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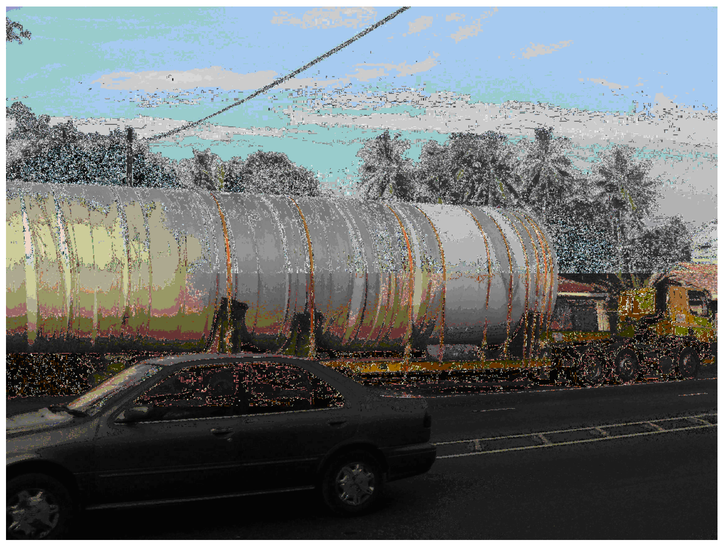

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A PUBLICATION OF THE
SRI LANKA ENERGY MANAGERS ASSOCIATION

SRI LANKA ENERGY MANAGERS ASSOCIATION

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The Editorial Board invites papers on energy related issues for publication in the SLEMA Journal.

Cover photo: What has a loaded truck got to do with energy ? Heavy transport of wind turbine components, was a common sight in Puttalam area in 2010. Three wind power plants each of 10 MW are already in operation.

SLEMA Journal is published by the Sri Lanka Energy Managers Association. The Journal is also available on line www.slema.org.lk. All correspondence should be directed to SLEMA Office, No. 29, Fairfield Gardens, Colombo 8, Sri Lanka. (Telephone 011-266 5737).

ENERGY POLICY MAKING WITH EXTERNALITIES

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Abstract:

Costing of externalities of energy is an essential component in assessing the "right price" of energy. This paper describes a modeling methodology of externalities of energy and illustrates some estimations obtained for certain countries. Some considerations for energy policy making with externalities are also described in this paper.

Introduction

Sustainable development is an issue of prime importance, both now and in the future. Since the environment damage due to energy related activates is unavoidable, it constitutes a significant challenge to sustainable development. Choosing one energy option over another may be influenced by many technical aspects as well as the aspects of society and the environment. As such, it has been argued that the environment damage and subsequent health impacts related to energy should be accounted for, to obtain the highest net benefit for the society. In other words, to get the "right price" of energy, externalities of energy, which are typically not taken into account in establishing the market price, are to be considered in the pricing mechanism [1].

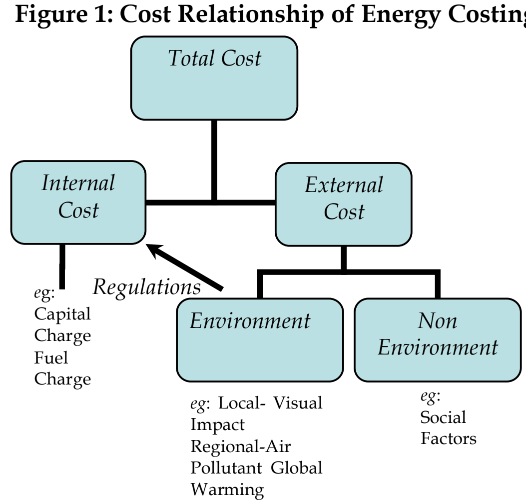
Furthermore, getting the right price is a prerequisite for market mechanisms to work effectively towards sustainable development in the energy sector. Traditionally, only the internal cost of energy is considered when pricing energy. However, in order to obtain the maximum net benefit to the society, the total cost of energy has to be calculated with the internal costs of generation and the external costs and benefits [2]. The internal cost is associated with fuel and maintenance costs, whereas the external costs are associated with the cost of the negative impact on the environment of their production. Approaches are developed in economic theories to assess and internalize external costs that can be easily applied to the energy sector as well.

In the recent past, there has been much progress in the analysis of environment damage and consequent public health risks related to energy systems. Thus, several major projects were conducted to evaluate the external cost of energy in countries such as USA and Europe [3]. Unfortunately, developing countries such as Sri Lanka have paid only very little or no attention to considering the externalities when selecting energy options or in energy pricing. Thus there is a lack of data on the cost of externalities of energy in these countries.

Owing to the significant changes in the global weather pattern and the environmental disasters in recent past, there is a growing concern on environmental impacts and thus it is opportune to investigate the externalities of energy development and use, even in Sri Lanka. This will enable the selection of the most suitable energy options by comparing their "right price", which would maximize the net social benefit.

However, the main issue in estimating the total cost of energy is that there is no clear distinction between internal costs and external costs [3]. Environmental cost may be moved to become part of the internal costs by imposing environmental and health regulations. As an example, regulations for emission levels of a pollutant compels industry to install pollution control equipment, which may reflect as an internal cost in pricing, as shown in Figure 1.

Figure 1: Cost Relationship of Energy Costing



The following section of the paper illustrates a general guideline, on how to estimate externalities of energy.

Estimation of Externalities of Energy

Externalities are defined as un-priced costs or benefits directly imposed upon one agent by the actions of another agent. Externalities cause market variations in the sense that there exists a difference between the private and the social (private plus external) costs and as a result, there will be non-optimality from society's point of view.

The most difficult issue from the practical point of view is how to cost the externalities of energy, because the marginal damage costs are not known. Because of this practical problem, several institutions worldwide conducted a series of studies to develop a methodology for measuring and estimating the cost of externalities of energy. Some of the studies [4] suggested using the economic cost of mitigating the emission of pollutants from a plant as the external cost of energy (see Table 1).

Table 1: Pollutants and Mitigating Costs for a Coal-fired Power Plant

Externality	Emission (*lb/MWh*) (1)	Control Cost (*$/lb*) (2)	Mitigation Cost (*$ cents/kWh*) (1)x(2)
SO_x	6.0	0.416	0.25
NO_x	6.0	0.92	0.55
CO_2	1820.0	0.0006	0.10
Particles	0.3	0.167	0.005
Water Impacts	na	na	0.10
Land Use	na	na	0.40
Total			**1.405**

Source: F. Kreith, "Integrated Resource Planning" Journal of Energy Resource Technology, June 1993, Vol. 115, pp 80-85.

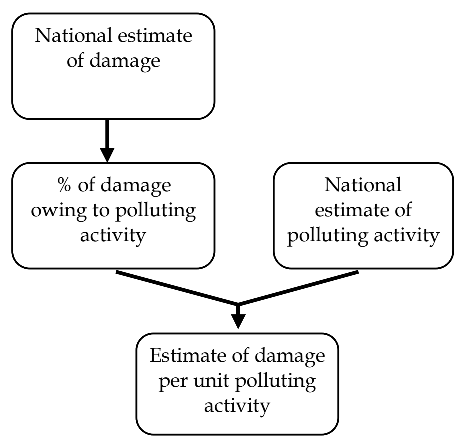
The main drawback of this approach is that, it does not consider the links of damages with the cost and consequently, mitigation cost is not the true external cost. Due to the increasing attention to the environment changes, several studies have been conducted in the late 1980s and in early 1990s, which have estimated some of the true cost of externalities associated with electricity production and fuel cycle. Most of these energy externality studies assess the negative externalities (external costs), for different energy options.

Two prominent methodological approaches called "Top down approach" and "Bottom up approach" are identified to estimate the external cost of energy. In the "Top Down" approach, externalities of fossil fuel based power plant are studied using the following key steps [3];

- Develop an inventory of emissions (CO_2, particulate matter, NO_x, SO_x, and volatile organic compounds);
- Weighting these emissions by relative toxicity factors;
- Estimation of the contribution by these emissions to the total damage;
- Estimation of damage caused by such pollutants using available literature on estimates of environment damage.
- Combination of the numbers to obtain the cost of damage per kWh of electricity production.

This can be graphically illustrated as shown in Figure 2.

Figure 2: Illustration of Top Down Approach for Estimation of Externalities

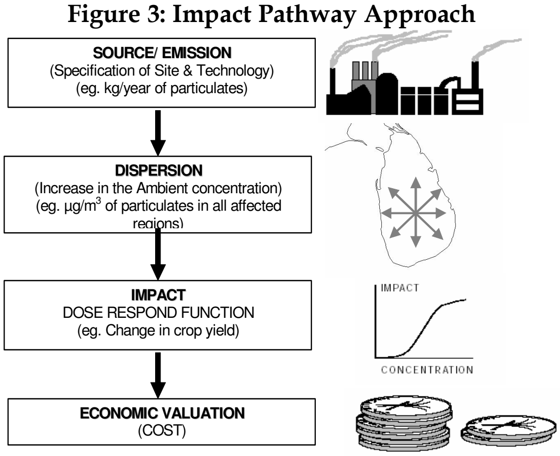


The "Top down" approach uses highly aggregated data and gives an average damage cost. This methodology needs relatively low data. The major problem with this approach is that it uses the relative toxicity factors which are derived from government regulations for minimum permissible concentrations at a place of work, and thus it does not reflect the exact damage to weight the emissions. This approach has not allowed any consideration of variation in impact due to technology, location (site specificity) or time. Therefore, this approach is not considered as the best approach for calculating marginal damage cost due to activities associated with energy sector.

In contrast, the "Bottom Up" methodology uses technology-specific emission data for individual locations to calculate marginal damage cost. This method is also known as the "**Damage function**" or "**Impact Pathway**" approach [3]. This approach considers the detailed information on the location of receptors and the source of pollutant emitter, to calculate the physical impact of the emission. The value of these physical impacts is calculated using economic techniques. This valuation is based on individual preference, which is expressed through "**Willingness To Pay (WTP)**" and "**Willingness To Accept (WTA)**".

Impact Pathway approach is also used in the recent study named "ExternE" project, which is jointly funded by European Commission and United States [3]. The main objective of this project is to develop an approach for the evaluation of external cost of energy production, covering a wide range of different fuel cycles. In the impact pathway approach, the assessment of externalities of energy is based on the sequence of events linking from "burden" to "impact", and subsequent valuation. The principal steps of the Impact Pathway approach can be represented as follows (See Figure 3).

Figure 3: Impact Pathway Approach



Characterization of the relevant technologies and the environmental burdens they impose (eg. kg/s of particulates emitted by the plant);

Calculation of increased pollutant concentration in all affected regions (eg. $\mu g/m^3$ of particulates, using models of atmospheric dispersion and chemistry);

Calculation of physical impacts (eg. number of cases of asthma due to these particulates, using a dose-response function);

In some cases a fourth step may be called for: the economic valuation of these impacts (eg. multiplication by the cost of a case of asthma).

The first step of the impact pathway approach is to identify the source of emission and characteristics of the relevant technology and the environmental burdens imposed by that source (for example, the number of tons of particulates per GWh_e emitted by a power plant) by considering the factors such as technology used, location of power generation plant, type of fuel used, and the source, and the composition of the fuel used. Each of these factors is more important in determining the magnitude of impact and hence the associated externalities.

