Sustainably Grown Fuel Wood[1] (Dendro) as a Biomass Energy Source in Sri Lanka

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Abstract

The world in general, Sri Lanka in particular, is at a crucial moment in deciding the path to be followed in meeting energy needs. The rising cost of fossil fuels, the impact of global warming and climate change by the emissions from fossil fuels and the need for energy security arising from hostilities between nations, particularly in the Middle Eastern region, are factors that need attention.

Sri Lanka is endowed with several indigenous and renewable sources of energy which have not received due attention of the energy authorities. Of these, bio mass and sustainably-grown fuel wood is of particular importance due to the multitude of spin off benefits that the energy plantations would provide. Bio mass is the potential source for supplying the energy needs of all sectors including transport fuels.

The use of bio mass for energy is not new for Sri Lanka, and the necessary lands, expertise and experience is already available to ensure the widespread use of this environmentally sound and economically attractive indigenous resource, which can be developed in a short time.

1. Energy Needs of Sri Lanka

The world in general, Sri Lanka in particular, is at a crucial moment in deciding the path to be followed in meeting energy needs. From a global point of view, the issues in the energy sector are: (a) The rising cost of fossil fuels; (b) The impact of global warming and climate change by the emissions from fossil fuels; (c) The need for energy independence arising from hostilities between nations, particularly in the Middle Eastern region.

We in Sri Lanka are encountering our own problems in meeting our energy needs. The dual forces of ever rising prices of imported petroleum fuels and the steady depreciation of the Sri Lankan Rupee with respect to international currencies have resulted in unbearable economic pressure on the citizens of Sri Lanka. Although our contribution towards climate change from Greenhouse Gas (GHG) emissions is minuscule. (Ref IPCC 4th Interim report.) Sri Lanka Energy Balance we have a moral obligation not to add to the already unbearable GHG load in the atmosphere. Being an island, Sri Lanka will certainly suffer from the effects of global warming. The most vulnerable sector affected by the inflationary effects of these problems is the rural poor.

Note 1. Sustainably Grown Fuel Wood is derived from Short Rotation Coppicing tree species as distinct from forest wood

The energy needs of the country fall into the following four categories:

1. Generation of electricity
2. Thermal energy needs of industries
3. Thermal energy needs of the domestic and commercial sector
4. Transport fuels

The current demands for energy from these sectors and the sources are as follows :

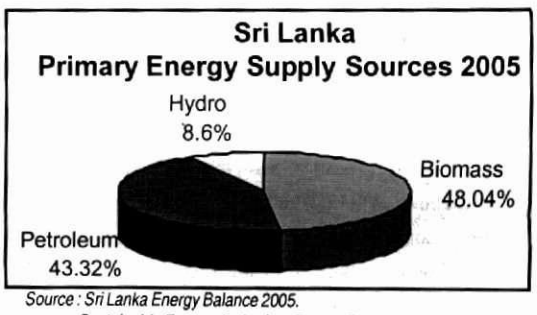
Table 1
Demand for energy from different sectors and sources in Sri Lanka

Category	Demand (ktoe)	Source Hydro	Petroleum	Biomass
Electricity	760.98	296.7	463.44	
Thermal Energy Needs of Industries	1906.57	Nil	490.29	1416.28
Thermal Energy Needs of the domestic and commercial sector	3529.39	Nil	361.55	3167.84
Transport fuels	2070.40	Nil	2070.40	Nil

ktoe – kilo tons oil equivalent
Source: Energy Conservation Fund Sri Lanka Energy Balance (2005).

The predictions of the energy authorities particularly in respect of electrical energy demands indicate that the present plans for energy supply through imported fossil fuels only as seen in the current long term generation plan of the Ceylon Electricity Board, will lead to a worsening of the already dire situation. A much greater effort and priority is required for finding indigenous sources of energy. This is the only way out for Sri Lanka, and contrary to common belief, Sri Lanka has many natural advantages which can be exploited to convert the present crisis to an economic boon. **Sri Lanka has the potential to be largely independent for its energy requirements. In addition, the options available have multitude of spin off benefits with wide ranging positive impacts on the social, environmental and economic well being of the country.** (Ref ECF Submission on Renewable Energy Potential to the Ministry of Power and Energy and BEASL web www.bioenergysrilanka.org)

It is unfortunate that our available resources are underestimated and underplayed by those in authority, at any forum where such topics are discussed. They are given scant attention in the misguided belief that they are not substantial. This is clearly seen in the adhoc target of only 10% for use of renewable sources of energy by year 2015 in the National Energy Policy approved by the parliament in May 2008, where as Sri Lanka is already using biomass resources to meet nearly 50% of its primary energy needs.



