ENERGY COST REDUCTION
IN INDUSTRIAL AND COMMERCIAL SECTORS BY SWITCHING TO BIO FUEL

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1. Introduction

The primary objective of all energy management activities is to reduce the cost of energy expended. Broadly speaking, there are two approaches to achieve this objective. In the first approach, we attempt to improve the efficiency of utilization of energy. In the second approach, we switch from a more expensive fuel to a cheaper fuel.

Examples of the first approach are: Eliminating steam leaks, insulating steam lines, adjusting the air-fuel ratio in combustion to reduce excess air, introduction of a heat recovery equipment to reduce waste heat etc. Examples of second approach are: Changing from diesel-firing to furnace oil-firing, changing a petrol-driven car to diesel-driven car, switching from oil to coal in electricity generation.

In this article it is proposed to discuss the cost-benefit aspects of switching from fossil fuel based industrial process heat generation to bio fuel based heat generation.

2. Costs of Useful Heat from Different Fuels

table below gives the parameters pertaining to the common fuels used in Sri Lanka to generate industrial process heat.

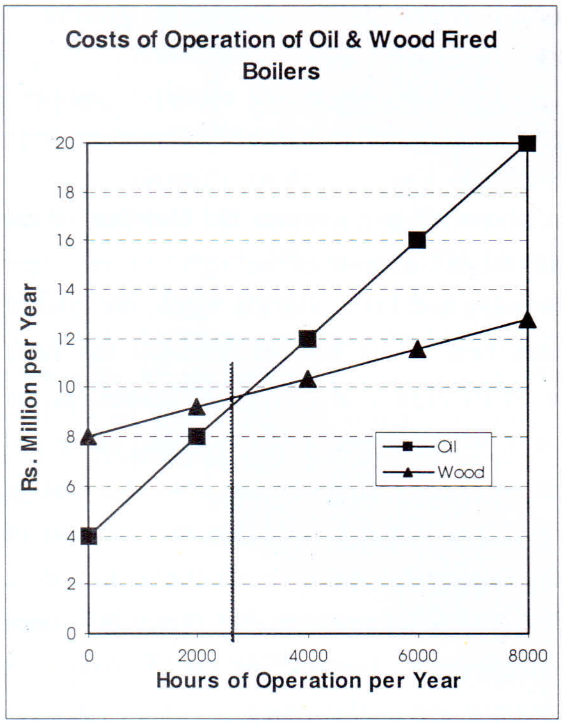
Fuel	Cal.Va lue kJ/kg	Price Rs./kg	Heat Recov. Eff. %	Cost of Useful Heat Rs. /MJ
LPG	45000	50	80	1.39
Diesel	42552	32	78	1.11
Furnace Oil	40860	25	78	0.78
Coal (Without tax)	26000	6	71	0.33
Wood (at 20% moisture)	14,000	1.5	71	0.15

The above table illustrates the fact that in the case of LPG, in spite of the high heat recovery efficiency and high calorific value, the cost of useful heat is the highest amongst the fuels due to its high cost of fuel. Whereas, in the case of wood, although it's calorific value and heat recovery efficiency are low, the cost of useful heat is the lowest due its low cost of fuel. Energy for energy, compared to wood, LPG is 10 times as expensive, diesel is 7 times as expensive, furnace oil is 5 times as expensive and coal is twice as expensive.

Given these wide variations in effective costs of producing heat, it may appear that one should always choose the cheapest option (wood) to generate process heat. But in actual practice, industrial and commercial institutions use many different fuels. The reasons for these selections are discussed below.

(a) **High cost of energy conversion equipment**

It is an established fact that the initial capital costs of liquid and gas burning energy conversion equipment are much less than solid fuel burning equipment. A wood-fired boiler would cost nearly twice as much as the cost of a oil-burning boiler. The total costs of operation of a wood-fired boiler and an oil-fired boiler are illustrated in the diagram below. (High fixed costs are used for clarity).