Then the calculation of increased pollutant concentrations in all affected regions due to power generation is done (for example increase of particulates in $\mu g/m^3$ per GWh_e in all regions affected by the power plant). Pollutants can be emitted to air, water or soil. The majority of pollutants are first emitted into the air, even if they later pass into water or the soil. Therefore, dispersion is analyzed as atmospheric dispersion, soil dispersion and transport by surface water.

Then the impact assessment is done to define the response as the incremental effect due to the dose. Dose-response functions are determined from epidemiological studies or from laboratory studies. Since the latter are mostly limited to animals, extrapolation to humans introduces large uncertainties.

The final step of environment costing is the economic valuation of the damage or in other words, estimate the monetary value of environment damage. This is done by estimating the WTP for environment improvement or WTA the environment damage. For example, for an illness one should count not only the treatment cost but also pain and suffering, as expressed by the willingness-to-pay to avoid the illness. Most pollution damage involves non-market goods such as health or visibility, and therefore, their valuation involves indirect valuation methods that are difficult and costly to apply, such as contingent valuation, hedonic price method, and travel cost method. The most difficult and controversial good is loss of human life or human health. The amount for the health impact due to environment damage is determined by the Value of Statistical Life (VOSL), which is defined as;

$$\text{VOSL} = \frac{\text{WTP for change in risk of death}}{\text{Amount of change in risk}}$$

Generally VOSL is determined by the following three different methods based on individual preferences:

Wage-risk studies: how much extra compensation do workers demand in jobs with high risk?;

Consumer market studies eg. how much are consumers willing to pay extra for safety measures such as air bags in cars?;

Contingent valuation: asking people directly how much they would be willing to pay if given the opportunity.

The impact pathway approach can be represented as an equation for the incremental damage D of a particular type (eg. asthma) due to an incremental quantity Q of a pollutant emitted by a source;

$$D = \sum_i f_{dr,i}\left[f_{dis \longrightarrow i}(Q)\right]$$

where:

$f_{dis \longrightarrow i}(Q)$ = C = increase in pollutant concentration for receptor i, and

$f_{dr,i}(C)$ = dose-response function for receptor i;

Dose-response function relates the quantity C of a pollutant that affects a receptor (eg. population) to the physical impact D on this receptor (eg. incremental number of deaths). For impact assessment, it is appropriate to define the response as the incremental (marginal) effect due to the dose. Thus, the dose-response function starts at the origin, and in most cases, it increases monotonically with dose C. At very high doses, the function may level off in S-shaped fashion, implying saturation.

Therefore we can define any dose-response function receptor i as;

$$D = \sum_i f_{dr,i}[C]$$

where:

D = incremental damage D of a particular type
C = increase in pollutant concentration for receptor i
Also we could write the increase in pollutant concentration for receptor i as;

$$C = f_{dis \longrightarrow i}(Q)$$

where: Q = emission rate of particular pollutant

The ExternE project estimated costs for the externalities of energy in different countries and different technologies, and some of the results are shown in Table 2.

Table 2: Damage Estimation

Country	External Cost for Electricity Production in the EU Countries (ECU cent/kWh)						
	Coal	**Oil**	**Gas**	**Nuclear**	**Biomass**	**Hydro**	**Wind**
Austria			3		3	0.1	
Belgium	15		2	0.5			
Denmark	7	8	3		1		
Estonia	8		2		5		0.1
Finland	4	5			1		
France	10	11	4	0.3	1	1	
Germany	8	5	1		0.8	1	0.25
Ireland	8						
Italy		6	3			0.3	
Netherlands	4		2	0.7	0.5		
Norway			2		0.2	0.2	0.25
Portugal	7		2		2		
Sweden	4				0.3	0.03	
UK	7	5	2	0.25	1	0.07	0.15

Source: European Commission "External Cost", Journal of Research Results on Socio Environmental Damage Due to Electricity & Transport, 2003, pp 13.

Estimation of External Cost of Energy in Sri Lanka

There is no comprehensive study done in Sri Lanka to estimate the cost of damage of environment and welfare related to the pollutant associated with the energy sector. Furthermore, cost of externalities in the developing countries like Sri Lanka can be lower than that of developed countries, because it is very unlikely to have the same WTP and

WTA values in both developed and developing countries.

Thus, it is recommended that the cost of externalities of ExternE project can be used in other countries with suitable adjustment [3]. The World Bank has recommended to use per capita GNP ratio of two countries as the best way of estimating externalities of energy until we get a better idea of “GDP Elasticity” of WTP or WTA [5,6]. The estimated damage costs calculated on this basis are shown in Table 3, which have to be added to the apparent cost of production from each generating technology.

Table 3: Calculated External Costs of Energy for Sri Lanka

Generating Technology	External Cost of Energy (LKR/kWh)
Coal	0.74
Oil	0.40
Gas	0.22
Nuclear	0.02
Biomass	0.19
Hydro	0.02
Wind	0.01

External costs and Policy Making

Even though there are many limitations and uncertainties underlying the analysis of externalities and the valuation mechanism, the concept has a wide range of possible applications. It can provide valuable support to decision makers with regard to technology evaluation, comparison of future energy supply options, and cost-benefit analysis of policy measures. Furthermore, cost of externalities of energy is also a useful tool for technology designers, providing indicators of technology-specific sustainability and pointing to priority areas for the reduction of environmental impacts.

Furthermore, analysis of externalities of energy can provide a useful set of indicators on the sustainability of different energy technologies, which could help national energy policy making by:

- Providing reasonable indications for the “right price” of energy when considered in the pricing mechanism.
- Providing indicators of the sustainability of different energy alternatives.
- Pointing to opportunities to improve the sustainability of full fuel cycle operations.
- Helping to assess the impacts of different economic instruments such as carbon taxes or a carbon cap, and a trading system.

References

[1] L. Schleisner, “Review of Externality Valuation”, Risø National Laboratory, Roskilde, Denmark, November 1998.

[2] E. Berteland P. Fraser, "Energy policy and externalities", NEA updates, No. 20.1, pp14-17, 2002.

[3] European Commission, “External Cost”, Journal of Research Results on Socio Environmental Damage Due to Electricity & Transport, Office for Official Publications of the European Communities, Luxembourg, 2003.

[4] F. Kreith, “Integrated Resource Planning” Journal of Energy Resource Technology, Vol. 115, pp 80-85, June 1993.

[5] A.S. Rodrigo, P.D.C. Wijayatunga, “Pricing of embedded generation: Incorporation of exernalities and avoided network losses”, Energy Conversion and Management, Vol 48, No. 8, pp 2332-2340, August 2007.

[6] B.D. Thanh and L.Thierry, "Assessing Health Benefits of Controlling Air Pollution from Power Generation: The Case of a Lignite-Fired Power Plant in Thailand",Environmental Management, Vol 27, No.2, pp 303-317, 2001.

OFF-GRID DEVELOPMENT OF SUSTAINABLE ENERGY RESOURCES FOR ECOTOURISM FACILITIES IN KALPITYA PENINSULA SRI LANKA

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Abstract:

Tourist industry, although contributing substantially to the GDP of Sri Lanka, pollutes the environment at an unprecedented rate. Therefore, having realized our commitments to a better global environment, Sri Lanka Tourism Development Authority (SLTDA) has moved towards establishing new tourist resorts under eco-tourism concepts. This paper attempts to analyse how green energy could be supplied for business operations in an eco-friendly hotel with 400 rooms proposed in Uchchamunai Island in the proposed Kalpitiya Integrated Tourism Resort Project. Wind and solar are the primary energy sources considered for this project to provide 6 million kWh/year of electricity with max demand of 780 kVA, and 2026 GJ/year of thermal energy. Although wind and solar resources are available in abundance, their temporal variations have a large impact on quality and reliability of the energy/power system. Thus, a storage system is inevitable. Producing hydrogen with renewable sources is the ideal option to overcome these uncertainties, but economy is of great concern. Three scenarios were modelled and it was found that wind with grid connected model provides the optimum overall performance with the fraction of renewable energy reaching 99.5%, along with a 34,735 tonne/year of CO_2 emissions. In the absence of a grid connection, a model which use only wind plants provide the optimum results with a fraction of 99.5% renewable energy with 241 tonne/year CO_2 emissions.

Introduction

Kalpitiya Peninsula is one of the most beautiful coastal areas in North Western region of Sri Lanka. This peninsula is a marine sanctuary with a diverse ecological system ranging from bar reefs, flat coastal plains, saltpans, mangrove forests, salt marshes and vast sand dune beaches. As this area has a significant potential for tourism, SLTDA has formulated a master plan, called 'Kalpitiya Integrated Tourism Resort Project' (KITRP), to develop this area as a tourist destination. There are 14 small isolated islands in the KITRP area which have been identified to carry a potential for ecotourism. Ecotourism is the best available option for the development to comply with the rules and regulation set by the environmental authorities. According to The International Ecotourism Society (TIES), Ecotourism is "*Responsible travel to natural areas that conserves the environment and improves the well-being of local people"*. This means that those who implement and participate in ecotourism activities should follow the following ecotourism principles such as Minimize impact, Build environmental and cultural awareness and respect, Provide positive experiences for both visitors and hosts, provide direct financial benefits for conservation, Provide financial benefits and empowerment for local people, Raise sensitivity to host countries' political, environmental, and social climate. Geographical locations of all the 14 islands including the island selected for this study are shown in Figure 1. Islands and their land extents are provided in Table 1. One of a major obstacle to ecotourism development is the non-availability of energy that is vital for business operations. Norms set by TIES Standards demand sustainable energy for ecotourism facilities but the problem is the supply of sustainable energy since these islands are isolated and away from the national grid. Again, electricity supply off the national grid consists of about 35% hydro, 55% fossil fuel based and about 10% other forms such as mini hydro and wind. Hence grid supply is not truly 'green Energy'. The only option available to overcome this problem is captive power generation using renewable energy sources. Studies [1] conducted by a US organization, National Renewable Energy Laboratory (NREL), in collaboration with Ceylon Electricity Board (CEB) shows that this area has 1100MW Good-Excellent wind and on average 5.1 $kWh/m^2/day$ solar energy potentials. However development of sustainable energy systems is a challenging task due to non-availability of infrastructure and other associated issues such as adverse climatic and environmental conditions.

