rural electrification constitutes about 3% of the total demand.

27. The social and economic benefits of rural electrification should be properly assessed in the present context of energy supply and demand, particularly on electricity provided for rural lighting only. Efforts should be made in using electricity for direct productive activities in the rural sector. Rural electrification schemes should be designed and selected as part of a comprehensive rural development programme.

28. It should also be remembered that any energy plan must be viewed in the overall context of the meaningful improvement in the standard and quality of life of the people. This plan must be viewed within the context of the Social economic and cultural factors which are the ultimate determinants of energy demand (Ref. 12)

29. In this country the majority of the population is connected to the rural agricultural economy. The country faces the problems of rural development which concerns the majority who are still living at levels below the basic needs, namely.

(a) a minimum requirement of private consumption (food, clothing and shelter).

(b) access to communal services (drinking water, sanitation facilities, public transport, health and educational facilities).

and (c) adequately productive and fairly remunerative employment.

30. The basic lighting requirements for the rural household that has no access to electricity should be provided by guaranteeing adequate supply of kerosene.

It has been observed that, on an average, a household of six would require 1.8 gallons of kerosene per month to meet the basic requirements of lighting and cooking. This is probably the amount that is now consumed by households that do not have access to electricity. This supply has to be guaranteed by issue of coupons to the identified households not having electricity as they may not be able to face the cost of escalating kerosene prices. This facility should be withdrawn to households that have access to electricity.

31. Encourage the use of electricity in villages for productive purposes.

32. The progress of domestic agriculture displaces more and more labour which should be absorbed in industries that are associated with agriculture. Industrial development calls for the utilization of energy.

CHAPTER IV

ENERGY RESOURCES

FOREST RESOURCES

33. The demand for fuelwood and agricultural wastes will be governed by its supply. The fast dwindling forest resources will have to be arrested and a planned fuelwood programme will have to be maintained during this decade to recover the forest cover lost over the last 20 years.

34. According to a survey of the forest area in 1956, a forest cover of 2.68 million hectares was identified. Recent estimates of forest cover is in the region of 1.6 million hectares. Although illicit felling of timber had been known to take place for a very long time, serious thoughts on protecting the fast dwindling forest resources have emerged only very recently.

35. The use of fuel wood and agricultural wastes have been estimated to gradually increase from about 4 million tonnes per annum in 1960 to about 5.2 million tonnes per annum in 1980. The Forest Department estimates fuelwood consumption at about 3.5 million tonnes per annum in 1980. The natural regeneration of fuel wood from the forest cover cannot exceed 1 million tonnes per year. The fuel wood from the rubber plantations which cover a little over half a million acres, has been estimated at around 0.3 million tonnes per annum. The residues from coconut wastes paddy husks, saw mills and from crop residues including rubber wood would yield about 1.5 million tonnes of fuel wood per annum. The remainder could be assumed to be derived from the denudation of the forests.

36. Fuelwood requirements of Sri Lanka 1956 -1980

Recent studies on Fuelwood use in Sri Lanka (Ref. 4, 5, 6) indicate that around 5 million metric tones (m.m.t) of fuelwood and agricultural residues is currently used per annum.

A hectare of natural forest when denuded is expected to generate 170 cu. meters of wood of which 20% may be assumed to be used as fuelwood. The annual harvest from a natural forest may be assumed to be 2% of this capacity.

37. It has been estimated that the fuelwood requirement during the period 1956 - 1980 has been in the region of 96 million tonnes. Of this

36 million tonnes is estimated to come from accretion of crop residues (including rubber wood)

27 million tonnes from natural regeneration of forests

and 35 million tonnes from the denudation of forests.

38. It becomes clear that it will no longer be possible to maintain the use of about 5 million tonnes of fuelwood per annum without embarking on a planned reforestation programme. Besides, the indiscriminate felling of trees in the catchment areas in the central hills has to be controlled, as it would otherwise affect the regular inflows into the reservoirs for precipitation.

39. The forest Department has renewed its measures to protect the forest resources in order to maintain a healthy ecological balance. The Forest Department recognises that sufficient forests must exist in order to ensure.

(a) Regular flow of water in streams;

(b) Prevention of soil erosion;

(c) Amelioration of the climate and development of the environment,

and (d) Sustained supply of timber and firewood to meet part of the local market.