Source : Sri Lanka Energy Balance 2005.
Sustainable Energy Authority - Energy Balance 2005.

It is important to dispel such misconceptions and avoid a repetition of the costly mistakes done in the past in the energy sector. The following points require careful consideration which can be easily verified by reference to reliable sources:

1. The present situation is more a financial crisis than an energy crisis due to the overdependence on imported sources of energy and the escalation of world prices over which we have no control at all. The current dip in oil prices is arguably a temporary phenomenon considering the fact that the world has already passed the oil peak.(www.youtube-peakoil)

2. It is also unfortunate that when the energy needs of the country and the present crisis are discussed, only the electrical energy requirements are discussed. The nation must appreciate that out of the total energy consumption, only 9.76% is electricity (Energy Conservation Fund, 2005) The major proportion of the balance is taken up by transport and industrial thermal energy demands. The cost of domestic energy is also a substantial problem for the ordinary householders with increased gas and kerosene prices.

3. Therefore, the primary requirement for the country is to focus on harnessing indigenous sources of energy, which would also be the more environmentally benign as well as the cheaper option. If even a fraction of the attention and concessions and facilities provided for use of the imported fossil fuels are granted, this is not a difficult task.

4. al is an imported fuel and is no longer a cheap fuel. The price of coal at source is now about US$ 150 per tonne and has not declined at same rate following the fall in oil prices. Therefore, what is more important to note is that the same amount of energy from a kilogram of coal can be obtained from 2 kilogram of fuel wood which would cost only Rs 8.00 (www.bioenergysrilanka.org.) and the money will flow into the rural economy in Sri Lanka instead of flowing out of the country as foreign exchange.

5. Sri Lanka is not obliged under the Kyoto Protocol to reduce its Green House Gas emissions. However, in the recent Bali conference of the United Nations Framework Convention on Climate Change (UNFCCC), it was highlighted that the developing countries too should be called upon to reduce the Carbon Dioxide Emissions by 30% from their 1990 emission levels. (www.unfccc.org.) The level of emissions in Sri Lanka is more than 200% *above the 1990 levels already. Sri Lanka* Energy Balance Year 1990 and 2005 With the proposed coal-fired power plants, this will increase several fold.This is not considering the environmental hazards that are inevitable with the coal-fired power plants even if the most sophisticated protection measures are adopted. In that case, power obtained from coal will certainly not be cheap. The pollutants which come into the country with the coal will remain in the Sri Lankan environment, even if they are trapped in the chimney stacks. We will not be allowed to ship them back.

Although we are not under any international legal mandate, we should accept the moral responsibility to not to contribute any more to the global warming, even ignoring the health and other environmental hazards from coal usage.

2. Alternative Energy Sources

In selecting the technologies for exploitation to meet Sri Lanka's energy needs, it is best to classify the available technologies by way of ease of development and the relative contribution as well as the cost of such technologies. The hydro, bio mass, wind and solar thermal technologies can be highlighted as the obvious choices. It is necessary to remember that the energy requirements transcend beyond electrical energy to include thermal energy for industries and domestic use, as well as the transport energy requirements.

A further consideration is the requirements of inputs of technical knowledge as well as the equipment and materials of construction and the spin off benefits from the use of the selected technology, in addition to the mere generation of energy.

Thus the relative merits and the priority order for development would be :-

1. Hydro power
2. Bio mass for thermal energy in the industrial and domestic sector
3. Bio mass for electrical energy
4. Bio mass for transport energy
5. Solar thermal energy to supplement electrical energy with bio mass
6. Wind energy

The exploitable potential of the different sources of alternative energy has been quoted by different authorities. It is useful to consider the estimates published by the former Energy Conservation Fund as a useful reference.

- Hydro - 360 ktoe /Year (balance potential)
- Bio Mass - 16,000 ktoe/Year
- Wind - 3440 ktoe/Year
- Solar - 8,600,000 ktoe/Year

  (Solar Thermal/ Photo Voltaic)
- Other – Wave energy
- Ocean thermal
- Current imports of fossil fuels - 4000 ktoe approx.

