Social Factors and Production Modes in Energy Use

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As Sri Lanka's colonial economy evolved into plantation production in the 19th century, the energy use pattern changed significantly. Thus energy was associated with plantation production (oil for drying and running the machinery), transport of produce (by steam train and ship and later lorry) and maintaining the farm machinery in the workshops of Colombo (steam and oil power). The technological infrastructure built around the plantations intensified the energy use pattern from the traditional system. In the early phase of the plantation economy, the traditional energy sources were partially used, for example in transport of plantation produce by bullock carts, solar drying of tea, firewood drying of tea and desiccated coconut. Use of aerial tramways and wire chutes worked by gravity fell into an intermediate category.

The plantation economy brought a new social stratification. Gradually those associated with plantations adopted the technology and energy use pattern in common with some of the Europeans. The energy uses included gas and coal for cooking, rather than firewood. New domestic technology and energy use patterns resulted partly from income differences between those using the new energy sources and the majority of the population, as well as of cultural differences between the two. The growth of Colombo as an urban center helped develop transport lines based on steam trains. Although the initial transport connection was from Kandy and helped transport plantation goods, other lines were added to transport workers, vendors and customers — personnel the new urban economy demanded.

From the 1930's onwards, and especially since independence, changes in the country have increasingly integrated the colonial economy with the rest of the country. These changes included the settlement of population in new areas and the spread of commercial transactions into the rest of the country. New industries have been established apart from the colonial plantation or the traditional handicraft based ones. Dams, irrigation canals and roads have been built, or in the case of canals and dams also partially restored. These have resulted in spilling over of the concentrated technological enclaves into the rest of the country, with attendant changes in energy use patterns. The new industries, as well as the physical infrastructure development, have helped map further some of the energy use patterns from the developed countries.

In domestic energy use the more affluent urban and rural people use electricity in place of oil as a light source, oil and to a smaller extent electricity have replaced firewood in cooking. In transport, the upper income groups use personal motor cars, the majority use buses or trains for short distances. Lower income groups use bicycles or bullock carts, although the latter is tending to fade out.

Energy use in present day Sri Lanka reflects the history of the modes of production in the country; in the case of personal and domestic energy use, the use reflects the social stratification system. The most significant uses of energy are in the dominant modes of production including the plantation sector, the industries built during the import substitution phase of post-independence growth and the new industries that developed in the post-liberalisation phase. The dynamics of the post-liberalisation phase are not yet clear. Currently, there is a shake out occurring. Some of the older industries are tending to lose their competitive edge vis-a-vis imports; certain other industries are opening up.

Firewood and other fuels associated with the traditional modes of production and the domestic use of the lower income group provide 60% of the total energy consumed in the country. Petroleum products and hydro electricity associated with the more recent modes of production and domestically with the higher income groups provide respectively 28% and 12% (Perera and Sepalage, 1979).

Commercial energy associated with the new modes of production and the domestic demands of higher income groups (who are associated with servicing the higher modes of production) gives a breakdown as follows:

Domestic Section	20%
Industries Sector	33%
Transport Sector	40%
Other	7%

(Source: Perera and Sepalage 1979)

The relative breakdown of commercial energy according to electricity, oil and coal (for the year 1975) is given below. It is noted that oil products provide almost 70% of commercial energy—

Hydro-Electricity	Oil Products	Coal
30.0	69.0	0.6

(Source: Perera and Sepalage, 1979)

Over the last two years or so, there has been a large increase of private motor vehicles at a time when petroleum prices were also increasing and countries with large motor car populations were actively attempting a shift to the use of public transport or low fuel consumption cars. Import of 35.000 motor cars over the last three years — roughly 20,000 a year — is more than twice the figure for the entire 15 year period prior to this. During the last two-year period, oil prices have more than doubled from a figure of $12 a barrel in 1978 to over $24 a barrel. Actual spot market prices today are nearer $40. The gross oil bill has also consequently increased from being Rs. 80 million of the import bill before the oil price hike to nearly Rs. 3300 million for 1979 and nearly Rs. 7000 million estimated for 1980. Motor cars consume 12% of the oil consumed today and so contribute somewhat significantly to the total import bill. But although the number of cars increased, the amount of oil consumed by private motor cars has remained stable over the last decade or so. A higher car population is being used somewhat less, say 25 miles or 1½ hours per day average instead of an earlier 36 miles and 2 hours (Diandas). We are buying more cars but using them less. Car imports for 1978 (about 15.000) cost nearly Rs. 300 million rupees whilst the petrol component of the fuel bill in the same year was Rs. 450 million (Diandas 1980), giving an annual expenditure of Rs. 750 million. (Note that the railway electrification scheme costs approximately Rs. 400 million and the 60 MW gas turbine Rs. 300 million).

