# Policies for Clean and Energy Efficient Technologies

Priyantha D C Wijayatunga[1], Kanchana Siriwardena[1], Rahula A Attalage[1]
W J L S Fernando[2], Ram M Shrestha[3],
[1]University of Moratuwa, Sri Lanka, [2]Ceylon Electricity Board,
[3]Asian Institute of Technology, Bangkok

**Abstract**

*The study presented in this paper involves identifying the barriers for the promotion of clean and energy efficient technologies in Sri Lanka and recommending policies to overcome them. Barriers for renewable sources such as wind and biomass (dendro thermal) and cleaner technologies like Liquefied Natural Gas (LNG) fired combined cycle and coal fired Integrated gasification Combined Cycle (IGCC) were identified based on a survey conducted during the study.*

*Analytic Hierarchy Process (AHP) is used to rank the identified barriers and the strategies are recommended to address the three major barriers for each of these technologies. While for wind-power a more attractive feed-in-tariff, geographical diversification and capacity building in commercial banks are suggested, for dendro-power, investment incentives, streamlining of wood production and research on site identification are proposed. Also the study suggests delayed implementation and combined planning with other sectors such as transport, incorporating environment cost in planning and investment incentives for IGCC and LNG.*

***Keywords:*** *Analytic Hierarchy Process, Renewable Policy, Barriers, Polices*

## 1.0 Introduction

Renewable energy based electricity generation has unique qualities. For example, about 85% of the production cost of a renewable plant consists of capital cost compared to 50% in a conventional plant. Hence, to promote renewable technologies, a separate analysis different to that of conventional sources is required. Also the uniqueness of each renewable technology makes it difficult to apply a common strategy for renewable energy and therefore the solutions have to be source specific.

Recent publications by P. Menanteau et al [1], Meyer and Koefoed [2] and Meyer [3] reveals that the Feed In Tariff(FIT) systems have achieved better in terms of renewable capacity addition in Europe, and highlights the drawbacks and difficulties in implementing other measures like Certificate trading and Tender procedures. Also Enzensberger et al [4] gives a comprehensive list of policy alternatives to promote renewables and the factors to be considered before implementing them. Most if these studies are on countries with developed markets having large power systems, applying those measures in developing countries needs more care. Studies by Kozloff [5] and Rajsekhar et al [6] highlights the need to move from supply pull approaches to technology and source specific, demand pull, measures in promoting renewable energy in developing countries.

The objective of the study was to identify, analyze and recommend suitable policies and measures to overcome barriers in promoting certain clean and energy efficient technologies in Sri Lanka power sector.

## 2.0 CURRENT POLICIES

### 2.1 Mini-Hydro

The policy applied is very clearly a feed in tariff (FIT) system. The tariff is based on the avoided cost of the utility, calculated yearly and has different rates for the dry season and wet season. The suppliers are on a 15-year agreement (Small Power Purchase Agreement-SPPA) and they are assured of a minimum tariff of 90% of the initial year tariff [7].

With the current policy, the promotion of mini-hydro power has been successful and there are many new projects either being constructed or planned. Also the level of local technology input is considerably high (locally manufactured turbines and assembled control gear are being used) compared to the volume. The growth is also partly due to the availability of international funds (RERED project of the World Bank) through local banks for a longer period. As a result of these developments there is a significant amount of local expertise in mini-hydro sector. Most of these installations are located in remote hilly regions of the country and hence the local community has benefited from better infrastructure developed. All these plants are run-off river type, therefore has caused low environmental damage.

## 2.2 Wind

Present policy on wind power development is to call for tenders to supply a predefined quantity (20MW installation) on Build Own and Operate (BOO) basis in two potential sites (North-West and South-East coastal areas) [8]. There were many concessions including tax holidays, tax exemptions and extension of the grid to allow interconnection according to the tender documents. But the progress has been disappointing.

The investors complain about strict tender conditions that discourage developers having enough experience and the low interest shown by the utility. Also the pilot project (3MW) shifted from the best site due to heavy environmental lobbying resulting in a low annual plant factor has been a bad experience in terms of operational efficiency. Further most of the favourable sites are located in marginal areas where the national grid is weak. Frequent grid failures are one of the reasons for the low plant factor in the pilot project.

## 2.3 Dendro Power

The current dendro thermal projects are developed under the small power purchase agreement (similar to mini-hydro) and hence the policy is to allow a feed-in-tariff. There is a proposal to enhance this tariff for dendro-thermal to encourage this sector. Though there is a significant enthusiasm about biomass based electricity, still the progress is slow due to lack of a good demonstration plant and reluctance of the developers to invest at the present power purchase price level.

The present 35KW gasifier based dendro thermal plant installed by Energy Forum is having lower efficiency than designed, due to high moisture content in the biomass. This plant is not grid connected and it supplies about 100 village houses. Another 315kW private power plant is operating under net meter tariff. In addition a 1MW grid connected dendro thermal plant came into operation in late 2004.