At present only 9% of the Wet Zone region is under forest cover when it should be 25 %. The Forest Department recognises that the existing forest cover in the Montane Zone above 1500 metres should not be exploited for any purpose and hopes to increase the Dry Zone forest cover to 25% of the land area.

40. Among the strategic objectives of the Forest Department are : -

(a) An annual reafforestation of derelict forest lands and unproductive lands in the Wet Zone and the Dry Zone extending from 2,400 and 4,800 hectares in 1981 to 3,200 and 6,000 hectares in 1983.

(b) Reafforestation of neglected tea and rubber lands in the Wet zone and Intermediate Zone at the rate of 600 hectares per annum from 1981 to 1983.

(c) An annual reafforestation of chenaed lands extending from 1,200 hectares in 1981 to 8,000 hectares in 1983.

(d) Reafforestation of Upper Mahaweli Catchment area at 1,200 hectares per annum.

(e) Fuelwood plantation in the Mahaweli settlement area at 2,800 hectares per annum.

(f) Protection of 1.6 million hectares of forest lands.

These objectives have been recognized by International Organizations and friendly countries who have lent generous support.

41. The Forest Department plan in 1979 to reafforest 7,200 hectares in 1981 under its normal refforestation programme has been stopped because the funding requirement of Rs. 17.5 million has been reduced to Rs. 6 million, resulting in their inability to execute their normal reafforestation programme for 1981. The cost of importing crude oil to meet the scarcity in fuel wood due to delayed reafforestation could will exceed the Rs. 11.5 million gained by the cut imposed on the Forest Department.

The Need for New and Renewable Sources of Energy

42. At the present rate of consumption of firewood, the forests are getting denuded at a rapid rate. Even to maintain the present levels of consumption of firewood, a planned reforestation programme is vital. The supply of crude oil is getting more expensive and scarce day by day. Yet it will not be easy to replace oil as a transport fuel. Substitutes for oil will therefore have to be found in the other sectors. In spite of the very sincere efforts that are being made to expedite the construction of certain hydropower projects to be commissioned on schedule, there may be significant delays. Such delays would become unavoidable if adverse soil conditions or climatic conditions are faced during the course of construction work. It has been observed that owing to the liberalised policies of the Government the demand for electricity has been growing at a very rapid rate since 1977. If these demand patterns continue to grow at these rates, the need for new sources of energy to supplement the demand for electricity would arise within a few years.

The New and Renewable Sources of Energy

43. Solar radiation, wind, biomass and micro hydel resources are generally freely available in plenty and require some capital investment in hardware for collection and conversion into useful forms. These technologies are highly developed mainly in the developed countries, with probably the exception of biomass. Due to low demand, the cost of these processes are still high.

44. A certain amount of research and development work has been done in the context of the conditions and needs of the developing countries. The technologies that are developed within the framework of the social and economic limitations of the community can contribute to a healthy rural development programme.

Energy Resource and Supply Options

45. The main energy resource in Sri Lanka is sunlight. Some 50,000,000,000 tonnes of oil equivalent in sunlight falls on Sri Lanka every year. Fuelwood and agricultural wastes which constitutes almost 60% of total energy consumption is derived through Photosynthesis while hydro electricity which constitutes almost 13.3% of the total energy requirements derives its energy from rainfall. Almost 26.7% of total energy consumption is obtained from oil imported to the country either in the crude form or as refined products. Sri Lanka does not have known deposits of coal, oil or natural gas. There are a few deposits of peat and mineral deposits contining uranium and thorium ores.

Hydro electric and thermal electric resources

46. There are 109 rivers and streams mostly originating from the central hill country, each having varying drainage areas ranging from 4 to 4000 square miles. The total annual rainfall over the entire island is estimated to be 107 million acre ft. The run off into the sea from all rivers and streams have been estimated differently at different periods of time and depicts a minimum estimate of 30.0 million acre ft. and a maximum estimate of 41.6 million acre ft.

47. Existing hydro resource potential has been estimated at around 2,000 MW with an annual energy capability of about 6,600 Gwh. Of these, a potential of 369 MW with an annual capability of 1,608 Gwh has already been harnessed. The Accelerated Mahaweli Development Programme is expected to harness another 640 MW power and 1,834 Gwh annual energy during this decade. Hydropower will continue to be the major source of electricity until the late 1990's with the development of Samanalawewa (240 MW, 400 Gwh) Upper Kotmale Oya (100 MW, 300 Gwh), Uma Oya (100 MW, 375 Gwh) Kaluganga (150 MW 450 Gwh) and other relatively less attractive projects.

