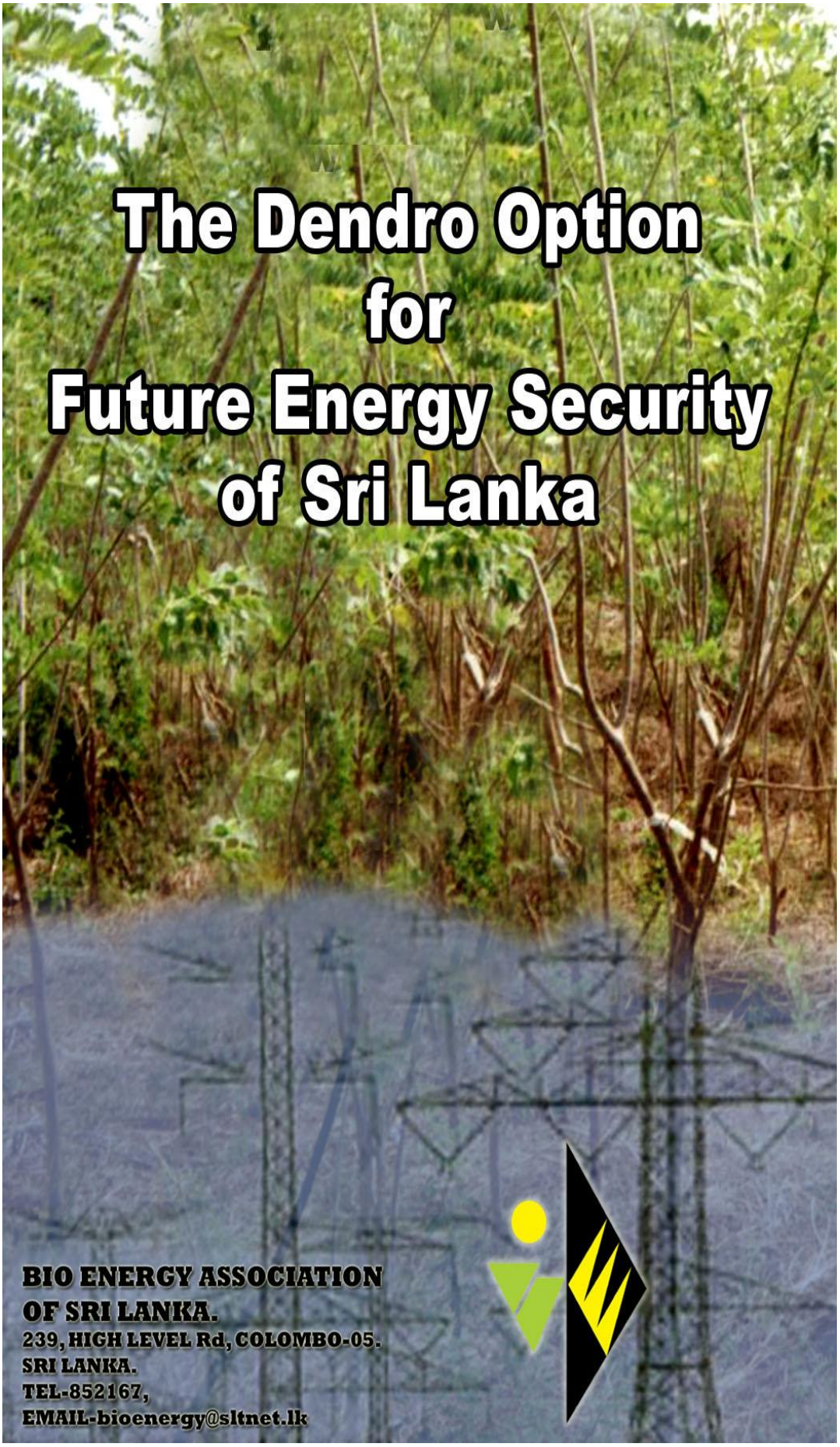

BIO ENERGY ASSOCIATION OF SRI LANKA.
239, HIGH LEVEL Rd, COLOMBO-05.
SRI LANKA.
TEL-852167,
EMAIL-bioenergy@sltnet.lk

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SECTION I

PROPOSALS FOR A POLICY ON DEVELOPMENT OF BIO MASS AS A RENEWABLE ENERGY SOURCE FOR SRI LANKA

PROPOSALS FOR THE IMPLEMENTATION OF A POLICY ON DEVELOPMENT OF BIO MASS AS A RENEWABLE ENERGY SOURCE FOR SRI LANKA

1. PREAMBLE

This report is submitted by the Bio Energy Association of Sri Lanka to be considered by the Government of Sri Lanka in developing the policies, action plans and achievement targets for the utilization of ample bio mass resources in Sri Lanka. The background to the establishment of Bio Energy Association of Sri Lanka (BEASL) and its aims and objectives are given below as a preamble to the proposals. The proposals on policy and action plans have been made to further the broad objectives of any Sri Lanka government and are expected to provide the focus and the direction necessary to ensure that the true potential of this valuable and indigenous resource receives the attention it deserves.

2. BIO ENERGY ASSOCIATION OF SRI LANKA

The Bio Energy Association of Sri Lanka (BEASL) was formed by a group of concerned citizens who have long strived to promote the use of indigenous resources for power generation and thus reduce the increasing dependence on imported fossil fuels for both generation of electricity and thermal energy requirements. In the backdrop of power shortages in the past years and the looming threat of further shortages and the escalation of costs of energy, the value of bio mass energy is at last being realized and has received the attention of the government authorities. In order to offer well considered opinions and advice for the formulation of necessary policies and plans BEASL has been incorporated as an association under the Companies Act Reg No (….) with the following aims and Objectives.

3. Objectives of BEASL

- To form a network among industries and farmer organizations for successful generation of bio-energy
- To serve as a forum for exchange of information and interaction on bio-energy development
- To encourage and promote bio-energy development , establishment of practices and activities in Sri Lanka
- To develop bio-energy as major development goal in addressing poverty alleviation
- To serve as a vehicle through which Government , bilateral and multilateral donor and private assistance for all aspects of bio-energy development may be equitably and effectively extended to members
- To provide adequate and updated information on effective and sustainable development of bio-energy systems to the members, and in co-operation with members to provide same to all relevant Ministries, including Ministry of Power and Energy, Ministry of Science and Technology , Ministry of Environment and similar bodies.
- To encourage provision of all types of services on bio-energy development, dissemination, ownership and management

- To provide information, lobby with and act as an industry promoter with GOSL, CEB and with the public in the furtherance of the industry

- To provide necessary services for the purpose, or act directly as a certification and /or regulatory body in biomass pricing, approval of standards to be met in installation and operation of plants.
- To liase with and promote bio-energy development with banks and funding agencies.

Further information on the constitution and the members of the BEASL is given in the annex.

The proposed Policies and Action Plan are given below. The background and the rational for these proposals are provided in the body of the report under the relevant sections.

4. The Need for a Renewable Energy Policy

The need for Renewable energy to replace/supplement the energy requirements does not need further emphasis. This can only take off, provided the government builds into its National Energy Policy the role of Renewable Energy. In the Renewable Energy policy should be embedded, a policy for Bio Energy. The Bio Energy Association of Sri Lanka wishes to recommend that the under mentioned policies be considered for inclusion in the Renewable Energy Policy : These are congruent with the policies proposed by Vidya Jyothi Prof. K K Y W Perera under Renewable Energy Policies. Strategy and Programmes in the document Investment Opportunities in Renewable Energy in Sri Lanka. It must be emphasized that these recommendations in relation to use of wood is specifically refers to **Sustainably Grown Fuel Wood** (**SGF**) of **Short Rotation Coppicing** (**SRC**) species and not of the use of forest wood or other non sustainable resources. The particular advantages mentioned can only be derived by using such species. It is also important to note that a number of species are recommended, all of which exhibits the desired properties. The advantages of multi-species plantations are well recognized.

The BEASL recommends that these policies be adopted as the guidelines for all future renewable energy related programmes and all those responsible be required by statute to follow these guidelines. They should also be required to meet the set milestones of renewable energy usage in the national energy consumption.

5. The Proposed Biomass Energy Policies

A. Providing basic Human Energy Needs

1. Encourage the development of commercialised Sustainably Grown fuel wood (**SGF**) or energy plantations and associated Industry. This should be accompanied with appropriate changes to the existing laws and regulations governing extraction, transportation, and processing of fuel wood and allocation of land for plantations.
2. Promote economically viable biomass based alternative sources of energy. Promote current conversion technologies of gasification and direct combustion

B. Reducing dependence on Imported oil and coal.

1. Establish a series of pilot programs for establishing the viability of **SGF** wood as a primary energy input for heat and electricity generation.
2. Establish reasonable tariff policies for the purchase of Bio Energy to the national grid recognizing the availability of such sources of power independent of the weather and their contribution to the power generation capacity
3. Promote Research and Development on Bio Energy based thermal and electricity generation , such as Dendro, agriculture residues ,Municipal Waste etc. , covering all aspects of plantations, handling and technologies of conversion .
4. Investigate fuel substitution options and potential to provide adequate policy directions for pricing, for design initiatives and for promoting indigenous energy sources.

C. Reduce burden of energy prices on the disadvantaged.

a. Promote off grid electricity applications to inaccessible areas.

b. Offer reasonable subsidies for developers of systems to service these areas to minimise their investment risks

D. Choosing the Optimum Mix of Energy Sources

1. Establish targets for the utilization of renewable energy (excluding major hydro) in the national grid and modify such targets as the resource is developed and the local capabilities are improved. The suggested targets are

   - Year 2004 2 %
   - Year 2006 10%
   - Year 2008 25%
   - Year 2010 50%

2. Establish targets for utilization of renewable energy (excluding traditional bio mass) for national thermal energy requirements. The suggested targets are

   - Year 2004 5 %
   - Year 2006 20%
   - Year 2008 40%
   - Year 2010 75%

E. Developing and Managing Forest and Non- Forest Fuel wood Resources.

1. Provide incentives to the private sector to step up establishment of sustainably grown fuel wood (**SGF**) plantations, particularly in areas close to fuel wood consuming industries.
2. Strengthen the management of existing forest resources (natural and man made) to ensure the maximum sustained production of both timber and fuel wood.
3. Lease marginal lands at a nominal cost to prospective growers for commercialised tree planting

4. Provide funding to establish fuel wood plantations of SRC species of adequate extent under the state patronage by selected parties to serve as the catalyst for the growth of the **SGF** fuel wood plantation industry.

