

## TREES- SRI LANKA'S MOST SUSTAINABLE SOURCE OF ENERGY AND RAW MATERIALS

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### ABSTRACT

This paper commences with a broad analysis of the range of industrial uses for trees in the Sri Lankan context. Analysis reveals that 78% of the total energy used in the country is from biomass. Natural forest cover is believed to comprise some 28% of the land area, forest plantations 1%, industrial plantations (tea, rubber, coconut, etc.) about 15%, and scrub lands 10% (600,000+ hectares). A further 15% (1 million hectares) is only marginally utilized for 'chena' cultivation.

The paper goes on to describe how even the 600,000 hectares of scrub land could usefully be converted to energy forests to generate electrical power - capable of producing 4,000 GWh of energy annually. It is shown that costs are appreciably lower than using imported coal or petroleum and are very competitive with hydro-generated energy.

A scheme for the employment of 200,000 rural families in the growing of fuelwood on the 600,000 hectares is then explored and it is suggested that a sustainable annual income of over Rs 39,000 per family is achievable.

Expansion of the program to include the 1 million hectares of chena lands into fuelwood production, involving a further 300,000 families and a reversal of the drift towards towns, is then discussed.

The project is so comprehensive that it would match the Mahaweli program in magnitude, could rid the country of its dependence on foreign sources for a very major part of its energy needs and could provide employment in rural areas for hundreds of thousands of families. But with a difference - it would cost much less, and, therefore, may not be all that attractive to the international lending agencies!

### 1 INTRODUCTION

Although the economy of Sri Lanka has long been supported by the produce of its tree crops, tea, rubber and coconut, it is rarely appreciated that the most valuable source of raw material available to any humid tropical country is its trees - invariably the most neglected! Although also one of the major sources of energy in a country which lacks fossil fuel (coal or petroleum) energy, tropical trees provide the raw material for a tremendous range of industries.

Food & Beverage	Tea, coffee, Cocoa, Coconuts, Vanillin, etc.
Industrial	Plastics (rubber), Timber, Gums, Oils, etc.
Fibers & Textiles	Rayon, Viscose, Pulp, Paper, Cellulose, etc.
Chemicals	Lignins, Xylose, Poly-isoprenes, etc.
Drugs	Allopathic, as well as Ayurvedic.
Heating	Fuelwood for industry and electrical power.

## 2 ENERGY SOURCES

Where energy is concerned, trees already provide about 78% of the total fuel consumed in Sri Lanka, the breakdown by source of energy usage being:

<b>a. Locally Sourced Energy</b>	
1. Trees (biomass) for industry.....	14. % ]
2. Trees (biomass) for cooking.....	64. % ] = 78 %
3. Hydropower .....	3 %
<b>b. Imported Energy (Petroleum &amp; Coal)</b>	
1. For Transport.....	12.3 %
2. For Electricity .....	0.7 %
3. For Industry (mostly for heating) ....	3.6 %
4. For Lighting (eg. kerosene lamps) ....	2.4 %

It is significant that although wood provides by far the greatest amount of fuel used in this country, it has hitherto received by far the least attention !

## 3 FUELWOOD

The fuelwood situation and related factors can be further analyzed:

<b>a. The distribution of land in Sri Lanka is as follows :</b>		
Total land area .....	6,560,000 ha.	100 %
comprising		
Natural forest.....	1,750,000 ha.	28 %
Forest plantation .....	75,000 ha.	1 %
Industrial plantations ... (Tea, Rubber, Coconut, etc.)	1,000,000 ha.	15 %
Paddy lands .....	500,000 ha.	8 %
<b>Scrub lands</b>	<b>600,000 to 625,000 ha.</b>	<b>10 %*</b>
Chena lands	(over) 1,000,000 ha	15 %
Other (urban, housing, roads, shores, rivers, reservations, mountains etc.	1,610,000 ha.	23 %

**b.** The Forestry Master Plan has identified over 600,000 hectares of land as 'scrub lands' (\* above). This land urgently needs some form of 'cover' to