Note : ktoe- Kilo Tons Oil Equivalent
Source : Energy Conservation Fund (2005)

The search for alternatives for imported energy resources must necessarily address all four sectors of energy usage viz: for electricity generation, thermal energy for industries, thermal energy for domestic and commercial use and for transport . However, hydro, solar and wind resources can provide only electrical energy, whereas biomass resources has the potential to generate both electrical and thermal energy, Technologies are already available to use biomass to generate renewable fuels for transport needs as well.

As such this article focuses on the need and the potential for development of bio mass as an indigenous source of energy, considering its versatility as well as the high potential and ease of development. Use of biomass for energy is not a new phenomenon for Sri Lanka as shown below:

3. Dendro Energy

As illustrated in the Table I, biomass is the major source of energy in Sri Lanka even now. However, it has not received due attention and support and is not yet targeted as a viable resource to be developed aggressively recognising its multitude of benefits.

In recent times, the use of sustainably-grown biomass as a major source of energy has been promoted. The potential of growing short *rotation* coppicing tree species such as Gliricidia sepium and the spin off benefits of such cultivation is now well documented (www. bioenergysrilanka. org - Dendro Policy Proposal BEASL, 2004,, H A G Gunathilake 2008).

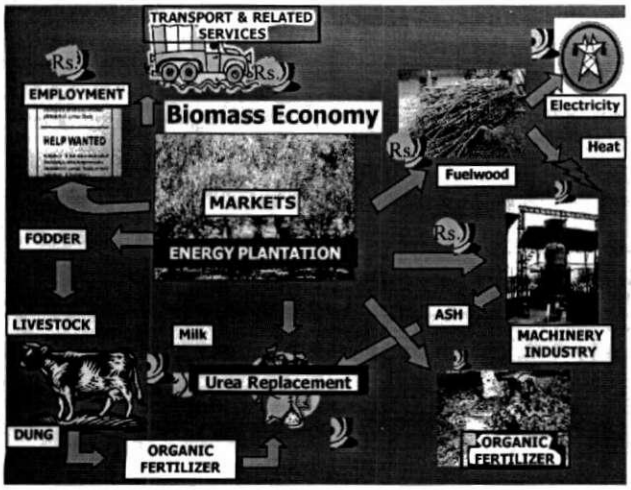
3.1 The Spin off Benefits of Bio Mass Energy

The multitude of benefits to be derived from adopting dendro power can be listed under several simple but most nationally important and relevant aspects.

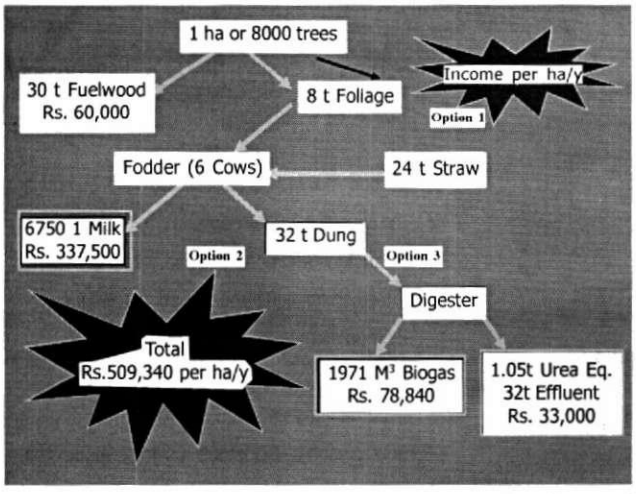
- Poverty alleviation
- Organic agriculture
- Energy security
- Self sufficiently in milk production
- Development of rural industries
- Renewable energy for rural development
- Reversal of urban drift
- Rejuvenation and enhancement of fertility of lands
- Creation of a national energy industry

How these objectives can be met is simply illustrated by the charts below:.

Multiple Economic Benefits of Dendro Plantations



Economics of Gliricidia Plantations – Income per Ha per Year



3.2 Dendro energy potential

Our energy demands are greater than what can be met from the most attractive source viz., Hydro. These include the electricity generation needs as well as the thermal energy needs of the industry and households and transport fuels .

