KTH Industrial Engineering
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Renewable for Rural Electrification in Sri Lanka

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Abstract

At the beginning of the 1970s, the industrial countries accounted for about 80% of world oil consumption. Today, they are down to little more than 50%. Already, China uses more total primary energy than United States. Developing countries are in the process of consuming a substantial amount of energy due to alarming growth, industrialization, urbanization etc. With a tight and volatile oil market, combined with sharply rising consumption in emerging countries there is renowned concerns about energy security. Various models are being implemented in these countries with the help of donors and local governments to enhance the use of renewable energy for a sustainable development. Use of renewable energy for rural electrification has not progressed as anticipated regardless of provisions of subsidies & other measurers by governments. In Sri Lanka, the primary energy contributions in 2009 to national energy supply were 51% from biomass, 44.8% from crude oil and petroleum products, and 3.6% from hydroelectricity and other renewable sources. The use of non-conventional energy resources, NCRE, (small-scale hydropower, biomass, biogas and waste, solar power and wind power) in Sri Lanka is of a relatively smaller scale (<1%) and therefore its contribution is presently of low significance in the macro energy picture. Regardless, the energy policy document of the government of Sri Lanka has set a target to reach a minimum level of 10% of electrical energy supplied to the grid to be from non-conventional renewable energy in 2015. In this context, this study attempts to analyse the strengths and weaknesses of the existing financial and institutional models for renewable energy dissemination for rural electrification in Sri Lanka and to recommend possible measures needed for better financial and institutional models. In addition to a literature survey, a questionnaire survey was carried out with power producers, financial institutions and government and non-government organizations in the renewable energy business to obtain their perception for better analysis.

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Abbreviations

BOO	Build Own Operate
BOT	Build Own Transfer
CEB	Ceylon Electricity Board
CEYPETCO	Ceylon Petroleum Corporation
CPSTL	Ceylon Petroleum Terminals Ltd
ECF	Energy Conservation Fund
ECS	Electricity Consumer Society
ESD	Energy Services Delivery Project
GCMH	Grid Connected Mini Hydro
GEF	Global Environment Facility
GOSL	Government of Sri Lanka
HNB	Hatton National Bank
IDA	International Development Agency
IPP	Independent Power Producers
ITDG	Intermediate Technology Development Group
LECO	Lanka Electricity Company
LKR	Sri Lankan Rupees
LPG	Liquefied Petroleum Gas
NCREL	National Renewable Energy Laboratory
NCRE	Non-Conventional Renewable Energy
NDB	National Development Bank
NGO	Non-Governmental Organization
OGVH	Off-Grid Village Hydro
PCI	Participating Credit Institutions
PUCSL	Public Utilities Commission of Sri Lanka
PV	Photovoltaic
RE	Renewable Energy
RERED	Renewable Energy for Rural Economic Development

Executive Summary

Use of renewable energy for rural electrification in developing countries has not progressed as anticipated regardless of the provision of subsidies and other measures by the governments. Sri Lanka is no exception. Implementation of RE programmes are far slow than the targets set by the national energy policy document. Identifying and analyzing the real problems that hinder the progress of implementing RE technologies is a big challenge. The overall objective of this study is to explore the strengths and weaknesses of the existing financial and institutional models in Sri Lanka for a more effective development and delivery system for the rural electrification through renewables.

The methodology for collecting information and data was carried out through a literature survey and through a questionnaire. This study also covers some models used in other developing countries and consists of literature review to find out the theoretical and conceptual knowledge on various types of the existing financial and institutional models used in rural electrification in Sri Lanka. A questionnaire survey was also carried out with Producers, NGOs and Financial Institutions, the key players in the rural electrification programs.

In the first chapter of this report, the country energy background, energy sector governance and the existing energy policy, strategies and targets are discussed. In the second chapter the progress of renewable energy in Sri Lanka, the status of RE in the rural electrification, present status of grid connected and off-grid RE projects, financing and subsidy are discussed. Chapter three of this document covers the existing financial and institutional models for the electricity sector in general and the specific models for the rural electrification through renewables, for both grid connected and off-grids. This chapter also covers some of the other financial models in developing countries used for rural electrification through renewables. The institutional model used in the RE sector in Sri Lanka is also discussed here. Chapter four covers the stakeholder's perception survey. Twelve financial institutions, forty six producers and six NGOs were contacted but only four financial institutions, eleven producers and two NGOs responded. Overall the response rate was only 27%. The respondents were provided with three separate questionnaires. Here the respondents were requested to rank the given barriers in a ranking scale for some questions and also to distribute weights for certain questions. The average, minimum, maximum and standard deviations of these responses were calculated for better analysis of the feedback. Answers to 10 key questions of the survey are discussed and analyzed in this chapter. In chapter five the strengths and weakness of the financial and institutional models are discussed with the knowledge acquired from the literature survey and questionnaire survey. Recommendations for better financial and institutional models are discussed in chapter six. Chapter seven covers the conclusion of the study.

Primary energy contributions in 2008 to national energy supply in Sri Lanka were 50.8% from biomass, 45.5% from crude oil and petroleum products, and 3.7% from hydroelectricity and other renewable sources. The use of non-conventional energy resources in Sri Lanka is of a relatively smaller scale and therefore its contribution is presently of low significance in the macro energy picture. Institutional responsibility of electrification of houses lies with Ministry of Power and Energy and Public Utilities Commission (PUCSL). Sri Lanka Sustainable Energy Authority (SLSEA) is the apex organization for rural electrification where it has to identify, conserve and manage all renewable energy sources and appropriate conversion technologies and preparation, maintenance and updating of an inventory of all renewable energy resources in Sri Lanka. Ceylon Electricity Board is the sole national organization responsible for generation, transmission and distribution of electricity in Sri Lanka. The national energy policy of Government of Sri Lanka (GOSL) has set a target to reach a minimum level of 10% of electrical energy supplied to the grid to be from Non-Conventional Renewable Energy (NCRE) in 2015. NCRE resources

include small-scale hydropower, biomass, biogas and waste, solar power and wind power. These are the leading sustainable, non conventional energy resources that are promoted in Sri Lanka where wave energy and ocean thermal energy are encouraged where appropriate.

Use of renewable technologies for rural electrification in Sri Lanka with the government initiative began in 1997 with implementation of Energy Services Delivery (ESD) project. The project continued up to 2002 and was funded by World Bank (WB) and Global Environment Facility (GEF). Loans for individual investments or sub projects are disbursed through participating credit institutions (PCIs). This was an initial boost to the use of renewable energy for rural electrification in Sri Lanka. With the success of ESD project, a second phase of this project was launched as the Renewable Energy for Rural Economic Development (RERED) during the period 2003-2007 with the objective of expanding the commercial provision and utilization of renewable energy resources. This was funded by a US$ 75 million line of credit from International Development Agency (IDA) of the World Bank and a US$ 08 million grant from GEF. This project was extended with US$ 102.5 million additional financing from 2008 to 2011. A total of 131,528 solar home systems with an installed capacity of 5,789 kW, 171 off-grid village hydro schemes with an installed capacity of 2,120 kW and 02 off-grid biomass projects serving 39 households with an installed capacity of 22 kW were completed by December 2010, under ESD, RERED and REDRED-Additional financing schemes.. The total grid connected projects were, 69 mini hydro projects (168 MW), 02 Wind projects (19.8MW) and one Biomass project (1 MW). This model has been replicated in Bangladesh, the Philippines and in several African countries.

Though five financial models are discussed in this report, only RERED and Micro-credit financial models play a significant role in the use of renewable energy for rural electrification. In RERED financial model, loans for individual investments or sub projects are disbursed through PCIs. These PCIs evaluate the projects for financial viability, economic justification, environmental compliance etc. Subject to meeting PCIs credit worthiness assessment, medium or long term sub loans from these PCIs could be obtained. In the Micro credit financial model, a fund is established using grants, soft loans, government allocations and from mix of other sources. Implementing organizations or consumers obtain loans from the micro credit institutions. Implementing organizations also receive direct grants from the fund. Consumers have the option to get the installation and maintenance done through the implementing organization for a fee or do it by themselves. Micro credit financing model has been an effective way to provide the poor to access electricity through renewable energy technologies such as PV solar systems and micro hydro projects. Traditional public ownership and financing model, Project financing model and Public –private partnership models are still being used for large scale grid connected hydro and thermal projects.

The response rate to the questionnaire though poor has provided some credible insight to the strengths and weaknesses of the financial and institutional models and associated barriers in promoting renewable energy for rural electrification and reaching the goals set by the energy policy document. Respondents have considered lack of attractive financing conditions as a major barrier to the financial viability of RE projects. The high interest rate of commercial lending and large collateral amount that is often requested by financial institutions has been ranked as major barriers and the mandated minimum collateral volumes generally preclude the financing of small off-grid projects. Political influence and high patronage have also been considered as major barrier by the respondents that may impede the rural electrification program reaching the poor and the remote. Respondents have also considered the subsidy system is not smart and need to be designed and implemented to counter market distortions and barriers and to strengthen the service providers. Political influence, environmental clearances, legal and regulatory frame work are also considered as major institutional barriers. The questionnaire survey also shows that lack of RE policy implication and lack of right policies and strategies are other major barriers in associated with the existing financial models that would impede rural electrification investment by financial institutions.

Exclusion of rural electrification projects through renewables from the traditional public ownership financial model, Project financial model and public private partnership model is a severe weakness in these models. On the other hand these models have the financial capability and technical competency for carrying out rural electrification through technologies using renewable energy and stands at a competitive advantage. RERED financing model has been the most successful financial model for rural electrification in the recent past in Sri Lanka. Limited financing, lack of financial capability to meet national RE targets, high bank intermediation cost, tedious approval process are some of the major weaknesses identified in this model. Diverse type of institutions such as Banks and non-banks, inclusion of an implementing organization and direct access for loans for consumers are some of the strengths identified in the Micro credit financial model. Nevertheless, the institution's financial viability and fragmented and complicated regulation and supervision are the major weaknesses of this model that shadows its potential to become a major player for a sustainable deployment of renewable technologies for rural electrification. Clear defined criteria for RE project licensing and the inclusion and co-ordination among key stakeholders in the governance of energy supply in Sri Lanka are the main strengths of the existing institutional model. Lack of an apex organization dedicated and responsible for rural energy provision and funding and lack of legislations for clear targets and time frames are the major weaknesses identified in the existing institutional model.

The report recommends implementing of an apex organization responsible and dedicated to rural electrification provision and funding with required regulations to address the barriers identified in this report for off-grid and grid connected RE projects. It also recommends regulations for mandatory time frame and targets. The off-grid service needs to be regulated to ensure that off-grid customers do not pay excessive tariffs or get poor quality or reliability. The off-grid projects need to be in consistent with the overall rural electrification plan and sustainability should be of higher priority. Private sector participation has to be encouraged through more innovative partnerships and through hybrid business models as much as possible. GOSL's energy policy decision to immediately switch to coal power should not hinder, delay or discourage rural electrification program through non-conventional renewables but should go in parallel and more local and international co-financing assistance need to be made available on affordable terms for the RE projects through renewables in Sri Lanka.

The overall conclusion of this study is that the weaknesses of the existing financial models and the institutional model dissemination for rural electrification out weights the strengths and therefore use of renewable energy for a sustainable development may not progress as anticipated. Recommendations discussed in this report offer some possible solutions to assist in overcoming these weaknesses.

1. Energy background

Sri Lanka covers an area of about 65,610 sq. km with a population around 20 million (2007 statistics). There are of 22 Districts, 17 Municipal Councils, 38 Urban Councils and 38,259 Villages. The Gazette of the Democratic Socialist Republic of Sri Lanka (Extraordinary) on June 10, 2008 specifies *The National Energy Policy and Strategies of Sri Lanka* by Ministry of Power & Energy. According to this policy document, electricity will be made available to all feasible areas by extending the national grid and focused rural energy initiatives using off-grid technologies. Capital subsidies available for grid-connected households will be extended to households seeking off-grid electricity, through the Provincial Authorities. The medium-term target is to electrify 85% of the households through grid extension and 8% of the households through off-grid electricity systems by 2015 [1].

In this policy document, Non-conventional Renewable Energy (NCRE) has been identified as the forth energy resource in the national energy policy under fuel diversity and security. NCRE generating facilities have been commercially developed by private investors since 1996, based on a standard power purchase agreement (PPA) with Ceylon Electricity Board (CEB). This concession is offered to all power plants using a renewable source of energy or waste heat. The capacity should be less than 10 MW, and the power plants are embedded in the medium voltage distribution network (i.e. they are not connected to the high voltage network, as in the case of large power plants). The envisaged target in the national policy is to have minimum 10% of NCRE in the electrical energy supplied to the grid in 2015.