Figure 1: Location of Project Site and 14 Islands in Kalpitiya Peninsula

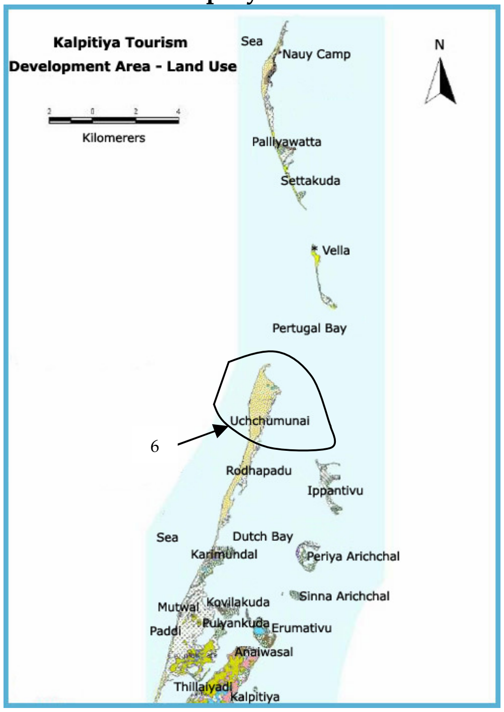


Table 1: Name of the 14 Islands and its Land Extent

Location Identification	Name of the Island	Extent (ha)
1	Baththalangunduwa	145
2	Palliyawatta	60
3	Vellai 1	2
4	Vellai 2	11
5	Vellai 3	14
6	**Uchchamunai**	**443**
7	Ippantivu	6
8	Periya Arichchalai	46
9	Sinna Arichchalai	17
10	Erumativu	86
11	Sinna Erumativu	3
12	Erumativu West	5
13	Kakativu	29
14	Mutwal (Dutch Bay)	611

SLTDA has requested green power/energy supply for the project area and this required a study on the development of sustainable energy systems for the islands. Thus one of the islands under KITRP project area, Uchchamunai Island was selected for our project. Primary reason for that is SLTDA plans to construct first eco-friendly hotel in Uchchamunai Island. The secondary reasons are it is closer to main island Sri Lanka, comparatively larger in size. It is an island with an approximate land area of 443 ha. Land size is the important parameter in developing this type of technologies. It is a barren land with bushes, and a few fishing families live there only during the fishing season.

The main objective of this study is to conduct a feasibility study and propose a techno-economically attractive solution to provide the power and energy requirements of the eco-tourism industry in Uchchamunai Island. To facilitate quantifying and measuring the achievements of the objective, it is necessary to divide the main objective into three sub-objectives, namely:

(a) Identify major activities which require electrical and thermal energy in hotels, and estimate the energy demand.
(b) Study on available energy options and their feasibility for utilization.
(c) Study the sustainability and techno-economic feasibility of electricity generation, storage and energy carriers, and supply backup.

These three sub-objectives are described below.

(a) Energy is needed for human comfort, transport, cooking and recreation less compared to conventional hotels. Thermal energy is necessary for hot water, cooking and transport whereas, air conditioning, lighting, small appliances and motors for water supply & treatment, etc. require electrical energy.

As Ecotourism developments are new to Sri Lanka, no historic data is available to assist estimation of energy demand in similar hotels. However, it has been observed that some of the hotels in Sri Lanka built along the coastal area do have employed eco concepts to a significant extent. Also 'Hotel Kandalama' built in mid 1990s and owned/operated by Aitkin Spence Ltd. has been built with strong eco-concepts. Therefore, the data obtained from these sources, with suitable adjustments, will be used for this study. The analysis of these data would yield reasonably accurate estimation of energy and power consumption for different categories of activities.

(b) Conventional energy sources in local hotel industry are electricity supply from the national grid backed up by local diesel generators. The 55% of Sri Lanka installed capacity contributes by thermal power plants which used fossil fuel. Therefore consuming energy from the grid does not allow in ecotourism projects. Therefore, local eco-friendly power generation is to be explored with the possibility of exporting power to the national Grid which increases the overall benefits. The region has good potential of wind energy in Sri Lanka. Being a tropical country near the equator, sun shines throughout the year indicating the abundance of solar energy. Therefore, prospective sustainable energy options are wind and solar. Supply of the base load will be the major concern, as the availability of these two sources varies with time. A solution to this problem is to use a secondary energy source with storage capability.

(c) For any energy system, a back up is required to meet an emergency situation. The energy carrier is required to counteract temporal variations of renewable energy sources. At the same time, it is essential to store the energy and to operate the services such as transport. Biogas from solid waste and hydrogen are the two energy carriers identified for the project. The estimated electricity demand of Uchchamunai Island is 780 kVA [2]. The system boundary will be the beach front. Wind energy, solar PV and solar thermal collectors are the energy options considered for development. The potential energy carriers identified for further investigation in the scope of this project are Battery backup, Hydrogen storages, Bio-gas from MSW. HOMER software and Polysun software were used for modeling and simulating the solar energy system. HOMER software of National Renewable Energy Laboratory – USA was used for micro generation system modeling. This software has the capability to model both off-grid and grid connected power systems for a variety of applications. In the design of a power system, it is necessary to consider several factors such as the configuration of the energy system, components of the power system and their quantity & size, technological options, costs and the availability of energy resources. These factors make decisions difficult. The optimization and sensitive algorithm of HOMER software makes it easier to evaluate system configuration in terms of technical, economical and environmental constraints. *(Source: http://www.homeregergy.com.)*

Solar Thermal System Modeling Software– Polysun 5: The solar thermal system was designed and simulated using Polysun software provided by Vela Solaris AG. Polysun 5 is simulation software which can combine solar thermal, PV, heating, cooling with other energy sources such as geothermal. Polysun provides easy-to-use pre-defined modules as well as yield and economic viability calculation.
Source: www.velasolaris.co

Methodology and Data

The methodology followed can be broadly described as understanding (i) the nature and magnitude of energy supply requirements, (ii) their periodic and seasonal variations, (iii) limitations imposed by the project, (iv) exploring the potential candidates for energy supplies (v) their economics, and (vi) selecting the optimum set of options for the island. Thus, basic steps in this methodology can be illustrated as in Figure 2.

Facility and Tourism Data

Historic data is available for conventional hotels and not for ecotourism operations. Most of the data used here is from conventional hotels of a similar nature. Hence they required to be suitably adjusted to reflect energy efficiencies expected of ecotourism. Fuel switching for eco-friendly environment is another task to undertake in this regard. Referring to the data given in USAID, Energy and Sustainable Tourism, Energy Supply and Use in Off-Grid Ecotourism Facilities document, we assume the average electrical energy consumption of eco-friendly type 4-5 star class hotel will be about 30-50 kWh/guest/day in Sri Lanka context [3]. As the hotel in Uchchamunai is with eco-tourism norms, the expected energy consumption target was set in this study, not to exceed 70% of conventional hotels. Table 2 shows the important data [4] of proposed resort at the island. This is the basic information required for designing the energy system.

Figure 2: Basic Steps in the Methodology

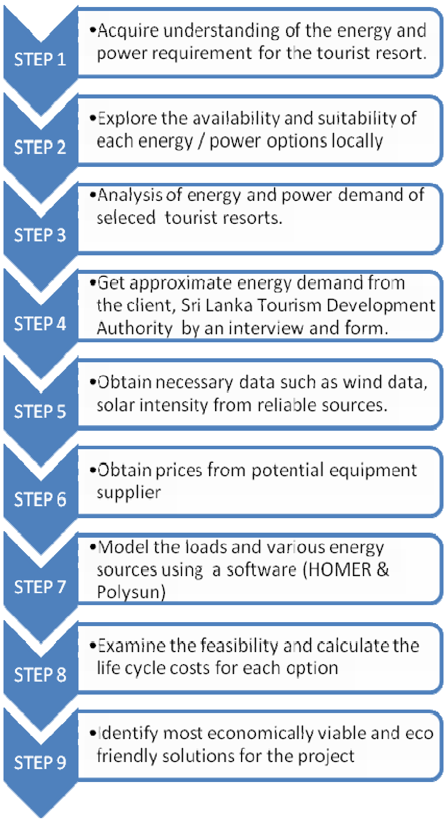


Figure 3: Occupancy Rate of Tourist Hotels in Sri Lanka

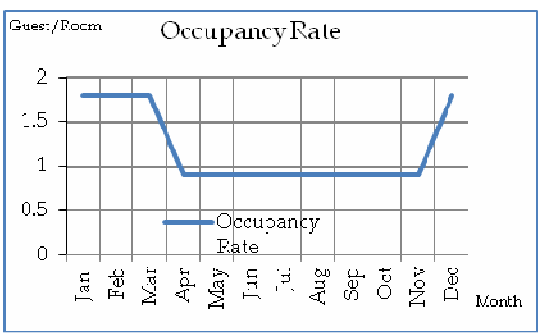


Table 2: Basic Data of the Proposed Resort at Uchchamunai Island [4]

Parameter	Value	Unit
Extent of Island	4.43	km²
Area of Buildings	15,000	m²
Roof Area	9000	m²
Number of Rooms	400	
Average Occupancy Rate	1.2	guests /room /day
Maximum Demand	780	kVA
Total Length of Road within the Island	5	km

For estimating the maximum demand and energy profile, occupancy rate of the rooms is required. The recent annual statistical report [4] published by SLTDA shows that the tourist arrivals peak during the period of December to March, and would be the occupancy rate of hotels. Rest of the year, on average, it is half the rate of the peak period. Figure 3 shows the variation of average room occupancy rate. Although there are fluctuations on a daily basis, a flat occupancy profile was considered for this study, for the sake of simplicity.

Data for Heat Demand Calculation

Through interviews with the management of a few selected hotels [5], the average energy demand and their use were established. Table 3 shows the composition of the heat demand of a conventional hotel.

As the system boundary of this project is the island, inland transportation was considered to be included in the scope. The island is about 4.4 km² and hence only limited transportation (between the boat yard and the hotel and for touring within the island) is required for the guests.

It is estimated that a conventional fuel (petrol or auto diesel) of about 0.5 litre/guest/day is required for inland transportation. A form of environmentally friendly fuel (electricity, hydrogen, etc.) was considered to replace this demand.

Table 3: Heat Energy Demand and Energy Source [11]

Heat Load	Conventional Heat Source	Demand with Conventional Sources [11]	Proposed Heat Source
Hot Water	Electricity	60 litre/ guest/ day at 50°C	Solar Thermal
Cooking	LPG	0.25 kg/guest/day	Biogas and Hydrogen

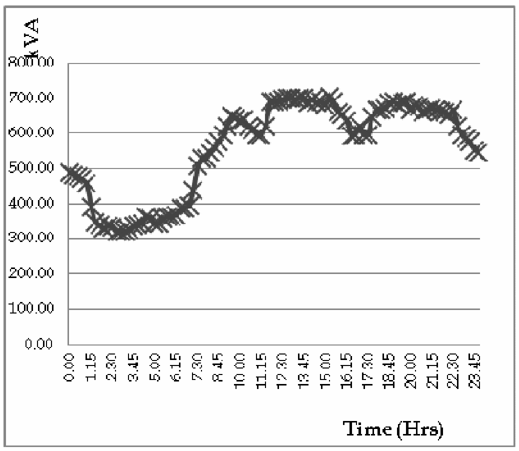
Electricity Demand

Analysis of the electricity consumption of some selected hotels in and around Colombo indicated that the annual electricity consumption pattern could be related to the number of rooms in a hotel as follows.

Annual electrical energy of Consumption (GWh) = 0.023 x No. of Rooms

Interviews with hotel management [5] revealed that the electrical energy consumption on usage-wise could be allocated as water heating: 15%, air conditioning: 35%, cooking: 15%, lighting: 25% and auxiliary services: 10%. On this basis, the hotel with 400 guest rooms in Uchchamuni Island would have annual electrical energy consumption about 8.83 GWh with a peak demand of 1600 kVA.

Figure 4: Daily Load Profile of Proposed Resort and Associated Facility at Uhchamunai Island.