Of these, the most abundant and easily developed resource is the sustainably-grown fuel wood species such as Gliricidia Sepium, This is an indigenous, renewable, cheap resource and moreover, is a source of multiple other spin off benefits. At present, a controversy exists in respect of bio-fuels saying that it will be responsible for the increase in food prices due to diversion of the agricultural lands for growing of crops for bio fuels. While this may be true for America and some western countries, it is unfortunate that some people in Sri Lanka are adopting the same stance with scant regard to the realities in Sri Lanka.

The already published data from the Ministry of Lands clearly indicates the availability of large extents of unused and abandoned chena lands and scrub lands in the country amounting to some 1,700,000 ha. (Ref Land Use Policy Planning Division, Ministry of Lands) These lands can be easily converted to energy plantations with no diversion of any resources used for food production.

Breakdown of this land availability is shown in Table 2.

Table 2
Distribution of land in Sri Lanka

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

Source: Land Use Policy Planning Unit, Ministry of Lands (2005)

In fact, the present method of cultivation of short rotation coppicing fuel wood plantations is to use alley cropping methods, which in fact enhance the food production.

Figure 1
Demonstration of Alley Cropping at Agricultural Park Gannoruwa

The concept of alley cropping is not new for Sri Lanka and is being actively promoted by the Dept. of Agriculture. A demonstration plot is shown in the picture above (Figure 1).

As explained later on, the lands under the coconut and tea plantations themselves are potential areas for generation of additional fuel wood with very significant benefits for the parent plantations and other spin off benefits.

3.3 Biomass conversion technologies

Any type of biomass has nearly the same heat content of 4500 kCal/kg at zero moisture and ash content. However, since the availability of agricultural wastes such as rice husk and saw dust is limited in Sri Lanka, the generation of sustainably-grown fuel wood using short rotation coppicing species of fuel wood is advocated. From the dozens of suitable species available, several

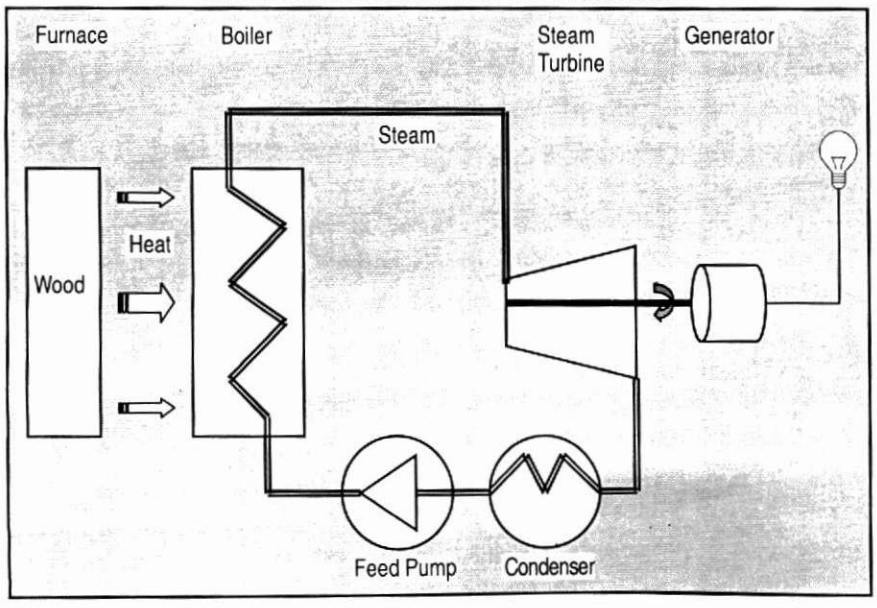
species such as *Gliricidia sepium* (Ladappa, wetahiriya, nanachi, weta mara), *Leucaena leucocephala* (ipil ipil), *Casia Siamea,(kaha cona) Calliandra calothisrus* have emerged as the more attractive spices due to their positive attributes of fast growth, nitrogen fixing ability, adaptability to many agro-climatic conditions, and high bio mass yields. (www.bioenergysrilanka.org.)

The conversion of the solar energy stored as chemical energy in the biomass, to useful forms of electricity and thermal energy is achieved using two main technologies viz., direct combustion and gasification.