Peat Resources

48. The only significant resource identified so far is the peat at Muthurajawela which is a relatively small deposit. The UNDP team that had assessed the Hydro-electric potential in the Mahaweli Scheme in 1968, mentioned in passing that the peat at Muthurajawela amounted to about 50 million tons. The availability of peat in other areas have not been assessed comprehensively. It would be desirable to have a reassessment of the resources. Considerable enthusiasm was generated to utilize the peat resources in the country when it was discovered that large areas in the neighbourhood of Colombo had become uncultivable due to salinity and once fertile land were fossilising into peat bogs. (Ref. 13)

49. A peat bog running into 2,200 hectares situated 10 kilometers north of Colombo, well known as the Muthurajawela Peat bog, was examined by a Russian Team in 1960. On analysing an area of about 1,500 hectares it was observed that 460 hectares have a peat bed 2.1 meters thick and no more than 30% ash. The quantity of the peat resource of this kind is estimated to be about 10 million cubic metres. If 0.6 of this peat is recoverable and the output of peat is 0.42 tonnes per cubic metre, the total tonnage of recoverable peat amounts to about 3 million tonnes of peat containing 40% moisture. The remaining part of the territory covering 1,000 hectares contains shallow peat or a bed inlaid with minerals and drifts, with an ash content reaching upto 45 - 50%. These beds are unfit for the extraction of peat.

50. The peat field is of the low moor type and the contents are mainly of herbaceous and tree type. Aluminium and Silicon predominate in the ash of peat. The peat has a high content of chlorine, magnesium and sulphur. Chlorine and magnesium are due to the ocean flood waters. Sulphur is due to the activity of aerobic bacteria as well.

51. The peat may be dried in the open air to attain a moisture content of 40 - 50% and heating value of 2600 K.cals/kg. to use as industrial fuel. 2 million tonnes of this peat could generate 1500 Gwh of electrical energy.

For domestic purposes, they may be turned into briquettes containing 15% moisture with a calorific value of 5600 cals/grm. The peat may also be used to produce gas. Peat may also be used to make alcohol, furfural, exalic acid, liquid carbonic acid, various kinds of peat fertilisers and insulating plates.

Prospects of Solar Energy

52. Photovoltaic cells for direct conversion of solar energy into electricity are expected to come down in price within the next decade. The technology of Photovoltaics cannot yet be accommodated in a Rural economy. It may be used to power VHF radio links between remote post offices and rural exchanges. Solar panels for heating and cooling of buildings may interest those who have no access to power for heating and air conditioning from a central electricity grid, such as rural health centres and hospitals. Conversion of solar energy into thermal energy and thence to electrical energy has not yet been proved to be adaptable into a rural economy. Low cost solar stills could produce potable water to rural households in areas where well water is brackish, and provide distilled water for car batteries and rural science laboratories. Solar driers will be useful for the quick drying of agricultural products and fish under hygenic conditions.

The feasibility of using solar stills to produce fresh water, driers for crop drying water heaters and cookers have been examined by the Ceylon Institute for Scientific and Industrial Research, The Eng. Faculties of the Universities at Peradeniya and Moratuwa, the National Engineering Research and Development Organization and the Ceylon Electricity Board.

Wind Energy

53. Wind energy is best utilised for lifting of surface water and the extraction of ground water and for the running of sailing boats on the seas. The best wind potential has been found in the Hambantota area (South East) and the Jaffna area (North). Except for the South Western parts of Sri Lanka, in the other parts of the island, where there is a good wind potential, the dry zeason coincides very well with the high wind period which makes it very attractive to use wind mills for water pumping. Historically, wind mills were built in the Dutch times (1658 - 1796) at the Forts at Galle, Hambantota and Hammond Heil. The Government of the Netherlands has assisted in the setting up of a Wind Energy Unit in Sri Lanka on the initiative of Mr. P.T. Smulders and Mr. A.D.N. Fernando with the objective to design and test small scale water pumping windmills and to promote manufacturing and the utilisation of these Windmills. This unit presently attached to the Water Resources Board has successfully designed and constructed two prototype windmills that are now under testing in Colombo (Ref. 7 and 8)

54. In the recent times several attempts have been made to use windmills for lift irrigation, electricity generation and to pump saline water to the salterns. The engineering faculties in the Universities at Peradeniya and Moratuwa and the National Engineering Research and Development Organization have been conducting some research in these areas. They have not been field tested as yet. The main reason for their failure was due to their unsuitableness for the wind regime that existed in that region.