In the case of oil-fired boiler, the fixed cost (based on the initial capital cost) is low but the variable cost is high due to high fuel cost. The situation is reversed in the case of wood-fired boiler. In the diagram above, the intercept (representing the fixed cost) for the oil line is low but the slope (representing the variable cost) is steep. For the wood line, these parameters are reversed. The two lines intercept at a point representing about 2800 hours per year of operation. This means that if the boiler is expected to operate for less than 2800 hours of operation per year, then the oil-fired boiler would be more economical. If the boiler is expected to operate for more than 2800 hours per year, then it is cheaper to install a wood-fired boiler.

(b) **Simplicity of operation**

LPG and diesel fired systems are much simpler to operate than furnace oil fired or wood fired systems. Hence for smaller installations, from an operational management point of view, it is better to incur additional energy cost for the sake of continuity of operation.

(c) **Non-availability of cheaper fuel in the locality**

In many locations in Sri Lanka, regular supply of furnace oil or fuelwood is not available. In such situations, investors are inclined to choose a sub-optimal system.

(d) Ignorance on the economic advantages of fuel switching

Many industrialists (energy managers and planners too) are unaware of the economics of switching to cheaper fuels. The purpose of this article is to draw the attention of these officials on this aspect of energy management.

3. Process Heat Requirements in Industrial and Commercial Sectors in Sri Lanka

The consumption of energy in the industrial and commercial sectors over 3 years (2000, 2001 & 2002) is given in the following table.

	Energy Consumption in 000 TOE			Value of Energy in Million Rs.		
	2000	**2001**	**2002**	**2000**	**2001**	**2002**
Biomass	1237	1051	1207	1856	1577	1811
Electricity	189	184	198	12131	14057	19317
Petroleum	251	271	263	5020	6233	6575
Total	**1677**	**1506**	**1668**	**19007**	**21866**	**27702**
Biomass	74%	70%	72%	10%	7%	7%
Electricity	11%	12%	12%	64%	64%	70%
Petroleum	15%	18%	16%	26%	29%	24%

The industrial and commercial sectors generate large quantities of process heat. This is done using a variety of fuels such as biomass, furnace oil, diesel fuel, liquid petroleum gas (LPG) etc. The continuing depreciation of the Sri Lankan Rupee with respect to the US $ and the ever increasing trend of imported petroleum fuels have made the case of switching from petroleum fuels to locally produced biomass fuels. For the year 2002, the value of petroleum fuels used to produce process heat in Sri Lanka is over US$ 65 million.

4. Economics of switching from petroleum to biomass fuel

Let us consider a factory operating a furnace oil fired boiler with a capacity of 1 tonnes of process steam per hour. Such a boiler would consume around 80 litres of furnace oil per hour. A brand new wood-fired boiler of the same capacity would cost Rs. 3.0 million (inclusive of local installation costs). Such a wood fired boiler would require 30 kg of wood at 20% moisture per hour.

Cost of new boiler
Rs. 3,000,000.00

Cost of furnace oil per hour (80*25)
Rs. 2,000.00

Cost of fuelwood per hour (300* 2)
Rs. 600.00

Savings per hour (Rs. 2000- Rs. 600)
Rs. 1,400.00

Simple Pay Back (3,000,000/ 1,400)
2143 hours.

If the boiler is operating for 8 hours per day, this would mean 268 days or less than 9 months. For an installation working for 24 hours per day, this would be 90 days or 3 months. The above analysis is based on the market price of Rs. 25,000 per tonnes furnace oil as at now (21st June 2004). This is a subsidised price. The actual price of furnace oil (based on Rs.101 per US$ and US$ 38 per bbl of oil) would be Rs. 32,000 per tonne. On this basis, for a facility with 3-shift operation, the pay back period is a mere 2-months!

The economics are far better for diesel fuel operating system or·LPG systems.