5. Develop schemes for the guaranteed, contracted release of the produce from such plantations to pioneering investors in the Dendro Power Sector

F. Maximize the content of Local manufacture, fabrication, construction, and value addition in energy supply and utilisation areas.

1. Identify components of large energy sector projects that can be undertaken by local manufacturers, designers, and contractors and invite them to participate in the tender process.
2. Eliminate import duties and taxes for equipment and components, except where such duties promote activities identified in item 1 above.
3. Provide market assurance for the power generated, until the pioneering ventures stabilise
4. Persuade large users of energy (through financial, policy and other incentives) to use renewable resource based energy for both thermal and electricity needs.

6. State Interventions Required

Many steps have already been taken by individuals and organizations to promote use of bio energy in Sri Lanka. The first gasifiers designed and manufactured by the NERD Centre for thermal applications have been running for more than a decade for different applications. The first gassifier driven power generation plant has been running for nearly a year. Haycarb Limited has fabricated several thermal gassifiers locally and have obtained several patents covering features to improve the performance.

However, it is essential that there is state patronage and intervention to provide the initial impetus for the establishment of this industry in addition to the adoption of the policies mentioned above. These items listed briefly below, with more detailed justification given in section 2.7.1

- Establish a revolving fund of Rupees two Hundred Million (Rs. 200,000,000) to fund the establishment of SGF plantations
- Release adequate stretches of presently uneconomic lands for the SGF plantations on an equitable basis
- Provide a transparent and fair tariff for the purchase of Dendro power by the single buyer CEB as already recommended by the Energy Supply Committee
- Adopt a National Policy for the mandatory replacement of an agreed portion of the imported fossil fuels used for the national power and thermal energy supply by renewable resources including bio mass, based on an agreed time plan.
- Establish a Non Conventional Energy Office, under the Ministry of Power and Energy dedicated and empowered to implement the recommended policies
- Arrange international collaborative programmes to enhance the in-house capacity of NERD Centre and other local relevant public and private sector institutions in the local manufacture of thermal and power biomass gassifiers.
- Include agronomical aspects of Sustainably Grown Fuel wood (SGF) in the R & D activities of national research institutions.

The following action plan notes the short term and medium term goals towards achieving non-dependant energy security for Sri Lanka.

7. Short Term Plans (2003 – 2004)

Action	Date	By Whom
Walapane Biomass Power Plant 01 MW	June 2003- March 2004	Ceylon Tobacco Company Limited / Lanka Transformers Limited (On Schedule)
Establish a transparent and equitable tariff policy for purchase of renewable energy from Bio Mass for the national grid	August 2003	Power Supply Committee/ Ceylon Electricity Board (Not yet done)
Establish Energy plantation – 500 acres in System C	March 2004 -	Investor / Mahaweli Authority
Establish Energy Plantation – Pilot Project 100 acres	October – December 2003	Bio Energy Association of Sri Lanka (Implemented)
Establish a revolving fund of Rs 200,000,000.00 for the growing of SGF plantations at interest rates comparable with donor funds	November 2003	Ministry of Power and Energy (Cabinet Paper being Prepared)
Reach agreement on National policy regarding Bio Energy	**December 2003**	**Ministry of Power and Energy/ Cabinet of Ministers (Yet to be done)**
Ensure availability, including current and new plantations (6500 Ha) of SGF plantations to meet the target of Bio Mass based renewable energy	December 2004	Ministries of Power and Energy, Irrigation and Water Management, Lands, Forestry and environment Private Sector investors, Farmers, Home gardens
Combined cycle plants in the Tea Industry	Dec 2004	Tea Research Institute/ Tea Factory Owners

8. Medium Term Plans 2005 - 2008

Develop Energy Plantations System B and new sites 500 ha at each site	January – June 2005	Investors
Power Plants in System B and C – One MW each	Year 2005 -	Investors
Increase the extent of SGF plantations to 50,000 ha to meet renewable energy targets	December 2006	Ministry of Irrigation and Water management, Private Sector investors, Farmers

9. Economics of Replacing Fossil Fuels with SGF

In order to achieve the fossil fuel replacement targets mentioned earlier the following extents of SGF plantations will need to be established. The cost of creating these, if the land is made available are also given in the table below.

Year	CEB Projection of Annual Energy GWH	Proposed Replacement %	GWH	Land Requirement Additional Ha	Incremental Cost of Establishment Rs Millions	F.E.Savings from fossil fuel imports Rs Millions
2004	6967	2 %	139.34	6500	65	**1112**
2006	8342	10%	834.2	35540	356	**6,673**
2008	9892	20%	1978.4	50,550	506	**15,827.**
2010	11505	50%	5752.5	176,630	1,767	**46,020**

10 Supplementary Details and Spin Off Benefits

The Section II of this document describes in details the different aspects of Bio Energy Usage commencing from the plantations, land availability trial plantation results, technologies and the spin off benefits of this industry.

In particular the spin off benefits listed below are note worthy. **If only 10% of the fossil fuel imports** are replaced by bio fuels, the benefits would result in

- **Employment potential** — **50,000 farmers**
- **Contribution to Rural Economies -** — **Rs 2000 Million/year**
- **Saving in Foreign Exchange** — **US $ 72 Million/year**
- **Soil Enrichment** — **22,000 tons of Urea/year**
- **Potential carbon Credits @ US$ 4.00 per ton** — **US $ 4,000,000/year**
- **Enhancement of Green Cover** — **75,000 Ha**
- **Livestock Development** — **32 Million Litres of Milk/year**

The total potential of this resource is more than enough for total replacement of fossil fuels currently imported for the Electricity generation and thermal use in Industry which would enhance the above figures several fold.

SECTION II

REPORT ON THE CURRENT STATUS OF THE ENERGY SECTOR IN SRI LANKA AND THE RELEVANCE AND IMPORTANCE OF ADOPTING THE PROPOSED POLICIES FOR THE DEVELOPEMNT OF RENEWABLE RESOURCES BASED ON BIO MASS FOR THE ENERGY SECTOR

CHAPTER 1 – Current Status

1.1 INTRODUCTION

The government of Sri Lanka in its economic policy has embedded in the Power and Rural Economy sectors the development of Renewable Energy as one of its key activities towards poverty alleviation and economic growth.

This trend is today prevalent globally. There is a deliberate attempt by governments worldwide to reduce the dependence on traditional fossil energy.(Petroleum, coal and natural gas) for primary power, and chemicals. They have identified the many compelling reasons to expand their energy choices to include renewable and alternative sources such as biomass, solar, wind, and geothermal energy. The high dependence on fossil fuels, a fast depleting source of energy the world over, could expose economies to critical disruptions in supply and potentially impact national security. Volatility in price and availability of fossil energy create economic and social uncertainties for businesses and individuals alike.

The US and EU governments have identified Biomass as a viable alternative to fossil energy and help create a more secure energy future. Many of the fuels and chemicals now created from petroleum could be produced from domestic biomass and with fewer environmental impacts. The bio Industry can provide avenues for productive uses of agricultural and forestry waste on a sustainable basis.

Sri Lanka is not endowed with any fossil fuel deposits. Therefore it is imperative that the government fall in line with the trends and thinking connected with the dwindling future availability of fossil fuel. The need to identify and pursue opportunities for non-traditional renewable energy sources is long overdue. The alternatives such as Wind and Solar – Photo Voltaic have proven to be economically unviable for connection to the national grid and in that context their contribution to energy sources in Sri Lanka, whilst being important, will yet be minimal.

The Bio Energy Association of Sri Lanka is a body incorporated with the primary objective of fostering Renewable Bio Energy to supplement/replace fossil fuel.

Biomass accounts for nearly 15% of world energy supplies. In Industrialised countries Biomass supplies about 3% of total primary energy. The dominant and fastest growing use of biomass fuels in industrialised countries is for process heat and electricity. Industrialised countries also use biomass to offset emissions from coal fuelled facilities. In developing countries, biomass fuel supplies about 35% of total primary energy. Most of this biomass energy is used traditionally for domestic cooking and space heating. In Sri Lanka the use of bio mass is over 50% of the total energy usage.

Recently renewable biomass has attracted fresh interest as an electricity source due to its potential as a low cost, indigenous supply of power, and for potential environmental and developmental benefits. Biomass conversion is seen as one option for reducing CO_2 build up. Local benefits can include reduced soil erosion, restoration of degraded lands, and amelioration of local impacts from fossil fired power generation. For developing countries, renewable biomass energy systems may offer a number of social benefits from employment to entrepreneurial ship.

1.2 OBJECTIVES

The Bio Energy Association of Sri Lanka is a group of professionals and corporates engaged in pursuing renewable energy options for the country through meaningful exploitation of the bio industry whilst ensuring that they fall within the framework of the economic policy of Sri Lanka.