- prevent further degradation. It could ideally be covered with energy plantations.
- c. While, under favourable conditions, one hectare of energy plantation could yield over 20 tonnes of dry matter/ha/yr on a continuous basis, a more conservative yield may be taken as 13 tonnes/ha/yr. This would be on a 4 to 10 year harvesting cycle.
  - d. The 600,000+ hectares of scrub land could conservatively produce 7.8 million tonnes of fuelwood annually, equivalent in heat energy to 2 million tonnes of oil (twice the annual consumption of petroleum). This quantity of wood, if utilised to produce electricity, could generate 4,000 GWh of energy annually - fully equivalent to the present annual consumption from hydro-power.
  - e. As regards pricing, energy efficiency wise, 4 tonnes of wood is approximately equivalent to 1 tonne of oil. Therefore, at the present oil price of Rs. 6,000 per tonne, the energy equivalent price for wood would be about Rs. 1,500 per tonne. As the price for imported oil continues to escalate, the price for wood fuel becomes (increasingly), even more attractive. Further, wood fuel costs about half the price of coal for an equivalent amount of energy.
  - f. The industrial sector in Sri Lanka consumes around 1 million tonnes of fuelwood annually. Most of this comes from natural forests or from rubber plantations. The demand for rubber wood (for other more remunerative purposes such as furniture and wooden toys) is, happily, increasing. However, continuing extraction of fuelwood from natural forests will further deplete the existing forest cover. Hence, there is an urgent need to grow the 1 million tonnes of fuelwood needed annually by the industrial sector, and this could be produced from about 80,000 hectares of highly profitable energy plantations.
  - g. The industrial sector also consumes about 0.25 million tonnes of imported oil annually - most of it to generate heat in boilers and furnaces. This could be substituted by 1 million tonnes of fuelwood grown from a further 80,000 hectares of scrub land thus saving about Rs. 1,500 million in foreign exchange.
  - h. The remaining 440,000 hectares (of the 600,000+ ha scrub land) could provide a further 5.7 million tonnes of fuelwood annually. This could be used to generate 3,000 GWh of electrical energy annually, and would be equivalent to a 500 MW power plant operating at about 70% power-factor. This itself would be the equivalent of 75% of our present annual consumption of electrical energy; (the present hydro-power generating capacity being 4,000 GWh) and approximately 50% of the total identified hydro-power potential of Sri Lanka. Incidentally, the planned coal fired power project - which is now

still necessary due to earlier indecision - is planned initially to produce 300 MW, (from imported coal) and increasing eventually to 1000 MW.

Note that the production figures above are based on only the 600,000+ hectares of identified scrub land. There is still over 1 million hectares of marginally utilised 'chena' lands awaiting similar more remunerative and fully sustainable production.

#### **4 EMPLOYMENT OPPORTUNITIES**

The situation where an extent of 3 hectares of land is given to a family will be considered. Although anything over one hectare of paddy land would be difficult for a family to maintain on its own, 3 hectares (about 7 acres) of forest upland is well within their capability. If fuelwood is grown on this land as a sole crop, it could conservatively produce 39 tonnes of fuelwood annually on a continuous cycle, which even at a farm gate price of Rs.1,000 per tonne, would represent an annual income of Rs.39,000. If however, the farmer intercroops this land with fruit and/or vegetables, his gross income could well be increased to about Rs.50,000 annually - or over Rs.4,000 a month - even considering the possibility of a slight reduction in the yield of fuelwood.

The 600,000 hectares of scrub land, alone, might thus be expected to provide continuous productive and very remunerative employment for 200,000 families while producing 5.2 million tonnes of fuelwood - the equivalent of 1.8 million tonnes of oil now costing the country Rs.9.8 millions in foreign exchange. This employment potential and energy productivity could well be trebled when the 1 million hectares of chena lands is also brought into the fuelwood program.

#### **5 PLANTATION MANAGEMENT**

Sri Lanka possesses unique experience in the area of Plantation Management - presently limited to the conventional plantation crops of tea, rubber and coconut. These skills could well be extended to the management of energy plantations, perhaps on the 'nucleus-plantation' basis whereby a centrally managed plantation of say, 200 hectares would have 'stewardship' responsibility for a further, say, 1,500 hectares of 'satellite' smallholder plantations around it, each of about 3 hectares. The 'nucleus' would arrange the supply of seedlings and plantation management guidance, while also organising the rotational harvesting and collection of the trees reaching maturity. Such systems are well established in India for forestry production, as well as in the sugar industry for the organised production and supply of cane produced by satellite sugar cane farmers.