The local demand for cars is dependent on the number and income of the higher income groups in Sri Lanka, which in turn reflects the total GNP and the income distribution in the country. The economic viability of a personal car is not only dependent on the capital cost but also operating. The income distribution in Sri Lanka appears to be changing towards a rise of upper income earnings. There is also evidence that the GNP itself is increasing. This perhaps indicates that the higher income groups are sharing more wealth among an increasingly smaller group. With rising petrol prices and the play of these contradictory pressures it seems likely that those who could afford personal motor cars would decrease. With the rise of petrol to Rs. 30/- a gallon, some middle group car owners dropped out of regular car use and resorted to public transport. With the next increase, the number dropping out has to increase. A considerable part of the population have addicted themselves to an expensive capital outlay and a game of unplanned obsolence of motor cars they cannot afford to operate.

How did this irrational situation develop where we are locked into a socially undesirable use pattern? The answer lies in the actual working out of the relationships between the different modes or production (especially how and who the determinants of their economic activities are) and the relationships between the different economic and social levels of population involved in a given mode or production. The decision to liberalise imports of motor cars was presumably taken under the broad ideology of the open door policy for Sri Lanka. This also fit into the aspirations of the upper income groups who had been denied access to motor cars for some time, as a result of the enlarging of the middle class during largely the import substitution phase.

However, with the increases in oil prices there have been spasmodic efforts "to do something" with various policy decisions such as limiting imports to only low capacity cars, its apparent ineffectiveness judging from the large size cars on the roads today, the Sunday travel ban, etc. At the same time the import flow continues, oil prices continue to rise and public transport remains at a low level.

The rural sector is being penetrated by new commercial forces that are transforming the rural economy based on older traditional methods of production. Consequently new social strata are emerging who, being attached to the new modes of production, preempt the access to resources. Therefore the next energy use aspects that I would like to highlight is the manner in which the rural sector uses energy, specifically how electrification schemes are selected. There is a new thousand-village rural electrification scheme that is to come into use in the future. Under this plan, houses and villages to be electrified are chosen through some rational criteria, the villages having been selected by a team of consultants. The general trend in actual selection for rural electrification over the last ten years or so has been done by priorities allocated by the local elected representatives. The result has been that electricity has been supplied essentially to the local elected member's sources of electoral support, namely those villages which supported the person or the social strata that helped mobilise the voters. The latter social group often were members of the rural elite and high income groups. Consequently electricity is usually provided for only a few families for whom often an expensive and uneconomic electricity supply line is provided. This pattern of domestic, small scale electrification is often at the expense of rural industries and clusters of rural poor. Supplying electricity to these groups would be more advantageous economically than supplying it to lone individuals with political influence.

Apart from this general selection policy, forces operating over nearly two decades have increased the importance of rural electrification generally in the eyes of the politicians. The importance of the rural voters and the importance of those who mobilise them have resulted in an increased demand for rural electrification, although on narrow economic terms, there is actually an uneconomical rate of return; rural electricity reaches only a narrow segment of the electrified villages.

In this note I have attempted to summarise briefly the energy demand and energy use patterns as they associate themselves with different modes of production and income stratification systems. I have also examined some of the social forces that determine two contemporary energy use situations; namely, the increased influx of motor cars and the social mechanics of rural electrification.

INTEGRATED ENERGY PLANNING - FUTURE SITUATION AND POLICY ALTERNATIVES FOR SRI LANKA

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The principal sources of commercial energy utilized in Sri Lanka's economy are electricity, oil and relatively small quantities of coal. In the domestic sector, in household industries and in certain small scale industries, traditional fuels like firewood and vegetable wastes are used. The consumption of energy in the main supply sources for the period 1950 to 1975 is given in the following tables 3:

TABLE I

Energy Consumption in Sri Lanka 1950-75 (in primary units)

Year	Electricity (hydro electric) (G Wh.)	Oil products ('000 tonnes)	Coal & Coal products ('000 tonnes)
1950	46.0	206.0	293.0
1960	257.7	535.0	256.3
1965	309.7	620.1	136.7
1970	624.9	893.0	25.0
1971	703.6	852.0	15.5
1972	732.2	924.0	12.0
1973	627.8	963.4	10.0
1974	880.7	764.6	10.0
1975	965.8	731.2	10.0

TABLE 2

Energy Consumption in Sri Lanka 1950-1975 in common units of measurement (Gwh. e.r.)

