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Report on “Recommendations for renewable energy resources based electricity generation policy”

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Introduction

Electricity sector scenario

Sri Lanka's population was around 19,668,000 in 2005, with population growth rate of 1.1%. In 2005, 74.9% of the population had access to electricity from the national electricity grid with a per capita electricity consumption of 348kWh/ year. When the planned electrification schemes are implemented, it is expected that 80% of the population will have access to electricity by year 2010. Present installed capacity of the system is 2547 MW, which needs to rise to about 5465 MW by 2019. The Government owned power supplier, Ceylon Electricity Board (CEB), predominantly owns the existing generating system in the country, which is about 76% of the total existing capacity. Balance is owned by Independent Power Producers. In 2005, the share of hydro, thermal, and wind in total electricity generation was 3453 GWh, 5314 GWh, and 2 GWh respectively. As per CEB's long term generation expansion plan, present share of the thermal capacity at 46% will be increased to 57% by the year 2010 and to 76% by the year 2019. All fossil fuel-based thermal generation in Sri Lanka would continue to depend on imports.

As per CEB's planning exercise (CEB, 2004), while in 2005, 60% of the energy demand was met by the thermal plants, by the year 2019, thermal plants will supply 79% of the energy demand.

As per Rural Electrification Policy document of Sri Lanka, the rural electrification rate varies from 20% of the households in certain rural areas to 92% in Colombo. The average rural electrification rate in rural areas is 47% and 50% in the estate sector. It has been estimated that 1.8 million rural households and 150,000 households in the estates yet to be electrified. While the target is to electrify 1 million households by 2007, it is estimated that only 80% of these households may be electrified through grid, that too in 10 years, because of technical and financial limitations.

Therefore, 20% of the households need to be electrified through off-grid systems only. Otherwise also, in the transition period, till grid reaches the villages that are viable, off-grid systems may have to be provided, although the off-grid options may be costlier. Estimated cost of grid-connected electrification is US$400 per household. It has been observed that the 'majority of rural households use less than 50 kWh per month, mainly for lighting.

Sri Lanka's renewable energy scenario, therefore, has to be viewed in the context of (a) its overall goal of socio-economic development and economic growth and (b) Sri Lanka's electrical system, which is unable to cope up with the rising electricity demands, especially those of the rural populace.

The share of grid connected renewable energy technologies (RET) in total electricity production was about 282 GWh in the year 2005. Further, through approximately 83,773 solar home systems 751.8 kW of community projects, electricity was supplied to various homes in Sri Lanka. Thus, about 2% of the total numbers of households in Sri Lanka use off-grid RET.

Electricity sector reforms and institutional responsibilities

The Electricity Reforms Act 2002 was passed by the Government of Sri Lanka (GOSL) in December 2002. According to the Act, the reforms in the electricity sector were to focus mainly on (a) regulatory reforms in the sector and (b) vertical and horizontal unbundling of CEB and Lanka Electricity Company Limited (LECO). This essentially implied the establishment of (i) a generation company, (ii) a single transmission and bulk-power trading company, and (iii) a number of distribution companies. Besides, there is a provision in the Act for an independent electricity regulatory commission to regulate the power sector. Under these proposed reforms, the power sector was to be regulated by the Public Utilities Commission of Sri Lanka (PUCSL) that was established in 2003.

To oversee the restructuring of key public enterprises (e.g. CEB) while retaining the Government ownership, a new government institution, Strategic Enterprises Management Agency (SEMA), has been established. SEMA, which is primarily mandated (need to incorporate the present SEMA mandate)to oversee government's shareholder ownership functions, is presently engaged in developing the requisite institutional structure and framework of governance. Once the parliament approves SEMA Act, SEMA would start functioning as an independent corporate entity (Tittawella, 2005).

The Energy Conservation Fund (ECF) is a statutory body, established in 1985 to (i) promote energy management and energy conservation; and (ii) develop and promote renewable energy. The ECF has recently submitted a proposal to the GOSL on 'elevating the ECF to a higher level authority' called the Sustainable Energy Authority. This proposal has been submitted keeping into view the developments in the energy sector reforms and the important roles that the new institution will be expected to play.