#### **6 ENERGY CONVERSION**

Three distinct well proven technologies are available for converting fuelwood into electricity:

**a. Gasification and external combustion**

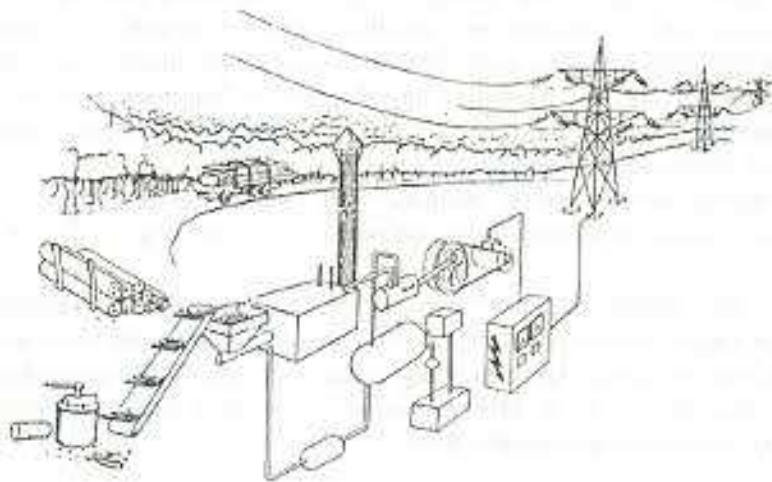
This process is very suitable and convenient for converting existing oil fired boilers and furnaces to wood fuel. Sri Lanka's NERD (National Engineering Research & Development) Centre has considerable experience in this area and a number of tea plantations have thus been economically converted.

**b. Gasification for internal combustion engines (usually below 2 MW)**

The technology for the generation of electricity from biomass fuels is well developed and used in a number of countries. In this process wood is gasified, cleaned, cooled and used to fuel 'diesel' engines. In South America a number of such (1.4 MW) plants have been in successful operation since 1983.

**c. Steam turbines for power generation (generally above 2 MW)**

This is the system usually adopted the world over to generate electricity from oil or coal or from fuelwood in larger (above 2 MW) installations. In Sri Lanka such steam turbines are already in use at sugar cane factories, and powered by the biomass available from the spent sugar cane (bagasse), for the generation of thermal energy, factory power and electricity.



**Figure 1 - Layout of a typical Dendro-Thermal (wood fueled) electricity generating system**

Figure 1 gives a schematic lay-out of a typical compact Dendro-Thermal wood-based electricity generating station surrounded by continuously coppiced (re-growth) farmer-managed forests feeding fuelwood into the generating plant, which in turn feeds electricity into the overhead grid. Hundreds of such small generating stations within the newly energy-forested areas would provide very gainful and continuing employment for many hundreds of thousands of rural families while also more than

doubling the output presently available from existing hydro power sources - and without recourse to imported fuels. Of special environmental importance is the fact that CO<sub>2</sub> produced from burning the fuelwood is fully absorbed (recycled) by the growing biomass of the forest areas from which the fuelwood is extracted.

## 7 SMALL FARMER PARTICIPATION

A great many 'land alienation' programs, hitherto for rainfed (upland) farming, have proven unsuccessful and non-sustainable as the settlers have little experience with farming other than 'chena cultivation' practices. Further, there has been no real attempt to teach them otherwise as the technology appropriate for farming such fragile terrain on a sustainable basis is only now being evolved. Likewise with the 'farming' of trees.

It is, therefore, necessary that, progressively:

- a. Farmers are trained in the correct use of such land and the culture of the tree crops (as recommended by the Forestry Department with its wide experience all over the country) and also in cultivating other cash crops which may be grown, applying appropriate conservation measures, on these lands. This would apply similarly to any carefully executed plantation industry. It is for this reason that the nucleus and satellite plantation system is proposed to provide both demonstration and continuing training and guidance, as well as to act as centres for the marketing organisation to purchase and distribute throughout the country the fuelwood and 'poles' harvested by the farmers in rotations commencing from about 3 years after planting.
- b. The organizations (industrial, plantation, tile making, ceramics, etc.) which presently use imported fuel oils, be encouraged to convert to the use of wood fuel.
- c. Dendro (tree based) Thermal Power stations be progressively established at strategic locations throughout the growing area to generate and feed electricity into the national grid. The generating capacity of each such station might be of the order of 0.1 to 10 MW, depending upon the location and extent of fuelwood plantation surrounding them.