3.3.1 Direct combustion

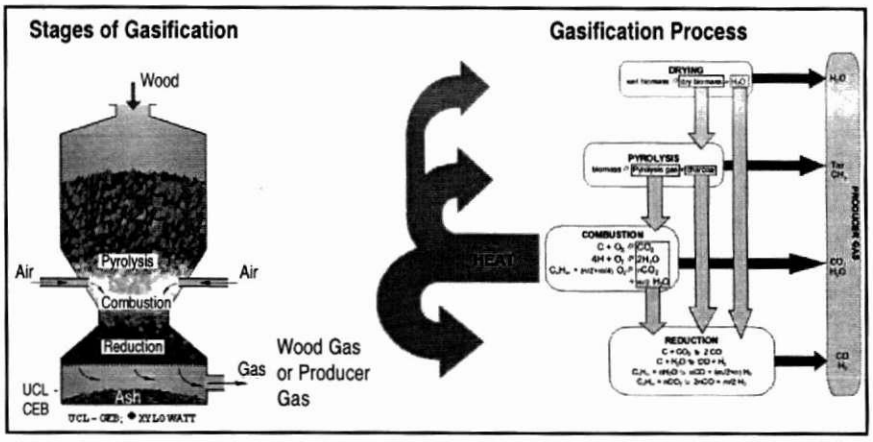
Direct combustion of biomass in a suitable furnace or boiler releases the intrinsic energy in the biomass as thermal energy. This can be converted to steam or used directly where ever the thermal energy is needed. Steam Turbine option is used where the biomass is combusted in a furnace to produce heat that in turn makes a boiler to produce high pressure steam that drives a turbine generator to produce electricity.

Schematic of a Biomass Steam Turbine Generator



3.3.2 Gasification

In gasification option, biomass is converted to a combustible gas that is used as the fuel to either generate thermal energy by combustion or to run an engine generator. This is a very useful technology to generate a fuel that is clean and as convenient to use as oil. The gas generator can be located in a remote location and the gas can be piped to the point of use. This method is used only for small-scale power requirements in the order of 100kW. However, this is the most viable option for electrification of the remote villages far away form the national gird where there is no potential for micro hydro installations. Already six villages have been provided with electricity using this technology and equipment developed in Sri Lanka. (www.lankagaslk.com)



Gasification is a means by which even the current usage of fuel wood in industries can be made significantly more efficient. It is reported that a 50% reduction of fuel wood used in the tea industry can be achieved by converting to gasification technology (Atalage and Jayasinghe, 2008)

3.4 Electrical Power Generation

The total potential for electrical power generation using dendro resources is estimated to be in excess of 4,000 MW by developing the necessary energy plantations using available sparsely-used lands. (www.bioenergysrilanka.org.) The practice of power generation using biomass in Sri Lanka is as old as the sugar industry. Even the now defunct Kantale and Hingurana sugar mills produced electricity from biomass (sugarcane bagasse) many decades ago. The two sugar factories at Pelawatte and Sevanagala are currently producing 4 MW of electricity using sugarcane bagasse for their energy needs. Both factories have plans for expanding this capacity and feeding the excess to the national grid.

A 10 MW power plant operating on rice husk, but with the capability of accepting wood chips has been commissioned recently at the Tokyo cement Factory at Trincomalee. There are many investors, both local and foreign, who will be ready to invest on the power plants, if the fuel wood supply is assured. It requires a long-term vision and confidence in using the skills and resources available in Sri Lanka to accept such seemingly large challenges at the present time. However, if a concerted effort is made to develop at least 100 - 200 MW of dendro power, as projected in the National Energy Policy as an urgent challenge, the viability of this potential will be easily recognised.

3.5 Thermal Energy Needs of Industry and Domestic Sector

It has been pointed out earlier that a major component of the country's energy demand is for thermal energy for industries and domestic use. It is in this respect that the contribution by sustainably-grown fuel wood becomes even more valuable.

The current import of 425,000 tonnes of petroleum products used by industries, just to generate steam or hot air can be replaced by fuel wood immediately. This would require only some 65,000 ha of fuel wood plantations. No new technology is needed and only minimal changes are needed in the existing equipment and facilities. The cost of such changes can be recovered in a few months by the industries by way of saving in energy costs.

The thermal energy provided by **one tonne of oil can be replaced by 4 tonnes of fuel wood.** Therefore, 425,470 tonnes of oil can be replaced by 1,701,880 tonnes of fuel wood.