National energy policy and strategies of Sri Lanka

In order to ensure a continuous supply of electricity and petroleum products, the growing economy of Sri Lanka has to manage a strategic balance between indigenous energy resources and imported fossil fuels. To meet this adverse challenge of ensuring energy security in the country, the Government of Sri Lanka (GOSL) has issued the "National Energy Policy and Strategies of Sri Lanka" in May 2006. The policy clearly outlines the implementing strategies, specific targets and milestones through which the GOSL endeavours to develop and manage the energy sector in the coming years. Further, institutional responsibilities to implement each policy element along with associated strategies to reach the specified targets have also been indicated in the Policy. One of the important targets that have been stated in the Policy is to reach a minimum level of 10% of electricity supplied to the grid from Non-conventional Renewable Energy by 2015.

Some of the other salient features of the National Energy Policy and Strategies of Sri Lanka, in the context of renewable energy based electricity generation are given below:

1. The policy states the goal of developing indigenous energy resources in order to minimize dependence on the imported resources.
2. It has been indicated that necessary incentives will be provided and access to green funding including Clean Development Mechanism (CDM) will be facilitated to develop non-conventional renewable energy resources to ensure their contribution to the energy supply in special situations, even if their economic viability is marginal.
3. The policy mentions that a facilitation agency dedicated to the systematic planning and promotion of non-conventional renewable energy resources will be established.
4. In the medium term, it proposes electrification of 80% of the households through grid extension by 2010 whereas 6% of the households are electrified using off-grid systems.
5. With regard to subsidy to the domestic sector, the draft policy indicates that subsidized electricity and kerosene will be provided for household use by 2007 based on the following arrangement (Table 1).

Table 1 Subsidy plan

Type of Household	Target of subsidy	Level of subsidy	Method of subsidy
On-grid Electrified Households	To all the Samurdhi Beneficiaries	50% of cost of supply of first 30kWh, through Coupons	Entire subsidy to be provided by the Treasury from savings accrued through elimination of cross-subsidies in electricity tariff now in effect, for social reasons.
Households Electrified with Off-grid Technologies		Coupons to the value of electricity subsidy (as above) will be provided to pay for off-grid supply	
Non-Electrified Households		Coupons to the value of the electricity subsidy (as above) will be provided to purchase kerosene	

6. It is proposed to immediately include coal as third fuel in order to ensure national energy security.
7. It sets a target of 10% of grid electricity though non-conventional renewable energy (NRE)*1* resources by 2015.
8. It states that the Government would provide incentives to certain NRE technologies, on a competitive basis.
9. In order to facilitate NRE, the Government shall create an 'Energy Fund', to be managed by the ECF, through energy cess, grants received from donors and funds received under the CDM.
10. Furthermore, there would not be any resource cost (royalty) on NRE development for a period of 15 years from the time commercial operations commence.
11. ECF shall prepare a Long-term Non-conventional Renewable Energy Plan (LTNREP) detailing (i) interim targets for specific NRE technologies and (ii) upper thresholds of pricing and resource costing.
12. The PUCSL and the ECF would jointly implement the NRE strategy.

[1] NRE Resources include small-scale hydropower, biomass including dendro power, biogas and waste, solar power and wind power as defined in the Policy.

Rationale

An analysis of the Sri Lanka's electricity sector brings out the following facts:

13. Sri Lanka currently relies on hydropower for most of its electricity, making it vulnerable to fluctuations in rainfall. Besides, out of a total estimated potential of about 2000 MW, more than half has already been harnessed. Further exploitation of hydro resources is becoming increasingly difficult owning to social and/or environmental impacts associate with large-scale development.
14. Presently, the total fossil fuel requirement of the country is imported either as crude oil or as refined products. As per CEB's planning exercise (CEB, 2004), thermal plants will supply 76% of the energy demand by 2019. All of this being imported, expenditure on fuel (in foreign exchange) will increase multi-fold. As it is, in year 2005, the oil import bill was 26% of total export earnings.
15. While about 74.4% population is connected to grid, provinces like Uva has less than 40% of the population having access to electricity and about 47% of rural population has access to grid electricity. It has been estimated that 1.8 million rural households and 150,000 households in the estates yet to be electrified.
16. On account of the projected fuel-mix, CO2 emissions/kWh would rise annually by 13.6%.

Against this backdrop, Renewable Energy Resources Based Electricity (RERBEG) becomes crucial from the point of view of (a) meeting growing electricity needs, (b) ensuring energy security especially in the context of volatile markets, (c) maintaining adequate foreign exchange liquidity, and (d) mitigating negative environmental impacts. Fossil fuel resources such as coal, oil and natural gas are limited and non-renewable, as well as environmentally harmful, and, therefore, need to be used prudently. On the other hand, renewable energy resources are indigenous, non-polluting and virtually inexhaustible. Sri Lanka's land resources can sustain production of significant quantities of biomass, whereas its topography provides opportunities for using small hydro, wind energy, and solar energy.