However, experience of Kandalama Hotel indicated that green concepts could reduce some of these loads substantially. Some loads could be shifted from one source of energy to another, for example, electricity to solar thermal. Hence shifting of energy sources into different eco-friendly sources resulted in reduction of electrical energy requirement to about 70% of the normal load which, yield an estimated electricity demand of 6 GWh, with a maximum demand of 780 kVA [2]. The load profile shown in Figure 4 is a typical one for hotels in Sri Lanka, adjusted to reflect the demand of the proposed hotel at Uchchamunai Island.

Wind Data

The Table 4 shows the mean monthly wind speed variation in Narakalliya area, located near Puttalam, about 40 km to the south of the site.

Table 4: Mean Monthly Wind Speed Obtained from Narakalliya [1]

Month	Mean Monthly Wind Speed m/s
January	5.84
February	3.74
March	3.74
April	6.77
May	8.75
June	9.95
July	9.75
August	10.36
September	8.37
October	7.44
November	5.44
December	5.66

Solar Radiation Data

There is no direct solar radiation data available owing as there is no meteorological station in the close proximity to the island. Therefore it was decided to use Sri Lanka's national average for this project as given in Table 5. This will be a good approximation for initials studies. The drawback of this data is that measurements have been taken on a horizontal surface and not on the exact inclination angle. However, as the geographic location of project site is very close to the equator, error in the calculation would be not significant.

Table 5: Annual Mean Monthly Total Solar Radiation for Sri Lanka [6]

Month	Mean Monthly Solar Radiation ($kWh/m^2.day$)
January	5.35
February	5.5
March	5.7
April	6
May	5
June	4.9
July	4.6
August	4.8
September	4.6
October	4.5
November	5
December	5.25

Energy Backup and Carrier System

Hydrogen is the suitable energy carrier and backup source as far as sustainability concern.

Modeling and Results

Design of the Thermal Energy System

Solar thermal technology is one of the economical options for thermal energy requirement. As this location is closer to the equator with good solar irradiance, solar thermal is the best renewable option for the thermal energy. The solar thermal system was designed and simulated using Polysun software provided by Vela Solaris AG.

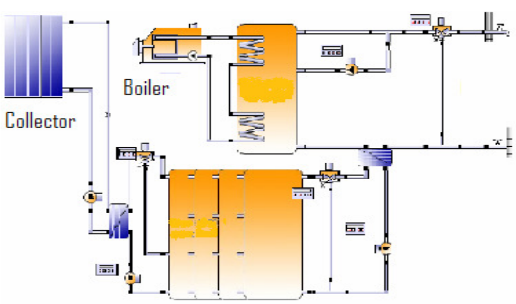
Hot Water System

The following parameters which were given in the Table 6 were assumed for requirements in system design.

Table 6: Design Parameters

Delivery Temperature	50 ^{0}C
Hot Water Consumption	60 litre/guest.day
No. of Rooms	400
Room Occupancy Rate in Season (Dec to Mar)	1.8
Room Occupancy Rate in Off-Season (Apr – Nov)	0.9

Figure 5: Schematic Diagram of Solar Thermal Hot Water System



Three loops were considered in this design, to achieve better efficiency and maintainability. Pure water can be used in the solar loop and the storage loop, which enables smooth heat transfer and longer life-time of the pipes and other accessories. Raw water is used only in the discharge loop. Electrical heater is considered to support when there is an energy deficiency and for quick temperature makeup in high demand case. All the loops and pumps will be controlled by sensing the temperature and flow rates. Considering operation and maintenance, it is assumed to assign one full-time person to carry out the operations and maintenance of the system. Further, 5% of the total investment is considered as the annual maintenance cost of the system. Figure 5 shows the schematic diagram of hot water system drawn using Polysun 5 and the Professional design report generated by Polysun 5.

The overview of the solar thermal annual values is given in Table 7. About 91% of energy demand is supplied by solar energy and the balance would be met with electricity.

The remaining fraction of heat demands has to be supplied by oil fired boiler or electric boiler. The unmet demand of 86,858 MJ of energy will be supplied by oil fired boiler. Electricity is an alternative option. Table 8 shows the basic details of oil fired boiler. Results of investment analysis are given in Table 9.

Table 7: Overview of Solar Thermal Energy

Collector Area (m^2)	**500 m^2**
Solar Fraction Total (%)	91.20
Total Annual Field Yield (MJ)	901,519
Collector Field Yield Relating to Gross Area (MJ/m^2.year)	1,803
Collector Field Yield Relating to Aperture Area (MJ/m^2.year)	2,003
Total Electrical Energy Consumption of the System [E_{tot}](MJ)	110,023
Total Energy Consumption [Q_{use}](MJ)	904,889
System Performance (Q_{use} / E_{tot})	8.22
Max. Fuel Savings (litre of diesel)	29,463
Max. Energy Savings (MJ)	1,060,611
Max. Reduction in CO_2 Emissions (Metric ton)	88

Table 8: Overview of Oil Fired Boiler

Power (kW)	50
Total Efficiency	82.5%
Energy to the System (MJ)	86,858
Diesel or Electrical Energy consumption (MJ)	105,255

Table 9: Cost Analysis of Hot Water System

Total Investment	$ 103,500
Operating Cost	$ 1,000
Life Time (Years)	30
Base Line price (Diesel)	$ 0.12/kWh
Annual Cost Saving	$ 35,350
Payback (Years)	4

Cooking Needs

Biogas and hydrogen energy options can be considered for cooking. Table 10 shows the annual heat demand for cooking for the 'business as usual' scenario.

Table 10: Business as Usual Scenario for LPG [11]

Consumption (kg/guest .day)	Demand (kg/year)	LHV (MJ/kg)	Total Heat Energy (GJ/year)
0.25	43,800	46.26	2026

Annual LPG gas demand is 43.8 ton which is equivalent to approximately 2026 GJ of heat energy. Table 11 shows the availability of biogas and its equivalent thermal energy. While biogas could meet approximately 10% of total demand, the remaining fraction of energy could be supplied either by Hydrogen or LPG. Hydrogen has been chosen since Hydrogen storage is available in the energy system. The storage will serve both the purposes i.e. both electricity and thermal requirements. About 15 ton of Hydrogen is required to meet the demand.

Table 11: Availability of Biogas [7]

Type of Feed Stock	Gas Yield (m^3/kg)	Avail. (kg / guest.day)	Gas Yield* (m^3/yr)	Loss (%)	Calorific Value of Biogas (MJ/m^3)	Total Heat Energy (GJ/yr)
Human Excreta	0.07	0.4	4906	7%	19.72	90
Solid Waste	0.1	0.5	5256	7%	19.72	96
Total Heat Energy	-	-	-	-	-	**186**

Transportation

The automotive transport system is required for moving people and logistics. The maximum distance from the resort to the jetty would be 500 m. Hydrogen powdered cars (both hydrogen and electric) are considered for guest shuttle services. Consumption of the hydrogen of car is 0.8kg /100km [7]. Therefore, 11 tons of hydrogen is needed for operation per year. Diesel vehicles will be used for moving heavy loads. Within the island periphery, bicycles will be used as another mean of transport.

Water Supply

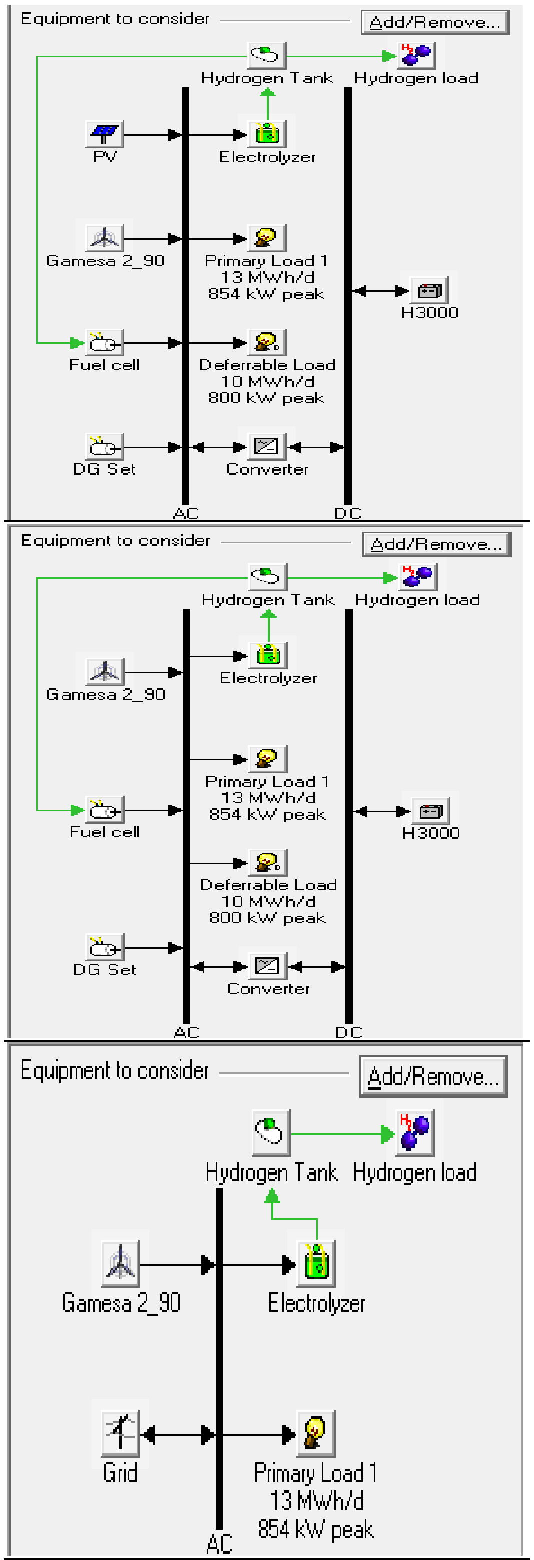
It was observed that ground water of good quality is available in Kalpitiya peninsula. Hence, water supply for the hotel operation is expected to be ground water. Electricity supply and energy demand for pumping and purification are included under demands for 'Auxiliary'.

Design of the Electrical Energy System

HOMER software was used for micro generation system modeling. The electric power system primarily consists of solar PV and wind turbines. As temporal variation of wind and solar is the biggest challenge for reliability of the system, an electrolyzer with a storage system is introduced to produce and store Hydrogen, the energy carrier of the system. Fuel cell is to supply the base load where as battery is to supply the peak demand. A standby DG set is connected to system to operate in case of emergency. As described above, the expected electrical load of the proposed hotel would be about 6 GWh/year with a maximum demand of 780 kVA. Three scenarios were considered for modeling, namely; wind only, wind-solar and wind-grid. For all three scenarios the results are quite different. The summary of the results are given in Table 12.

The island power system, shown in Figure 6, is a mixed one, with both AC and DC buses present in the system. All the loads are assumed to be AC in nature and the converter is a cyclic one acting as an interface between the two buses.

Figure 6: Single Line Diagrams of the Power Systems; Wind-Solar, Wind only, Wind-Grid



Results indicate that model 'Solar PV + wind and no grid connectivity' has the highest cost. Also it yields the highest energy cost, 0.15 US$/kWh. Hence compared with 'Wind only' model, Solar PV + wind and no Grid connectivity' is not an option for further study and could be disregarded. High cost of the solar PV system, low efficiency and high storage cost could be the reasons for lower economic performance of this combination.