Most of the industries are located in the Western and North Western Provinces. Coincidentally, most of the coconut estates are also in this region, which are ideal for growing of Gliricidia as an intercrop with symbiotic relationship with coconuts. This fact has been proven by estate-level experiments over several decades. Only about 50% of the total area under coconut by intercropping with Gliricidia is needed to supply the full complement of fuel wood to replace the 425,000 tonnes of oil used in the industries (Based on studies carried out by the Coconut Research Institute)

It is useful to consider the following benefits if this conversion is made based in current prices and costs.

- Foreign Exchange saving for the country
  Rs. 24 Billion
- Savings for the industries in fuel costs
  Rs 20 Billion
- Flow of income to the growers
  Rs 6,720 million
- Additional foreign exchange saving by fertilizer value of leaves as replacement of urea (28,220 tonnes urea @ $ 1000)
  Rs 3 Billion

In order to reach this goal and to achieve the above very attractive benefits, the following measures are possible.

- Encourage the industries using fossil fuels for thermal energy to covert to the use of fuel wood by subsidising the interest on the loans taken for implementing the change.

To ensure the reliable supply of the fuel wood needed, encourage the coconut plantation owners, small holders and homesteads with small plots of land to grow Gliricidia and other recommended Short Rotation Coppicing (SRC)trees by a suitable subsidy scheme

3.6 Domestic energy needs

The past two decades have seen a distinct shift towards the use of liquefied petroleum gas (LPG) for domestic and commercial cooking even in rural areas. The escalation of LPG prices has left this sector with no alternative source of fuel. There are several acceptable wood stoves developed by the National Engineering Research and Development (NERD) Centre and others to help this sector. However, their widespread usage is limited by the lack of a ready and convenient supply of suitable fuel wood, in comparison to the aggressive marketing of LPG.

If the above proposal for the replacement of oil use in industries is implanted, it will have the potential of developing a supply chain of fuel wood for the domestic sector as well. These can be sourced from the off cuts and be processed and packaged for marketing in the retail sector.

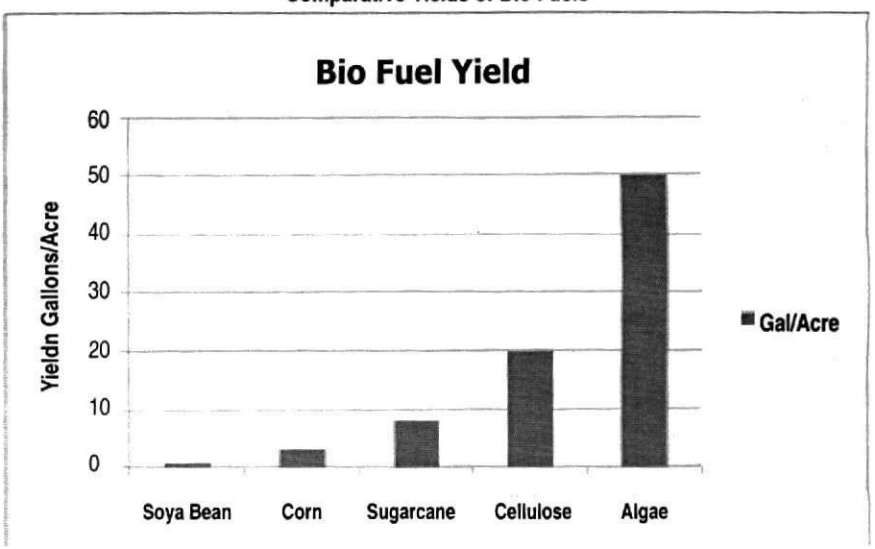
3.7 Transport Fuels

The replacement of fossil fuels needed for the transport sector is a more difficult problem. Some of the solutions proposed, such as ethanol from corn and sugarcane have come under fire as being detrimental to the food production.

However, several other technologies are maturing, such as the use of algae and conversion of the cellulose content of bio mass into ethanol which Sri Lanka has the ability to benefit from if the potential is realised and correct steps are taken now.

These technologies have the advantage of not using any food grains or lands targeted for food production. They have the added advantage of higher yields per unit of land as shown in Figure 2 The dividends will accrue in the medium term as renewable and indigenous sources, even for this seemingly difficult sector.