Through this paper the association envisages to achieve the following objectives:

- To create awareness among the Political leadership of the country, the bureaucracy, entrepreneurs, professionals, governmental and non governmental organisations and the society at large of the justification to explore a sustainable and renewable bio energy option for the generation of energy as a contribution towards the economic policy of Sri Lanka

- To motivate, convince and harness the energies of stakeholders in pursuing this bio energy option

- To induce the private sector and the government to work in partnership

- To recommend to the government the policy for bio energy to be included in its National policy for Renewable energy

- To prepare an action plan

1.3 The Energy Situation

The energy scenario is deteriorating throughout the world. Non-renewable resources are being rapidly depleted with consequent environmental and economic damages. According to current estimates, all known reserves of oil , natural gas, uranium, accumulated over millions of years will be exhausted within the next fifty years and coal within the next two hundred and fifty years. The haphazard use of these resources has accelerated global warming, acid rains, oil spills, explosions, and nuclear contamination and energy wars. On the hopeful side are, solar energy, with its subsystems of light and heat. Then there is wind. Water movement and photosynthesis are abundant, environmentally responsive and free. Over the years significant technological advances have been made in the area of renewable energies particularly in the field of solar photo voltaic (PV) wind energy and biogas technology.

1.4 Energy Resources of Sri Lanka

The major forms of primary energy used in Sri Lanka during the year 2002 were biomass (52.9%), hydro electricity (08.3%) and petroleum oil (38.8%). Figure 1.4.1 shows the composition of energy supply by source

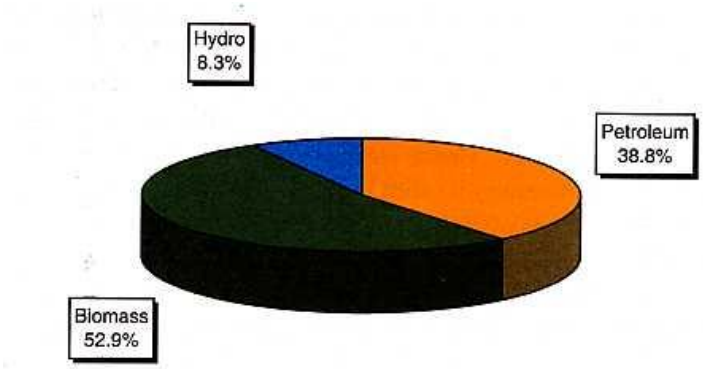


Figure 1.4.1 Energy Supply by Source – 2000(Energy Balance 2002 – Energy Conservation Fund)

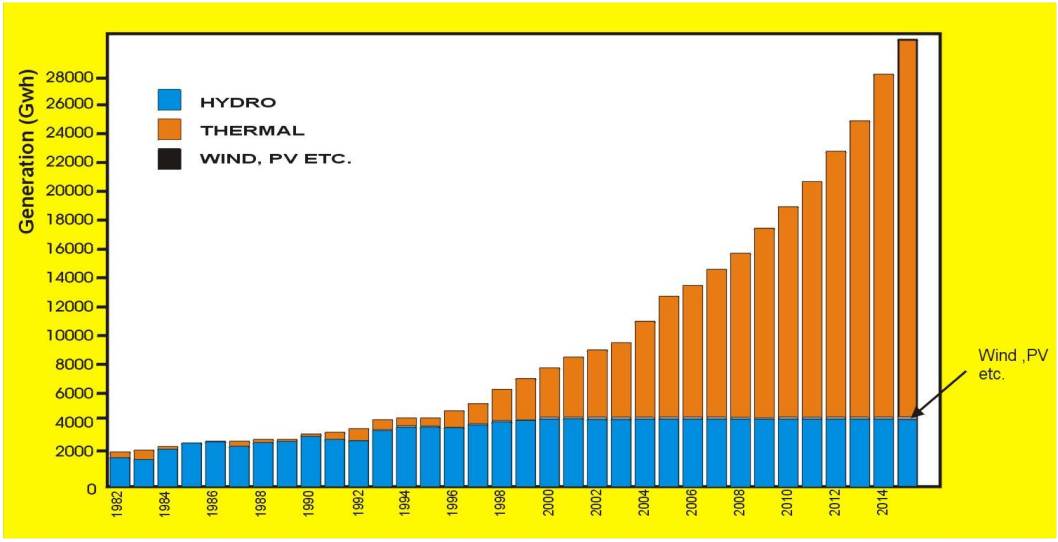
The reality is that over the years, in the absence of fossil fuel resources, Sri Lanka has no option but to rely on the locally available energy resources of Hydro and Biomass that together contributes 61.2% of the total energy consumption.

Growth in the economy and in areas of social development both in the medium and long term has placed a high demand on energy with emphasis on electricity. It has been recognized by the World Bank that economic growth is directly linked to growth in the energy sector.

The Ceylon Electricity Board that currently enjoys a monopoly in the electricity sector estimates growth in the consumption to be approximately 8%.annually in the next five to ten years requiring an additional 120-150 MW annually to meet this demand. However industrialists and other power experts estimate an approximate average demand growth of 8% in the industry, commercial hotel category and a growth of 10-12% in the domestic household category, increasing the estimated requirement to 150 – 200 MW on an annual basis. While only 56% of households presently have access to electricity, this is expected to increase to 80% by 2005. The electrification of balance households is included in the 8% growth levels. Forecast figures from 2001 – 2014 by the CEB as indicated in the long term Generation Plan is reproduced below.

1.5 Energy Demand

The Chart below indicates the historical growth of Electricity demand.



Hence it is evident that there is an exponential growth in the electricity demand in the country that will require to be supplied by a mix of Hydro, Thermal and other means.

It is noted that although losses have been indicated as steadily decreasing in the above forecast from 18.5% in Year 2000 , the average losses currently experienced by the CEB is estimated at 22% of generation.

Sri Lanka experienced its worst power crisis during the period July 2001 to May 2002 a period of almost one year, due to inadequate rains in the catchments areas. The lessons learnt were the risk involved in high dependence on hydro power and from a strategic perspective, the price that has to be paid for lack of a comprehensive energy strategy at a national level. This single event had unprecedented loss of revenue, and economic growth, reiterating that the country cannot depend hydro power for its future requirements.

While there is a government policy of meeting this requirement with 10% Renewable Energy, this is not reflected in the CEB strategies as described in their Long Term Generation Plans .

1.7 The Electrification Rate

The electrification rate in the country incorporates the plans to provide grid electricity to the predominantly rural areas that are currently far away form the grid. There is an evident slack in the rate that may be attributed to many reasons such as funding, accessibility, economies of scale, etc. However, even the rural electrification plans for the next 10 years do not provide for electrification beyond 75 % of the population. The left over 25 % will be in the rural areas and **2 million households will never receive grid connected electricity supplies.**

Even when the targeted 75% electrification is reached by year 2010, the actual coverage in the rural sector will not be at 75% with the urban sector reaching near 100% electrification. This inequity can only be resolved by bio mass based power generation, as micro hydro schemes, the only other viable option, is not available for all locations.

1.8 The Prohibitive Cost of Thermal Generation

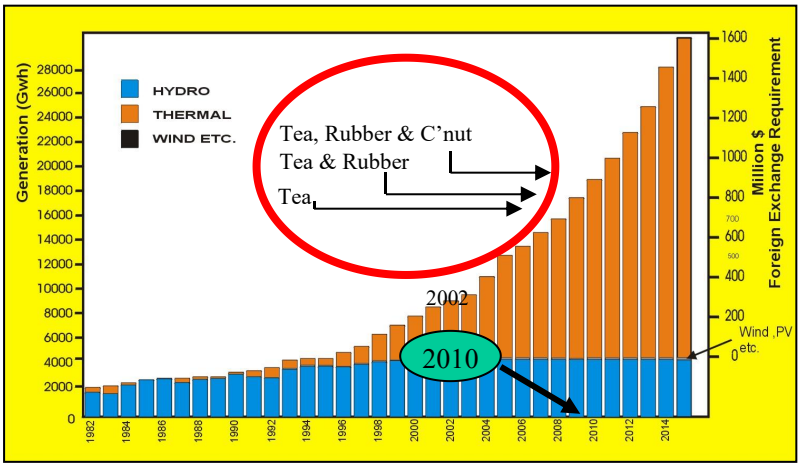


Figure 1.8.0
Power Generation Data (Planning Division - Ceylon Electricity Board)

The above graph illustrates the electrical power requirement of Sri Lanka up to year 2015. The potential for hydropower remains static at around 4000 GWh. The potential for Solar PV and wind power is insignificant yet to contribute to the overall requirement. If the country decides to take this route as the strategy to meet our electrical power needs, by about the year 2010 the country would exhaust all its foreign exchange earnings from traditional exports of Tea, Rubber, and Coconut i.e. Rs100 Billion,($ 900 Million) to cover the payment in foreign exchange for power generated by imported fossil fuel. . Is the country prepared to take this route ?

The dramatic escalation in the rate of exchange i.e. Sri Lanka Rupees per US Dollar is illustrated in the above graph. For the period indicated, the rate of exchange rose from less than Rs 20.00 per US $ in 1980 to over Rs 96.00 per US $ by 2002. According to financial analysts this rate will continue to increase to the future and make our ability to pay for fossil fuel even more grave.

CHAPTER 2 – The Way Forward

2.1 The Way Forward

The need to identify alternate renewable means of generating energy as an alternative to thermal and the traditional hydropower does not need further emphasis. In finding the alternatives the following attributes are considered paramount:

- Use of Low cost fuels
- Ability to decentralise production
- Modular in use
- Be economically viable and affordable
- Are sustainable
- Provide multiple benefits
- They involve people
- Provides energy security

2.2 Energy Options

Sri Lanka is a country with very few conventional energy resource options and no proven fossil fuel reserves. Hydro, biomass, wind and solar are the only significant indigenous resources available in the country. Of these resources it is estimated that about 90% of the hydropower generation has already been commissioned. What is left may be confined to mini and micro hydro systems. Whilst alternatives such as wind, solar PV are certainly important options for exploration the contribution they can make seems negligible in the context of the exorbitantly high investment costs in the case of solar PV and the and the high investment cost of expansion of the grid into areas where significant wind power potential exists. The risks outweigh the benefits for the purpose of mass scale deployment.

2.3 Renewable Biomass Energy

Biomass accounts for nearly 15% of world energy supplies. In industrialised countries, biomass supplies about 3% of total primary energy, and is used for heating, electricity and to off set emissions from coal-fuelled facilities.