In contrast to the policy document, the ministry of power and energy has taken an initiative in 2010 to electrify all the households by 2012 through grid extension. Financial allocations have already been made to CEB to fulfil this target.

Table 1.1 shows the total primary energy supply (TPES) in 2009 [3]. Biomass, petroleum and hydroelectricity are the three main energy resources in Sri Lanka. There are no petroleum resources with the country itself at present and therefore Sri Lanka totally depends on imported petroleum. It is seen from table 2.1, that in 2009 biomass based energy contribution had amounted to 51% while Non-conventional Renewable Energy (NCRE) based energy contribution is less than 1%. Energy based on Solar, Mini hydro, Wind, Biomass (Dendro), Agricultural & Industrial Waste, Municipal Waste & Geothermal etc are considered as NCRE.

Table 1.1 Energy balance for Sri Lanka 2009
(Source:www.iea.org)

	Energy / ktoe	Percentage /%
Hydro	366	3.6
Geothermal, Solar etc	2	0.0
Combustible Renewable & Waste	4738	51
Coal & Peat	53	0.6
Crude Oil	2128	23
Petroleum Products	2024	21.8
TOTAL	**9281**	**100**

The total primary energy demand is expected to increase to about 15,000 kTOE by the year 2020 at an average annual growth rate of about 3%. Electricity and petroleum sub sectors are expected to have annual growth rates of about 7% & 8% respectively. Hydroelectricity and biomass based energy supplies are expected to increase marginally in the future. Thus, the country's incremental energy supply in the

medium term has to be supplied mainly from imported fossil fuels and possible development of indigenous and non-conventional renewable energy will be in the longer term.

1.1 Energy Sector Governance

The Government of Sri Lanka's ***Ministry of Power and Energy*** is the main entity responsible for the management of the Energy Sector as a whole. The Ministry consists of several divisions to discharge its functions in Planning and in the Management of sub-sectoral state institutions. From time to time, the subject of Energy has been combined with others such as Irrigation and Lands, in the establishment of the Ministry.

Ceylon Electricity Board **(CEB)** is the sole national organization responsible for Transmission and distribution of electricity in Sri Lanka. According to 2009 CEB Statistics, 55% of the Gross Generation is by CEB and balance 45% is by Private Power Producers (P.P.P). The total gross electricity generation in 2009 was 9882 GWh. Out of this, 60% was from thermal (auto diesel, heavy fuel & naphtha), 40% from hydro (including small hydro). Solar PV, Wind and biomass had totally accounted for less than 1% of the total gross electricity generation in 2009 [2].

Since the national grid owned by CEB is connected with different types of energy sources such as Hydro, Thermal & Wind, grid extension RE projects cannot be single out to be from renewable resources. Most of the off-grid RE projects are based on renewable resources and carried out with the financial support from various local and foreign agencies.

The Norochcholai Coal Power Station is the first major coal-fired power station in Sri Lanka. The construction of the facility began in May 2006 and the first phase was completed in 2010 which has now added 300MW to the national grid. The second and third phase will add another 600MW and the total plant capacity would be 900MW. Once completed, this would be the largest power plant in Sri Lanka in terms of capacity.

The National Energy Policy has emphasized that after the present two-energy resource (hydropower and oil) status, government will immediately diversify to a third energy resource which is coal. Non-conventional Renewable Energy (NCRE) shall be the fourth energy source in this diversification and security strategy.

Sri Lanka Sustainable Energy Authority (SLSEA) will identify, conserve and manage all renewable energy resources and appropriate conversion technologies, conversion and utilization norms and practices including preparation, maintenance and updating of an inventory of all renewable energy resources in Sri Lanka indicating the geographical location of sites, exploitable potential, land ownership and existing infrastructure facilities. It is also expected to develop guidelines on renewable energy projects and disseminating them among prospective investors and developing guidelines in collaboration with relevant state agencies, on evaluation and approval of on-grid and off-grid renewable energy projects [4].

A regulatory structure in the form of the ***Public Utilities Commission*** of Sri Lanka (PUCSL) is already in place, for all physical infrastructure sectors, inclusive of the electricity and petroleum industries. Although the PUCSL has been already set up under the provisions of the Public Utilities Commission of Sri Lanka Act No. 35 of 2002 to regulate the physical infrastructure sectors, it will be empowered to execute regulation only when the individual industry legislations are enacted and made effective. At present, only the electricity industry, the water service industry and petroleum industry are listed in the PUCSL Act.

1.2 Energy Policy, Strategies and Targets

The national energy policy document which was published in June 2008 is the long awaited first such official energy policy document in Sri Lanka. It has emphasized the use of non-conventional renewable energy (small-scale hydropower, biomass including dendro power, biogas and waste, solar power and wind power) based electricity in the national grid and specified a target of minimum 10% of electrical energy supplied to the grid to be from NCRE by 2015. It has recognized the incentive requirements to ensure NCRE capacity build-up to the NCRE national target and if justified GOSL may subsidize the energy utilities for this purpose. NCRE developments will not be charged any resource cost (royalty) for a period of 15 years from the commercial operation date.

This policy document has specified rural electrification programmes in paragraph 4.12 where a special fund to be created for this purpose with door funds, government contributions and contributions from the future electricity distribution utilities. The institutional responsibility lies with the Ministry of Power and Energy and the Ministry of Finance, assisted by PUCSL. The Government will study the RE practice hitherto and the policies/programs adopted by other developing countries. It has also emphasized the serious consideration of entrusting the management of RE schemes to consumer co-operatives, a policy successfully implemented by some developing countries.

Policy Decisions

According to the policy decisions made by Sri Lanka's Ministry of Power & Energy, all future long-term thermal generating plants will be based on Coal and Oil. Phase ii (300 MW of power) and phase iii (300 MW of power) of the Norochcholai Coal fired power Project will be implemented simultaneously with the implementation of Phase I (300 MW of power) of the project, thereby to ensure addition of 900 of MW of power at the end of 2012.

Another policy decision is to construct a Coal fired power project of 1000 MW of power at Trincomalee by the CEB Jointly venturing with the National Thermal Power Company (NTPC) of India in phase out basis (500MW of power under phase i and balance 500MW under phase ii). Construction of another coal fired power plant of 1000 MW of power at Muttur East site –Trincomallee under Build Own Operate (BOO) basis.

In addition to these coal fired power plants, construction of a 300MW LNG operated combined cycle power Plant at Kerawalapitiya with LNG receiving facilities (Funds committed by JBIC) is another policy decision. It has also been decided to grant permission for the private sector developers to develop and implement Biomass power generation, A 50 MW power plant using waste sugarcane, a Wind power plant of 80MW capacity in Kalpitiya area and a power generating plant using municipal solid waste [5].

It is evident from these policy decisions that with the increasing thermal energy mix in CEB, the losses CEB incurring is mounting up daily with the renewable energy portion being adversely affected by less rainfall. At some time CEB will have no option other than to sell the electricity at least at the cost which at present is not allowed for political and social reasons. Electricity supply plans without taking the global energy crisis into consideration may bring unforeseen economic crisis to the country. It is not worthwhile to exchange one depleting energy resource (oil) with another depleting energy resource (coal) for a sustainable development. Tapping RE resources in the next few years would be the better strategy for Sri Lanka. It would be a questioning approach to solve access to electricity on one hand constructing more and more coal power plants and on the other hand talking about moving towards renewable energy sources.

2. Renewable Energy for Rural Electrification

2.1 Introduction.

Since late 1800s, Sri Lanka has had used micro and mini-hydro for electricity generation and for direct driving of machines in its tea plantations. About 500 such plants were abandoned in 1960s as grid connected supply was available by that time. A few of these micro hydro plants are still in operation in some tea plants. The Sri Lankan small hydro program was initiated in 1979 by CEB. This was followed by NGOs who initially concentrated on refurbishment and demonstration of micro-hydro power in the tea states.

The GOSL energy strategy in 1994 was to optimally develop the energy resources in a least economist cost with sound environment state. By 1994, about half of the available hydro power had been developed. The imported petroleum resulted in a significant trade deficit. There was growing necessity to explore wider range of energy technologies including renewable energy projects. By this time about 300,000 off-grid households were using car batteries for their basic electricity requirements. Due to the high cost of extending the high voltage grid at that time, GOSL took an interest on Solar PV systems and off-grid micro hydro projects. As a result, in 1997, the Energy Services Delivery (ESD) project was prepared by GOSL's Ministry of Power & Energy to encourage the use of renewable energy for rural electrification with the participation of private sector, NGOs and cooperatives. This ESD project also had the global environmental objective of mitigating carbon emissions in Sri Lanka [6].

The Energy Services Delivery (ESD) project was implemented during 1997-2002 by the GOSL with the financial assistance from World Bank (WB) and Global Environment Facility (GEF). Six Participating Credit Institutions (PCIs), namely DFCC Bank, National Development Bank (NDB), Sampath Bank, Hatton National Bank (HNB), Commercial Bank and Sarvodaya Economic Enterprises Development Services (SEEDS) were appointed to assist the ESD project. Both Grid connected and off grid RE schemes using renewable were commissioned.

Under ESD project off-grid hydro schemes were applicable for villagers at a distance of 5 km or more from the existing grid. The ownership, management, finance control and load regulation are carried out by electricity consumer societies (ECS) who consume the power delivered. The ECS deals with the administrative issues such as non-payment of monthly fees and disputes arising among members due to over consumption by some members or non-availability of supply. Most of these projects have the capacity from 5 to 15KW. The project developer identifies a site, motivates the community and organizes them in to an ECS. He also helped them in obtaining necessary clearances and statutory approvals, and approvals for loan from a PCI. The developer was responsible for the supervision of design and installation and training the society members as operators. The initial investment required for site identification had to be borne by the project developer. The consultancy fee of the project is linked to achievement where 50% was paid on PCI approval and the balance at the time of first disbursement by the PCI. The project preparation costs were paid separately from the grant funds subject to a maximum of US$ 9,000. Capital subsidy was based on installed capacity (KW), up to a maximum of US$ 20,000. There were occasional grants from provincial councils. About 30% to 40% of project cost could be covered from the loans directly given to the electricity consumer societies. ESD project also provided technical assistance and capacity building support. Typically these projects were financed from four sources. About 30% of the project cost had to borne by the villagers, about 50% from ESD, 20% from co-financing and occasional grants from provincial councils. At times, Provincial councils provided loans to cover the 30%

equity of the villagers. For SHSs, the credit line provides 80% refinance with 10 year repayment and maximum five-year grace period. On the other hand, GEF grant is used for co-financing, where capital is subsidized according to the SHS capacity.

At the end of 2002, under ESD, 350KW of capacity through 35 village hydro schemes serving 1,732 households and 20,953 Solar systems with a total capacity of 984.6 KW had been completed. The cumulative capacity of grid-connected mini hydro projects commissioned under ESD, at the end of 2002 was 30.88 MW from seventeen projects.

With the success of ESD project, another follow up project called Renewable Energy for Rural Economic Development (RERED) was implemented during the period 2003-2007, to expand the commercial provision and utilization of renewable energy resources. This RERED project was funded by a US$75 million line of credit from the International Development Agency (IDA) of the World Bank and US$8 million grant from GEF. In addition to the six PCIs involved in ESD project, another four PCIs were selected under RERED project due to their keen interest. They were Seylan Bank, Ceylinco Leasing Corporation, Lanka Orix Leasing Company and Sanasa Development Bank. Under this project, the subsidies provided under ESD are continued with two major changes. This project offers consumers to choose the SHS capacity according to their desire and subsides are subject to time-bound declining over the life of the project. The idea of declining grant is that the when a project gets closer to completion, existing business should be able to offer cheaper systems to customers, and thus smaller grants are needed for the same levels of affordability. Under this RERED project, at the end of 2007, another 1,082 KW capacity off-grid village hydro schemes serving 4137 households were completed. The solar home systems installed during this period was 94,242 with a total capacity of 4,185.6 KW. The number of grid connected mini hydro projects commissioned was 35 with a total capacity of 80.16 MW [7].