Table 12: Summary of Rating and Details of Power System Components

Component	Wind Only	Wind & Solar	Grid Connected
Wind Turbines (2 MW)	6	6	8
PV (kW)	0	300	0
Fuel Cell (kW)	70	70	0
DG set (kW)	500	500	0
Batteries (6 kWh)	200	100	0
Converter (kW)	400	250	0
Electrolyzer (kW)	1,000	1,000	200
H_2 Tank(kg)	500	500	300
Grid Capacity Million (kWh)	0	0	900
Initial Capital US$	$2,806,500	$3,752,500	$847,500
Operating Cost US$/Yr	$304,873	$315,254	-$12,030,764
Total NPC using 10% DR US$	$5,573,844	$6,614,075	-$108,356,224
Cost of Energy US$/kWh	0.1250	0.1480	-2.43
Cost of H_2 US$/kg	10.760	12.796	-447.3
Renewable Fraction	0.95	0.95	0.95
Fuel Cell (h)	2,415	2,416	0
DG (h)	605	874	0
CO_2 Emission (tone/yr)	241	284	-34,735

Note: + ve values represent the costs and -ve values represent the income.
NPC = Net present cost, DR = discount rate

Conclusions

The study was to identify the feasible renewable energy technologies for sustainable operation of tourism services. Considering all the factors required to develop an island energy system, wind energy system is found to be feasible for the business operation. Wind energy projects can be put into operation within a very short period of time. However, at present, there are barriers at the infrastructural, economic, regulatory, political and administrative level.

Further studies are required to address the barriers given above. Complexity of these barriers will make the implementation a tough task.

References

[1] National Renewable Energy Laboratory (NREL), Technical Report- Sri Lanka and the Maldives Wind Energy Resource Assessment (Updated 21st Aug 2006), Available at: http://www.nrel.gov/docs/fy03osti/34518.pdf [Accessed on 10th Feb 2010].

[2] Ceylon Electricity Board, Kalpitiya Integrated Tourism Resort Project, Requirement of Electricity Supply. Published on 20th Sep 2010.

[3] Pam Baldinger, USAID, Energy and Sustainable Tourism: Energy Supply and Use in Off-Grid Ecotourism Facilities (Updated 26th of February 2006), Available at: http://www.pdf.usaid.gov/pdf_docs [Accessed on 10th Feb 2010].

[4] Sri Lanka Tourism Development Board, 2008. Annual statistical report 2008. [Online] Available at: http://www.sltda.lk/statistics [Accessed 4th Feb 2010]

[5] Tourism Development Project Proposal Kalpitiya (Updated 2010), Available at: http://www.sltda.lk/kalpitiya [Accessed on 10th Feb 2010]

[6] Dave Renné, Ray George, Bill Marion and Donna Heimiller (NREL) and Chris Gueymard (Solar Consulting Services), Solar Resource Assessment for Sri Lanka and Maldives with the Collaboration of Ceylon Electricity Board and National Renewable Energy Laboratory, USA.

[7] F. N. Büchi et al, Consumption and Efficiency of a Passenger Car with a Hydrogen/Oxygen PEFC based Hybrid Electric Drive train, Fuel Cells, 2007(04), pp 329-335.

[8] Sri Lanka Tourism Development Board, Master Plan for Kalpitiya Integrated Tourism Resort Project (KITRP), Published on 13th Aug 2008.

[9] Statistical Digest– 2009, Ceylon Electricity Board.

[10] Neven Duic, Maria da Grac Carvalho, Increasing renewable energy sources in island energy supply: case study Porto Santo, Renewable and Sustainable Energy Reviews (2004) pp 383–399.

[11] National Institute of Industrial Research, India, Handbook on Biogas and its applications, published by Ajey Kr. Gupta. Date unavailable.

[12] Rohit. H, Discussion on unit energy consumption of hotels managed by Aitken Spence (Pvt.) Ltd. [Telephone] (Personal Communication 5th Feb 2010)

The New Electricity Pricing Policy in Sri Lanka

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Abstract[1]: After years of decline by way of inadequate investments on new generation and transmission assets, and poor financial performance that caused the sector to report losses since 1999, the electricity industry in Sri Lanka is now on a path for recovery. The success of the recovery process depends on the extent to which the Government and its policy and regulatory agencies, electricity suppliers and customers alike, understand, appreciate and abide by the electricity law, follow the rules and diligently implement the transition arrangements. This paper explains the new pricing policy, which is a key ingredient for a successful recovery of the electricity industry by the target year of 2015.

Electricity Industry of Sri Lanka: A Sector in Turmoil

A long-term debt exceeding LKR 200 billion, projected to increase to LKR 500 billion by year 2015; a business in which the income is adequate only to meet about 90% of the expenditure excluding debt service; electricity prices that give rise to the inadequate income being high when compared with other countries in the region; a country that generates over 40% of its electricity requirements from renewable sources; the country with the lowest network losses in South Asia; and the only country in South Asia that has had no planned load shedding since year 2002; probably the only country in South Asia that issues invoices for all electricity used and collects almost all the due revenue.

A mixed bag indeed, of good and bad, successes and failures. Isn't there a way out for Sri Lanka, to bring the electricity industry back to profitability, or to breakeven, while providing a more reliable, competitively-priced service to customers?

This paper sets out the issues, problems and solutions, available for Sri Lanka to reach this objective. In fact, the reform process has already begun. The challenge is to keep the reform and recovery process on track.

Electricity Sector Financial Performance

The industry is dominated by Ceylon Electricity Board (CEB), the state-owned corporation. Lanka Electricity Company (LECO) is a distribution utility. Let us consider the recent financial performance of CEB, shown in Table 1.

Table 1 - Recent Financial Performance of CEB

Year	2006	2007	2008
Net Profit before Tax (LKR million)	-11,125	-19,811	-33,870
Return on Average net Fixed Assets	-0.56%	-2.29%	-5.85%

Source: CEB Annual reports

This is not a healthy situation, to report recurrent losses. The question is why these heavy losses continue to occur. Let us consider the situation in year 2010, just the last year. Actual information for the last year is not released yet, but it is possible to make some assessments.

Table 2 - Cost Structure of the Power Sector 2010

Cost Structure of Sales to End-Users		2010
Generation Capacity	LKR/kWh	3.20
Generation Fuel	LKR/kWh	10.54
Transmission	LKR/kWh	0.45
Distribution	LKR/kWh	2.71
Total Average Cost of Sales	**LKR/kWh**	**16.91**
Forecast Income from Selling Electricity at Government-Determined Tariffs of 2010	**LKR/kWh**	**13.15**
Forecast Loss on Sales	**LKR/kWh**	**3.76**

Source: Author's own assessments, includes all electricity sales in Sri Lanka

Note: The cost assessment is made on the basis of CEB and LECO each making a marginal profit. A debt moratorium (both capital and interest) is in place. Depreciation is provided for, where appropriate.

Even with a moratorium on debt repayments in place, the selling price is significantly

[1] *This paper was presented as the Eng (Prof) RH Paul Memorial Lecture, 9th February 2011, Institution of Engineers, Sri Lanka.*

below the cost. Accordingly, the revenue shortfall is estimated to be about LKR 35,000 million in 2010.

Therefore, the obvious answer to the question of losses seems to be that of raising the electricity prices by about 30%. When interest payments too have to be made on long-term loans, the tariff increase would be larger than 30%.

Electricity Prices in the Region

Sri Lanka's electricity prices are not the highest in the region. However, they are higher than most countries in the region, for certain customer categories. Please see Table 3 where "typical" customer electricity prices are compared on the basis of average price per kWh.

Table 3 - Electricity Prices in the Region

Customer	Class	Electricity Usage (kWh/mth)	Maximum Demand (kW)	Average Unit Price in LKR per kWh											
				Bangladesh	Kerala, India	Maharashtra, India	Tamilnadu, India	Malaysia	Nepal	Pakistan	Philippines	Singapore	South Korea	Sri Lanka	Thailand
Household	Small	30	-	5.31	2.82	1.87	2.78	8.00	7.80	3.26	11.92	21.09	8.46	5.00	5.58
	Medium	90	-	4.58	3.98	6.59	4.61	8.00	10.05	5.68	14.54	21.09	7.77	6.07	7.04
	Large	300	-	4.94	7.53	9.12	7.32	9.41	11.50	7.63	18.31	21.09	12.92	23.87	8.79
Commercial	Small	1,000	-	5.33	21.23	14.02	15.73	14.56	13.85	17.32	26.44	21.09	10.52	19.74	10.11
	Medium	58,000	180	8.82	15.03	21.02	16.52	13.29	12.66	12.01	18.93	21.09	9.44	22.09	8.76
	Large	600,000	1500	6.67	11.23	18.47	16.08	12.76	12.15	10.68	16.95	14.60	7.67	20.98	8.75
Industrial	Small	5,000	-	6.81	8.11	11.95	12.04	12.77	10.27	11.60	16.33	21.09	5.74	10.55	10.65
	Medium	65,000	180	4.12	9.20	12.31	11.86	12.13	9.83	10.72	18.37	20.95	6.50	12.47	8.49
	Large	270,000	600	7.71	8.84	13.21	11.45	9.39	9.47	10.18	16.61	20.49	6.51	11.55	8.46
	Very Large	1,050,000	2250	5.25	8.49	13.18	11.40	8.84	7.61	9.72	16.36	19.57	6.35	11.48	8.38

Source: Author's own assessments

Notes:

1. Electricity use and maximum demand have been defined for typical customers. Thus, the average prices calculated reflect the price if each typical customer is located in different countries. Analysis is based on published tariffs. Whether the tariffs are cost-reflective or not, and whether the utilities are profitable or loss making, has not been considered.
2. Sales taxes such as VAT are not included. Fuel surcharges, if any, are included.
3. These are based on published tariffs. Special concessions given to identified customers or within special economic zones are not included.
4. Optional tariffs (such as time-of-use, TOU) are not included. When TOU tariffs are mandatory, a flat load profile has been assumed.
5. Unity power factor is assumed, where relevant.
6. Prices updated as of 1st Feb 2011.

Therefore, it is not possible or reasonable to raise the electricity prices by whatever percentage desired by the Government or the electricity utilities. Such an action is likely to be strongly opposed by all electricity customers, and if imposed, may even cause certain electricity intensive industries themselves to move from profit to loss. If other countries in the region can sell electricity at lower prices, Sri Lanka too may have avenues to reach such lower levels of costs. However, here we have to be cautious: if such "cheap" electricity is found in a country where,

- Energy resources, both renewable and fossil-based, are available and are under-priced, or
- Electricity industry receives substantial subsidies from the respective Governments, or
- Electricity services are not available throughout the day, with moderate to severe unreliability of supply,

then, Sri Lanka should not emulate such countries when pricing electricity.

In fact, there is no country in the region listed above that is an "exact match" to Sri Lanka, in terms of the primary energy resources used for electricity generation, their prices, power supply reliability and state support. Therefore, an exact comparison is somewhat unreasonable from the Government and electricity industry point of view, but comparison from the customer point of view helps to highlight the relevant issues in pricing and the price structure.

The Breakup of Costs

As in any business, a breakup of costs assists in evaluating what has gone wrong with each component of costs. For this comparison, we show the costs of both year 2010 and 2011, in Table 4.