Renewable energy resources should be viewed not in isolation but as a key component of country's energy security plan. Renewables are also crucial from the point of view of maintaining diversity in the fuel-mix for electricity generation.

Even at village (or provincial) level, use of locally available resources is preferable than using fuels imported from outside or extending the grid to low-demand centres. In such cases, renewables are more appropriate as these resources are diffused and decentralized. Renewable energy resources have enormous potential to meet the growing energy requirements of the increasing population, while offering sustainable solutions to the global threats of climate change.

Renewable energy can increasingly satisfy these energy needs in an environmentally benign and cost effective manner while reducing dependence on import of fossil fuels, thereby providing a higher degree of national energy security.

Policy declaration

The key policy declaration of RERBEG policy are stated below.

Meeting basic electricity needs

Considering that providing for basic energy needs of the population has been recognized as a primary social responsibility of the state; RERBEG will be the prime-mover for addressing the basic electricity needs of the populace, especially of the rural poor, in an equitable and cost-effective manner. RERBEG will also help improving the livelihood of the people and generally uplifting socio-economic condition of un-served regions.

Enhancing utilisation of indigenous energy resources

Taking advantage of widespread availability of renewable energy resources in the country, RERBEG will be utilized optimally to promote sustainable development, and to complement conventional energy sources in meeting the basic electricity needs of the rural population, as well as the rapidly increasing requirements for electricity associated with high economic growth. RERBEG will also help in stabilizing electricity prices over a period of time by reducing the dependence on imported fuels.

Ensuring energy independence

The energy independence in the country can only be achieved through minimizing the dependence on imported fuels. RERBEG that is based on locally available renewable energy resources will, therefore, be employed to achieve this goal. Moreover, in order to secure country's energy future and to tide over any supply disruptions or price-volatility on account of extraneous reasons, RERBEG will facilitate diversification of energy portfolio.

Promoting socio-economic development

Renewable energy resources generally being dispersed and decentralized, RERBEG will help boosting socio-economic development in rural and peri-urban areas of the country by way of creating opportunities for economic activities and local employment, thereby reducing imbalances among the people as well as regions.

Minimising negative environmental impacts of fossil fuel utilisation

The emissions from fossil fuels' combustion impact negatively the local as well as global environment. Optimized use of RERBEG will help in minimizing these adverse effects by reducing the consumption of fossil fuels. Similarly, large-scale energy plantation will arrest land degradation and desertification of country's dry zones.

Specific targets

RERBEG for national grid application

Taking in to account (a) the potential of renewable energy resources in Sri Lanka and (b) the target of 10% electricity generation from non-conventional renewable energy by 2015, outlined in the Draft National Energy Policy, the technology-specific goals have been worked out for two scenarios. These scenarios are:

17. Scenario 1: Annual generation from mini-hydro , wind and biomass increases gradually during the period up to 2015
18. Scenario 2: The capacity of mini-hydro plants increases rapidly over the period, 2005-10 and thereafter, i.e. post 2010, there is a gradual fall in annual capacity addition of mini hydro, till the point the entire mini hydro exploitable potential is harnessed.

Based on an analysis that has been carried out to estimate the technology-wise renewable energy targets and the aggregate renewable energy targets for the period up to 2010 and from 2010-2015[1], the following emerges:
The aggregate renewable energy target in Scenario 1 with 300 MW of mini-hydropower, 81 MW of biomass based power and 83 MW of wind power, for the period 2006-2015 are –

(a) Period up to 2010: 7.99%
(b) Period up to 2015: 10.78%

The aggregate renewable energy target in Scenario 2 with 300 MW of mini-hydropower, 81 MW of biomass based power and 83 MW of wind power, for the period 2006-2015 are –

(a) Period up to 2010: 8.78%
(b) Period up to 2015: 10.78%

Tables 2 and 3 give the technology-specific targets for RERBEG for national grid application, under these two scenarios.