Figure 2
Comparative Yields of Bio Fuels



Source : National Geographic October 2007

4. Benefits from Carbon Trading

It has been mentioned earlier that Sri Lanka has no, legal obligation to met any targets under the Kyoto Protocol. But we are well placed to benefit from the Clean Development Mechanism under the protocol by venturing in to the Carbon Trade which has seen spectacular increase in price of carbon credits.

At current price of about Euro 15.00 per Ton of Carbon or Certified Emmission Reduction (CER) this represents an enormous avenue of revenue for Sri Lanka. It will be noted that the largest contributions will come from the replacement of fossil fuels with renewable fuels and from renewable energy generation. As such not only will we be able to generate our energy from indigenous renewable resources and thus avoid the huge drain in foreign exchange , but we stand the chance of earning additional income in foreign exchange as well. Revenues in excess of 100 million Euro annually, as carbon credits is certainly feasible.

5. The Way Forward and State Interventions Needed

The government has taken some meaningful steps to develop the renewable resources. However, under the present crisis, they are inadequate and receiving only lukewarm attention by those who can catalysthe change.

I believe that only His Excellency the President can give the necessary leadership to encourage the relevant state machinery include energy also into his drive for independence of our food supplies. The great advantage we have is that we can have fuel, fodder and fertiliser from the same source grown in synergy with the food crops.

Some specific initiatives deserve urgent attention are:

- The newly-established Sustainable Energy Authority (SEA) has a very great challenge in converting the Nation Energy Policy to a reality. They have an even greater responsibility to ensure that the state officials acknowledge the vast potential of renewable resources in Sri Lanka and proactively contribute towards achieving the very conservative targets already set of 10% of all energy to come form renewable resources by 2015. This target set 3 years ago needs urgent revision in the present circumstances. The SEA has to take up the role of developing indigenous sources of energy as their main objective and should use the wide ranging powers provided

by the Act to force other state institutions to provide the support necessary overriding any barriers.

- The state agencies, the Ceylon Electricity Board and the Ceylon Petroleum Corporation should be given the task of achieving the set targets of indigenous renewable energy for electricity and for industrial thermal energy. These must be challenging targets which will set the country definitely on the road for non dependence on imported fossil fuels. They can do this as state enterprises or by encouraging the private sector to corporate. However, the onus of archiving the targets should remain with the two state agencies.
- The main impediment to the development of the dendro resources is the inability of the developers to obtain lands for energy plantations. If it is the government policy not to release land to the private sector, then the government should ensure that various state institutes such as the National Livestock Development Board (NLDB), Janatha Estates Development Board (JEDB) and Mahaweli Authority of Sri Lanka which already hold vast extents of lands under their authority, should be compelled to bring them under energy plantations themselves and thereby ensure the steady supply of the fuel to the developers. The bankers regularly bring this up as a reason for not funding any renewable energy projects.
- The forest department must make clear declaration of the strict forest areas so that the other areas mostly abandoned chena lands and scrub lands can be released for energy plantations.
- The development of an acceptable alternative for transport fuel requires the concerted and focused efforts of all our research agencies. A solution targeting the more attractive technologies of algae and cellulose-based liquid or gaseous bio fuels should be the choice instead of targeting the less productive and controversial use of food grains. The basic knowledge and expertise is available with the local scientists and engineers, and should be harnessed for this task instead of looking for foreign expertise.
- Any kind of subsidies for use of fossil fuels for industry is a short sighted vision. Instead, very substantial incentives including low interest loans should be provided for industries to convert their systems for use of fuel wood. This will encourage them to take proactive measures to ensure steady supply of fuel wood for their needs with multiple benefits for the growers. A saving of 400,000 tonnes of oil imports per year can be guaranteed within two years if this measure is followed with necessary vigour.

Most importantly, it is imperative that all concerned citizens do make themselves aware of the true situation and voice their opinions on the various proposed programs which can be both economically and environmentally disastrous for the country. A vast amount of information is available on the world energy situation and the progress being made to find acceptable alternatives.

Sri Lanka will need to buy or seek foreign assistance to obtain the technologies and the equipment for the conversion of the energy resources to the required form. **But under no circumstance should we resort to purchase of the fossil fuel from abroad as the solution to our energy needs.**

It is customary to lament about Sri Lanka's lack of natural resources particularly fossil fuels. But the reality is that we are endowed with many potential renewable resources if only we have the courage to develop and sustainably exploit them for the benefit of the country.

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