From 2010 to 2011, the generation costs have decreased, transmission costs have increased, and a new levy to (i) settle short-term debts, and (ii) to pay for renewable energy, has been added.

Table 4 - Costs of Year 2010 and 2011

Cost Structure of Sales to End-Users	2010		2011	
Generation Capacity	3.20	18.9%	2.64	18.5%
Generation Fuel	10.54	62.4%	8.11	56.9%
Transmission	0.45	2.7%	0.77	5.4%
Distribution	2.71	16%	2.73	19.2%
Total Direct Costs	**16.91**	**100%**	**14.25**	**100%**
Levy to Settle Short-Term Debts			0.59	
Levy to Pay for Renewable Energy			0.12	
Total Average Cost of Sales	**16.91**		**14.96**	

Note: All figures are in LKR/kWh sold, kWh sold is the total sales to end-use customers by all distribution licensees.

Source for 2011 information: Consultation Paper on Setting of Tariffs for the period 2011-2015, PUCSL, November 2010

The fundamental problem with the above costs and the cost structure is the high generation costs. Years of delays in making decisions on lower-cost generating plants (ie coal fired generation and large hydropower) and the unrealised expectation that the private sector would provide solutions to the problem of electricity generation, have caused Sri Lanka to be a country with a very high cost of generating electricity. Even the 40% contribution from very low cost hydropower could not resolve the cost issue.

The reduction of generation capacity costs from 2010 to 2011 owes to the new debt moratorium announced by the Government. The reduction in fuel costs is because of the commissioning of the first generating unit of the Puttalam Coal-fired Power Plant, expected in 2011. The first generator in Puttalam is estimated to save at least LKR 16,000 million to the country in year 2011, even during its first year of operation amidst testing and commissioning runs. Transmission costs have increased owing to the new methodology to calculate transmission prices. So, as demonstrated by the calculations, the answer to the question of profitability of the electricity industry lies not only in raising electricity prices but in reducing costs as well. Why Sri Lanka did not take action on these cost reduction methods earlier is already well known.

The Price Structure

Sri Lanka has a complicated electricity price structure, that evolved over more than seventy years, and now plagued with ambiguity and confusing definitions, causing nightmares to commercial engineers who have to determine, for example (i) whether a household is one house or two houses, (ii) whether an industry has enough motive power to qualify to be classified as an industry, (iii) whether a tourist hotel is serving an industry or providing a commercial service. He/she then has to determine the customer category, and the customer pays based on that determination.

The paper will later discuss the current price structure in 2011, which has some of the unpleasant elements of the 2010 tariffs already removed.

The Transition in the Electricity Industry

Sri Lanka is now placed in a unique window of opportunity, to resolve the problems related to the costs and pricing of electricity. Not many countries have this opportunity to restructure the industry, in an environment of (i) reducing production costs in real terms, (ii) reducing network losses, (iii) a period of higher economic growth.

The Transition in Costs

The production costs of electricity will decline over 2011-2015 owing to,

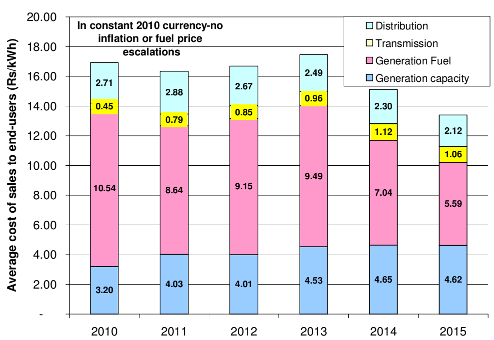
- reduction on the use of oil burning power plants (replaced with coal-fired generation) and retirement of several

Independent Power Plants (IPPs), saving on capacity charges.

- reduction in network losses, if diligently pursued by the licensees and by the Public Utilities Commission of Sri Lanka (PUCSL)
- overall improvement in network utilization, serving more energy over the same network, including vigorous demand-side management
- improvement in overall efficiency, causing network costs to increase at a rate less than inflation.

Out of the above, the reduction in generation costs is expected to be significant. Figure 1 shows how the fuel costs embedded in a kWh of electricity sold, presently in 2011 at 8.64 LKR/kWh (a) would gradually rise by 2013 to 9.49, (b) then with the commissioning of the 2nd and 3rd generators of the Puttalam Power Plant, would drop, in real terms, to 7.04 LKR/kWh by 2014. The commissioning of the Upper Kotmale hydroelectric power plant would further cushion the fuel costs in 2013. The most significant drop will be in year 2015, when (c) the Trincomalee power plant was scheduled to operate.

Figure 1- Forecast Transition of Costs and Cost Structure



Source: Analysis of the filing, allowed revenues and tariff calculations, PUCSL, Nov 2010

If for any reason, economic or political, environmental or sentimental, the Government or CEB delays the commissioning any one of these power plants, the consequences would be significant and would prevent the electricity industry from achieving the cost targets.

Table 5 - Targets for Network Losses Stipulated by the PUCSL

Year	Sales to End-use Customers (GWh)	Input to Transmission Network (GWh)	Sri Lanka T&D Loss (% of Input to Transmission)	Policy Target for Sri Lanka T&D Losses
2009	8,371	9,754	14.2%	13.5%
2010	9,031	10,503	14.0%	
2011	9,667	11,185	13.6%	
2012	10,308	11,903	13.4%	
2013	10,989	12,612	12.9%	
2014	11,713	13,375	12.4%	
2015	12,485	14,206	12.1%	12.1%
2016				12.0%

Source: Analysis of the filing, allowed revenues and tariff calculations, PUCSL, Nov 2010

The new regulatory regime established under the Sri Lanka Electricity Act No 20 of 2009, administered by the PUCSL, has established key targets for network losses described in Table 5, in keeping with the targets stated in the National Energy Policy and the Government's 10-year Development Plan. The reduction of network losses by about 2%, should bring about a corresponding reduction in the cost of electricity.

The overall improvement of network efficiency, by way of demand management, cost control, etc. would also bring about a saving of about 0.50 LKR/kWh, which is even more significant than the reduction of losses.

The Transition to a Regulated Market

Sri Lanka is not planning a competitive market in the electricity industry in the near future. Sophisticated markets where the electricity customer has the option of choosing his supplier, then pay a transmission/ distribution fee and purchases electricity, are in operation in many countries. Beyond the excessive publicity on the customer tariffs that would have attracted the attention of many, what Sri Lanka established on 1st January 2011 is a multi-year tariff regime, based on clear and transparent principles and methodologies. In other words, it is not a change in the way the electricity business operates. The business will remain as a monopoly, but a well-regulated monopoly where the costs and the prices are transparently calculated and presented.

On 9th April 2009, Sri Lanka's electricity industry moved from a Government-owned, vertically-integrated, traditional monopoly to an unbundled industry with clear separation of the functions of the policy-maker, owner, regulator and the operator. The industry continues to remain under Government ownership, but regulated on the basis of the Electricity Act and the licenses issued to each business line. Accordingly, the following are the roles of each party:

Policy Maker: Government of Sri Lanka (Ministry of Power and Energy)
Owner: Government of Sri Lanka (General Treasury) for CEB, other owners
Regulator: Public Utilities Commission of Sri Lanka
Operators: Ceylon Electricity Board (six licenses), Lanka Electricity Company (one license), Independent Power Producers (ten licenses), Small Power Producers (about 100 licenses)

Table 6 - Licensees and Their Licensed Businesses

Licensee	Businesses			
Generation (CEB, IPP, SPP)	Generation of Electricity and Selling to the Single Buyer	-	-	-
Transmission	Single Buyer (from generation)	Transmission Business (lines and equipment)	System Operator	Bulk Supply to Distribution
Distribution (five licensees)		Distribution Business (lines and equipment)	Supply of Electricity	

Much of the reforms into a regulated market are already being implemented.

Generators: These are licensed to produce electricity and sell to the Transmission Licensee. They cannot sell to any other buyer. Existing Power Purchase Agreements (PPAs) will continue. CEB's own power plants too would have a PPA with the Transmission Licensee, although they are the same legal entity. New PPAs are only possible for power plants in the approved Long-term Least-cost Generation Expansion Plan, through a competitive bidding procedure. All private power plants should carry some shares owned by the Government. There are special issues related to renewable energy-based small power producers.

Transmission Licensee: Buys from generators, operates the transmission system in the most economical manner, and sells to Distribution Licensees. All capital expenditure must be based on an approved plan. Maintains a bulk supply account to manage the transactions.

Distribution Licensees: There are five distribution licensees. All licensees buy from Transmission and sell to end-use customers. All capital expenditure must be on an approved plan. They are required to meet loss targets.

(a) CEB Region 1
(b) CEB Region 2
(c) CEB Region 3
(d) CEB Region 4
(e) Lanka Electricity Company (Pvt) Ltd.

The New Tariff Policy

The term "tariffs" has a broad meaning in the electricity industry. Tariffs do not purely mean the prices paid by end-use electricity customers. In the new tariff methodology published by the PUCSL, the following principles apply:

(a) All generation is priced on the basis of Power Purchase Agreements. Generation costs are passed-through by the purchaser (transmission) to distribution. Distribution licensees pass them through to end-users.

    Transmission and Distribution Licensees do not make a profit or a loss through buying from generation and selling to end-use customers.

(b) The Transmission Licensee:
    a. Transmission Business: Invests on and maintains all transmission assets (from power plant HV metering points to the 33 kV delivery points at each grid substation)

b. Bulk Supply and operations business: Relevant costs are paid
c. Generation costs are passed-through to distribution [no profit or loss]

(c) Distribution Licensees:
a. Distribution Business: Invests on and maintains all distribution assets
b. Retail services: metering, accounting and revenue collection
c. Retail Business: Generation and transmission costs are passed through to end-use customers [no profit or loss]

Therefore, each licensee is "ring-fenced", making the licensee (i) responsible to the components if his business that are within his control, (ii) compensated transparently for external or market-related features of the business which are not within his control.

As a consequence, the sad history of under-pricing electricity, and naming and blaming those assumed to be responsible for the financial status of the electricity industry, should come to an end. Year 2011 marks the first year in which all the licensees' allowed costs were transparently calculated and published.

Generation Costs

In the new tariff methodology, generation costs are fixed for a period of six months. Any surpluses will be "clawed back" six months later. Similarly, any deficits will be compensated for, six months later. Thereby, the "fuel surcharge" that was arbitrarily fixed is the past (and frequently misused as a tool to provide concessions to certain customer groups and to penalize other customer groups) has now been withdrawn. However, every month, the payments due to all generators will be paid. The Transmission Licensee (acting as the Single Buyer) would have access to funds to meet any shortfalls to pay the generators on-time.

Power generation costs during the day and the month vary, depending on the available generating plants and the demand on the system. Arguably, the generation costs in the dry months of February-April should be higher. Generation costs in the peak period of 1830-2230 of each day should be higher than at other times.