From 2008, there was RERED-Additional financing of 102.5 million US$, for both grid connected and off-grid renewable energy projects up to 2011. With this additional financing, during the period 2008 to 2011, another 580 KW off-grid village hydro schemes serving 1797 households were completed. This also enabled installation of another 16,333 solar home systems with a total capacity of 619.7 KW. The grid connected mini hydro projects commissioned during this period added another 60.34 MW to the grid with 21 projects. The cumulative approvals and disbursements of credit for grid connected and off-grid renewable projects under RERED and RERED-Additional financing as at June 30, 2011 is given in Table 2.1.

Table 2.1 RERED & RERED-Additional Financing as at June 30, 2011 [7]

		Approval / Rs. million	Disbursement /Rs. million	%
Grid connected	Hydro	9,602.9	7,545	78.57
	Wind	882.0	882.0	100
	Biomass	20.8	20.8	100
Off-grid	Solar PV	2,252.3	2,248.4	99.8
	Hydro	29.1	18.9	64.94
TOTAL		12,787.1	10,715.1	

Under RERED project, loans for individual investments or sub projects are disbursed through Participating Credit Institutions (PCIs). These PCIs will evaluate the sub projects for financial viability, Engineering Standards, Environmental compliance and economic justification. The executing agency of

the RERED project is the Administrative Unit (AU) set up within DFCC Bank. Fig. 2.1 shows the RERED Financing Model for Micro Hydro Sector in Sri Lanka.

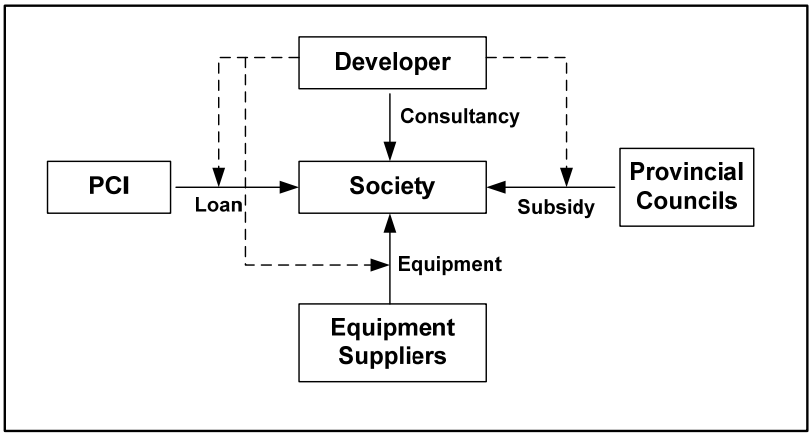

Fig. 2.1 Micro hydro sector financing by RERED in Sri Lanka [7]

There are sub-projects which are investment projects utilizing the credit and/or grant funding provided by the RERED Project. An investment enterprise eligible for financing may be any private enterprise, non-governmental organization (NGO), co-operative or individual operating in Sri Lanka. Subject to meeting PCI's credit worthiness assessment, they obtain medium or long-term sub-loans from PCIs to establish eligible sub-projects and procure assets.

Fig. 2.2 shows the geographical distribution of grid connected projects approved under RERED and RERED-Additional financing as at 31st December 2010. Accordingly, grid connected hydro capacity is 160.8 MW (69 projects) and there is one wind plant of 10MW. The first grid connected biomass based power plant of 1.0 MW was commissioned in Walapane in October 2004 within the Small Power Purchase (SPP) scheme of CEB. In addition to this, a small scale biomass based power plant of 0.3 MW capacity is in operation at a Factory in Madampe, producing electricity for the use of the factory.

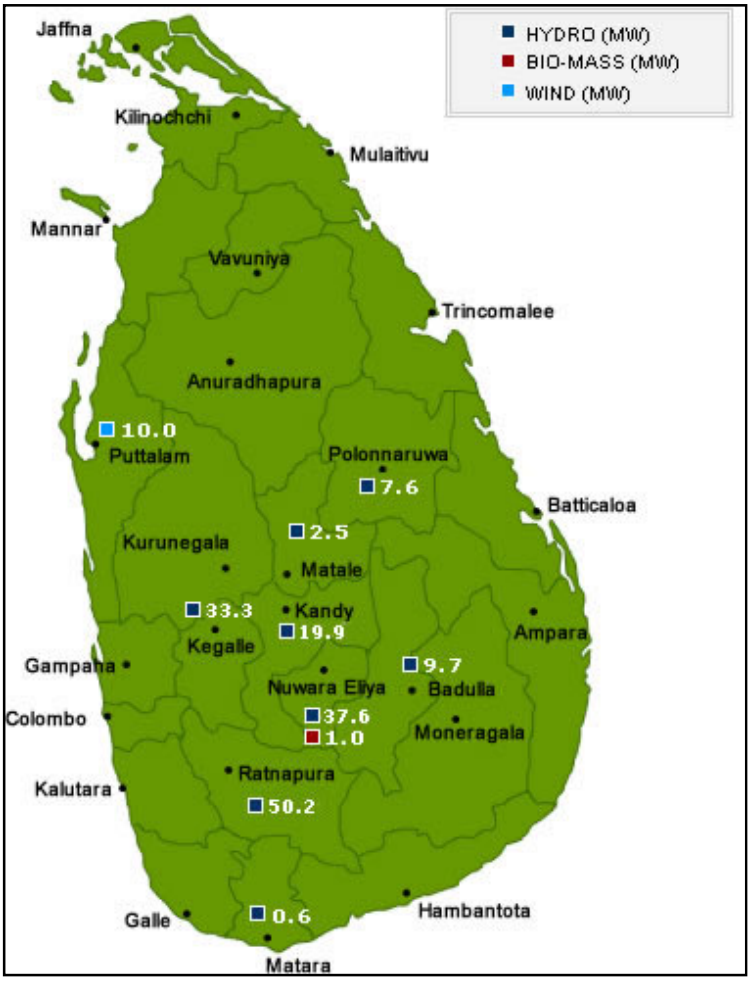

Fig. 2.2 Geographic distribution of grid connected projects approved under RERED & RERED-additional financing as at 31 December 2010 [7]

Rural electrification through grid extension is the preferred political option for rural electrification in Sri Lanka. According to Statistical Digest 2009 of CEB, at the end of 2009 a total number of 18,614 grid extension RE schemes have been completed. These RE schemes were funded by ADB, Government of China, ADB, NORAD and SIDA. Regardless, off-grid renewable energy based systems make an important contribution providing electricity to rural areas unlikely to be served by the national grid in the medium and long term. The RERED project aims at electrifying 160,000 remote rural homes through solar home systems, off-grid village hydro and biomass projects.

Fig. 2.3 shows the geographical distribution of off-grid projects approved under RERED and RERED-Additional financing as at 31st December 2010. There are ten hydro, twenty- five solar and one biomass based off-grid projects as shown in fig. 2.3.

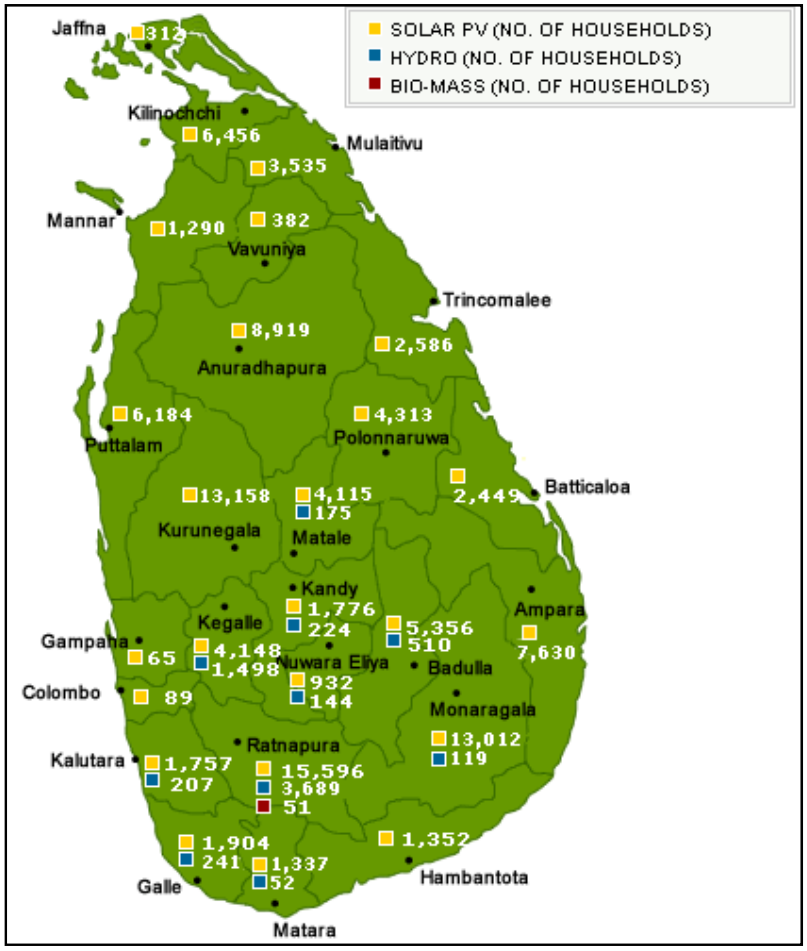

Fig. 2.3 Geographical distribution of off-grid projects approved under RERED & RERED-additional financing as at 31st December 2010 [7]

The off-grid biomass project is to serve 51 households whereas solar home systems are to serve 108,653 households. Off-grid hydro will serve 6,807 households. The cumulative solar home systems systems installed under ESD, RERED and RERED-Additional financing at the end of 2010 was 124,800 and the total installed capacity was 5.5MW.

ESD and its follow-on project, RERED are the most successful national solar home system projects in Sri Lanka. This model has been replicated in Bangladesh, the Philippines, and several African countries.

2.2 Solar Power Development

Sri Lanka being a tropical country, solar radiation over the country does not have a marked variation. Fig. 2.4 shows the solar resource map of Sri Lanka prepared by National Renewable Energy Laboratory (NCREL) of USA. Some significant spatial difference in solar radiation could be seen between upcountry and down country regions. Most of the flat dry zones of the island receive 4.0-4.5 KWh/m2/day solar radiation. Since most solar energy is used in non-commercial purposes, the total solar energy has not been

quantified properly. In fact CEB pioneered the introduction of solar PV during early 1980s. It is obvious from the map that Sri Lanka has substantial potential of solar energy to be harnessed.

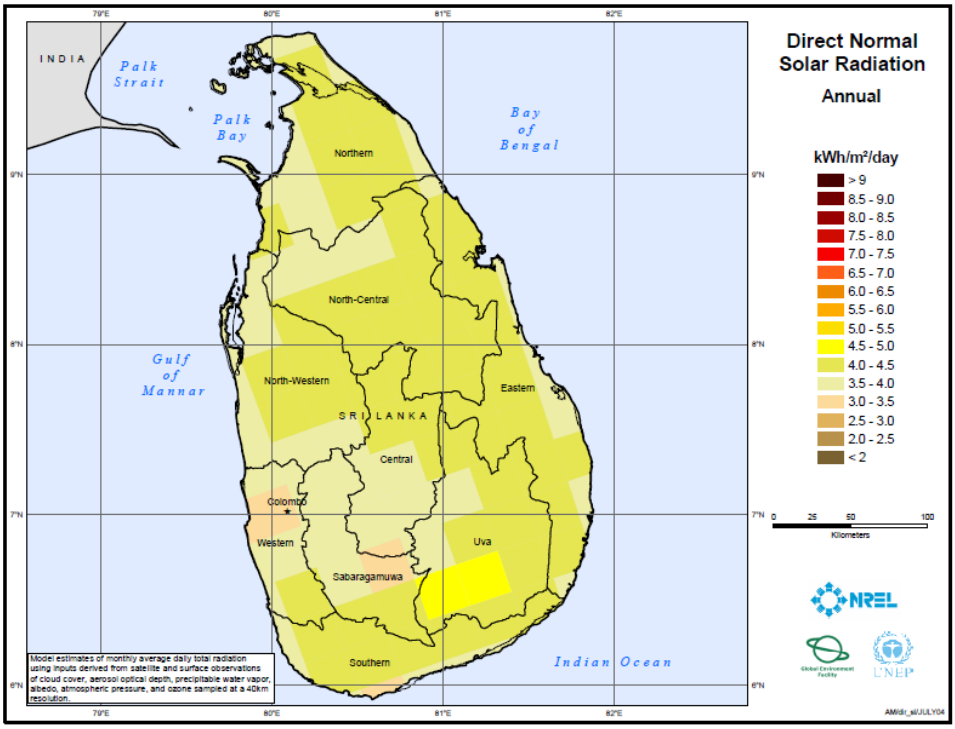

Fig. 2.4 Solar resource map of Sri Lanka [15]

2.3 Wind Power Development

Fig. 2.5 shows the wind resource map of Sri Lanka prepared by NCREL. Moderate wind energy potential of 300-400 W per m2 at 50m is available in the coastal and central regions. The hilly area has the excellent wind potential over 800 W per m2. Sri Lanka is yet to harness the wind energy potential to a significant level. It is estimated that about 5,000 km2 of windy areas with good potential is available. The windy land area is about 6% of the total land area of 65,600 km2. About 20,000 MW of wind potential can be estimated with the assumption of 5 MW per km2 of wind energy [4].