Year	Electricity (Hydroelectric) (Gwh.e.r.)	Consumption of Oil Producers (Gwh.e.r.)	Coal & Its Products (Gwh.e.r.)	Total Commercial Energy Consumption (Gwh.e.r.)
1950	46.0	618.0	549.4	1213.4
1960	257.7	1605.0	480.6	2343.3
1965	309.7	1860.3	256.3	2426.3
1970	624.9	2679.0	46.9	3350.8
1971	703.6	2556.0	29.1	3288.7
1972	732.2	2772.0	22.5	3526.7
1973	627.8	2890.2	18.8	3536.8
1974	880.7	2293.8	18.8	3193.3
1975	965.8	2193.6	18.8	3178.2

This table is built up from Table 1.
Conversion factors are (a) '000 tonnes of oil products = 3 Gwh.e.r.
(b) '000 tonnes of coal products = 1.875 Gwh.e.r.

The relative share of different fuels in the total commercial energy consumption in percentage is given in Table 3.

TABLE 3

Percentage Share of

Year	Electricity (Hydrel)	Oil Products	Coal
1950	3.8	50.9	45.3
1960	11.0	68.5	20.5
1965	12.8	76.6	10.6
1970	18.6	80.0	1.4
1975	30.4	69.0	0.6

If the energy consumed in different forms is brought down to a common unit it is found that in the year 1977, the total energy requirements of 10 TWH were met by petroleum products 28%, hydro electricity 12%, and firewood and other fuels 60%.

Consumption of Energy- Projected

Table 4 above shows the electrical energy consumption pattern expected over the period 1979 to 1984.

TABLE — 4

Electrical Energy Consumption and Requirements in Gwh Expected for the period 1979-1984

Class of Consumption	1979	1980	1981	1982	1983	1984
Domestic	116	124	133	142	153	153
Industrial	715	812	209	1018	1143	1284
Other	490	539	596	677	757	839
Total consumer demand	1321	1475	1638	1837	2053	2286
Total demand on Generation Gwh	1508	1685	1836	2089	2319	2592
Total demand on Generation MW	307	338	367	411	456	510

In arriving at the above forecasts, the requirements of large industries schedule up to 1980 have been taken into consideration individually. For the existing industries, a 25% increase in consumption over 1976 consumption has been applied to account for working at increased capacity. Consumption of the new large industries scheduled for after 1980 has been assumed to increase at the rate of 15% from 1981 to 1984. The rates of growth adopted for the other significant consumption sections over the period 1979-1984 are: domestic sector 7.07%; small and medium industries sector 7.57%; commercial sector 8.0%; and bulk supply sector; 6.0%.

For the longer term demand prediction, regression analysis using GDP growth rate of the different sectors of the economy had to be used. Based on this the total demand on energy generation until 1990 are predicted and given at top right. The GDP growth rates assumed are, manufacturing and mining 8.1%, agriculture 1.9%, transport and other sectors 5.5%. A population growth rate of 2.0% per annum also has been assumed.

Total Demand on Energy Generation upto 1990

	Generation Demand	Consumption Total
1985	2796.1	2431.4
1986	3100.5	2696.1
1987	3437.7	2989.3
1988	3812.0	3314.8
1989	3679.5	4231.4
1990	4092.9	4706.8

Predicted Consumption of Oil Products

The predicted estimate of consumption of oil products given is as follows.

TABLE 5

Estimate of Consumption of Oil Products

Product	Actual consumption in 1976 in '000 tonnes	Predicted rise in growth of consumption per annum	Predicted Consumption in 1982
Gasolene	101.4	4%	128.3
Kerosene	206.7	7%	310.0
Auto-diesel	257.6	10.2%	461.4
Heavy diesel	33.0	—	50.0
Furnace Oil	126.2	6%	219.0
Total:	724.2	8.2%	1168.7

A more recent prediction, taking into account the effects of price elasticity, is given below.