Table 7 - Monthly Average Costs of Generation in 2011

Month		1	2	3	4	5	6
Capacity Cost of Generation	LKR million	2,079	2,079	2,083	2,110	2,124	2,076
Energy Cost of Generation	LKR million	6,894	6,229	7,031	6,181	6,172	6,000
Total Generation Cost	LKR million	8,973	8,308	9,114	8,291	8,296	8,076
Electricity Generated	GWh	924.8	873.1	973.4	882.6	945.1	915.8
All Inclusive Generation Cost	LKR/kWh	9.70	9.52	9.36	9.39	8.78	8.82

Note: The expected increase of fuel costs in Feb-Apr does not occur owing to the commissioning of the coal-fired power plant in Feb-March period of year 2011.

Table 8 - National Average Rates for Billing from Transmission to Distribution

		Economic Dispatch	ST Debt Recovery	Renewable Energy above Avoided Costs	Total BST (E)
BST day (E1) 6-month Weighed Average	LKR/kWh	7.16	0.52	0.11	7.78
BST peak (E2) 6-month Weighed Average	LKR/kWh	9.37	0.52	0.11	10.00
BST off-peak (E3) 6-month Weighed Average	LKR/kWh	4.97	0.52	0.11	5.60

Note: BST: Bulk Supply Tariff, for sale from Transmission to Distribution
Source: Consultation Paper, PUCSL, Nov 2010

Generation costs during the three time intervals of the day have been determined in a more simplistic manner, through revenue balancing. The day-time (0530-1830) cost is fixed at the monthly average cost. The peak time costs are raised by a certain percentage, and the off peak rate is calculated in such a way that the monthly revenues are balanced.
Accordingly PUCSL has published the rates for billing from Transmission to Distribution, shown in Table 8.

Transmission and Distribution Tariffs

Table 9 provides the allowed costs for transmission and each distribution licensee. Each licensee has a revenue cap, which will be subsequently adjusted for factors beyond the licensee's control. eg: inflation, customers served, energy sold. In constant January 2011 terms, all licensees show a declining cost of service. Therefore, although these allowed revenues will be inflation-adjusted every year, the end-use customer should see a reduction of transmission and distribution costs in real terms.

Table 9 - Transmission and Distribution Tariffs Proposed by the PUCSL

Licensee	2011	2012	2013	2014	2015
	Revenue Cap (LKR million)				
DL1	6,981	7,303	7,623	7,939	8,286
DL2	7,956	8,318	8,706	9,073	9,455
DL3	4,657	4,859	5,073	5,292	5,517
DL4	3,776	3,926	4,056	4,187	4,318
DL5	2,514	2,581	2,663	2,729	2,780
Distribution Total	25,883	26,988	28,122	29,220	30,356
TL	7,288	7,288	7,288	7,288	7,288
Total	33,172	34,276	35,411	36,509	37,645
Sales Forecast (GWh)	9,667	10,308	10,989	11,713	2,485
	Sales by each Licensee (GWh)				
DL1	2,704	2,882	3,071	3,272	3,486
DL2 (including sales to DL5)	3,193	3,403	3,626	3,863	4,116
DL3 (including sales to DL5)	2,115	2,253	2,401	2,558	2,726
DL4 (including sales to DL5)	1,730	1,843	1,964	2,093	2,230
DL5	1,198	1,241	1,284	1,327	1,370
Distribution Total	9,667	10,308	10,989	11,713	12,485
TL	10,890	11,546	12,233	12,974	13,780
	Cost of Service (LKR/kWh sold by each licensee)				
DL1	2.58	2.53	2.48	2.43	2.38
DL2 (including sales to DL5)	2.49	2.44	2.40	2.35	2.30
DL3 (including sales to DL5)	2.20	2.16	2.11	2.07	2.02
DL4 (including sales to DL5)	2.18	2.13	2.06	2.00	1.94
DL5	2.10	2.08	2.07	2.06	2.03
Distribution Total	2.68	2.62	2.56	2.49	2.43
TL	0.67	0.63	0.60	0.56	0.53
Total T&D Cost (LKR/kWh sold)	**3.43**	**3.33**	**3.22**	**3.12**	**3.02**

End-Use Customer Tariffs

While removing the complexities and ambiguities of the tariff structure and definitions, it would also be required to move the tariff structure to a cost-reflective structure stipulated in the Electricity Act, as early as possible. Sri Lanka's electricity prices are nowhere near the cost of supply to any customer category, as shown in Table 10.

A closer look at the subsidy column would show that all household customers using up to 180 kWh/month are subsidised. Additionally, religious, Industrial 2 and Hotels 2(IP) customers too were subsidised. The subsidy is carried by larger households and other institutional customers. The hardest hit, are the households using more than 600 kWh per month, who pay about 2.5 times the cost of supply.

The disparities between tariffs are too large to make adjustments overnight to make them cost-reflective. Therefore, a road map for tariff reforms and rebalancing has been announced, which would, over a period of five years, cause the customer tariffs (i) to be cost reflective, (ii) to be based on the voltage at which electricity supply is received, but not the purpose for which electricity is used, and (iii) encourage demand management to achieve the desired results.

Table 10 - Cost of Supply and Income from Sales for each Class Customer, if 2010 Tariffs Prevailed in 2011

Customer Category in the 2010 Tariff Schedule	Total Sales Forecast in 2011 (GWh)	Total Cost (LKR million)	Total Revenue (LKR million)	Total (Subsidy) or Surcharge on Customers (LKR million)	Cost of Supply (LKR/ kWh)	Forecast Revenue (LKR/kWh)
Households						
0-30	233	5,518	1,113	(4,405)	23.66	4.77
31-60	756	15,928	3,695	(12,233)	21.07	4.89
61-90	1,018	20,093	5,974	(14,119)	19.73	5.87
91-180	1,254	22,225	14,973	(7,252)	17.72	11.94
181-600	492	8,346	9,957	1,611	16.98	20.26
>600	100	1,479	3,561	2,082	14.79	35.61
Sub Total	**3583**	**73,590**	**39,273**	**(34,317)**	**19.10**	**10.19**
Other LV						
Religious	57	1,004	513	(491)	17.65	9.02
General Purpose 1	1,149	15,809	23,943	8,134	13.76	20.83
Industrial 1	238	3,171	2,611	(561)	13.32	10.96
Hotel 1	1	19	20	1	15.01	15.73
Street Lighting	148	2,292	3,668	1,376	15.43	24.70
Sub Total	**1,594**	**22,295**	**30,754**	**8,460**	**13.99**	**19.29**
LV BULK						
General Purpose 2	875	9,751	18,555	8,803	11.14	21.20
Industrial 2	1,561	19,899	19,444	(455)	12.75	12.46
Industrial 2 TOU	174	2,159	2,343	184	12.41	13.47
Hotels 2 TOU	2	26	30	4	11.10	12.60
Hotels 2 (GP)	73	824	1,169	345	11.21	15.91
Hotels 2 (IP)	54	656	625	(31)	12.25	11.67
Sub Total	**2,739**	**33,315**	**42,165**	**8,850**	**12.16**	**15.39**
MEDIUM VOLTAGE						
General Purpose 3	223	2,263	4,378	2,115	10.13	19.61
Industrial 3	1,035	10,965	11,661	697	10.59	11.26
Industrial 3 TOU	143	1,376	1,721	345	9.64	12.06
Hotels 3	8	77	83	6	9.66	10.44
Hotel 3 TOU	71	629	725	95	8.89	10.24
Sub Total	**1,480**	**15,310**	**18,569**	**3,259**	**10.34**	**12.55**
Total	**9,666**	**144,510**	**130,761**	**(13,749)**	**14.95**	**13.53**

Source: Consultation Paper, PUCSL, Nov 2010.

Note: Cost of supply information includes the Government's debt moratorium is given. If interests were to be paid, these costs would be higher. TOU = time of use

Table 11 – The Road Map for Tariff Reforms and Rebalancing

<table>
<tr><th>Year</th><th>Households</th><th>Religious</th><th>Other Retail (Industry, General, Hotel)</th><th>Industry (bulk)</th><th>Hotel (bulk)</th><th>General (bulk)</th></tr>
<tr><td>2011</td><td>No major changes</td><td>No changes</td><td>Reduce the gap between the three classes</td><td>TOU mandatory</td><td>All hotel customers unified into one category. TOU mandatory</td><td>No changes</td></tr>
<tr><td>2012</td><td>Reduce blocks from 6 to 4 For 0-30 kWh customers, Govt fully implements a direct subsidy, as provided in the National Energy Policy and the Govt's 10-year plan</td><td>No changes</td><td>Further reduce the price gap between the three classes of customer</td><td colspan="3">All three classes of bulk customers to be unified and TOU tariffs to be mandatory

Introduce a charge for reactive power</td></tr>
<tr><td rowspan="3">2013</td><td rowspan="3">Reduce blocks from 4 to 3</td><td rowspan="3">No changes</td><td colspan="4">No difference between the customer classes, except in terms of voltage at which service is provided. For the purpose of retaining a database, customer classification will be retained in the accounting system.</td></tr>
<tr><td colspan="4">TOU tariffs will be mandatory for all retail and bulk customers in industry, hotel and general purpose categories</td></tr>
<tr><td colspan="4">Any subsidies will be addressed outside the licensee tariffs.</td></tr>
<tr><td rowspan="3">2014</td><td>Retain 3 blocks</td><td>No changes</td><td colspan="4" rowspan="2">No further changes</td></tr>
<tr><td>Optional TOU tariff for all 3-phase customers</td><td>No changes</td></tr>
<tr><td colspan="6">Tariffs yield adequate revenue to breakeven, meet all commitments including debt service, but excluding a return on assets to GOSL</td></tr>
<tr><td rowspan="2">2015</td><td>Abolish block tariffs. Optional TOU tariffs to all customers.</td><td>No changes</td><td colspan="4">No further changes</td></tr>
<tr><td colspan="6">Tariffs to all customers are targeted to be fully cost reflective. GOSL earns a return on assets on the sector.</td></tr>
</table>

Note: This tables shows only the structural changes and not the price changes

Table 12 - Structure of Electricity Prices in Year 2015 if Planned Reforms are Implemented

<table>
<tr><th>Customers</th><th colspan="2">Energy Charge (LKR/kWh)</th><th>Demand Charge (LKR/kVA.month)</th><th>Reactive Power Charge (LKR/kVArh)</th><th>Fixed Charge (LKR/month)</th></tr>
<tr><td>Households</td><td>All day</td><td>15.00</td><td>-</td><td>-</td><td>100</td></tr>
<tr><td rowspan="3">Other retail</td><td>Day</td><td>15.00</td><td rowspan="3">-</td><td rowspan="3">-</td><td rowspan="3">100</td></tr>
<tr><td>Peak</td><td>18.00</td></tr>
<tr><td>off-peak</td><td>12.00</td></tr>
<tr><td rowspan="3">LV Bulk</td><td>Day</td><td>10.00</td><td rowspan="3">1500</td><td rowspan="3">0.50</td><td rowspan="3">1000</td></tr>
<tr><td>Peak</td><td>13.00</td></tr>
<tr><td>off-peak</td><td>7.00</td></tr>
<tr><td rowspan="3">MV Bulk</td><td>Day</td><td>9.00</td><td rowspan="3">1200</td><td rowspan="3">0.40</td><td rowspan="3">2000</td></tr>
<tr><td>Peak</td><td>12.00</td></tr>
<tr><td>off-peak</td><td>8.00</td></tr>
</table>

Note: This table is provided only to demonstrate the tariff structure. The prices shown too are in the probable range, but should not be considered as a forecast.