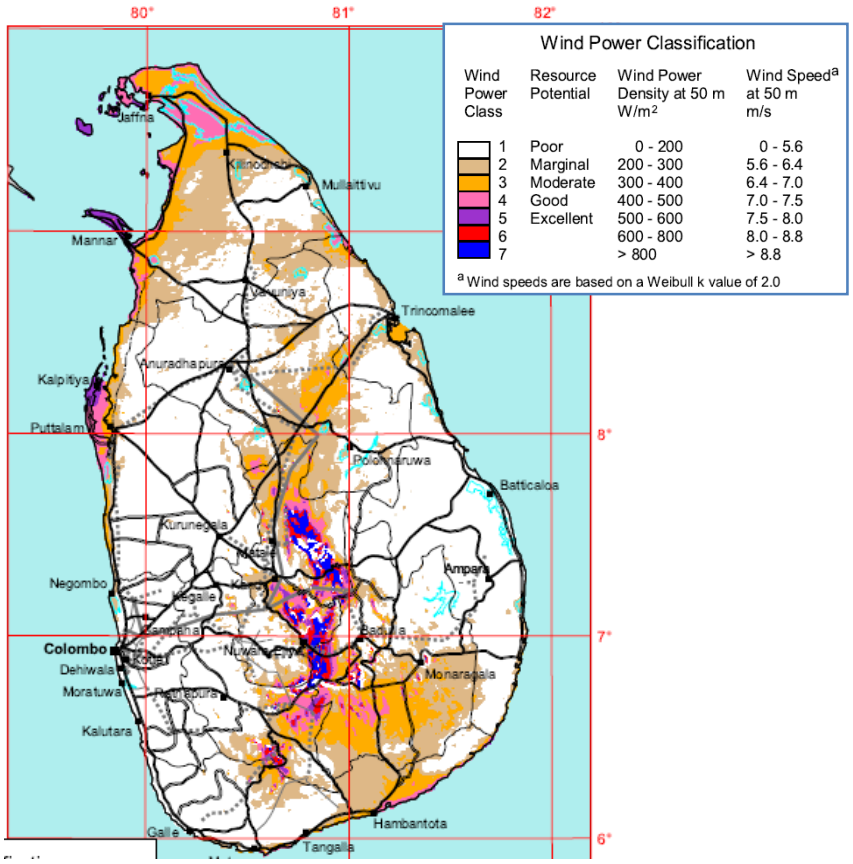

Fig. 2.5 Wind resource map of Sri Lanka [15]

The first grid connected wind power plant of 3 MW capacity was commissioned by CEB in 1999 in a 17 ha land at Hambantota as a pilot project. This plant consists of five wind turbine generators of 600 KW each. CEB has received several proposals from private investors under Standardized PPA to develop wind power plants in Kalpitiya area. As seen from the wind resource map in fig. 2.4, this area has an excellent wind power density of more than 800 W per m². A 50MW wind power plant was under consideration at the end of 2007. Sri Lanka can follow the neighbour India to have an in depth study on the wind potential. The total installed wind power capacity in India in 2010 was 12,276 MW and it was expected to reach 24,026 MW by 2020. The cumulative grid connected wind power target set by GOSL by 2015 is 85 MW [4]. Wind power projects have high upfront costs and therefore Private Public Partnerships (PPPs) or Build Operate and Transfer (BOT) models will be the most suitable models.

2.4 Dendro Power

Biomass based electricity generation has the advantage of non-energy benefits to rural socio economic development. In fact it deserves an incentive price to attract private investors. This is also a better technology for rural electrification. GOSL had granted cost based, technology specific three-tiered tariff for the biomass power generation. At the end of 2007, two projects of 2MW capacity each, were in operation and seventeen projects, each having 18.55MW capacity was under consideration.

2.5 Subsidies for RE Projects

Direct and indirect financial support ("subsidies") to promote rural electrification through renewable energy has been a major boost to this sector in Sri Lanka. Public subsidies come in different forms. It can be direct subsidies including grants and low-interest loans, tax incentives, R & D spending, liability insurance, leases, land rights-of-way, waste disposal and guarantees to mitigate project financing or fuel price risks. Indirect subsidies include government intervention and trade restrictions and various forms of energy sector regulation. Subsidies should be able assist the poor to get a quality electricity service and to provide incentives to RE business to serve poor and remote.

In Sri Lanka, renewable energy project direct subsidies are channeled through provincial councils from its decentralized budget for energy. Political interest, selectivity, corruption practices, and the lack of knowledge and interest of the provincial council staff about RE technologies are some of the drawbacks in this system. Regardless, the provincial councils are encouraging small hydro in a big way and more than 50% of small hydros have received some contribution from provincial councils. However, subsidies need to be 'smart', i.e. they should be transparent, not open-ended and targeted to the correctly identified groups. They also should not be complex so that the targeted groups can be easily identified, and should not be restrictive on renewable energy technology. [8] Subsidy schemes for grid-connected, off-grid village hydro and Solar PV systems should be based on different terms. In general subsidy policies should be well-targeted, efficient, soundly based, practical, and transparent and be limited in time.

When the grid connected electricity tariff is not cost reflective, renewable energy lies at a competitive disadvantage. This is the case in Sri Lanka and a major contribution to the discontinuation of SHS regardless of the subsidy schemes. Basically the off-grid technologies have become the second choice for the consumers till they get the grid connected electricity.

2.5 Sustaining off-grid electrification projects

Sustaining the operation of off-grids electrification projects is vital for the expansion of such projects. Therefore attention must be paid at the design stage for the sustainability. Otherwise gradually off-grid projects would become unattractive to the developers. Fig. 2.6 shows the elements that have to be taken into consideration for sustainable off-grid electrification project development [9].

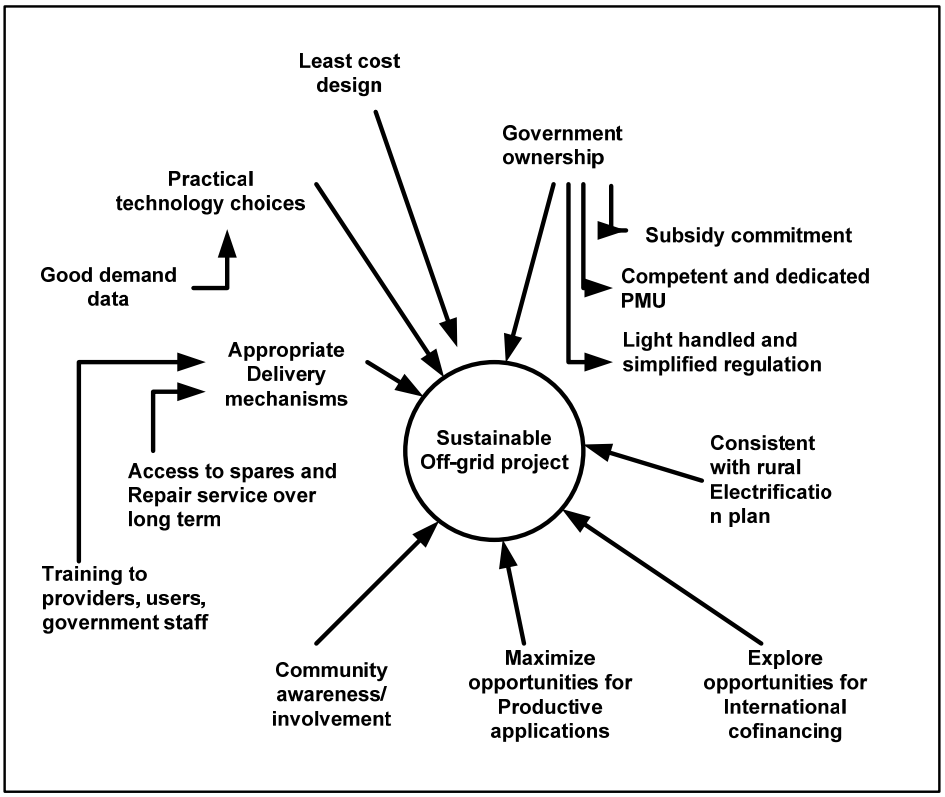

Fig. 2.6 Elements for sustainable off-grid electrification [9]

It is important that the developing of off-grid projects fall in line with the overall rural electrification plan. Ad-hoc decisions such as availability of funds or political pressure may lead to the projects unsustainable. It is necessary to obtain the government's subsidy commitment upfront, to manage any subsidy lack that may arise once the external financing ceases with the completion of the project. A local project management unit (PMU) comprising experts, experience and skilled people will be required together with simplified regulations from government for private-sector participation.

Once it is determined that a certain community cannot be served via grid extension, then choose of appropriate technology should be based on the available energy resources, baseline data for energy consumption, income and willingness to pay among the community. It should not be merely technology driven. The choice of technology should be based on technology maturity, availability of adequate resources and operation and maintenance considerations. It is also important to carry out a cost-benefit analysis of alternatives to determine the least cost solution.

Community awareness/involvement from the inception of the project with regular meetings with community leaders need to be conducted and they should be given the opportunity to take active involvement in the project. When off-grids projects need funds from private sector, a simple business model need to be in place. The design must take into consideration the capabilities of local service providers, appropriate technical standards, access to adequate financing, timely disbursement of funds and address the risks involved in all these steps.

Appropriate training at various levels need to be arranged. These training may include government officials, service providers, consumers and other stakeholders and may range from a broader level to basic training such as operation of the business. It is also important to maximize the economic attractiveness of

the off-grid projects. One way of achieving this is to incorporate other community applications such as information and communication technologies that may improve the social and economic standards and generate new revenues. The high capital costs involve in micro-hydro and other RE technologies may otherwise not be economically justifiable providing only lighting and other basic household requirements. It should also be noted that the RETs that use Wind, hydropower and Biomass may face serious limitations imposed by seasonality of resources. Alternative solutions should be implemented in such cases to maintain supply reliability.

It is also important to take the advantage of the opportunities provided by international co-financing sources such as World Bank's Global Environment Facility (GEF), Global Partnership for Output Based Aid (GPOBA), Asian Development Bank (ADB), Clean Development Mechanism (CDM) of the Kyoto Protocol and other bilateral agencies. Grants could be obtained from these sources for training programs, specialized demand studies, preparatory activities etc.

As a consequence, designers of off-grid renewable projects should bear the responsibility for the sustainability. A clear understanding and follow up of above mentioned factors at the project inception itself is vital.

3. Financial and Institutional Models

Rural electrification is not an attractive investment for private investors looking to maximize their return. There are state-provided schemes that are run by private investors profitably by cutting costs. Reasons may be less staff, tariff adjustments etc. Experience also shows that private sector itself will not expand the access rate without contractual obligations such as additional incentives. This is because rural areas are considered high risk and low-return markets. Therefore most of these schemes have been given to private investors on very favorable terms and conditions.

Certain development finance institutions may provide guarantees or credit packages especially for community micro hydro. Currently little interest is seen from the conventional banks for these projects. When the schemes are accredited or supervised by an intermediary agency, the conventional banks can be encouraged at least to provide a proportion of the capital.

3.1 Financial Models

3.1.1 Traditional Public Ownership

Traditional Public Ownership and financing model used in Sri Lanka and in most developing countries is shown in Fig. 3.1 where vertically integrated public monopoly generates transmits and distributes power to end-use customers [10]. Electricity supply is often viewed as a socio-economic service and a risky political issue. In Sri Lanka, regardless of the recent restructure of the Public monopoly, CEB, this is the financial model still being largely used for power sector development including grid connected rural electrification schemes. Typical sources of financing for this model are from utility's internal resources, host government budgets, soft finance through multilateral agencies and loans from foreign export credit agencies [10].