Figures 2a and 2b indicate, to scale, the extent of land that would be required for two typical wood fuelled electricity generating plants on a continuing basis. One, with a 1 MW capacity might be required for a town the size of Kalutara. The other, with a 10 MW capacity, might be required for the NW Province around Puttalam.

## 8 BENEFITS

The benefits to the country from such a program for efficiently exploiting this, perhaps the most valuable of it's natural resources, would include:

- a. The highly remunerative and productive employment of over 200,000 families (initially, from just the 600,000 hectares of scrub land alone) each with a fully

- sustainable income of at least Rs.35,000. This employment becoming available to them all over the countryside and not just in towns - thus reversing the 'urban drift'!
- The progressive saving of the many millions now spent on the importation of industrial raw materials (pulp, paper, gums, resins and yarn for the textile industry). It is little known that Rayon and Viscose yarns are made from wood pulp, unlike Nylons which are made from petroleum. Neighbouring countries - India, Thailand and Taiwan - already have considerable experience with textile industries based on such locally produced (tree based) yarns - a technology which originated in well-forested countries such as Sweden and Canada.
  - The 'Greening' once again of Sri Lanka, through the generation of highly profitable incentives for the **growing** of trees - rather than, as at present, their **felling** and extraction from the now very limited forest reservations of the Government.

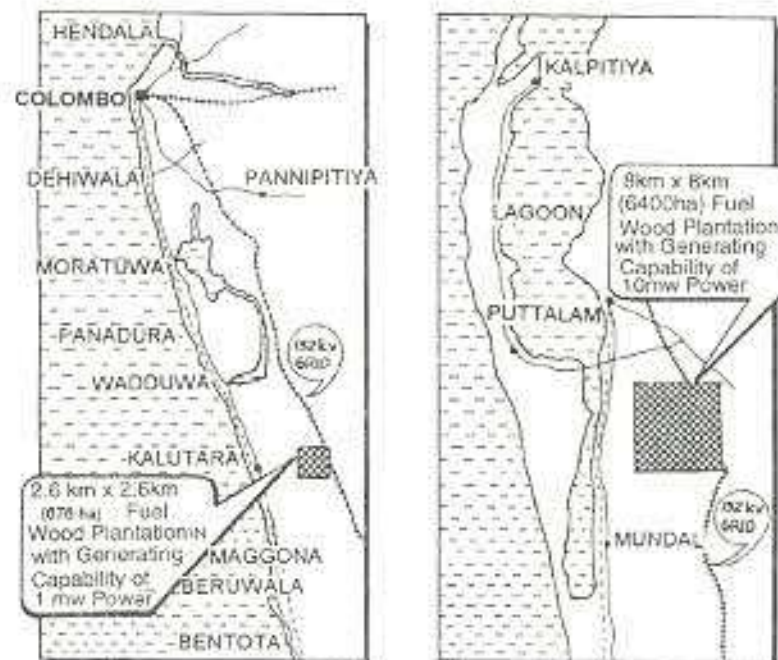


Figure 2 - Maps illustrating to scale, the extent of land required for small scale wood-fueled electricity generating stations  
(a) 1 MW (b) 10 MW

## 9 PROJECT POTENTIAL AND PLANNING

It will be appreciated that such a program for the comprehensive exploitation of the Dendro (tree based) potential of the country would be of the order of magnitude approaching that of the Mahaweli program - but with an important difference. It would not require tremendous foreign investment and loans. For this reason the program may not be all that attractive to 'foreign investment' and banking.

It is also so wide in concept as to require close collaboration and concurrence between the several Ministries concerned with Lands, Forestry, Industry and Agriculture. Such concurrence was wholeheartedly granted to the project following a succession of high powered inter-Ministerial study groups and meetings during 1992 and 1993. These culminated in Cabinet Approval, granted in April 1993 for a 'go ahead' commencing with a pilot Dendro-thermal power-generating plant and a detailed international expert study into the details and programming of the project in it's overall application to the particular circumstances of the Sri Lankan context.