Thus by year 2015, all customers would be paying the cost of supplying electricity to them, depending on their

(i) point of purchase (retail, bulk or MV) (ii) load profile. The summarized tariff structure and tariff would be of the form shown in Table 12.

Customer Tariffs for 2011

After much debate between the stakeholders, both on the supply-side and the demand-side, a new tariff structure and tariffs were announced in January 2011. See Table 13. The tariffs display the implementation of a few steps towards tariff reforms, leading towards the goal of reaching cost reflectivity by year 2015. The significant achievements towards the goal in the January 2011 announcements are,

- All industry and hotel bulk customers have been placed in the mandatory TOU tariffs. TOU tariffs were previously optional.
- Bulk customers in the hotels previously classified as either industries or commercial, have now been unified into one category.
- Household blocks have been retained at 6 (although a reduction was previously envisaged)
- Street lighting costs have been socialized, meaning that all customers share the cost of approved street lighting services.

However, the following desired steps have not been included in the January 2011 announcement.

- unification of the bulk customer groups: industry and hotels
- non-implementation of reductions to customers who are already paying prices significantly higher than the cost of supply (households >600 kWh/month, bulk customers in general purpose category)
- increases to customers who are paying below the cost of supply.

Table 13 - Customer Tariffs Announced for January to June 2011

Customer Category and Consumption per month	Energy Charge (LKR/kWh)	Fixed Charge (LKR/ month)	Maximum Demand Charge per month (LKR/kVA)
Domestic (D)			
0-30	3.00	30	-
31-60	4.70	60	-
61-90	7.50	90	-
91-120	21.00	315	-
121-180	24.00	315	-
>180	36.00	315	-
Religious (R)			
0-30	1.90	30	-
31-90	2.80	60	-
91-120	6.75	180	-
121-180	7.50	180	-
>180	9.40	240	-
Street lighting	15.60	-	-

Customer Category and the Time Interval, if Applicable	Energy Charge (LKR/kWh)	Fixed Charge (LKR/ month)	Maximum Demand Charge per month (LKR/kVA)
Industry (I)			
I-1	10.50	240	-
I-2			
Day	10.45		
Peak	13.60	3,000	850
Off-peak	7.35		
I-3			
Day	10.25		
Peak	13.40	3,000	750
Off-peak	7.15		
Hotel (H)			
H-1	19.50	240	-
H-2			
Day	13.00		
Peak	16.90	3,000	850
Off-peak	9.10		
H-3			
Day	12.60		
Peak	16.40	3,000	750
Off-peak	8.85		
General Purpose (GP)			
GP-1	19.50	240	-
GP-2	19.40	3,000	850
GP-3	19.10	3,000	750

Notes on tariffs:

1. Eligible Government institutions shall be entitled to a 25% discount on energy charges stated above.
2. Energy charges to Religious premises have been reduced by 25% compared with the present tariffs.
3. The above tariffs do not cause any increase to Domestic customers using up to 120 kWh per month and to Small and Medium Enterprises (SMEs) classified under I-1, H-1 and GP-1.
4. Fuel Adjustment Charge will no longer be applicable to any customer category.
5. "month" means a 30-day billing period.

Notes on Customer Categories and time intervals

1. Codes refer to the tariff codes presently used for billing by the Distribution Licensees.
2. Hotels which presently pay either the Industrial rates or General Purpose rates are unified into a single customer category identified as Hotels.
3. Customers in I-2, I-3, H-2 and H-3 would pay on the basis of mandatory Time of Use (TOU) tariffs. Time intervals applicable shall be as follows.

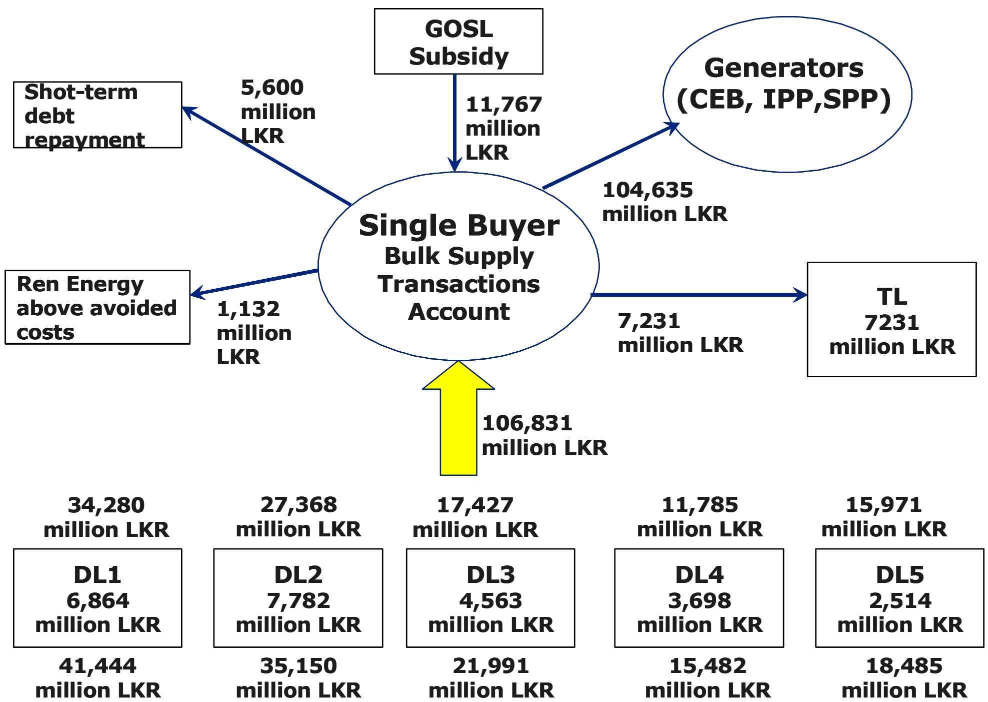
Interval Description	Interval (hours)
Day	05.30 to 18.30
Peak	18.30 to 22.30
Off-peak	22.30 to 05.30

In spite of the shortcomings in the published customer tariffs, the first step towards tariff reforms have been taken, and are being successfully implemented. Some initial difficulties are expected, such as delays in programming the bulk customer meters to align with the new TOU tariff time intervals. These are being resolved speedily by the licensees, who are enthusiastically participating in the reform process.

Tariffs for Transfers between Licensees

The new pricing mechanism for transfers between licensees has commenced. Figure 2 shows the forecast cash flows between licensees in year 2011.

Figure 2 - Forecast Cash Flows between Licensees in Year 2011



Note: Transfers are shown for the entire year, assuming the tariffs announced for January-Jun 2011 will prevail.
Source: Adapted from the Consultation Paper Nov 2010 and Tariff Decision, PUCSL, 2011.

Each Distribution Licensee (DL1 to DL5) and the Transmission Licensee (TL) is free to retain the amounts due to the licensee, and transfer the balance to the Single Buyer, who maintains the Bulk Supply Transactions Account. The following are the key issues remaining:

(i) **Government Subsidy:** A sum of LKR 11,767 million is due from the Government to the Single Buyer (CEB Transmission Licensee) to ensure that Government's policy for January 2011 on,

a no price increases to households using less than 120 kWh/month

b the 25% reduction to religious institutions and Government schools

c no price increases to small and medium enterprises

d a nominal 8% increase to other customers is to be implemented successfully. Hopefully, PUCSL would shortly publish for the information of the public how the Government subsidy would actually be paid to CEB, and what the Commission would do if the subsidy is not received. The logical way to handle non-payment would be to pass it on to customers with an interest, and compensate the CEB. We should remember that licensees are expected to control and manage only those parameters within their control.

(ii) **Renewable Energy Levy:** Sri Lanka is a country that has been considered to be an example on how small renewable energy could be developed by the private sector. All that status has been lost in the past two years, when the pricing formula has been mishandled both by the Government and now by the regulator. The prices offered are arbitrary and exorbitant, and significantly exceed those offered in developed countries. CEB is left with the dilemma of being unable to meet the commitments to private renewable energy developers. Ultimately the customer has to pay these exorbitant prices. In the present tariffs, the customers are paying 0.12 LKR on each kWh to foot the additional cost on renewable energy. It would be additional to what we would have paid if such energy was obtained from oil or coal.

(iii) **Short-term Loans:** These appear as a levy on the tariffs, and should be a diminishing feature. Presently the load on the customer tariff is high, at 0.55 LKR/kWh.

Conclusions

Sri Lanka has embarked on a process to reform the electricity industry, and gradually bring it back to profitability, or to at least breakeven, so that it would not be a burden on the general public. Privatization is not a relevant argument in this scenario, where the Electricity Act prevents privatization in the foreseeable future. The Act provides for introducing a regulatory mechanism on which the costs of the state-owned utilities CEB and LECO are monitored and transparently assessed. Public hearings at various points in the process would enable customers as well as state sector stakeholders to participate in the process.

The most important feature is the transparency of the process. For the first time in the history of the electricity industry in Sri Lanka, electricity customers now know how much it costs to serve them with electricity, how much they pay, and who is subsidized and who has to pay a surcharge.

Keeping the new tariff reforms on track and taking it towards full implementation is a challenging task. There are many skeptics, both in the Government hierarchy and in the utility industry. Will this system work? Will the Government honour the promised subsidy? Will licensees, who are state owned, respond to regulatory oversight of their operations? Will we ever reach cost reflective tariffs in Sri Lanka? Will electricity prices ever come down?

These are the questions foremost in the minds of all stakeholders. We have to begin with a positive mind. We have in fact already begun the reform process. The licensees have become revenue neutral entities from 1st Jan 2011. If they run the business according to the rules, by the end of 2011, all licensees should be reporting marginal revenue surpluses. That does not mean the sector has become profitable, because we should not forget that the sector enjoys a debt moratorium until end 2013. The licensees' annual accounts are most likely to report losses for 2011 as well, but the important issue is whether the sector is on the path for recovery.

All have to work to achieve the objective. There will be many shortcomings, interferences, but they can be overcome if,

- The Public Utilities Commission remains strong and professional
- The licensees cooperate and stand strong against outside interference
- The customers stand strong and demand for their rights and a cost-reflective price

The plans are ready, and the mechanism is in place, and working. The stakeholders must ensure that the new tariff policy and the system continue without any hindrance, but making important corrections on the way.

Sector profitability is not too far away: by end 2015, all licensees should report real profits, all customers should be paying lower prices than today in real terms.

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Sri Lanka Energy Managers Association possesses a set of valuable instruments, which can be used for energy auditing and other measuring requirements. The instruments are available for institutions and individuals on a chargeable basis.

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- For extra logger			500
Portable Power Meter 1 - Nanovip	1	9,000	750
Portable Power Meter 2 - Clamp On	2	7,500	750
Digital Thermometer	1	3,000	250
Laser Sighting Infrared Thermometer	1	3,000	750
Data Logger - Grant & Exel	3	12,000	750
Thermo anemometer - Vane type	2	10,500	500
Thermo anemometer - Hot wire type	2	10,500	500
Lux Meter	1	1,500	100
TDS Meter	2	1,500	100
Multimedia Projector	1	15,000	3,500

Assistant charges per day 500

Engineer charges per day 1,500

Please call SLEMA office on 011 266 5737 for details and availability of instruments.

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