5. Demonstration Facility

The Alternative Energy Division of the Ministry of Science and Technology established a demonstration facility at an activated carbon factory in Badelgama to convert an existing oil-fired boiler to wood firing through gasification system. The gasification system was purchased from India. This boiler was consuming around 1 tonne of furnace oil per day. After conversion to wood firing, the system consumed 3.75 tonnes of wood. The cost of furnace oil per day was Rs. 25,000. The cost of wood (delivered to the factory site) is Rs. 7,500. A daily saving of Rs. 17,500 has been achieved.

Based on this success, this company has converted 3 of their oil fired dryer furnaces with wood gasifiers, fabricated locally. This facility at Madampe consumes 12 tonnes of wood daily, thus saving Rs. 56,000.

6 Fuelwood Supply

Coconut Research Institute and the Ministry of Science and Technology have demonstrated the feasibility of establishing and harvesting fuelwood in a sustainable manner from Short Rotatation Coppice (SRC) energy plantations in the degraded marginal land in the dry zone in Sri Lanka. A hectare of SRC energy plantation with Gliricidia sepium would annually yield 30 tonnes of dry wood and 26 tonnes of fresh foliage annually. While the wood could be sold to industrial energy consumers the foliage could be used for a variety of applications such as cattle fodder, organic nitrogenous fertilizer and biogas production. Gliricidia could also be established as a mixed crop under coconut or tea. It can be planted in home gardens also along fences.

At present many hundreds of hectares of such plantations has been established in many different parts of the island. Workers in these plantations are earning over Rs. 200 per day. The facility at Madampe is purchasing 12 tonnes of Gliricidia wood daily from such plantations.

Annual income from a hectare of Gliricidia plantation is as follows:

Wood, 30 tonnes @ Rs. 1,500 per tonne	Rs. 45,000
Milk, 6750 liters @ Rs. 18 per litre	Rs. 121,500
Organic fertilizer, 1.05 tonnes urea eq. (from digestion of dung) @ Rs. 23/ kg	Rs. 24,240
Biogas, 19,500 c.m., eq. to 1000 litre of LPG @ Rs. 50 per kg	Rs. 50,000
Total	Rs.240,740

7. Desiccated coconut industry

Processing of coconut into 1 kg of desiccated coconut would require 1 kg of fuelwood. A hectare of coconut land on average would yield 6250 nuts per year. This would yield 780 kg. desiccated coconut. This would require 780 kg of fuelwood to process. If inter-planted with Gliricidia, an yield of 7.5 tonnes of wood could be obtained annually from a hectare. This is nearly 10 times the requirement of wood required to process the nuts into DC. So, the coconut plantations, in addition to producing nuts for the DC industry can also produce surplus wood for the generation of heat or electricity for other industries in Sri Lanka.

Research carried out at the Coconut Research Institute has revealed that 35 kg of fresh Gliricidia foliage on a coconut palm applied annually has the same nutritional effect as that of 800 grams of urea. A hectare of plantation would require 5.6 tonnes fresh foliage. Inter-planting coconut with Gliricida would yield around 6.5 tonnes of fresh foliage. Thus a coconut plantation can be self sufficient in nitrogenous fertilizer as well.

8. Conclusion

Establishment of Gliricidia sepium as a crop for SRC energy plantation is a commercially viable option. Fuelwood from the plantations could be used to replace fossil fuel used in industrial and commercial sectors. This would reduce the cost of thermal energy by a factor of three. Nationally it will enable the country to conserve US$ 65 million annually. Foliage could be used as cattle fodder thus increasing the national milk production and increasing the income of dry zone farmers. Utilizing the dung in biogas digesters would enable the farmer families to switch from hazardous wood stoves or expensive LPG for domestic cooking. The effluent from these digesters could be used as nitrogenous fertilizers in the plantation industry. This will sustain coconut and other plantations without the need to import chemical nitrogenous fertilizer, thus conserving further foreign exchange.