In developing countries, biomass fuel supplies approximately 35% of total primary energy, most of which is used traditionally for domestic cooking and space heating.

Recently, sustainably grown biomass has attracted interest as an electricity source due to its potential as a low-cost, indigenous supply of energy and for potential environmental and developmental benefits. Biomass conversion is seen as one option for reducing CO_2 build up, the benefits to plantations to include reduced soil erosion, restoration of degraded land and amelioration of local impacts from fossil fired power generation e.g. $SO_2$and NO_x

Traditional biomass accounts for nearly 52% of the primary energy supplied in Sri Lanka. The major use is for household cooking which absorbs nearly 76% and the balance 24% is consumed in the industries, including the plantation industry. Nearly 76% of our population still depend on fuel wood and other forms of biomass for their household cooking

The current supply of bio mass in Sri Lanka comes mainly from crop residues and home gardens and some plantation off cuts.

The heavy usage of biomass as a primary energy in Sri Lanka particularly for domestic cooking purposes in the rural areas is well established. This trend will continue to the future until there is a substantial increase in the per capita income of the rural population and they have access to other forms of energy. This is unlikely to happen in the next ten years. Industry presently absorbs 24% of the total biomass used for purposes of generating energy. Various initiatives have taken place to enhance the usage of SGF biomass to replace a substantial quantum of the fossil fuels now being used for the generation of energy.

2.4 The Biomass Availability in Sri Lanka

Type	MT / Year	%
Rice Husk available from commercial mills	179,149	6.2
Biomass from Coconut Plantations available for industrial use	1,062,385	37
Sugar Bagasse	283,604	8.3
Bio degradable garbage	786,840	27.4
Saw Dust	52,298	1.8
Off cuts from Timber Mills	47,938	1.7
Biomass from Home Gardens Such as Gliricidia	505,880	17.6
Total	2,873,880	100

These figures are as at 1997 and obtained from the Sri Lanka Energy Balance. Potentially there would be a further enhancement of these values as of now.

2.5 Examples from Other Countries

Only two countries selected from the Developed and Developing world are sited here. There are many worthwhile examples for Sri Lanka to emulate.

America

Sustainably grown fuelwood(SGF) biomass is now been adopted by many countries as an alternative fuel for the purpose of generating electricity. The mission of the United States, Department of Energy(DOE) Office of Energy Efficiency and Renewable Energy (EERE) is to strengthen America's energy security, environmental quality and economic health. Today the US economy is dominated by technologies that rely heavily on fossil energy (petroleum, coal, natural gas) to produce fuels, power, and a wide range of chemicals. The DOE recognizes that they have many compelling reasons to widen their energy choices to include more renewable sources such as biomass solar, wind and geothermal energy. They also are aware that the volatility in the price and availability of fossil energy create economic and social uncertainties. Creating the new domestic bio industry is one of the key portfolio priorities of the EERE. In order to enhance the US energy security the US government has established an Office of the Biomass Program (OBP) to foster development of the technologies needed to drive the growth of a new bio Industry.

India

India has recognized that with the growing population and the depletion of fossil fuel that there is an urgent need to tap the non conventional energy sources. Among the various alternatives biomass hold a special promise owing to its inherent ability to store solar energy and is the only renewable source of carbon and a host of other chemicals. Biomass contributes around 40% of the total energy consumption in India.

Modern thermo-chemical technologies such as gasification and pyrolysis and the biological conversion route of biomethanation to convert all forms of available biomass to convenient solid, liquid and gaseous fuels have a large potential to meet the ever growing energy demands of the country in the domestic and the industrial sectors. The available technologies are highly energy efficient and environmentally friendly. The Indian government is one of the very few countries took take a lead in focussing on this issue with the establishment of the Ministry of Non Conventional Energy Sources. This Ministry has been promoting biomass gasification technology for electrification, thermal and mechanical applications by supporting R & D as well as field installations with substantial subsidies and other incentives.

India has plans to achieve a 10% share for Renewable in the new power capacity by adding up to about 10,000MW through Renewables. India currently has 7 manufacturers of Gassifiers/Associated equipment. India estimates the potential for Bio Energy as 19500 MW. As on March 2003 the Indian government through Indian Renewable Energy Agency (IREDA) has committed US $ 3.2 Billion to assist the generation of 801 MW of Biomass power through Co-generation / Gasification *(IREDA presentation South Asia Energy Coalition 11-12 June 2003 – Sri Lanka)*

Is it not pertinent that we in Sri Lanka who has miniscule resources in comparison to the USA in terms of finances and purchasing power to take a cue from the initiative of India?

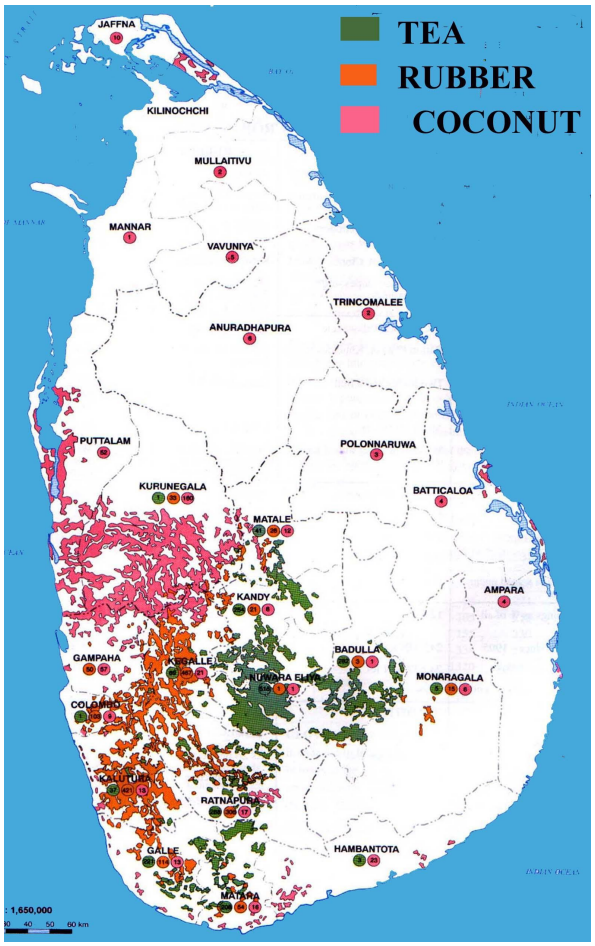
2.6 Land Availability for Dendro Plantations

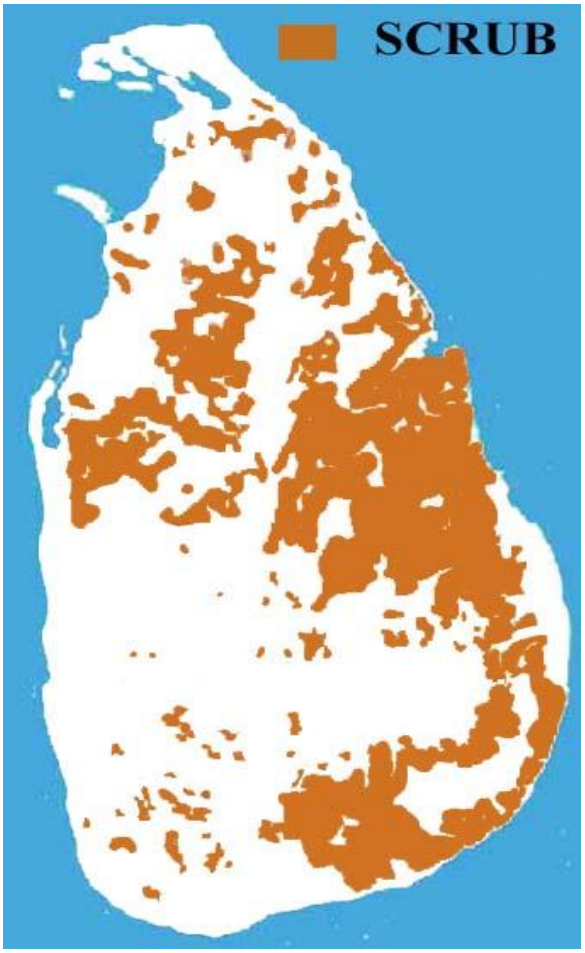
Land Type	Extent – Ha	%
Natural forest	1,678,000	26
Forest Plantations	81,000	1
Industrial Plantations	769,000	12
Paddy Lands	799,000	12
Sparsely used crop lands	1,263,000	20
Range scrub lands	502,000	8
Other	1,408,000	21
Total	6,500,000	100

What is evident from this information is that the sparsely used crop lands and the range scrub lands amount to 28% of the total land extent and is more than the industrial plantations and paddy lands in the country which amounts to 24%.

Hence this is evidence to support that there are large extents of less productive lands, which offer opportunity for large scale energy plantations. Shown below is the land use map of Sri Lanka, which illustrates the locations, and extents of the scrub lands which are well suited for the development of SGF plantations. The extent of such land available quoted earlier of

1,700,000 ha is excluding the already cultivated lands in the patches shown and the reserved lands such as natural forests, national parks and other special areas.





Availability of Marginal Lands for SGF Plantations

2.7 Relevance of Renewable Energy for Sri Lanka

There are many reasons for developing renewable energy in Sri Lanka. These are discussed below.

2.7.1 Absence of Local Fossil Fuel Resources and Lack of Foreign Exchange Reserves

Exploration for fossil fuel exploration in or around Sri Lanka has so far not produced positive results. Therefore, all fossil fuel requirements must be met from imports. The non-availability of adequate foreign exchange to import essential items for the country had been a recurring feature for the past many decades. The demand for foreign exchange has invariably exceeded the supply. This has resulted in the steady depreciation of the Sri Lanka Rupee with respect to US $ over the past several decades. This trend clearly emphasizes the need to produce locally whatever items could be produced competitively. By developing our renewable energy resources, we could substantially reduce the foreign exchange expenditure incurred in importing fossil fuels.