The use of wind energy for electricity generation is possible in the Hambantota regim, and in certain parts of the hill country like the Matale Valley, the Haputale gap, the Ella gap, Horton Plains, Hunnasgiriya, Madugoda, Corbett's gap, Umbugal and the Ginigathhena pass.

Although there are 500 stations to monitor rainfall, there are only 16 Meteorology Stations and 17 Agro met. stations to monitor wind regimes. The anemometers are installed at heights of 6 meters above the ground at the Meteorology stations and at $1\frac{1}{2}$ meters above ground at the AGRO MET. stations.

The objectives of a wind energy programme should be directed at the building up of an anemometer network (preferably at the internationally accepted height of 10 M.) in Sri Lanka and the Windmill design to be inkeeping with the wind regime.

55. Biomass

The use of biogas generators in recycling animal, agricultural and municipal wastes for the generation of methane on the one hand and for the production of a higher value fertiliser on the other hand has its applications in Sri Lanka. Various types of biogas generating and utilising systems have been tested at the University of Peradeniya. The Ceylon Electricity Board, the Industrial Development Board and the Department of Agriculture have programmes for the popularisation of biogas generators. The Indian design as well as the Chinese design have been popularised and it is estimated that there are over 500 biogas generators currently installed in Sri Lanka.

Fuelwood and Charcoal

56. Fuelwood is used in the domestic sector, in tea factories, brick and tile industries, bakeries, tobacco curing etc.

Charcoal became popular in use for domestic consumption since April 1980 and to date there are about 6000 charcoal stoves. Charcoal consumption is about 30 tonnes per month today. (Ref. 14)

57. The normal domestic fuelwood heath uses fuelwood at around 14% efficiency. Improved stoves which have efficiencies in the range of 20 - 25 per cent have been developed by the Ceylon Institute for Scientific Research and the Industrial Development Board. The CISIR design is a prefabricated modular stove which costs about $ 2.

The CISIR has developed several charcoal stoves which are currently sold by the State Timber Corporation. The low cost wood stove is being field tested and popularization of the stove may be possible towards the end of this year.

58. At least 250,000 hectares of fuelwood plantations are estimated to be needed by the year 2000.

Gasification or pyrolysis of wood charcoal or briquetted paddy husks and coir dust are being examined.

59. A recent study (Ref. 9) indicates that paddy husk can cater to the heat energy requirements of the entire rubber, dessicated coconut and tobacco industries as well as a part of the tea industry. The cost of paddy husk briquettes per unit energy delivered is as much cheaper than that of coal, electricity and oil and about 1.25 times that of fuelwood.

Ocean Thermal Energy Conversion (OTEC)

60. A recently study made by the National Science Council of Sri Lanka (Ref. 10) has shown that Sri Lanka could possess sites favourable for OTEC plants. However a systematic investigation around the coastal regimn to map out temperature and depth profiles is a preliminary requirement. A large scale OTEC project for Sri Lanka cannot, however be recommended at the present stage.

Mini Hydro development

61. Some Tea estates which had been using mini hydro plants before the advent of cheap oil resources had abandoned these plants in favour of diesel generators. About 3 MW of power capacity from abandoned mini hydro plants can be recovered by upgrading and repairing these machines already installed in the estates.

However, the economies of developing a new mini hydro scheme should be evaluated against the development of larger hydro resources still undeveloped.

Geo-Thermal energy resources

62. There are a few hot springs in Sri Lanka but the energy in them is not sufficient for commercial exploitation. There is however a suspected geological fault running across some parts of the island. An investigation into this geological fault may throw some light into possible sources of Geothermal energy.

CHAPTER V

THE RURAL ENERGY CENTER

The Rural Energy Demonstration Centre for the Asian Region at the Pattiyapola Village under the aegies of the United Nations Environment Programme and the Sri Lanka Government.

63. The United Nations Environment Programme at the Third and Fourth meetings of its Governing Council decided "to accord high priority to the establishment in some of the typical rural areas of the countries of Asia, Africa and Latin America of a few demonstration centres harnessing individually or in combination the Renewable Resources of energy locally available".