## 2.4 LNG and IGCC

The present policy on generation system expansion is to follow the least economic cost planning methodology. The IGCC technology has been considered in the thermal generation options study and it is considered as experimental technology. Its high initial cost eliminates the technology in the initial screening stage of the planning study. Also the negative public opinion on coal based power in the country is likely to be extended to IGCC.

As the power system of the country is too small, the economies of scale do not allow LNG as an option until about 2015. However, the recent study funded by the USAID SARI/Energy project has suggested cheaper alternatives for LNG transportation to Sri Lanka [9]. Even with such an arrangement LNG based power will only be economical if its usage is expanded into other sectors such as land transport sector in the country. As at present, the scale and cost of the smallest terminal and energy demand does not favour LNG based electricity in Sri Lanka [10].

## 3.0 BARRIERS

Overall ranking of the barriers for individual technologies are as given in Table 3.1. This is the outcome of the application of Analytic Hierarchy Process (AHP) with the survey output of stakeholder group consisting of Policy Makers, Utility Professionals, Energy/Environment Sector Experts, Developers/Financiers and Users. The group of stakeholders interviewed was limited to 24 excluding weak responses (according to AHP) [11, 12].

**Table 3.1: Barriers to Penetration of Different Technologies**

| Wind-Power | Rank |
|---|---|
| **High overall unit cost of energy** | **1** |
| **Seasonal variations in wind speeds** | **2** |
| **Lack of financing instruments** | **3** |
| *High initial cost* | *4* |
| *Lack of wind measurements* | *5* |
| **Dendro Power** | |
| **Lack of feedstock assurance** | **1** |
| **Lack of financing instruments** | **2** |
| **lack of awareness about the technology** | **3** |
| *Insufficient knowledge about energy plantations* | *4* |
| *Unclear government policy* | *5* |
| **LNG Based Power Generation** | |
| **Uncertainty about fuel price stability** | **1** |
| **High initial cost** | **2** |
| **Insufficient demand for electricity** | **3** |
| *Lack of a clear policy* | *4* |
| *High fuel cost* | *5* |
| **Coal based IGCC** | |
| **Technology not fully commercialised** | **1** |
| **Lack of clear policy** | **2** |
| **Dependency on imported fuel** | **3** |
| *Negative public opinion on coal* | *4* |
| *High initial cost* | *5* |

## 4.0 STRATEGIES TO OVERCOME BARRIERS

Strategies and measures to address the key barriers are analyzed for each of the technologies discussed in the previous section. The cost of implementation, ability to finance, effectiveness, administrative feasibility and political acceptability are used as the bases for initial selection the strategies.

### 4.1 Wind Power

#### Design and implementation of a production incentive

A tariff similar to what is being used for mini hydro in Sri Lanka is proposed. It may need to be higher than the avoided cost of the utility. The tariff should be site specific and based on the performance of a benchmark technology. It should be decreased during the contract period taking into account the loan repayment impact on cash flows. Also tariff should be revised periodically taking into account technological advancements. This high tariff paid may be constrained to a maximum number of peak power hours to limit the costs to the utility, in case of good wind conditions. When the installed capacity grows, the burden on government will increase and hence it may require some restriction on the capacity additions during a period.

#### Geographical diversification of wind plants

Out of the main wind sites north-western and south eastern sites are affected by south-west monsoon. The North-east site is mainly affected by North-east monsoon. If those three sites are developed simultaneously, the seasonal effects on the power system due to wind power absorption can be minimized.

By controlling the site development to allow diversification may lead to inefficient investment as less favourable sites will have to be developed before the better sites, but the resulting consistent supply of energy may improve the reliability of the power system.

#### Capacity building in commercial banks on the technology

Due to the lack of knowledge on the nature of wind technology and the uncertainty related to a new technology, the financiers are defensive in developing financial instruments for wind technology. Institutions such as SLEMA, Energy Forum and ITDG are presently involved in capacity building activities and these need to be expanded to include the banking sector.

The activities would be to organize workshops or seminars on the technology characteristics, international trends, current state & potential in the country and on the cost/ revenue structure in the Sri Lanka context. The cost involved is minimal and it is already politically accepted.

## 4.2 Dendro Power

### Conducting research to identify sites and potential for dendro development

Although the estimated land availability is about 1.2 million hectares in the island the specific sits where land is available and their potential generation capacity are unknown [13].

Hence a proper detailed study on available infrastructure, competing industries (sugar) and resulting social impacts (a large extents of temporary farm land will have to be acquired for energy plantations) is required before selecting a site. Also this needs to be followed by proper dissemination activity.

### Streamline wood production mechanisms

In the 1MW pilot project the suppliers are on a contract to supply predetermined quantity of wood for a price depending on the distance from the power plant. Presently, the suppliers are paid US cents 2 per kg for processed wood having about 40% moisture content. Lack of proper storage capacity and transportation facilities discourage the actual farmer from supplying wood, also this has left the farmer receiving only about 30% of the selling price.

Significant level of awareness building and technical assistance will be required to streamline the wood production, processing and transportation for power production.

It is proposed to study and develop a model plantation at least around the 1MW plant and extend it to other potential areas in stages. This may require a high level of coordination among farmers, intermediaries, developers and community leaders.