2.7.2 An Industry by Itself

While renewable energy projects generate energy for the national grid to serve all sectors of economic growth, a large number of people are employee directly in the renewable energy projects. The mini and micro-hydro power sector in Sri Lanka is engaging a large number of people of varying grades and skills. The development of a further 250 MW of mini and micro hydro projects would provide additional productive employment for many thousands of our people.
Dendro power projects have the largest scope for providing employment to the rural communities. Each MW of this power could provide employment for 300 rural people earning around Rs 300 per day. This has been well proven in the commercial energy plantations that supply fuelwood for thermal energy applications.

Other renewable energy projects such as wind, solar PV, solar thermal, etc. all provide productive employment opportunities only for the countries manufacturing the equipment .It should be noted that the wind power programme in Europe receives massive support from the respective governments, as wind power development in these countries constitute a huge industry by itself. The fossil fuel sector also receives huge annual subsidies of over US $ 200 billion from the respective governments.

2.7.3 Social Equity and Rural Economic Development

The major hydro and thermal electrical projects undertaken in the country have been described as major social engineering programmes, which with hindsight, have failed to address the issue of equity. The expected generation of electricity, too, has not reached the people affected by the land acquisitions for the reservoirs, but the more affluent in the urban areas.

The proposed Dendro projects, are small and regional projects. Therefore the beneficiaries will be the growers of energy plantations. They will remain in their own areas and homes to grow fuel wood as an additional source of income, not as an alternative to growing food for sale and consumption. The technology involved too could easily be assimilated by the Sri Lankan people and it would assist them to evolve indigenous capabilities too.
Whereas, the major projects had hardly any impact, neither on the local industry nor on the construction sector, as they were all undertaken with foreign aid and therefore with foreign contractors.

There are findings which also indicate that investment in marginal farms creates better returns on investment and has a bigger impact on the economy than investment on capital intensive farming.

We believe that the proposed Dendro energy development is a step in the correct direction, as indicated by these studies, to grow plants for multiple use based on agro ecological principles. As proposed in our project part of the biomass is recycled for soil conditioning and providing soil cover throughout the year, to promote biodiversity and soil conservation. Further these operations will remain small and medium scale depending on extensive and labour intensive cultivation thus addressing issues of social equity better than the large projects.

2.7.4 Cost Effective in the Long-Term

Most new technologies or industries encounter initial teething problems and find it difficult to compete with traditional proven technologies. In the long term however, as these technologies mature, they become competitive and later become cheaper than the traditional technologies. Good examples are micro hydropower in Sri Lanka and wind power in Europe. When grid-connected wind power projects commenced commercialisation in Europe about a decade ago, a unit of electricity produced by these devices was around 10 to 12 US cents. Today, in certain cases, cost of electricity from wind power is the lowest in Europe; lower than traditional fossil fuel based systems. In the initial stages, the power utilities in Europe paid a premium price for energy from wind power projects. The consumers co-operated with this arrangement.
Now, with wind generated energy costing less than fossil fuel based energy in those countries, their consumers are benefiting.

2.7.5 Reliability of Supply

We are an island nation. Imported fossil fuel can reach us only by ships, travelling thousands of miles. Different regions in the world are always in turmoil. There is every likelihood of disruption of imported fuel supplies. The region is a hot bed of trouble and any disruption to supplies will have disastrous consequences to the Sri Lankan economy.

In this situation, there is justification and a need to achieve a status of non dependence on imports as much as possible for our needs of food, fuel and fertilizer.

2.7.6 Price Stability

The local selling price of imported fossil fuel depends on many external factors, most of which are beyond the control of Sri Lanka. Though this will have a pronounced impact on the price of petroleum products such as oil and gas, it will also impact on coal as well. Firstly, the mining and transporting cost of coal depend heavily on the price of oil. Secondly, the additional insurance premium on ships during periods of international or local turmoil can be substantial. The port charges in Colombo escalated by about US$ 30 per tonne soon after the attack on our airport two years ago. In the case of coal, this will result in doubling of the final price. Heavy dependence on imported fuel will cause unbearable local cost escalations.

2.7.7 Improvement of Local Technical Skills

Renewable energy development involves the design, fabrication, installation and commissioning of many engineering devices in many different locations in the country. This will give an opportunity to many local technical workers to improve their skills. This has been amply demonstrated in the case of micro hydro projects and biomass energy projects already commissioned.

2.8 Advantages of Distributed Energy

Renewable energy projects are usually small projects located close to load demand centres, mostly meeting local energy needs. This method of installing energy generating facilities close to the load centres has many advantages.

- **Social Equity**

  The projects are essentially small scale and the fuel needs can sometimes be met even from home gardens. Also the type of labour inputs needed for the SGF plantations leaves much room for those engaged to devote to other activities. Thus this would be means of providing additional income and means of more widespread utilization of labour.

- **Minimal Need for Transmission and Distribution**

  The initial capital costs of transmission and distribution networks are very high. It could be 60 to100% of the capital cost incurred in the generation equipment.
  More over, in Sri Lanka, obtaining "Right of Way" for transmission and distribution networks is very tedious and is politically sensitive. Long delays and deviations from optimal routes are very common in Sri Lanka. By locating small generating stations close to load centres, we minimize the need to construct such new extensive transmission and distribution networks.

- **Transmission and Distribution Line Losses**

  The transmission and distribution line losses in Sri Lanka at present are estimated at over 22%. The introduction of large centralized power plants and the associated transmission and distribution network to link the generation facility to the consumers aggravates these losses. It is interesting to note that in the Netherlands, with distributed energy accounting for nearly 50% of the total electricity generated, the transmission and distribution losses are only 5%.

- **Smaller Investment and Shorter Gestation Period**

  Conventional large fossil fuel based power plants take three years to plan and a further 6 years to construct and commission. Donor agencies that had been financing such projects on soft terms and grants have stopped funding such projects. These projects can now be implemented only under BOO terms with private funds. The need for large funds to the tune of close upon a billion US Dollars and the long period for the cash flow to become positive make this option (i) a very expensive way to meet our energy needs and (ii) limit it to large foreign conglomerates.

  Renewable energy projects are small; require a gestation period of less than 3 years. Funds required are in the order of US$ 2-4 million. Such funds could be obtained through many of the development-funding projects (such as RERED, the Indian Line of Credit or even local commercial and development banks). Equity requirements from project developers are small and local entrepreneurs could arrange this easily. The cash flow becomes positive within 1-2 years of commencing operation.

2.9 Relevance Of Bio Mass For Renewable Energy In Sri Lanka

There are many advantages that are specific in the development of bio energy in Sri Lanka. These are discussed below.

2.9.1 Ease of Replacement of Fossil Fuels

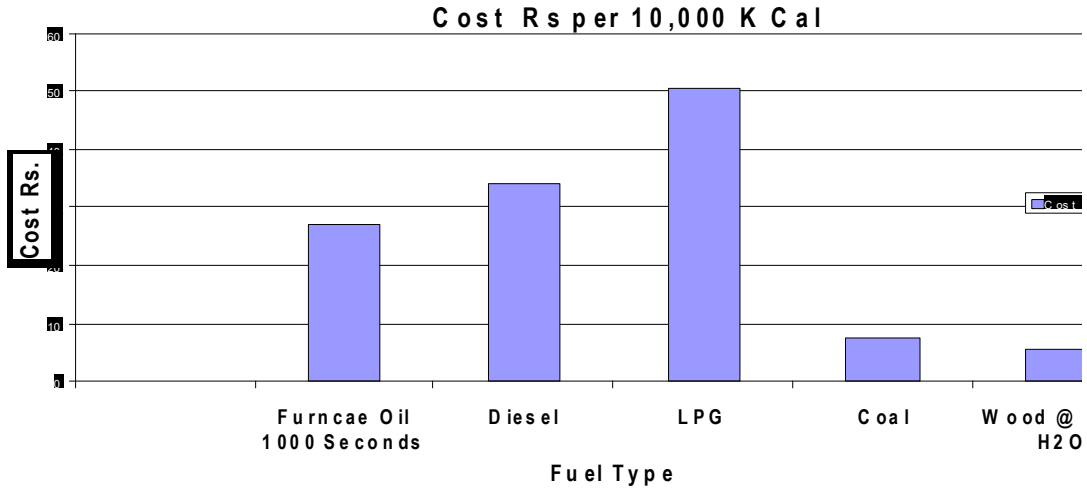
The process of bio energy applications consists of two distinct phases. In the first phase, bio fuel is produced in dedicated energy plantations or as a by-product of agricultural or forestry activity. In the second phase, bio fuel is converted into the desirable form of energy such as hot air, steam or electricity. Once the first phase is completed, the second phase is a simple variation of the traditional fossil fuel applications.

There are two ways of achieving this latter objective. In the first, the energy conversion device such as a furnace or boiler, is very similar to the devices used in fossil fuel application and designed to match the properties of the bio fuel. In the second approach, bio fuel is first converted into a gaseous fuel through a process known as gasification, and this combustible gas is cleaned and cooled if necessary, and used in identical energy converting devices as used in the traditional fossil fuel applications.

In terms of energy content, the calorific values and the weight ratios, taking into account the conversion efficiencies are given in the tables below.

2.9.2 Comparison of Calorific Values

Comparative Costs of Energy Derived form Different fuels In Sri Lanka- Average prices



Energy Equivalents of Fuels

3 Kg Wood = 1 kg oil
2 Kg wood = 1 kg Coal

By deploying appropriate equipment and technology, a fossil fuel based system could be replaced by a bio fuel based system. The fuel replacement ratios are as per table above.