TABLE 6

Projected Oil Products Requirements in Sri Lanka in '000 Tonnes (1979-1990)

Year	Domestic Kerosene	Industrial Heavy Diesel and Furnace oil	Transport, Petrol & Auto Diesel	Total
1978	234.2	240.225	422.599	897.024
1979	212.4	207.209	329.579	749.188
1980	188.6	215.354	339.084	743.038
1981	194.0	224.234	348.904	767.138
1982	199.8	235.774	358.993	792.567
1983	205.9	244.106	369.391	819.397
1984	211.9	255.380	380.077	847.357
1985	218.1	267.756	391.055	876.911
1986	224.8	281.198	402.318	908.316
1987	231.4	295.689	413.064	940.953
1988	238.2	311.638	425.684	975.522
1989	245.5	328.846	437.767	1012.113
1990	252.3	347.556	450.105	1049.961

FUTURE DEMAND FOR FIREWOOD

It is difficult to give yearly estimates for the consumption of firewood, because the figures have been arrived at indirectly. It is however estimated that the annual demand for firewood would have increased from 3.4 million tons in 1970 to about 4.5 million tons in 1978. The pattern of use of firewood in the future cannot be predicted but can be influenced by such steps as restrictions on felling of trees and clearing of jungle areas. In particular, the introduction of more efficient firewood cookers can reduce the per capita consumption of firewood from 1/3 to 1/2 of the present usage.

ENERGY RESOURCES

Hydro Electric Energy

The most predominant commercial energy resource of substantial importance to Sri Lanka is its hydro power potential. There are 103 rivers and streams mainly originating from the central hill country, each having varying drainage areas varying from 10 to 10,000 square kilometres. The total annual rainfall over the entire island is estimated to be 107 million acre per foot. A total of 329 MW of hydro power with an annual energy capability of approx. 1500 Gwh. has been presently developed. The technically attainable and the economically feasible hydro power potential as reported in the UNDP/FAO 'Mahaweli Ganga Hydro-Power Survey' 1968 when updated considering the recent developments indicate 2000 as the total power potential and 6600 Gwh the total energy capability from medium and large hydro power plants.

Coal, Oil and Natural Gas

There are no known coal, oil, natural gas or similar resources in Sri Lanka. Approximately 3 million tons of peat have been discovered in the neighbourhood of Colombo city. The extractable quantity of peat in this area has been estimated to be equivalent to 2 million tons of peat with a calorific value of 2600 Kcal/kg. Other peat deposits may exist but have not been identified and evaluated.

Nuclear Resources: Monazite sands found in certain parts of Sri Lanka contain uranium and thorium ore in the form of oxides to the extent of about 10 per cent thorium oxide and 0.1 per cent uranium oxide.

Firewood: Firewood and agricultural wastes constitute a major energy resource for Sri Lanka. The area under forest in Sri Lanka is roughly 60,000 hectares under proclaimed forests and a similar area of proposed reservations and about 1.8 million hectares under other crown forests. A major portion of firewood is supplied by the rubber plantations which becomes available due to re-plantation of rubber cultivations considered under a Government subsidy scheme. Substantial amounts of firewood are also supplied in the form of wood wastes from saw mills, paddy husks and from wastes available from coconut plantations and tea plantations.

ANIMAL AND VEGETABLE WASTES

Animal wastes, primarily cow-dung is available in the major cattle breeding areas in the Northern and Southern parts of the country. Cow-dung is not burnt as an energy source in Sri Lanka. However, it could be very economically used to produce biogas as an energy source for certain limited applications, and composted manure through anaerobic fermentation. Large volumes of biogas could be produced by using animal wastes supplemented with other vegetable wastes available in substantial quantities throughout the country.

Solar Energy and other Renewable Resources: The near equitorial position of Sri Lanka and the very topographic nature of the island guarantees the availability of high solar insolations and reliable wind regimes throughout the year.

There is also energy available to be exploited in the ocean waves and in the thermal gradient of the warm tropical sea surrounding the island. There are no known areas for geothermal energy of any significance and the tidal energy is quite diluted.