64. The decision to have the Asian Demonstration Centre in Sri Lanka was welcome by the Government of Sri Lanka. A site having plenty of sunlight, strong winds and animal and agricultural wastes, bordering an existing natural lake, was selected to the satisfaction of the UNEP authorities and their consultants. The average solar insolation has been estimated at 5 KWh/sq.m. per day with an average wind regime of 12.3 m.p.h. at the site. The project envisages to harness the three renewable sources (solar, wind and biomass energy) in an integrated manner to produce electricity for lighting the houses, pumping drinking water and providing motive power for cottage industrial growth for as many families of the Pattiyapola Village as possible (about 200) living within a radius of 1½ miles (2.4 Kms.) of the site. The system is to make available annually about 60,000 KWh of electrical energy at 230V AC for the consumers. The cost of the various components were estimated as follows : -

Solar (Rated 10 - 20 KW capacity)	US $ 55,000
Wind (Rated 20 KW capacity)	$ 26,000
Battery Bank (300 KWh per day)	$ 25,750
Biogas (Rated 50 KW capacity)	$ 23,250
Power Distribution	$ 12,500
Overhead Tank of 3000 gals.	$ 15,000
Water Purification Plant	$ 5,000
Meteorology Observatory	$ 3,000
Misc. including contingencies	$ 20,000
Consultants (3 trips to total 6 weeks)	$ 12,000
Training 2 local engineers for 3 months	$ 5,000
	US $ 202,500
$ 160,000 Foreign	
$ 42,500 Local	

65. A project agreement was signed between the Sri Lanka Government and the UNEP in September 1976 with the Ceylon Electricity Board as the executing agency to have the Demonstrating Centre operational by November 1978 with the UNEP contributing US $ 191,000 and the Sri Lanka Government contributing US $ 42,500 in local currency.

The UNEP consultants have, from time to time, made changes due to improvements in technology during the period of construction and the project was later expected to be operational in June 1979. The UNEP has also enhanced its contribution by US $ 105,000 to US $ 296,000. The Ceylon Electricity Board spends about US $ 3,000 per year in local currency to maintain their staff at the site.

The objective of the project is "to demonstrate the technical, economic and social feasibility of harnessing solar energy, wind energy and biogas energy to meet the energy needs of a remote village and to prove that the existing state of the art of appropriate technologies for harnessing renewable energy resources under the conditions prevailing in rural areas of developing countries could justify the use of such technologies."

66. The project is composed of a wind electric system, a solar electric system based partly on thermal power generators and partly on photovoltaic generators and a biogas plant. The electricity produced by the three systems will be stored in a battery bank, transformed to 230 V AC and distributed in the conventional manner. The proponents of this system have claimed that, if successful, the concept would revolutionize the life style of no less than 800 million people living in small isolated village conditions in developing countries of Asia, Africa and Latin America.

67. The project is now reaching its final stages of completion. At the request of the United Nations Environment Programme, a standing Committee consisting of Meteorologists, Social Scientists, Engineers and Economists working in Sri Lanka Institutes and Government Departments has been appointed to monitor the progress of the Rural Energy Demonstration Centre. The Standing Committee did not meet after the Ceylon Electricity Board was requested to execute the project.

The Standing Committee would be meeting very soon to evaluate the Project.

CHAPTER VI

Collaboration with Governments Inter Governmental Organisations and International Agencies

68. Important issues for collaboration.

The following issues on energy area of importance to Sri Lanka in the decades to come and therefore collaboration on these topics would be fruitful.

(a) Investigation, feasibility study, engineering design and planning of remaining hydropower resources

(b) Promotion of decentralised renewable energy systems like solar, wind and biomass.

Solar	-	Water heating, distillation, drying of grain and cash crops, pumping, refrigeration, space heating and cooling and development of Photovoltaic systems passive solar heating.
Wind	-	for lifting underground water for irrigation, and powering boats using sails.
Biomass	-	Recycling animal agricultural and Municipal wastes.

(c) embarking on a planned reforestation programme.

(d) improving efficiencies in the domestic heath .

(e) improving rail transport to cater to mass transportation of goods and people. Electrifying areas of high density traffic.

(f) replacing petroleum products for industrial and domestic heat by the renewable energy resources.

(g) persuing energy conservation programmes like replacing incandescent fittings with flourescent fittings, and promoting fuel efficiency in industry.

(h) developing information systems on energy.