2.9.3 Large Potential

Based on the yield data obtained from many independent studies a hectare of energy plantation with 5000 trees per Ha of Gliricidia, Accacia or Cassia in the dry zone of Sri Lanka would produce a minimum of 15-20 tonnes (dry) per hectare per year. This would be sufficient to meet the fuel requirements of a 2.5 KW power plant operating on an annual plant factor of 70% annually generating 15,000 kWh of electrical energy. The total extent of degraded marginal land suitable for energy plantation in Sri Lanka is estimated at 1.6 million hectares. Hence the national potential for Dendro power in Sri Lanka is estimated as 4000 MW annually generating over 24,000 GWh. This is nearly 4 times the total hydropower potential in this country. The Dendro potential in our country is adequate to meet our electrical energy demand for many decades. The potential for commercially viable wind and solar photovoltaic energy is very small in Sri Lanka.

2.9.4 Plantations are Part of Our Tradition and Culture

Year round availability of sunshine and adequate rainfall has resulted in Sri Lanka possessing a long tradition and culture of sustainable plantations. Our country has been sustained for over a century, by the plantation economy. In spite of opening our economy for industrialization with foreign investments, the plantation sector continues to play a dominant role in our economy. The expansion of plantation technology for bio energy production is in total harmony with this tradition and culture.

2.9.5 Synergetic Impact with Many Other Economic Activities

The establishment of energy plantations in the dry zone with nitrogen fixing trees will have the following synergetic benefits:

2.9.5.1 Supplementary Income to less affluent Farmers

Farmers engaged in the traditional rice cultivation in the dry zone in Sri Lanka have employment opportunity only for peak labour periods during certain months of the year. These farmers need alternative income generating avenues in the remaining months in the year. The introduction of energy plantations in their locality would enable these workers to productively engage themselves also during these slack months. Each worker could earn around Rs 300 per day. A husband-wife combination working 150 days in the year would bring a supplementary annual income of at least Rs 100,000 per family.

Every MW of Dendro power could provide employment to 150 farmer families providing employment for 400 workers for 150 days of the year. The total potential of 4000 MW of power could employ 600,000 families throughout the year with a total work force of 1,800,000.

2.9.5.2 Organic Fertilizer Production

Experiments carried out at the Coconut Research Institute has revealed that the incorporation of 35 kg of green Gliricidia leaves to a coconut palm has the equivalent effect of applying 800 grams of urea fertilizer.
In this manner, the leaves obtained from energy plantation could replace a substantial quantity of imported chemical fertilizers, reducing the cost of production of our agricultural products. This would substantially reduce foreign exchange expenditure incurred for imports of fertilizer, while the woody matter is available as a source of fuel.

2.9.5.3 Enhancement of Dairy Industry

At present over 80% of the national milk requirement is met through imports. The high cost of this item has resulted in severe malnutrition amongst the children of the poor families in Sri Lanka. A study conducted and published by the National Science Foundation reveals that rice straw and Gliricidia leaves jointly constitute an excellent feed for dairy cattle. Burning rice straw in the field annually destroys large quantities of rice straw in the country. Surplus rice straw and Gliricidia leaves from energy plantations could be processed into cattle feed. This feed could be transported to locations such as Ambatale or Nuwara Eliya to be used as cattle fodder for a modern dairy industry.

2.9.5.4 Prevention of Land Degradation and Desertification

Land degradation has been identified as a serious problem in dry zone in Sri Lanka. About a third of our land area has been degraded and is under utilized. Annually, about 0.1% of virgin forestland is encroached by shifting cultivators. Clear signs of desertification are appearing in many parts of our dry zone. The only practical method of arresting this situation is to provide a viable alternative to shifting cultivation, which provides a permanent closed green canopy. Establishment of energy plantations and the modern method of continuous harvesting technology is an economically viable way of resolving the sustainability.

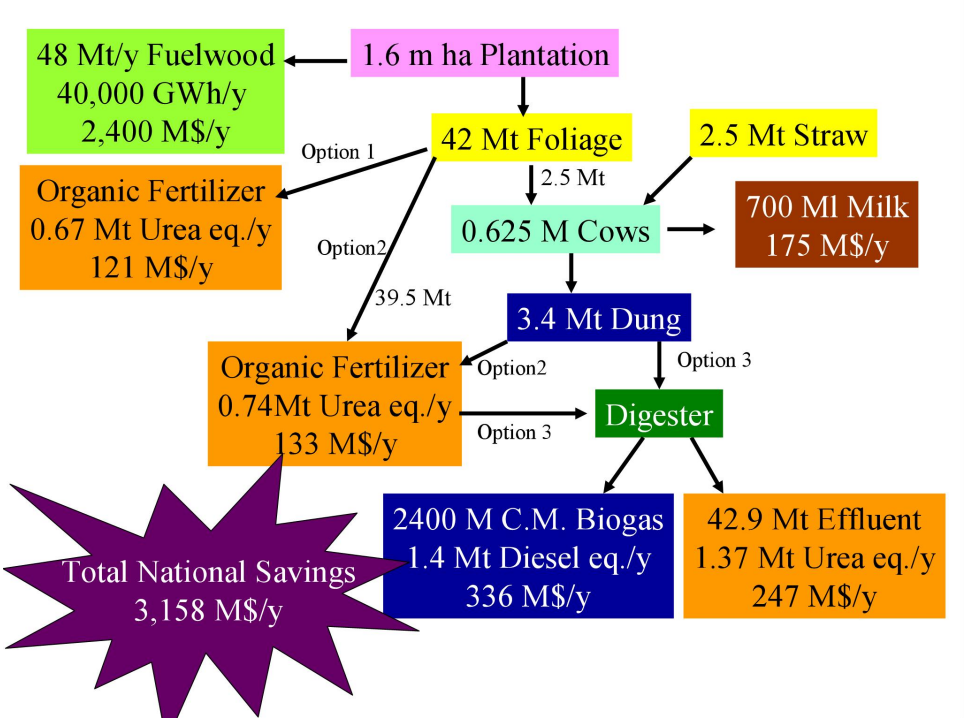
2.9.5.5 Fuel-Based Renewable Energy System

Amongst the many renewable energy options, bio energy is the only fuel-based system. A fuel based system has two distinct features. Firstly, the fuel-based system is not affected by short-term fluctuations weather. Fuel is grown, harvested, stored and utilized according to demand. By suitably adjusting the storage quantity of fuel, we could cater to all variations in the weather pattern. Secondly, fuel could be transported to any desired location and the energy conversion facility could be located at any location irrespective of the location of the primary energy source.

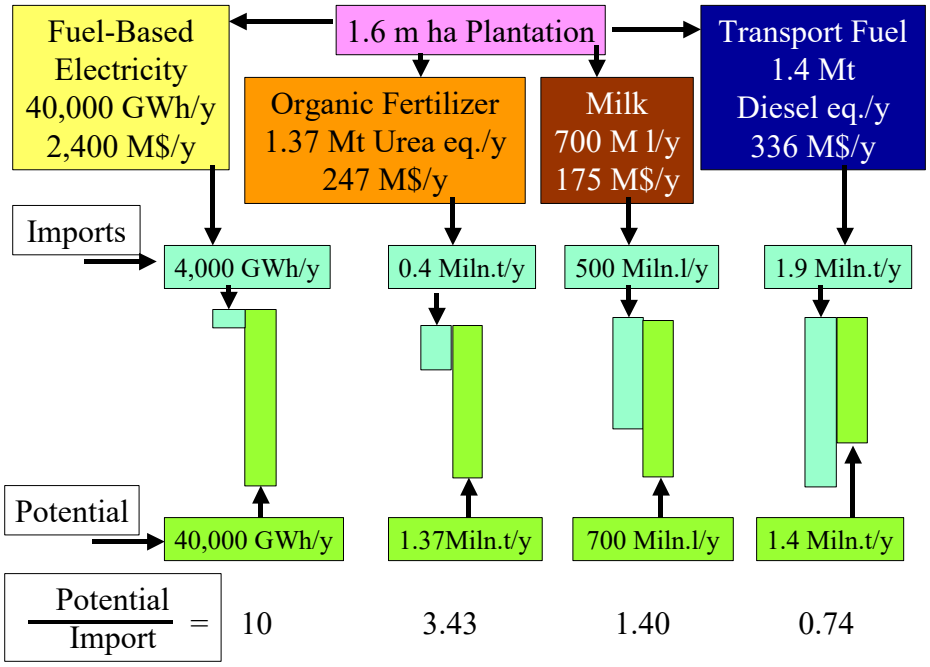
2.9.5.6 Amenable for Combined Heat, Power and Refrigeration Systems

The application of steam turbine or gassifier IC engines enables the recovery and utilization of waste heat for industrial process heat or refrigeration using absorption technology. This approach will reduce the cost of energy in our industrial and tourism sectors.

The overall utility of a bio mass plantations, both in terms of quantitative outputs and income levels as well as the relative impact on several sectors are illustrated in the charts below.



The Overall Potential Benefits from Dendro Plantations



Comparison of Imports Replacement Potential

CHAPTER 3- The World Is Moving Towards Bio Energy

3.1 World is Moving towards Modern Bio Energy

The world is moving away from fossil fuels towards renewable energy. Amongst renewable energy, the emphasis is on Solar and Modern Bio Energy. As far as we are concerned, bio energy is very appropriate to our economy. We should move in that direction.

3.2 Production of Biomass

Traditionally fuel wood in Sri Lanka is harvested from degraded Rubber Plantations where the entire plantation is removed. Another source of fuel wood is generated from Chena cultivations, where jungle timber is chopped down with approval from authorities. These plantations may be 25-40 or more years old. Traditionally the harvesting cycle can be from 7 years upwards. This time interval is chosen to cater to the traditional fuel wood using industries such as tea factories, which are accustomed to purchasing and using fuel wood in the form of billets of approximately 150 mm diameter and one meter in length. Purchases are made on the stacked volume basis. These varieties of fuel wood are more costly and an industry by itself.

The tobacco industry, has for many years been using solid fuel wood obtained from the many different sources described above to meet the heat energy requirements of the industry. However, in recent years, this industry has changed over to paddy husk as the sole fuel in all the tobacco barns in the country.