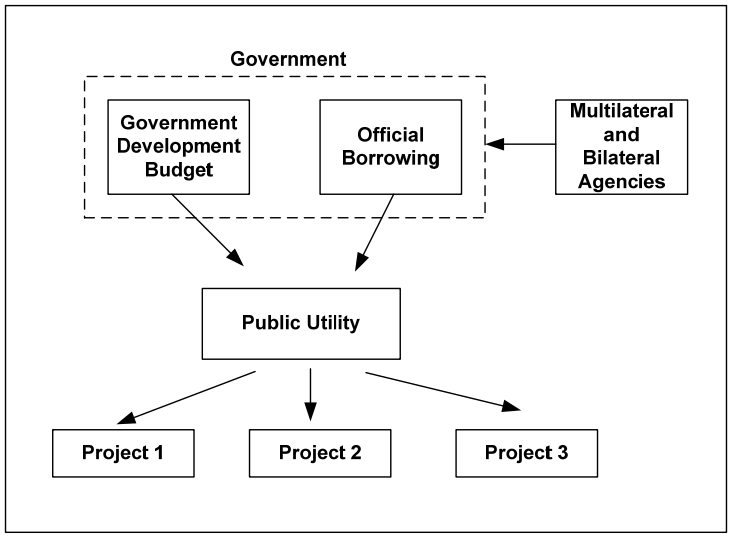

Fig. 3.1 Traditional public ownership and financing of power projects [10]

The government usually obtains loans from multilateral and bilateral agencies for rural electrification schemes via grid extensions. Although this is the general picture in Sri Lanka too, sector reform has initiated the invitation of private and foreign public investors for the business of generating electrical

power. The host government usually provides sovereign guarantees to secure the financing from other governments.

3.1.2 Project Financing Model

When private sector is involved in the ownership of power assets, the financing arrangement become more complex, time consuming and involve numerous sources. Here the private sector forms a special company to develop, build and maintain and operate the asset for the contracted period. With a special purpose company, this financing model is commonly known as the project financing model. Fig. 3.2 gives a general picture for a power generation project.

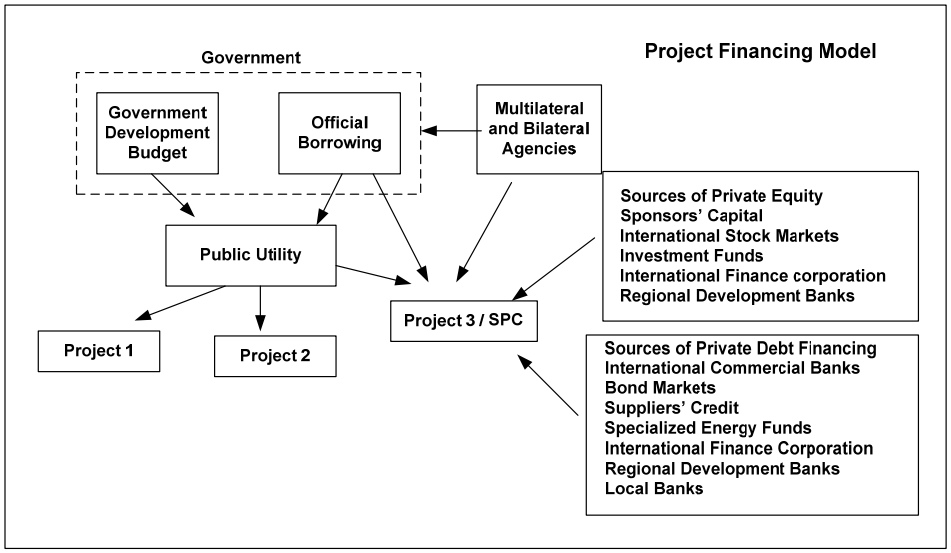

Fig. 3.2 Project financing model [10]

As seen there are numerous sources of finance for this sort of project financing models. The most common sources for project financed investments are equity from private/foreign investors plus host governments, International commercial sources, Local bonds, other financial markets and International and domestic guarantees.

Though traditional public financing model and project financing model are defined in different terms, the sources of funding tend to converge in developing countries. These project financing models usually apply to power generation projects as can be seen in Sri Lanka and other developing countries. Traditional financing models usually apply to power transmission and distribution.

3.1.3 Public-Private Partnership (PPP) financial model

In most developing countries, rural electrification has been separated and dedicated to a separate organization. In this model, government funds, donor funds and other funds are pooled and channelled

through this organization dedicated and responsible to rural energy service provision and funding. Funds are awarded on a competitive basis to project developers.

The goal is to achieve a high degree of cost recovery by buying down capital costs with upfront subsidies. This model usually attempts to implement de-politicization of rural electrification, attract private investors, implementation of priority projects and efficient allocation of capital subsidies. Fig. 3.3 shows the PPP financial model for rural electrification. Both public utilities and private investors can compete for the project and avail the capital subsidy that is provided to promote long-term financial viability.

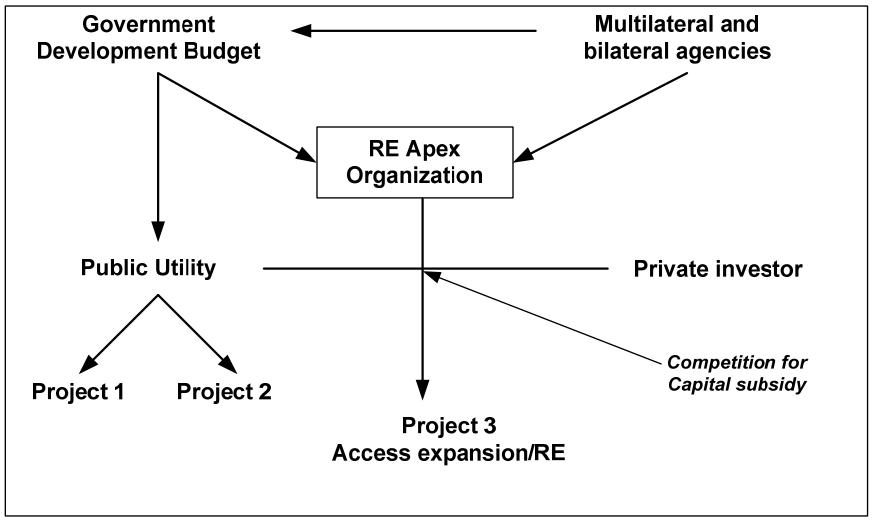

Fig. 3.3 PPP model for rural electrification [10]

It is the responsibility of the RE apex body to provide a wide range of technical and institutional services to the consumer owned cooperatives.

3.1.4 Micro-Credit Financing Model

Micro-credit financing scheme has been found to be an effective way of providing the poor with increased self employment opportunities and make them credit worthy. It also equally applies in the off-grid renewable energy sector. For example, Solar Systems are purchased by villagers through micro-credit financing. Each family pays for its own system and participates in the ownership of community systems, spreading development funds to help more people. Fig. 3.4 shows the elements of a Micro financing model for renewable technologies for rural applications [11].

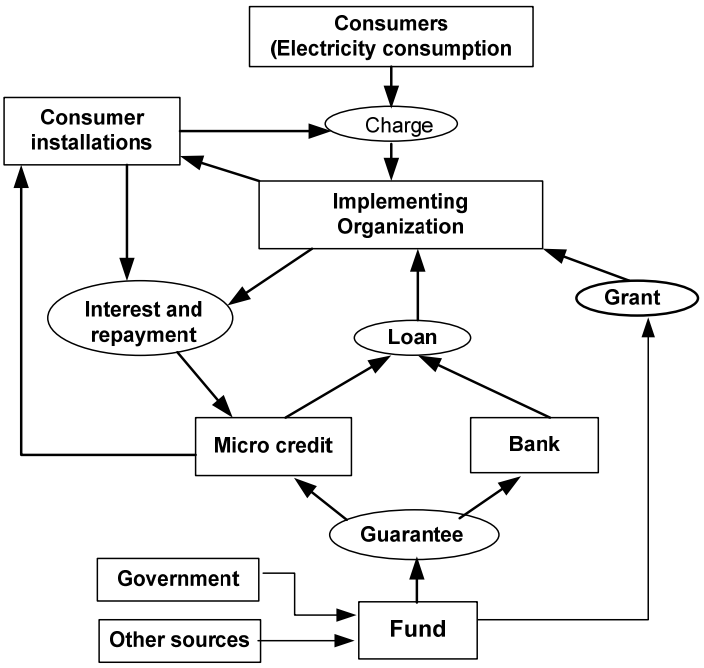

Fig. 3.4 Elements of a micro credit financing model [11]

The fund can be a grant, soft loan or a commercial loan and can be a mix of government and other sources such as NGOs, development agencies and private companies. As seen from the figure 3.3 this model has both direct sales and fee for service models incorporated.

The consumers can purchase the RE installations installed and maintained through an implementing organization or can directly purchase through the finance obtained from the micro credit organization. The implementing organization takes a loan from the micro credit organization or from the bank. These implementation organizations may also receive direct grants from the fund. Due to the technical nature and the necessary operation and maintenance, usually consumers prefer the installation to be installed and maintained by the implementing organization that will have the required technical expertise. In such cases a service fee will be charged from the consumer. The tariff will structure will reflect whether the consumer installations are paid by the consumer or not.

3.2 Other Financial Models in developing Countries

In India, *Single point supply through user associations'* is being tried out, under which inhabitants of a cluster of villages form an association, which handles power distribution from the feeder level onwards. The association, which gets an outlay from the Government for setting up new connections and for the upkeep of the system, is also entrusted with the task of collecting charges from users.

Another model is being tried out under which *a person is chosen* by the villagers, on the lines of a chief executive, and is given the responsibility of overseeing the work of the State-owned utilities. Another model is being experimented with is, under which a cooperative formed by villagers would set up stand-alone power generating systems such as bagasse-fuelled captive units. The cooperative has to collect

charges from users, part of which goes into paying back the investments incurred by the Government on setting up the unit.

The basic aim of all the franchisee models being tested out currently is to include the local population as much as possible in the planning and execution of the projects that the State funds. The Indian government expects the end-users to become stakeholders in these projects and to replicate the successful models across the country on a larger scale to achieve complete household electrification over the next five years.

In Nepal, electric co-operative concept is being implemented. It is a socialist approach to make people responsible for local management of electric energy distribution by the process of participatory management [16]. The difference between other co-operative societies and this electric co-operative concept is that this is no-profit driven and provides service to their consumers. However, all these co-operative concepts will operate on sound business practices and will be responsible for transparency and accountability, democratic control or mutually agreeable decisions. Financial viability will have to be maintained. The surplus or savings will be distributed among the members.

Another financial model for off-grid renewable projects is to make the *community to become the owner and operator*, providing maintenance, tariff collection and management. Since the community may lack required technical skills, it will be necessary to provide substantial technical training and support. Private investors are unlikely to take up this type of RE projects. In Sri Lanka, community owned and managed micro-hydro schemes, the communities borrow about 15-20% of the capital cost from banks to supplement the subsidy they receive. In China, more than 700 centralized, PV micro-grids, each with a 10-15KW capacity are managed by another business model [9]. Here a public utility or a government contracted energy service company operates a small grid. The tariff is regulated and the operator is provided a subsidy by public sources or from a cross-subsidy. The Philippines also had used this model for many years to fund the isolated diesel operations [10].

Some models are a hybrid of the above mentioned models. The leasing model is a variation of above models. Here SHSs are provided to consumers on lease or lease-to-own agreements. This model has not been practised in Sri Lanka but has the potential to be a successful model for communities without access to electricity and to the urban consumers who are already struggling with the high tariff rates. Since the electricity tariff structure in Sri Lanka is based on segments or blocks, Solar PV could be a supplement to avoid reaching the high tariff segments.

3.3 Institutional Model

The institutional responsibility of electrification of houses lies with Ministry of Power and Energy and PUCSL. Ministry of P&E is responsible for preparing a long-term electrification plan which is to be updated yearly. PUCSL will be responsible for its implementation with the support of electricity utilities, SLSEA, Provincial councils and stakeholders. It will also prepare plans and implement the provision of targeted subsidies. Ceylon Electricity Board is the main electrical utility coming under Ministry of power and energy.

Fig. 3.5 shows the elements of the institutional model that is in practice for RE in Sri Lanka. The grid connected RE producers come into power purchase agreements with CEB after due process. Authority of issuing licenses for both grid connected and off-grid RE schemes is coming under SLSEA.