### Designing a investment incentive

The present pilot project is developed under a Small Power Purchase Agreement (SPPA). It is using used equipment imported from India and site specific advantages like availability of biomass from wood plantations used to avoid soil erosion in tobacco plantation have reduced the installation cost. Especially the cost related to plantation establishment is avoided.

The estimated initial cost is about $1500/kW including plantation establishment cost. The levelised tariff required to have a reasonable rate of return is likely to be higher than the tariff paid under SPPA but lower than what is paid for medium term diesel plants. Hence a capital incentive to cover at least part of investment cost is proposed. This is justifiable considering the high level of employment and rural economic activity created.

## 4.3 LNG and IGCC

### Incorporate environmental costing into planning process

The objective in the present generation planning process is to minimize the economic cost of the overall plan. The planners are aware and trained on incorporating environment costing to the planning process [14]. It is proposed to incorporate environment costs at least as an option in the present planning process to create awareness among decision makers on the costs and benefits of cleaner technologies/ sources such as IGCC and LNG. This will make sure that these technologies will be considered when the environment is suitable. Also possibility of CDM for these technologies can be regularly examined.

### Designing a production incentive

Recognition can be given, to both LNG and IGCC based power plants due to its relative cleaner nature of electricity generation, by providing an incentive based on the energy output of the plant. This incentive can be designed in such a way that it relates to the avoided emissions in comparison to traditional fossil fuel based generation which would have replaced these plants under normal circumstances. In Sri Lanka they are conventional coal steam power plants at present.

The associated incremental cost of this policy measure in Sri Lanka can be in the region of US Cents 2 per kWh of electricity generation. This is assuming that the economies of scale of LNG based generation are met and the capital costs of coal and LNG based plants become the similar at the scale of about 2000MW.

**Combined planning with other sectors**

The transport sector in Sri Lanka is totally dependent on petroleum as its source of energy. This can be always supplemented by compressed natural gas (CNG). Therefore the economy of scale required for LNG in the powers sector can be partially addressed by coupling the transport sector requirements with the power sector[10]. While the total transport energy requirement in the year 2002 was 1.7 million tonnes of oil equivalent (TOE) or 47% of petroleum imports. The total oil used in the power sector in their thermal plants (installed capacity about 1100MW) amounted to about 0.9 million TOE. If about 50% of the transport requirement can be met through CNG and convert all the thermal plants to LNG fired stations, the economy of scale required in LNG based power plant development, can be marginally met.

This measure is very effective in addressing the issue of economy of scale requirement in LNG based development in the power sector but it has its own heavy economic costs to the country. Converting the present vehicle fleet to fire CNG instead of diesel or gasoline requires costly technological interventions including replacement of engines in diesel driven vehicles.

While this measure will have only a very little political acceptability due to its complexities in implementation and many parties involved in the process, positive environmental implications in terms of avoided emissions both in the urban transport sector and in the power sector will attract attention and appreciation among the environmental groups. Administration of this measure will be difficult mainly because of the involvement of the transport sector having many facets and socio-economic implications.

**Design investment incentives**

The main barrier to introduction of LNG based power generation is the initial investment cost and the cost of the LNG terminal in particular. It is possible to consider the LNG terminal as a common infrastructure investment, which can be used across a few other areas such as transport and industrial sectors, and provide this investment by the government. This will greatly reduce the burden on the developers of LNG based power plants and take away one of the main cost components, which makes LNG based power uneconomical.

This measure is very effective in bringing down the cost of investment more than 50% for a 300MW LNG (to replace a 300MW coal steam plant) based power plant in Sri Lanka. That means the levelised cost can be brought down by about US Cts 2.3 per kWh. This will make LNG competitive with coal steam option.

Though this measure would be politically and environmentally acceptable due to replacement of controversial coal steam with cleaner LNG option, it would cost the state approximately US$ 400 million which is equivalent to the construction of an additional 400MW coal steam power plant.

## 5 CONCLUSIONS AND RECOMMENDATIONS

To promote **wind power** capacity building and site diversification can be implemented at very low cost and administrative effort. They will address the seasonal variation in wind speeds and lack financing instruments effectively. It can be recommended to implement all simultaneously as the costs are justifiable.

In the case of **dendro thermal,** as large scale dendro power plants are rare and they have been successful when implemented as cogeneration plants and hence the establishment of a proper demonstrating plant is vital for the development of dendro power, this need is partly satisfied by the 1MW grid connected power plant already established.

However lack of awareness about energy plantations, potential and wood supply mechanisms can be major issues in further development and the research on potential and site identification is necessary. Also the production incentive and model wood production projects will be required simultaneously.

Out of policy measures for **LNG and IGCC**, incorporating environmental costing into planning process, designing a production and combining with other sectors to meet economies of scale required in LNG development can be considered as the most promising options for the development of these technologies.

It is recommended that the generation planning process immediately start incorporating environmental costs. It is further recommended to prepare a comprehensive plan on the level of production incentives required to make these technologies viable in the Sri Lanka context. This will have to include both scenarios; only the power sector related replacements and combining with other sectors.


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