3.3 Traditional Bio Mass Energy Conversion Facilities

3.3.1 Household Sector

For many years the household sector has been using the 3-stone method to cook meals. Many government institutions and NGOs have promoted a variety of improved wood stoves, which use wood fuel more efficiently and with reduced pollution.

3.3.2 Industrial Sector

Billets of fuel wood are first manually split into smaller pieces before fed intermittently, into firing chambers of furnaces and boilers. Agricultural industries such as tea and desiccated coconut use cast-iron air heaters. More recently, some of these industries have converted to wood-fired boilers and steam radiators to generate the hot air required for the drying process. The brick and tile industries use direct firing systems without the use of any heat exchangers. Due to the intermittent feeding of fuel wood, these systems operate at sub-optimal efficiency and produce smoke and other pollution.

3.4 Modern Method Of SGF Production

In the modern method, fuel wood is produced in short Rotation Coppice (SRC) plantations. In these plantations, trees with the dual ability to coppice and fix atmospheric nitrogen are planted at high densities of 5,000 to 10,000 trees per hectare depending on variety. When the diameter of the main stem reaches 25 to 50 mm at a height of 1.5 meters from the ground, the main stems are trimmed at this height to stimulate coppice growth.

Thereafter, when the branches reach a basal diameter of more than 25 mm, the branches are trimmed about 50 mm from the base of the branch. Branches with a basal diameter of less than 25 mm are not harvested. They are allowed to mature until they reach this minimum size. The main stems of the trees are not harvested at any stage. This process of harvesting mature branches is carried out throughout the year, depending on the availability of labour. When stems of *Gliricidia sepium* are used as the planting material, the first harvest could commence within 15 months of planting. Thereafter, each tree could be harvested at around 2 to 4 month intervals.

Under good conditions a minimum yield of 20 tonnes of wood at 20% moisture level per hectare could be expected in the dry zone in Sri Lanka. If grown as an inter-crop in coconut plantations, a yield of 10 tonnes could be expected. The leaves of some of these tree species also provide useful animal fodder.

3.6 Recommended Species for SGF Plantations

Many species have already been extensively tested with field trials for suitability as SGF plantations in Sri Lanka. Many of these species are well established and known to our farmers. These include

Gliricidia sepium has been identified as the best species. Other suitable species are

- *Gliricidia sepium*
- *Leucaena leucocephala*
- *Accasia auroculiformis*
- *Casuarina equicetifolia*
- *Casia Siamea*
- *Calliandra calothisrus*

Amongst others

Figure 3.6.1
Gliricidia Sepium

This deciduous tree grows to a height of 8-10 M tall and 15-35 cm in girth. Grows in tropical deciduous forests, hillsides, and ravines, often in cut over weedy areas at an elevation up to 1600 meters from msl. A leguminous tree used to improve soil, for weed and erosion control, live fencing and popular as a SGF plant. Very fast re-growth.

CHAPTER 4 – What Needs To Be Done

4.1 What Needs To Be Done

The most important factor affecting the adoption of the Bio Mass Energy options in Sri Lanka is the lack of awareness of the potential by the policy makers and other stakeholders of all levels. Dissemination of verified, reliable and adequate information on the current availability, and the viability of using this resource needs to be done . The current on going trials would generate some information in this regard. Further work in the same vein needs to be continued to remove any doubts and grey areas.

4.2 State Facilitation Required

Although the development of the renewable resources of energy including all forms of bio mass, mentioned in Chapter II - section 4, can and will be undertaken by the private sector, some urgent and essential facilitation measures need to be initiated by the state sector. The Ministry of Power and Energy has the mandate to provide these facilities.

The main impediment to wide spread acceptance and investment in biomass energy industry is the lack of confidence in availability of adequate supplies of fuel. Although all evidence point to the vast potential for the development of SGF, some catalyst is needed to encourage the industry to take the initiative.

- The BEASL proposes that a fund of Rs 200 Million be established as a revolving fund to be disbursed at rates of interest not more than those charged by the donor countries to investors willing to venture into the plantation of SGF species. This fund is adequate to create 20,000 ha of plantations. This will provide adequate fuel to meet the proposed contribution of renewable energy to the national energy mix by year 2005. It will continue to provide the impetus needed to meet the future targets for 2006, 2008 and 2010 given in **Section I** of this report.

The second input needed for the development of SGF plantations is naturally the availability of land. It has been illustrated in Chapter II - section 6, that there are more than 1,700,000 Ha of scrub lands suitable for these plantations, particularly in the dry zone. Most if not all of these are state lands. The map shown illustrates the locations of growing trials conducted by the Ministry of Science and Technology for SGF plantations with several species meeting the desired characteristics. All these trials have proven the viability and the projected out put targets.

- As such it is proposed that a scheme should be developed in consultation with the relevant Ministries to release adequate tracts of land to potential developers on a well structured program coupled with the development of the power generation plants associated with the plantations in such lands.

The current regulations relating to the electricity supply and distribution, and even the proposed restructuring plans for the sector leaves the Ceylon Electricity Board as the single buyer of electricity for the National Grid. As such a transparent and equitable tariff structure is of paramount importance as an encouragement to attract investors for the renewable energy sector for power generation. At least in the short and medium term all such plants are likely to be of capacity less than 10 MW. The current Power Purchase Agreement (PPA) applicable to such power producers , must recognize the stable and reliable nature of SGF fuel based power generation. This has been also been recommended by the National Energy Supply Committee .(As per report prepared by the Centre for Energy Studies at Moratuwa University)

- The BEASL proposes that this recommendation be accepted and the Ceylon Electricity Board be required to pay the recommended capacity charge for the SGF fuelled power plants supplying power to the national grid, in addition to the energy charges currently being paid under the Small Power Purchase Agreements.

It has been illustrated that the continued dependence on fossil fuels for the country's energy needs is not sustainable and could be a danger to national economic independence. The major export earnings will be absorbed by the expenditure on the import of fuels for the requirements of electricity generation alone. The requirements for transport and other sectors are growing equally rapidly.

Thus a long term plan for the substantial reduction of import of fossil fuels, to reach a position of non dependence must be a firm and continuing policy of the country.

- It is proposed that a policy be formulated early after careful study of all indigenously available resources of energy. The most promising economically, technically and abundant sources should receive higher priority in the development plans. These include the SGF and other sources of bio mass, all viable locations of hydro resources and wind resources, which are reported to be substantial in some locations.

The energy Industry is a highly capital intensive and technology dependent industry for the generation, transmission and distribution. The amount of money spent by the country in both development and maintenance and operation of the power system is a substantial fraction of the gross national product . Another very salient point that must be recognized is that the demand and the growth of the energy industry is local and is not subject to fluctuations of markets aboard which affect the pricing and market size and other factors controlling the viability and growth of the industries.

In Sri Lanka to date there has been no effort to develop indigenous skills and capabilities to exploit this captive market and save the vast sums of foreign expenditure spent which only serve to develop the industries in other countries. The notable exception has been the creation of Lanka Transformers Limited whose success should serve as a beacon to venture into other equally important areas relate to the energy industry.

- Therefore a policy initiative is urgently needed to develop the local capabilities of both technical expertise and infrastructure , to expand rapidly the local contribution.

This must cover

a) Development of relevant resources in the public and private sector
b) Investments in necessary infrastructure such as manufacturing facilities
c) Policy initiatives to progressively promote the use of local skills and capabilities with set targets matching the expansion of the market.

A more detailed study of this important aspect is possible with the assistance of the major players in the industry The Ceylon Electricity Board, Lanka Electricity Company and the Lanka Transformers Limited

4.2.1 Plantation Trials

Trials have been completed to determine the optimum parameters for energy plantations. Species of trees have been identified for the different agro-climatic conditions. Optimum spacing and harvesting regimes also have been determined. Independent yield data have been compiled. Research is continuing in order to establish the most economical methods of establishing plantations and increasing yields. The location map of trial plots already underway by the Ministry of Science and technology is shown below. Trials have been conducted on several species and are continuing to determine the particular advantages and properties of the species.

4.2.2 Demonstration Facilities

Two facilities have established to demonstrate the technical feasibility of (a) Electricity Generation and (b) Process Heat Generation using locally grown coppice wood from Short Rotation coppice (SRC) plantations.

The electricity generating facility is located at the Galvanizing Plant of Lanka Transformers Ltd at Sapugaskanda. This has the capacity of 34 kw. Dry coppice wood with diameters less than 50 mm in diameter is first cut to 50 mm long pieces. Moisture content should be less than 20%. These are fed to the top of the chamber of a gassifier. The charge is lit through lighting ports. Combustible gas is drawn out of the gassifier under the action of a fan. Gas is first cooled and washed in a venture ejector. This gas is then filtered through a serious of filters and finally mixed with appropriate quantity of air is fed to an internal combustion engine provided with spark ignition, designed to operate on natural gas. This has been operating satisfactorily for over 10 months.

The process heat generating facility is located at the Coir Fibre Pith Processing factory of Lignocell Ltd. at Madampe. Here air heaters generating heated air for process applications have been using furnace oil as its fuel. These have been now converted to work with gassifiers similar to the electricity generating gassifier. This facility too has been operating satisfactorily for the past 18 months. The equipment for the above facility was designed and built in Sri Lanka

Arrangements are being made to extend this technology for industrial thermal application on a much larger scale at the Haycarb factory in Madampe. A number of Desiccated coconut mills have shown interest in gasification options for thermal application.

4.3 Modern Bio Fuel Energy Conversion Facilities

4.3.1 Conversion Technology Options

Wood can be used as fuel to generate energy primarily for two applications. Heat Application, such as Industrial Process Heat and Electricity generation. Where Sri Lankan industries are concerned presently fuel wood is a primary thermal energy source. However , nearly 25% of petroleum imported to the country is used in Industries to produce steam or hot air for drying applications. Wood fuel could easily replace the petroleum in these applications.

4.3.2 Industrial Sector - Gassification

- The production of a combustible gas from solid biomass fuels has become very popular in many countries, including some of the developing countries such as India. This is achieved through a device known as “Gasifier”. In gasification, solid biomass is systematically combusted under controlled conditions to produce a combustible gas mixture.