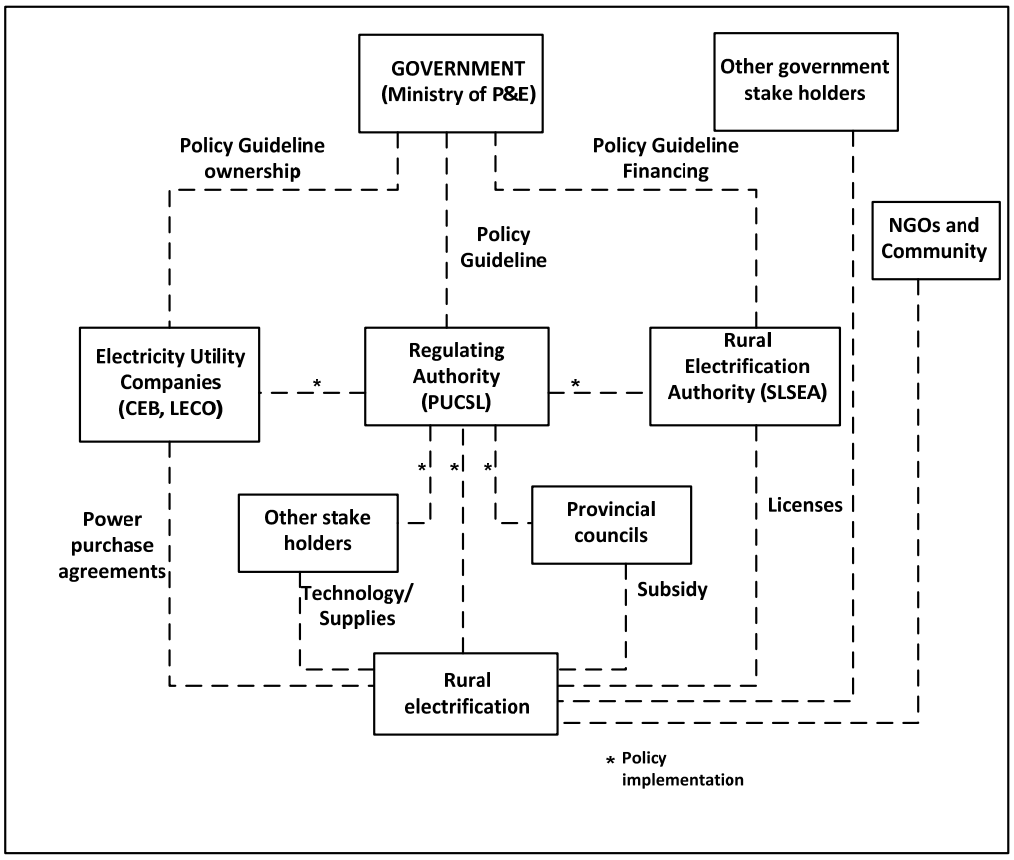

Fig. 3.5 Elements of the institutional model for RE in Sri Lanka [4]

The power purchase agreements (PPAs) between CEB and producers are governed by the government policies and PUCSL guidelines. Subsidies are managed through Provincial councils in addition to the government subsidies such as import concessions, fuel prices and fiscal incentives. Other government stake holders are the ministries and departments whose approvals/clearances play a vital role for the project progress. There are also NGOs or communities who may object certain RE projects on environmental or social and economic grounds.

4. Stakeholder perception survey

This thesis study also covered the perception of the stakeholders of electricity sector especially, power producers, financing companies and NGOs. Sri Lanka has a limited number of financial institutions and NGOs dealing with rural electrification projects. But there are considerable numbers of producers especially in the small hydro sector. About 46 power producers, 12 financing companies and 6 NGOs were approached for the survey out of which 11 power producers, 4 financing companies and 2 NGOs responded. The questionnaire was emailed/ posted and some stakeholders were contacted over the phone. The response rate was only 27%. The response rate of the questionnaire is shown in Table 4.1

Table 4.1 Response rate of the questionnaire

Sector	**Number sent**	**Number responded**	**Remarks**
Financial Institutions	12	4	Commercial banks, International agencies
Power Producers	46	11	Private IPPs and SPPs
NGOs	6	2	NGOs working in the renewable energy business

The main objective was to get the stakeholder perception of the gravity of the given barriers that may impede the rural electrification program reaching the poor and remote. The respondents were requested to rank the given barriers in a ranking scale so that those barriers could be analysed. Similarly, certain barriers were requested to give weights. It was also attempted to the get views on the existing financial and institutional models and issues related to subsidy.

Some key questions of this survey are discussed here, with the response received.

4.1 How do you rank the following barriers when it comes to financial viability of rural electrification? Rank in a scale 1 to 5 (1=most severe barrier, 2=second most severe barrier and so on).

Interest rates for commercial lending are still high and large collateral amount if often required for RE projects. The conditions are unattractive for capital requirements. The mandated minimum collateral volumes generally preclude the financing of small off-grid projects. Commercial debt is often required for financial closure, as user payments and subsidies do not cover the initial investment. The local bank's experience with rural electrification increases the perceived risk and in turn, the interest rates.

Energy projects, in general, do not take lifecycle cost analysis into account. RE technology projects are more capital intensive. These have less operation and maintenance intensive than conventional energy projects. However the per unit cost of electricity generated by such renewables plant are generally higher than the conventional plant but there is no policy currently which gives special treatment for such renewable energy generation so that it can complete with conventional technologies. The concessionaire's capacity for investment considerably reduced with the losses they incurred resulting from energy shortage and the market practices adopted during these shortages. Low income households, generally lack financing, especially with regard to volume and credit period. Micro credit organizations in Sri Lanka often

consider solar home systems to be consumptive technologies and do not finance them. Equipment is often not recognized as collateral. When compare to the volume, the transaction costs are very high for rural users.

Table 4.2 shows the ranking of given financial barriers. This question was an attempt to get the views of the barriers for the marginal portion of the rural electrification in the country's energy sector. The respondents were asked to rank the given list of barriers in a raking scale of 1 to 5 giving 1 for the most severe barrier, 2 for the second most severe barrier and so on.

Table 4.2 Ranking of financial barriers in the rural electrification

Financial Barriers	Average	Min	Max	Std Dev
Lack of attractive financing conditions	1.92	1	4	0.954
Lack of commercial financing for RE providers	2.15	1	5	1.281
Lack of special treatment for renewable energy	3.08	1	5	1.324
Current Financial situation of concessionaries	3.23	1	5	1.423
Lack of financing possibilities for low-income households	4.15	2	5	0.987

Lack of attractive financing conditions has been regarded the most severe barrier with an average ranking of 1.92 followed by lack of commercial financing for RE providers with a close average ranking of 2.14. Lack of special treatment for renewable energy has been ranked the 3rd with an average ranking of 3.08 followed by Current financial situation of concessionaires (3.23) and lack of financing possibilities for low-income households (4.15)

4.2. How do you rank the following barriers typical for Sri Lanka that may impede the rural electrification program reaching the poor and remote? Rank them in a scale 1 to 6 (1 = most severe barrier, 2 = second most severe barrier, 3 = third most severe barrier and so on. Ties in the ranks are allowed. Please add any more.

The need to provide electricity service to the rural population is treated as a political issue and also a popular political pledge during elections in Sri Lanka. Most of the political decisions are biased, selective, and corrupt and RE schemes need much political patronage regardless of government energy policy decisions. With the number of government ministries exceeding 50 at present, and the subjects being distributed among them without proper coordination or understanding, the procedures have become more complex. Ministries and public departments, who are stakeholders in the energy sector, often have their own interests. In case of a land acquiring and getting environment clearance for a mini hydro project, as these institutions have their own interests and responsibilities, the RE projects do impede in progress or sometime being abandon. Off-grid renewables sector lacks technical standards and customer service standards. There is no mechanism for subsequent grid connection.

The marginal RE opportunities in Sri Lanka are in more remote areas where private investors take little interest. Most Independent power producers either do not have the interest or resources to support research and development of new renewable energy technologies. Usually this is left to equipment

manufactures or technology-dedicated developers. Lack of knowledge, misunderstanding and bias has acted as deterrents to the wider utilization of renewable energy technologies. Small RE market has resulted in lower manufactures and equipment suppliers.

This question was another attempt to get the views for another list of barriers from respondents experience and knowledge in RE sector. The respondents were asked to rank the given list of barriers in a raking scale of 1 to 5 giving 1 for the most severe barrier, 2 for the second most severe barrier and so on. The given list of barriers and the ranking is shown in table 4.2.

Table 4.3 Ranking of the barriers typical for Sri Lanka.

Barriers	Average	Min	Max	Std Dev
Political Influence	1.615	1	3	0.650
Environmental clearance/Approvals	1.846	1	3	0.800
Legal and regulatory framework of the country	3.615	1	6	1.386
Financial viability of RE Projects	3.769	1	6	1.363
Technological know how	4.307	1	6	1.493
Lack of suppliers and plant and equipment	5.307	4	6	0.751

Respondents have ranked political influence as the most severe barrier with an average ranking of 1.615 followed Environmental clearance/approvals by a close average ranking of 1.846. Legal and regulatory framework of the country has been ranked the 3rd (3.615) followed by Financial viability of RE projects (3.769). Technological know-how has been ranked the least severe barrier with an average ranking of 5.307

4.3) Do you consider the existing subsidy to be 'smart'? i.e. they are not open ended, transparent and available to the users (not suppliers) for the initial cost, not running cost Tick the statement you agree with.

Subsidies in real sense represent good intentions of the society and the governments. But the implementation may go astray. The effectiveness of subsidy depends on how they are designed and implemented. The benefit of electricity subsidies is that they counter market distortions and barriers. This enables the poor to obtain a quality electricity supply which otherwise would not have been possible. They also could introduce and strengthen the service providers. However electricity subsidies have often failed to fulfil the objective of making the electricity services more affordable to the poor.

This question was asked from the respondents from producers and NGOs about their perception on smartness of the existing subsidy policy. They were given three options (yes, no, partially) to tick and requested reasons or to comment on their option. From the respondents, 60% was on the opinion that the existing subsidy was not smart. 40% viewed it to be partially smart and none considered it as smart. Few commented that the subsidy is politically biased and not transparent at all. Fig. 4.1 shows the graphical representation of the response received.

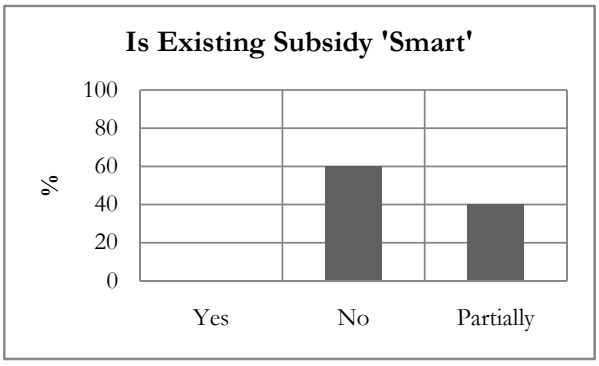

Fig. 4.1 Response to the question whether existing subsidy is 'smart'

A few respondents were not satisfied with the procedures they have to follow and commented on the political patronage needed to get things moving. Some respondents were only concerned about the direct subsidy they receive and were lacking the knowledge of the indirect subsidies the government place on RE based projects.

4.4 The Government of Sri Lanka has envisaged developing the renewable energy resources to reach 10% of total electricity by 2015. The investment opportunities available in these areas are given below. As a producer how do you rank the following Financial and Institutional barriers that may hinder the expected target? Rank in a scale 1 to 5 (1= most severe barrier, 2=second most severe barrier and so on) Please add more as appropriate. Ties in ranks allowed.

The investments opportunities given in this question are shown in Table 4.4.