Policy Alternatives for Sri Lanka

It would be seen from the above that the commercial forms of energy resources available in Sri

Lanka, which can readily be made use of, are quite limited. Hydro-electric energy resources form the major commercial form of energy that could be developed in the foreseeable future. The hydro electric resources themselves are limited; even if all potential hydro electric schemes are developed, they would be adequate only to meet the naturally rising electrical demand up to about 1994 or so. Development of hydro-electric energy is also a very expensive process; the per kilowatt cost of installation of hydro-electric plant along with associated dams, tunnel etc., is in the region of Rs. 20,000/-. A substantial portion of the funds is required in foreign exchange and has to be paid back to the donors with interest. Hence hydro electric energy, although indigenous, bears a significant foreign exchange component.

The use of firewood for non-commercial energy is seen from the above to be quite widespread. In fact it would be seen that presently about 60% of all energy consumption in Sri Lanka is met out of firewood. Although felling of trees is necessary for the production of firewood, if undertaken on a properly planned programme along with reafforestation, use of firewood is not something to be highly discouraged. In fact the introduction of a suitable firewood cooker which can be used in practically all homes can cut down the use of firewood to less than 35% to 50% of the present consumption. With a proper strategy combining reafforestation and economic use of firewood, the majority of the cooking needs could be met using this form of energy for the next 10 years or so. It must be remarked that firewood is a replenishable form of energy, the energy really derived from the sun.

Oil and coal are imported energies and unless the on-going exploration programmes show significant quantities of these, the use of oil and coal will have to be discouraged in selective spheres. It is likely that oil will become more and more expensive and differentially more expensive in relation to coal. Hence for certain applications such as for large thermal power stations which may be required in the nineteen nineties, coal will show better prospects.

The other renewable sources of energy such as from wind, solar, bio-gas, etc., can be used increasingly in the coming 10 years for limited applications. Although this may not create a significant dent in the extent of commercial energies used, the use of these energies should be encouraged with a view to arresting the need for expensive use of commercial energy where possible.

Summary

The following summarises some thoughts for policy considerations.

(1) **Economic use of energy should be encouraged**
For example, flourescent lighting uses 25% to 30% of the electrical energy needed for comparable lighting using incandescent bulbs.

(2) **Waste should be reduced**
Operationally, switching off of street lights at the correct time, idle motors in factories etc., are examples. In design, proper natural lighting, sound, ventilation for houses, factories, commercial establishments etc. are required.

(3) **Energy appropriate to each demand.**
Although there will be exceptions, the following are generally suggested:

(a) **Electrical Energy**
The use of electricity should be encouraged in general for motive power and for transport purposes in urban locations. Electrification of factories such as in tea, coconut and rubber, should be encouraged to reduce the consumption of diesel oil. These can go on progressively particularly because of the fact that after 1983, adequate supplies of hydro-electric energy are likely to be available until at least 1989 due to the commissioning of Kotmale, Victoria, Randenigala, Samanalawewa and other hydro-power projects. However, the electrification of railways should be undertaken with appropriate planning and caution; thus if the initial work in relation to this commences during 1980 it would be about 1983-84 by the time Sri Lanka can have its first electric train running. This would also match with the availability of adequate hydro-electric supplies.

The use of electricity for the purpose of heating and particularly for domestic cooking should be discouraged. This is because of the high capital cost required for electrical generating plant, transmission, distribution; etc. To support a single one kilowatt hot plate using hydro-electric plants, it may require as much as Rs. 20,000/- of investment in the above, particularly because most people use electric hot plates during the peak time of about 7 o'clock in the evening. Also during the period from 1980 till about 1984, the hydro-electric energy available in general would not be adequate to meet the demand for electricity consumption. This means that electricity using imported oils will have to be utilised for supplying additional loads coming in. Thus to support the generation required for a hot plate, fuel oil will have to be burnt at a power station at approximately one third efficiency. It would be more logical to use the fuel oil directly in an oil burning cooker.

(b) **Firewood**
For a majority of cooking needs, more efficient domestic cookers should be popularized. Suitable reafforestation programmes are needed. (The alternative of electrical energy for cooking needs should be discouraged).

(c) **Oil and Oil products**
For industrial heating and for general transport needs, use of oil will have to be continued. Limitations on private travel by pricing or other methods will be required. (Coal may be reintroduced for specific applications.) Oil exploration should be continued.

(d) **L.P. Gas**
For limited urban domestic cooking, industrial and commercial uses.