Table 2 Renewable energy targets in Scenario 1

S.No.	RETs	Period up to 2010	Period up to 2015
1	Mini hydro	6.1%	6.4%
2	Biomass	1.2%	3.2%
3	Wind	0.65%	1.12%

Table 3 Renewable energy targets in Scenario 2

S.No.	RETs	Period up to 2010	Period up to 2015
1	Mini hydro	6.9%	6.4%
2	Biomass	1.2%	3.2%
3	Wind	0.65%	1.12%

Off-grid electrification

There are various technological options available for off grid electrification but the main classification is (a) electrification through minigrids based on different energy sources like hydro, biomass and (b) electrification through use of individual household systems mainly the solar photovoltaic systems. At present, under the RERED project, about 4500 households are electrified through village hydro and about 83700 households are using SPV systems.

The Draft National Energy Policy has set the goal of 80% electrification of households by grid extension and 6% through off grid electrification by 2010. Based on these,

[1] Refer to Annex I for detailed calculations

even by 2010 about 15% of households will remain unelectrified. Thus, goal for off grid electrification, mainly through renewable energy sources like solar, biomass and village hydro, is to electrify about 15% households by 2015. The selection of particular technology at location depends upon the local availability of resources like hydro, biomass etc. A comprehensive assessment of resources in the context of off grid electrification may, therefore, be undertaken to arrive at technology specific goals for off grid electrification.

Policy approach

1. With a view to reduce dependence on imported fuels, especially in view of a volatile crude oil market and almost saturated large hydro potential; exploitation of indigenous, renewable energy resources like biomass, mini hydro, wind, and solar energy shall be pursued vigorously.
2. Considering the fact that the promotion of RERBEG requires formulation and implementation of a number of policy measures along with a great deal of coordination with different ministries, agencies, and departments; a Sustainable Energy Authority' (SEA) shall be created within Ministry of Power and Energy (MOPE); reflecting its holistic mandate.
3. To meet social obligations with regard to serving basic electricity needs, the emphasis will be on (a) dedicated energy plantation, (b) provision of electricity through either grid extension or through 'off-grid' systems.
4. With a country rich in biomass resources, having a long history of managing plantations on a large scale; this reliance on energy plantation is a natural choice. The energy plantation will also be linked to other crucial development programmes such as livelihood improvement and livestock development.
5. With a view to attract greater investments in RERBEG and to encourage private participation, the clearance procedures will be simplified and time bound.
6. To provide clear directions and goals, the `Long-term RERBEG Plan' would be prepared, which would be updated every two years.
7. In order to develop indigenous capacity to absorb, develop, and maintain the renewable energy technologies; due priority will be accorded to R&D, including resource assessment; and capacity development at all levels.
8. In the initial period of development, considering the higher upfront cost of renewable energy technologies, necessary incentives and subsidies will be provided through a transparent mechanism.

   The areas that are remote and which do not have access to the grid-electricity also have people that belong to the lowest economic strata. Since extension of grid may not be economically viable for many such places, the main option left is of the 'off-grid' RERBEG. The need to provide subsidy to such consumers is justified from the socio-political point of view.
9. In the interim period, till the PUCSL gets empowered to carry out the tariff setting; MoPE shall constitute a 'Tariff Review Committee' comprising PUCSL, CEB, Finance ministry and representatives of renewable energy resources based electricity producers.
10. For motivating the potential investors to invest in RERBEG, there shall be long-term SPPA commensurate the anticipated life of the SPP.

11. To encourage RERBEG, grid-connected small power plants (up to 10 MW) shall be exempted from generation license without compromising on the safety standards.
12. A royalty (or resource charge) on natural resources such as water and wind shall be imposed with a specific purpose of ploughing back such funds for RERBEG development.
13. The off-grid generation for plant capacities up to 50 kW and distribution shall be exempted from license while complying with safety and critical technical parameters.
14. For RERBEG for off-grid applications i.e. rural electrification, the focus would be on such models that take into account people's need; involve community in decision making and operation; aim for income enhancement; and have built-in provisions for developing local entrepreneurs.
15. The rural electrification/off-grid project planning would essentially be a 'village level electrification planning process', involving participation of grass root communities, organizations, and provincial agencies.
16. To meet overall developmental goals, different government programmes such as RERBEG based rural electrification, rural development, poverty-alleviation, and social welfare may be operated in an integrated way.
17. Similarly, a level-playing field would be provided to RERBEG i.e. explicit as well as implicit benefits of renewable energy sources would be taken into consideration in any decision-making process. Towards this, wherever required, RERBEG would be given adequate incentives.
18. GoSL shall accord high priority to R&D and indigenous technology development, based on local needs.
19. Since wind, dendro thermal and biomass power technologies are relatively new to the country, development of trained manpower for entrepreneurship and maintenance of systems and plants would be facilitated and supported by SEA.