Table 4.4 Investment opportunities for RE projects in Sri Lanka [1]

	Type	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Electricity Generation Cumulative Capacity (MW)	Biomass	20	31	42	53	64	75	80	91
	Mini Hydro	134	151	168	186	203	220	250	267
	Wind	30	54	78	102	125	149	170	194
Investment Opportunity / LKR Mill		5724	5724	5724	5724	5724	5724	5724	4057

Renewable energy resources are either free or low cost but conversion technologies have a higher investment cost per kW compared to conventional energy resource conversion. Thus renewable energy investments require higher capital investment than conventional energy investments for the same capacity. Since the capital being risked up front than conventional energy projects, capital markets may demand a premium in lending rates and renewable technologies may also face high taxes and import duties. Excessive collateral may be required, as the financial institutions are in particular not familiar with non-recourse project financing. Proven, cost effective technologies may still be considered risky ventures if

there is little or no experience with them. Ignorance of the technology, misunderstanding and bias may unjustly put the renewable energy project too risky to deal with and may face increased lending rates. Utilities, on the other hand may be hesitant to develop and maintain unfamiliar technologies. Project developers often lack either technical or financial skills. Government officials and lending institutions often lack information about renewable energy project's economical and financial costs and benefits. The lack of skills and information may impede or block decisions. Since information about the performance of renewable energy technologies are not ready available, banks may require more time and cautious approach. This may result in high transaction costs compared to conventional energy projects. In practice some transaction costs such as utility fees for engineering reviews and inspection may be unnecessarily higher. [13]

The list of list barriers given is shown in ranking table 4.5. This question was an attempt to get the views of the financial and institutional barriers in reaching the anticipated GOSL's renewable energy target. The respondents from Producers and NGOs were asked to rank the given list of barriers in a raking scale of 1 to 5 giving 1 for the most severe barrier, 2 for the second most severe barrier and so on.

Higher investment cost has been ranked the most severe barrier with a ranking average of 1.417 followed by Lack of access to capital as the second most severe barrier with a close average ranking of 1.750. Perceiving technology risks has been ranked the third most severe barrier (3.333) followed by High transaction cost (4.083) and Lack of technical or commercial skills and information (4.417)

Table 4.5 Ranking of financial and institutional barriers

Financial Barriers	Average	Min	Max	Std Dev
Higher investment costs	1.417	1	2	0.515
Lack of access to capital	1.750	1	3	0.622
Perceived high technology risks	3.333	1	5	0.985
High transaction costs	4.083	3	5	0.900
Lack of technical or commercial skills and information	4.417	3	5	0.669

4.5. How do you evaluate the suitability of following financial models for RE development in Sri Lanka? Please rank in a scale 1 to 5 where 1=most suited model, 2 = second most suited model and so on. Ties in ranks are allowed. Your reasons/comments will facilitate our analysis. Pl. add any other model appropriate and rank accordingly.

Private sector participation in rural electrification through renewables is hampered by several constraints such as lack of access to suitable financing, viability of the RE projects, perceived high risks, legal and regulatory framework. Private participation in off-grid renewable projects is yet to make adequate progress. For these off-grid projects to become attractive to private investors, subsidies will be an important factor where access to subsidies remains difficult at present. Traditional financing and project financing primarily focus on large scale power generation, Transmission and distribution projects. RERED has been a successful project for the off-grid projects in Sri Lanka, but it has finance limited, defined time period and totally depends on the donor agencies. Public-private partnership is an emerging

model with a dedicated organization for Renewable energy, as in Sri Lanka. In India, a separate ministry has been formed for Renewable energy sector.

The list of five financial models given with the questionnaire is shown in Table 4.6 with ranking average and standard deviations. The respondents from financial institutions have ranked public-private partnership model as the most suited model with an average ranking of 2.0. This has been closely followed by RERED financing model with an average ranking of 2.5. Traditional public ownership and financing model has been ranked the third most suitable model (3.0) followed by project financing model (3.5) and private financing model (4.0).

Table 4.6 Ranking of suitability of existing financial models

Financial Model	Average	Min	Max	Std Dev
Public-private partnership financing model	2.000	1	5	2.000
RERED financing Model	2.500	2	4	1.000
Traditional public ownership and financing Model	3.000	1	5	1.633
Project financing model	3.500	2	4	1.000
Private financing model	4.000	3	5	1.155

4.6) When it comes to legal and regulatory frame work of RE in Sri Lanka, how do you rate the relative importance of following issues. ?

The rate-base-regulation typically prompts utility managers to be traditional in their technology choices and prefer low capital cost power plants regardless of future fuel prices. Therefore regulated utilities usually do not strongly adopt renewable energy projects except small hydro projects. Wind turbines face specific environmental issues related to siting along migratory bird paths and coastal areas and social and economic issues with fishing communities. Solar PV installations, rooftop hot water heaters and biomass combustion facilities may all face building restrictions based on height, aesthetics, noise, safety, pollution and social and economic concerns. Competition for land use with agricultural, recreational, scenic or development interests can also occur. In Sri Lanka, most of the lands with good scenic or historical values are being used for development of tourism facilities such as hotels and recreation. Renewable energy sources typically connect to a distribution feeder close to end users. Therefore it does not burden the operators of transmission and distribution network. But the pricing will be same and producer does not get the benefit of the location value. Renewable energy depends on the resource availability and therefore will not be able to provide energy to the utility requirement schedules. This may also lower the price or have different prices according to the availability time.

Producers of renewable energy based on resources such as Biomass and Wind, which are located far away from the populated areas, may require access to transmission lines to feed their electricity supply. Generally, utilities do not allow this or may charge high prices. Also construction of new transmission lines may be blocked by right-of-way disputes or transmission access rules and regulations. Independent power producers, who are private investors of power generation projects, may face difficulties in selling power to the utility, unless the legal framework in the country does not adequately address this issue. Power purchase agreements (PPAs) need to be in place and should be reasonably termed for both parties [13].

This question was aimed at getting the perception of the respondents from producers and NGOs on the gravity of the list of issues given. The respondents were requested to distribute 100 points giving a greater number of points for the more important issues. Table 4.7 shows the distribution of points for the given list of issues.

Interest/incentive of regulated utilities to implement renewable RE based on rate based regulation has been weighted as the most important issue with an average point of 36.145. *Legal framework for independent power producers* has been weighted as the second most important issue (24.231) followed by pricing rules (18.462). *Permitting requirements or sitting restrictions* has been weighted the fourth important issue (16.077) followed by *Access to transmission* (6.6150)

Table 4.7 Average points for issues in legal and regulatory framework

Issue	Average	Min	Max	Std dev
Interest / incentive of regulated utilities to implement renewables based on rate based regulation	34.615	25	45	6.6022
Legal framework for independent power producers	24.231	15	35	5.7177
Pricing rules	18.462	10	30	6.5779
Permitting requirements or siting restrictions	16.077	10	29	5.5896
Access to transmission	6.615	4	15	3.1764

4.7) Please rate the following barriers to a more widespread use of RE in Sri Lanka. Please distribute the 100 points giving the more important barriers a greater number of points. The total points should be 100.

This question was another attempt to get the views of the barriers for promoting renewable energy sector in Sri Lanka. Respondents from producers and NGOs were requested to distribute 100 points giving more points to the barriers they think more important. Table 4.8 shows the average of points given to the list of barriers.

Table 4.8 Barriers to a more widespread use of RE in Sri Lanka

Barriers	Average	Min	Max	Std Dev
Lack of suitable financing systems at low interest rates	25.833	15	35	5.967
High capital investment costs & high costs of operation compared to conventional fuels.	24.583	10	35	6.894
Awareness barriers among policy makers, consumers, suppliers etc	19.583	10	30	5.822
Lack of coordination among government agencies and the private sector	17.916	10	30	6.200
Lack of local standards for renewable energy equipment and systems.	12.083	5	20	3.964

Accordingly they have selected lack of suitable financing systems at low interest rates as the most important barrier with an average points of 25.833 followed by High capital investment costs & high costs

of operation compared to conventional fuels with a close average of 24.583 points. Awareness barriers among policy makers, consumers, suppliers etc has been weighted the third most important barrier (19.583) followed by Lack of coordination among government agencies and private sector (17.916). Lack of local standards for renewable energy equipment and systems has been elected as the least severe barrier (12.083). Fig. 4.5 shows the response in a pie chart.

4.8) How do you evaluate the following barriers which would impede rural electrification investment in a financial institution? Please rank them in a scale 1 to 5, where 1 = most severe barrier, 2 = second most severe barrier and so on. Ties in ranks are allowed. Please add any more barriers appropriate and rank them accordingly. Your comments are highly appreciated.

The National Energy policy and strategies of Sri Lanka has stated that it will closely examine the existing rural electrification programmes and seriously consider entrusting the management of RE schemes to consumer co-operatives. Implication of RE policy is still at the incipient stage without suitable policies and strategies for off-grid RE projects through renewables. Establishing a mechanism for subsequent grid connection and defining the legal status of off-grids are important. Long-term sustainability of off-grid RE depends on more than technology. It requires economic choices of technology, appropriate infrastructure, sustainable financing and implementing of private sector-led renewable energy projects. It is also important to have a mechanism for capturing environmental and other non-commercial benefits to the tariffs.

Table 4.9 shows the ranking of the severity of the given list of barriers from respondents in financial institutions They were requested rank the given list of barriers in a ranking scale 1 to 5 giving '1' for the most severe barrier, '2' for the second most severe barrier and so on. *Lack of RE policy implication* and *Lack of right policies and strategies* have been ranked as the most severe barriers with equal ranking average values of 1.5. *Lack of information and new mandate to combine social and environmental factors* and *Lack of appropriate appraisal methods or loan procedures* have been ranked the second most severe barriers with equal ranking average of 3.5. followed by *Lack of trained personnel* (5.0).

Table 4.9 Ranking of barriers for RE investment in financial institutions

Barrier	Average	Min	Max	Std Dev
Lack of RE Policy implication	1.5	1	2	0.5773
lack of right policies and strategies	1.5	1	2	0.5773
Lack of information and new mandate to combine social and environmental factors	3.5	3	4	0.5773
Lack of appropriate appraisal methods or loan procedures	3.5	3	4	0.5773
Lack of trained personnel	5	5	5	0

4.9). IPPs in particular, prefer to use non-recourse project financing for their RE projects. How do you evaluate following which would impede the financial institution in fulfilling this requirement? Please rank in a scale 1 to 5 where 1= most severe barrier, 2 =second most severe barrier and so on. Ties in ranks are allowed. Please give your reasons/comments.

Table 4.10 shows the ranking of given barriers for non-recourse financing by financial institutions. This question was an attempt to get the views of the non-recourse financing barriers from the respondents in financial institutions.

Table 4.10 Ranking of barriers for non-recourse RE project financing

Barriers	Average	Min	Max	Std Dev
Structured to require high level of collateral	1.250	1	2	0.500
Financial institutions' unfamiliarity with this type of financing	2.250	1	4	1.258
Focus on narrow targets by loan officers	3.500	3	4	0.577
Unwillingness to consider as RE technologies are new to them	3.750	3	5	0.957
Lack of incentives for officers to strongly consider on RE investments	4.250	3	4	1.577

The respondents have ranked *Structured to require high level of collateral* as the most severe barrier for non-recourse financing with an average ranking of 1.250 followed by *financial institution's unfamiliarity with this type of financing* (2.25). *Focus on narrow targets by loan officers* have been ranked the third most severe barrier (3.50) followed by *unwillingness to consider as RE technologies are new to them* (3.75). *Lack of incentives for officers to strongly consider on RE investments* has been ranked the least severe barrier.

Many producers usually are excluded from bank credits due to lack of adequate collateral where bank credit terms usually depends on the nature of the security. Lack of incentives to the financial institution's staff to strongly consider RE investment was ranked as the least severe barrier. Nevertheless lack of sector exposure of the banks may lead to prudence and restrict lending approvals [14].

4.10) In general there is a lack of local financial institutions willing to lend renewable energy equipment to end users, or to enterprises wishing to develop or market products for renewable energy equipment. Please rate the following barriers in this regard according to their relative importance. Please distribute the 100 points giving the more important barriers a greater number of points. The total points should be 100.

This question was asked from the financial institutions. A list of 05 barriers was given and they were asked to distribute 100 points giving the more importance barriers a greater number of points. The average of the points given by the respondents to each barrier is shown in Fig. 4.2. *Non-recourse financing and standardized finance mechanisms are generally not used* has been given the most weights (35 points) and considered the most important barrier for the end users to obtain financing for renewable equipments. *Concerns over cost recovery and elevated perceptions of risk* has been weighted the second most important barrier (25 points), followed by *Debt financing is based primarily on the financial strength of the project owner* (20 points).