The net reaction is the production of a gas mixture commonly known as “Producer Gas” with combustible components made up of Carbon Monoxide, Methane, Hydrogen and Hydrocarbons. Non-combustible components comprise Carbon Dioxide and Nitrogen. The heating value of the gas is 4 to 6 MJ per normal cubic meter. This gas could directly fuel the burner of a combustion chamber in a boiler or furnace.

The following options are available: for generation of Heat for industrial use

- Direct combustion in grate furnaces

  This method of heat production is most common at present. Industries such as tea, desiccated coconut tile and tobacco adopt this system

- Direct combustion in steam boilers

  For many industrial applications heat energy needs to be provided in the form of steam generated in boilers. Biomass fired boilers could be used to generate this steam. A number of industries use this form of heat production such as desiccated coconut, plywood, timber, and rubber Industries.

- Gasification of biomass

  The biomass is first converted into a gaseous fuel known as producer gas prior to combustion. The producer gas generated could be used by combustion to generate thermal energy needs. Alternatively it could be used to drive an internal combustion engine which can die an electric generator or provide shaft power for other requirements.

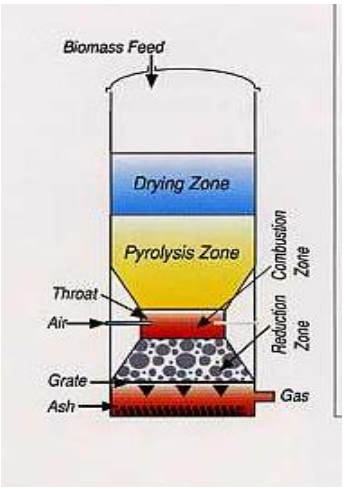
4.3.3 Generation of Electricity

4.3.3.1 Boiler- Steam Turbine Generator

This form of power generation is already practised in sugar mills. Biomass (Bagasse) fuelled boilers generate high pressure steam which in turn drives steam turbines. To generate power for use at the mill. Similarly biomass (Fuelwood) harvested from energy plantations could be combusted to generate electricity. The system can be operated independently for isolated village/industry applications or to be connected to the grid. Scandinavian countries such as Finland & Sweden use the fluidized form of combustion to gassify biomass prior to combustion in steam boilers

4.3.2.2 Gassifier- IC Engine Driven generator

The producer gas generated by the gasifier is cleaned through a series of filters and used to drive an IC engine similar to LPG gas driven motor vehicles. This method has two modes,i.e.100% gasification and the Dual Fuel mode where 20% diesel is added into the combustion chamber.



Down Draft Gasifier Schematic diagram **Biomass Gasifier**

CHAPTER 5 – Spin Off Benefits & Conclusion

5.1 Spin Off Benefits of Bio Energy

- **Carbon Sinks** There is a vital difference between energy production from fossil fuels and from biomass. Burning fossil fuels releases CO_2 that has been locked up for millions of years. By contrast burning biomass simply returns to the atmosphere the CO_2 that was absorbed as the plants grew and there is no net release of CO_2 If the cycle of growth and harvest is sustained. Thus the biomass option is proven to be CO_2 neutral. Energy plantations will act as carbon sinks. As such the energy producers using bio mass could benefit from the Carbon Credits under the Cleaner Development Mechanism (CDM) formulated under the Kyoto Protocol carbon credits are being traded for US $ 4-6 per MT.

- **Soil Enrichment** The establishment of SRC plantations with Nitrogen fixing trees such as Gliricidia and Leucaena in degraded lands previously used by shifting cultivators will over time upgrade the land to its original status.

- **Soil Erosion** Gliricidia has been proven to be ideal for Sloping Agricultural Land Technology (SALT). Through a method of planting along the grid lines in twin hedgerows soil erosion can be arrested. This method has been very effectively sustained in the hill country in tobacco growing lands.

- **Pricing** Energy efficiency wise 4 tonnes of fuel wood is equivalent to 2 tonnes of Coal or 1 Tonne of oil. At current prices for oil at around Rs 24,000/= per tonne the energy equivalent price of fuel wood would be around Rs 6000/= per tonne. The current delivered price of sustainably grown fuel wood (Gliricidia) is Rs 1500/= per tonne. Presently, energy for energy, sustainably grown fuel wood (SGF) is three times cheaper than oil. With the creation of the market fuel wood is likely to be even cheaper to the future. As the price of fossil fuel continue to increase and the supply becoming volatile, domestically grown fuel wood will become increasingly attractive.

- **Employment & Growth in Rural Economy** Fuel wood farming can become an attractive employment opportunity to the rural youth. A fully grown energy plantation of 50 Ha can provide employment to around 40 persons on a sustainable basis bringing an income of around Rs 200 a day per person for manual labour. A one MW power plant would inject a sum of Rs 22 million to the rural economy. This sum will be shared between the farmers and the collecting agents. This opportunity will also prevent migration by the rural youth to urban areas.

- **Foreign Exchange** Large sums of foreign exchange will be saved from not importing fossil fuel and can be diverted to other important areas or reserves.

- **Land Use/Green Cover** Large extents of unproductive lands would now be better utilised as energy plantations. Not only will there be plantations but simultaneously the green cover in the country will be enhanced.

If 50,000 Hectares of energy plantations are grown it can increase the forest cover from the current 19% to 25%.

- **Electricity To Inaccessible Areas** There are many areas in the country where grid electricity may not reach due to transmission difficulties. Biomass electricity is an ideal solution to such areas.

- **Economic/Social/Environmental Impact** The economic, social, and environmental impact from the above will be a tremendous boost to the country as a whole. For example the pressure for urban migration of youth could be reduced by providing employment opportunities and means of income generation in the rural areas.

- Thermal Energy for Crop drying and processing . The bio mass gasification as wells as waste heat form the power generation are valuable sources of energy for low grade heat requirements for crop drying and processing needs and are available practically at no cost.

5.2 Conclusion

Wood is the dominant domestic fuel for rural people in developing countries and for many of the urban poor as well. It is estimated that more than 1.5 billion people in the world use wood daily for cooking and for maintaining essential levels of warmth in the home. Wood is a preferred fuel as its use and distribution does not require complex equipment and can be acquired at little cost. Often this will be similar to the cost of gathering. (World Bank 2003)

In Sri Lanka around 53% of the total energy generated is by the use of biomass in the form of fuel wood. Presently 24% of this is used up by the industry.

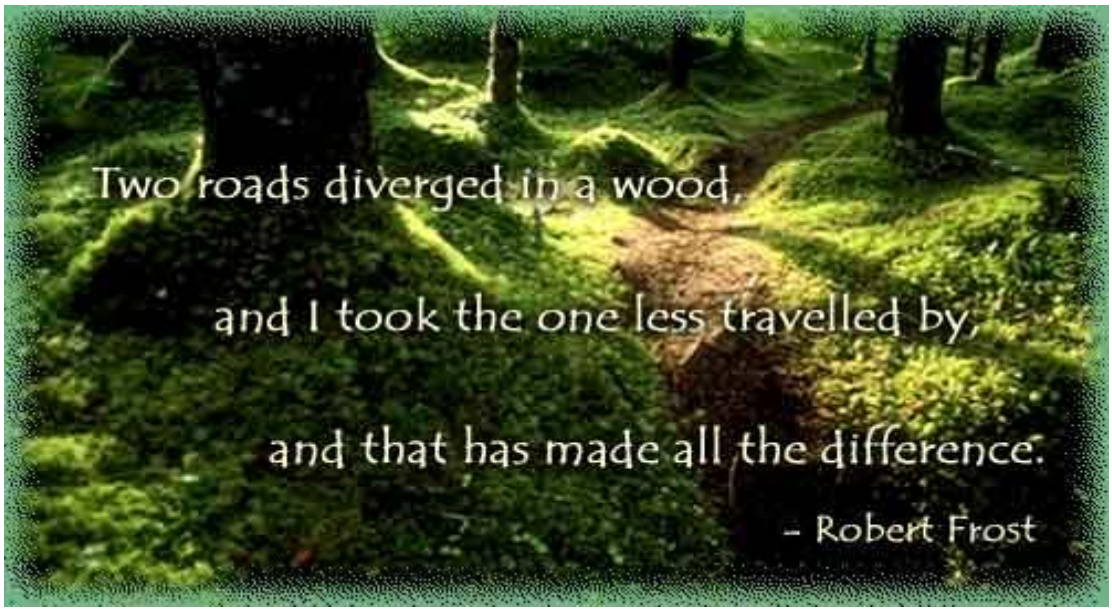
38.8% of the total energy generated is coming from Petroleum that has to be imported at a significant cost in foreign exchange. In view of the potential available for the development of Energy Plantations in the lesser productive land which represents almost 25% of the total land availability there is sufficient justification for Sri Lanka to move towards biomass in supplementing / replacing the petroleum component.

The free availability of Short Rotation Coppicing varieties of trees makes it an attractive business opportunity to investors to participate in the energy scenario. The following numbers alone amply justify the case for SGF Bio Mass as the future source of Energy for Sri Lanka

The Unsuspected Reality is that :

If only 10% of our fossil fuel imports of 3.6 Million Tons, for generating energy can be replaced by SGF biomass, the benefits that can be accrued are as follows:

Savings in foreign exchange	**US $ 72 million**
Employment opportunities	**50,000 farmers**
Contribution to Rural economy	**Rs 2000 million**
Soil enrichment	**140,000 tons of leaves= 22,400 tons of Urea**
Potential Carbon Credit in US 4 / MT	**100,000 tons of CO2 = US$ 4,000,000**
Livestock Development	**32,000,000 Litres of Milk**



Bio Energy Association of Sri Lanka
239, High Level Road
Colombo 5
Sri Lanka
Tel 94 1 852167, 94 75 524613
E Mail : bioenergy@sltnet.lk
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