69. Sri Lanka systematically developed her hydro resources for power generation since 1950. Prior to this only mini hydro resources were developed to provide power in the tea estates. With the development of the hydro resources in cascade down the Kelani Ganga, the potential and use of the development of hydro resources was realised. A lead project of the Government is the accelerated Mahaweli development programme. Financial and Technical assistance has been provided by the Governments of Sweden, Britain, West Germany and Canada for the development of these hydro resources. Even

with the completion of the Accelerated Mahaweli Development Programme another half of the hydro potential yet remains to be harnessed. The exploitation of these resources would be priorities for development in the next decade.

70. Fuelwood has been assumed to be available in plenty until it was realised in the latter part of the 1970's that the Forest Cover had dwindled to half the size it was in 1956. The Forestry sector accounts for 7% of total agricultural production and only 2% of the total GDP.

71. The United Nations Development Programme has allocated US $ 120,000 for

(a) Formulation of a Master Plan for the Forestry sector

(b) Establishment of about 20,000 hectares of industrial plantation over a five year period

(c) Strengthening of existing technical training institutions and the establishment of a University level education facility for the training of professional foresters.

72. The USAID has funded a reforestation and watershed management project in the areas of the accelerated Mahaweli programme. The Asian Development Bank has given technical assistance for a Community Forest Project. Assistance is also received from the World Bank and the World Food Programme.

73. The United Nations Environment Programme is collaborating with Sri Lanka in the establishment of the Asian Rural Energy Demonstration Center in Sri Lanka, which is being executed by the Ceylon Electricity Board. The objective is to demonstrate the utilization of the renewable energy resources like Solar, Wind and Biomass to meet the basic energy needs of village community of about 200 families having no access to a central electricity grid.

74. The Netherlands has an agreement with Sri Lanka on Wind Energy Utilization. The programme is presently executed by the Water Resources Board. India has gifted 10 Biogas generators which the Department of Agriculture has installed in different sites. France has an agreement with Sri Lanka where the CNRS collaborators with the CISIR on the development and use of Solar Energy.

75. Sri Lanka has participated in most of the ESCAP programmes on the renewable energy resources. Sri Lanka is a member of the Commonwealth Consultative Group on Energy (CHOGRM). Sri Lanka collaborates with the Resources Systems Institute of the East West Center in Honolulu on Energy for Rural Development.

Sri Lanka collaborates with the Asian Institute of Technology which is developing a renewable energy resources programme.

76. The National Science Council, being the focal point in Sri Lanka on Information systems on renewable energy resources collaborates with UNESCO, CRRERIS, RERIC of the Asian Institute of Technology in Bangkok and ERDINET of the East West Center in Honolulu.

77. The International Centre for theoretical Physics in Trieste, Italy, the Solar Energy Research Institute at Golden, Colorado Volunteers in Technical Assistance at Maryland, the Asian Productivity Organisation in Japan and the University of Florida at Gainsville have programmes on the Renewable Energy Resources which have been used by some Sri Lankans. Sri Lankans have also participated in the Energy Management Training Programme under the auspicies of the Institute for Energy Research, State University of New York at Stony Brooke and USAID.

78. In view of a shortage of Fuelwood envisaged over the next few years, improving the efficiencies of the domestic health from about 14% as of today to about 25% or more would ensure better utilization of available fuelwood and arrest further degradation of the forest cover.

79. If the Railway System is better managed, encouraging mass and goods transport by rail rather than by road, there would be considerable savings in the use of petroleum products.

80. As 73% of the total energy consumption in Sri Lanka is from the renewable energy resources and half of the remainder (27%) is consumed in the transport sector, the strategy for economic development would be to optimise the utilization of the renewable energy resources.

81. Until recently there has been no central organisation to co-ordinate the development and use of the energy resources in a manner to suit the best interests of the country. Although Sri Lanka possesses the resources, and talent needed to harness the energy resources, the lack of a co-ordinating mechanism has impeded the development process.

82. The Natural Resources, Energy and Science Authority is an advisory body which would be expected to lay down policy with regard to all aspects of energy requirements in Sri Lanka as well as plans and programmes for the overall development of the energy resources in Sri Lanka and advise measures for optimum use and conservation of energy. The Ministry of Power and Energy which now functions under the President, was recently instituted to co-ordinate all aspects of Power and Energy in Sri Lanka.

83. The creation of these two institutions is the start of an intensive and co-ordinated energy development programme in Sri Lanka.

84. Sri Lanka will therefore welcome collaboration with Governments International Agencies, and inter-governmental organisations represented at the United Nations Conference on New and Renewable Energy Sources on issues that have been highlighted in this paper.

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