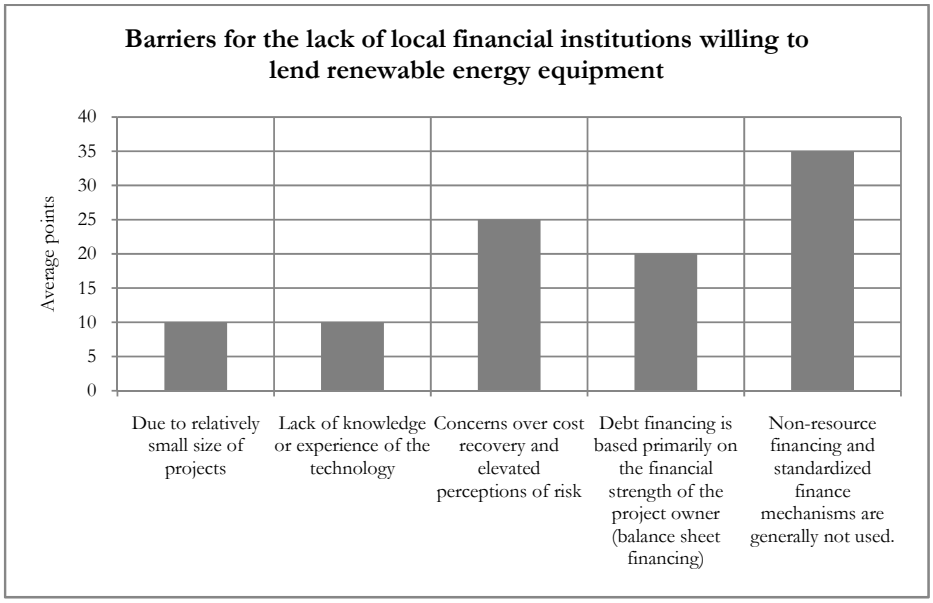

Fig. 4.2 Barriers for financing for RE equipment

The response rate for the questionnaire was poor and some key stakeholders did not reply. Even those who responded did not expose financial status or subsidy they received. Respondents had taken very little interest in responding to questionnaires. The non-response of some key stakeholders in the renewable energy sector may have caused some distortions of the survey outcome. The perceptions of the respondents on the questions therefore may not depict an accurate or an unambiguous position of the barriers for renewable energy development or the weaknesses and strengths of the financial and institutional models in Sri Lanka. Nevertheless, out of the received response from producers and NGOs, some perceptions on the questions do converge with small standard deviations.

From the perceptions of the respondents, it can be concluded that, lack of attractive financing conditions for renewable energy projects poses a major barrier to the anticipated RE targets in Sri Lanka. The financial institutions have not been geared to deal with RE projects as a policy of national interest. Instead they continue to operate on the traditional collateral base approach for lending. There is little or no special treatment for RE projects from the existing financial institutions. The unfamiliarity of the financial institutions with RE project financing also have been considered as severe barriers.

Respondents have considered the public-private partnership financing model and RERED financing model as the most suitable RE financing models of the existing few models in Sri Lanka. Management of off-grid RE projects by cooperative societies or similar financial models discussed are still at the incipient state in Sri Lanka. None of the respondents have considered the existing subsidy to be smart and majority considered it is not smart at all. Direct subsidy that is channeled through the provincial councils for renewable energy projects have been ad hoc and not transparent. Respondents also commented that acquiring the required lands and other infrastructure facilities for off-grid RE projects even in the remote areas have been hampered by political and other influences and private investors do consider those projects are highly risky ventures. The respondents also on the view that the investment opportunities for RE projects given in national energy policy and strategies may hamper mainly due to the required higher investment and the lack of suitable access to capital apart from the severe institutional barriers that become apparent once the project is commenced.

The respondents consider that non-recourse financing and standardized finance mechanisms need to implemented to enable the end user to purchase RE equipment so the RE product market may sustain. Political influence, environmental clearance and approvals and lack of interest of other key stakeholders in the government sector, have been considered as severe barriers in the institutional model that exists in Sri Lanka. Lack of RE policy implication and right policies and strategies are considered other severe institutional barriers for RE investment in financial institutions. Some respondents were highly disappointed on the unprecedented political patronage required at present to get any business moving and the inconsistent and unstable economic policies that crop up from time to time.

Nevertheless majority of the respondents were satisfied with the various awareness programs conducted by government with the help of university researchers and other key stakeholders on the development of renewable energy projects and the keen interest shown to address the issues discussed at higher level discussions for the implementation of right policies and practices.

5. Discussion – Strengths and Weaknesses

5.1 Micro-Credit Financing Model

Microfinance sector has a long history and has gained considerable level of maturity in Sri Lanka over the years. Micro-credit financing is geographically distributed and finance renewable energy projects. It provides more opportunity to market growth and has a less involvement of the government. There are diverse type of institutions such as commercial banks, co-operative societies, development banks, NGOs and international NGOs in addition to microfinance programmes run by government agencies. Microcredit financing has provided the poor with increased self employment opportunities. Finance is provided for both grid connected and off-grid renewable energy projects. The inclusion of a dedicated and responsible implementing organization is a major strength as these organizations relieve the burden of the installation and maintenance of renewable energy technologies that may be unfamiliar to the poor and remote consumers. The implementing organizations also have the opportunity for direct grants from the fund. The consumers can get the loans for RE technologies themselves, install and maintain or can get the implementing organizations to provide the service for a fee. Here it is mandatory for the participating companies to do the operation and maintenance for a specified period, usually 2 to 5 years.

The fragmented and complicated regulation and supervision of microfinance sector with the diverse type of institutions involved, has become a major weakness for a sustainable delivery of financial services. There are different regulatory bodies having different standards thus making the situation more complicated. For certain institutions prudential regulations do not apply. For NGOs, registration under a certain act is not compulsory. The interest rates are usually high and communities have less opportunity to enter the macro RE business. Despite the maturity gained over the years, most of these institutions yet to achieve operational self sufficiency. The lack of financial self sufficiency, inadequate diversification of product portfolios, lack of regulatory framework to enhance depositor's confidence are some other weaknesses encountered in this model. Incorporation of co-operative societies, village electricity management boards and user associations in the rural electrification has been sluggish due to lack of varying interests from the government and increases access rate is yet to be commensurate with more income generation activities in the rural areas. This model has limited finance and poorest individuals are often excluded from financing**.** Micro credit financing has to be expanded to the poor as well. Often the poor people can afford if financed in such a way that the repayment period is based on their payment ability.

5.2 RERED financial Model

This model has been the most successful model for rural electrification through renewables in Sri Lanka starting in 1997 and has provided the initial boost to promote RE projects. There have been considerable external funds through international organizations from 1997 to 2011. This model has the capability to fund both off-grid and grid connected projects. More than ten local credit institutions which are geographically distributed assist this program so that access for loans has been made convenient. This is a major strength of this model. The administrative has been centralized through a unit at DFCC bank. The access to information has been made easy. Good control and governance of RE projects adds to its strength. This model has encouraged the participation of electricity consumer societies in the ownership, management, finance and load regulation activities in the rural electrification projects.

One of the main weaknesses of this model is the total dependency on external agencies for finance. The financing of this project though extended up to 2011, there has been no assurance so far for additional financing and it may come to an end if external fund did not continued. Also this models lacks the financing capability to meet the national RE targets. The high bank intermediate costs and tedious approval process are other weaknesses of this model. There are no mechanisms to evaluate costs of environmental externalities and usually subject to wide interpretations.

5.3 Traditional Public Ownership and Financial Model

Prior to 1990, the electricity generation, transmission and distribution was a responsibility of public sector. With the restructuring of power sector, private sector participation started growing. Regardless, this vertically integrated model is widely used for large scale power plant projects in Sri Lanka. Electricity supply is still considered as a socio-economic service. One of the main strengths of this model is variety of sources of financing including utility's internal resources, government budgets and soft financing through multilateral banks and donor agencies.

One of the main weaknesses of this model is the exclusion of off-grid projects and small scale projects in the generation plan prepared by Ceylon Electricity Board. Here the public utility, Ceylon Electricity Board is confined only to power purchase through power purchase agreements from the developers where grid connection is possible. Transmission and distribution are still considered monopolies. The financial limitations of CEB and the extensive legal and regulatory requirements do hinder RE development. CEB carries out all rural electrification projects by extending the grid. Selection and Financing of projects totally depends on political will. Frequent policy changes, standard bidding procedures are other weakness in this model that discourages the private sector participation for rural electrification projects.

5.4 Project Financing Model

The main strengths of this model is the involvement of private sector and the variety of sources of financing including private equity, soft finance through multilateral and bilateral agencies and private debt financing. The host government offer sovereign guarantees.

Project financing model is usually more complicated and managed by foreign contractors. Lending usually depends on project economies and operating risks. The numerous financing arrangements make this model more complicated and time consuming. Requirement to establish a special purpose company and exclusion of small scale renewable energy projects are other weaknesses of this model to be used in RE projects for rural electrification.

5.5 Public-Private Partnership (PPP) Model

Public private partnership model has the advantage of attracting private investors and equity from foreign commercial sources. RE projects can be implemented on priority basis and RE schemes can be managed by co-operatives or societies. One of the main strengths of this model is the inclusion of an organization dedicated and responsible for rural electrification energy service provision and funding. Ability to efficiently allocate capital subsidies and ability for both public utilities and private investors to compete for the projects are the other strengths of this model.

On the other hand, insufficient allocation of government budgets and political influence adversely affect the implementation of projects. The lending from banks and financial institutions based on collateral and involves high bank intermediations costs. The absence of legislations for clear targets and time frame is another weakness in this model. The entire success of this model depends on the Apex organization. Another weakness in this model is that the schemes proposed or implemented are sometimes inferior compared to schemes based on public procurement.

5.6 Institutional Model

One of the main strengths of this model is the ability to SLSEA to function as the Apex organization for rural electrification with the provision of required legislation and funding. The PUCSL oversees all utility services and does the tariff regulation. RE projects are based on cost reflective tariff and funds are awarded to RE developers on a competitive basis. The clearly defined criteria for licensing, greater coordination among key stakeholders are other strengths of this institutional model. There is an active involvement of NGOs and other stake holders.

On the other hand, no decisions have been made regarding the formation of an apex organization dedicated for rural energy provision and funding and introducing legislations for targets and time frames for RE. Another weakness of this model is the extensive legal and regulatory requirements that prolong the project duration. The provincial councils involve in the provision of capital subsidy lack the sector exposure and politically biased and selective. The different stakeholders have different goals and have different responsibilities. Lack of co-ordinate institutional approach required to boost renewable energy based technologies is another major weakness in this model. The user associations, co-operative societies, village electricity management boards etc., are not incorporated and local population is not included in the planning and execution of rural electrification projects. Political interference, higher political patronage required for clearances, lack of R&D, inadequate expertise are some of other weaknesses in the existing institutional model. There is no consistent and serious approach and support at National, Intermediary and local level.

6. Recommendations

With the knowledge acquired from this study, following solutions are recommended to assist to overcome the weaknesses of the existing financial and institutional models used for RE dissemination for rural electrification in Sri Lanka.

Financial models

- Broaden and Regulate Micro-credit institutions.
- Broaden the RERED model financial capability and lesson the constraints that results in tedious approval process.
- Establish special legislations for the regional banks to finance RE projects.
- Create a dedicated separate financial mechanism to meet the 10% NCRE target in 2015
- Broaden the involvement of Public private partnership model in the RE business by establishing the apex organization required in this model.
- Introduce a mandatory quota of RE dissemination for rural electrification in the Traditional public ownership financial model.

Institutional Model

- Establish a separate apex institution dedicated and responsible for rural energy service provision and funding.
- Direct the entire subsidy through the apex organization.
- Establish decentralized institutional setups in addition to the centralized institution.
- Set up legislations for clear targets and time frame.
- Prioritize different renewable energy options based on economics, social impact and environmental impact
- Form an advisory body to accommodate the stakeholders to be part of the decision making process.
- Introduction of a mandatory quota of RE on the generation basis.
- Introduction of mechanisms for the developers to access carbon funding.
- Make available wind and other resource information to potential developers
- Leasing of lands for developing biomass resources
- Establish mechanisms for capturing environmental and other non-commercial benefits in RE projects
- Establish mechanisms for capacity building of off-grid stakeholders and micro finance institutions.

7. Conclusion

The weaknesses in the institutional model and financial models discussed in this study remain as significant barriers to the wide spread application of renewable energy dissemination for rural electrification in Sri Lanka. It is important that such weaknesses are addressed in order to see renewable energy for rural electrification progress as anticipated. This study offers some possible solutions to assist in overcoming the weaknesses in the existing financial and institutional models used for renewable energy technologies dissemination for rural electrification in Sri Lanka.

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