Institutional arrangements

SEA as nodal agency would make the endeavour of promoting RERBEG more focussed apart from accelerating the process of mainstreaming of renewables within the country. SEA, working under the Ministry of Power and Energy (MOPE) would also help in taking an integrated view of the energy situation wherein renewable energy plays a complementary role. Attached to SEA, Advisory Council may be formed, composed of the representative stakeholders. The broad functions of SEA will include:

- Facilitation, policy formulation, planning, coordination, and monitoring
- Promotion of R&D in RERBEG in association with the Ministry of Science and Technology; demonstrations, and resource assessment
- Capacity development at various levels, including at the provincial levels
- Financing
- Knowledge management and awareness creation
- Integration with other organizations and developmental programmes

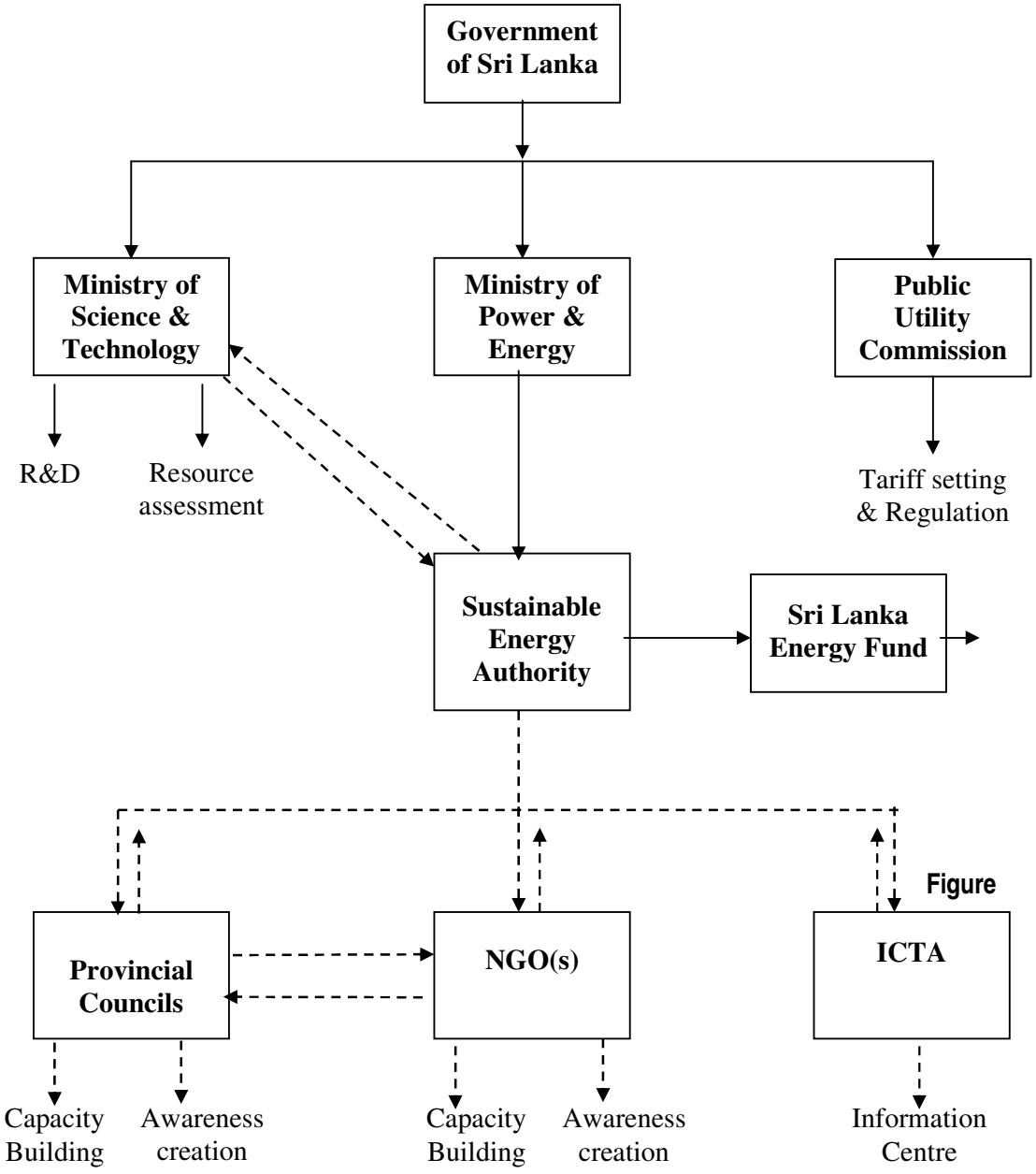
With SEA in the pivotal role, the following institutional setup is suggested to promote RERBEG:

1. SEA would formulate guidelines, policy-measures, plans, and programmes in consultation with the Provincial Councils considering the fact that responsibility of energy related matters within a province is a subject of the Provincial Council.
2. Since the extension of electrification and the promotion and regulation of the use of electricity within the Province is a concurrent subject, it may be desirable to devolve most of the RERBEG related functions of SEA to the relevant Provincial departments gradually, in a manner that the Provinces take up RERBEG within overall national framework. The policy framework may be designed taking into account, the provincial needs and recommendations. The bottom up approach would help in providing solutions appropriate to the Provinces concerned. Considering that the proposed Provincial Energy Acts would, therefore, have significant effect on how the policy and regulatory aspects are shaped at the national level; all efforts should be made to expedite the enactment of these Acts.

   Apart from this; it may be desirable to have 'decentralized institutional set up' at the provincial level considering that a major share of RERBEG is going to be decentralized in nature. Rather than creating new provincial agencies, the relevant existing department(s) may be designated and empowered to carry out renewable energy related activities.
3. SEA may undertake the activities related to (i) renewable energy resource assessment and (ii) technology/product based R&D in close cooperation with the Ministry of Science and Technology and other relevant Ministries. Specifically, the work related to biomass resource assessment may be entrusted to the Divisional Secretaries, the Provincial Councils, and other relevant agencies such as Vidatha Resource Centres, Coconut Development Authority, and Forest Department, etc.
4. SEA may undertake preparation of `Long-term RERBEG Plan' for Sri Lanka, providing targets for specific renewable energy technologies, in consultation with CEB and the relevant provincial agencies/organizations; and obtain approval of the PUCSL. This plan, developed for 20-year time horizon, may be reviewed and updated every two years. In order to place it in the national perspective, it shall be closely monitored by Ministry of Finance and Planning, GOSL.
5. For activities concerning financing/refinancing of RERED projects, R&D, incentives and subsidies, SEA may establish and manage a special fund – Sri Lanka Energy Fund (SLEF) under already available statutory provisions of the Energy Conservation Fund Act 2 of 1985. The Advisory Council for SEA may also provide overall guidance insofar as managing disbursement portfolio and earnings of the SLEF is concerned.
6. The task of tariff setting for RERBEG (grid-connected) shall be handed over to PUCSL to bring greater transparency and public participation.
7. SEA will prepare a rural electrification plan for meeting the goals of 6% electrification by 2010 and 15% electrification by 2015. The plan would include the technology specific targets depending upon the resource availability in off grid areas.
8. For carrying our rural electrification planning, SEA may develop a coordination mechanism that takes local communities, Grama Niladhari, the Vidatha Resource Centres, the Provincial Councils, and the Divisional Secretaries in its ambit.
9. SEA may work closely with the Ministries of Rural Economic Development, Samurdhi and Poverty Alleviation, Rural Livelihood Development, Rural Industries & Self-employment Promotion, and Social Service & Social Welfare to develop an integrated rural development programme around RERBEG.

10. The task of creating awareness at various levels about the potential and relevance of renewables in the emerging energy scenario; as well as different aspects of RERBEG may be undertaken by SEA through the Provincial Councils and suitable NGO(s).
11. For facilitating project development under Clean Development Mechanism (CDM), SEA may establish a CDM Cell in consultation with Ministry of Environment and Natural Resources, which will work closely with the Designated National Agency (DNA) on CDM.
12. SEA may establish a RERBEG Information Centre or a web based 'RERBEG Clearinghouse' for providing a single source of information, in cooperation with 'Information and Communication Technology Agency (ICTA) of Sri Lanka'.

Figure 1 illustrates the proposed institutional setup.



Figure

Figure 1: Recommended institutional setup for RERBEG

Strategy

Legislative and regulatory support

Sustainable Energy Agency

The empowerment of SEA may be carried out through the National Energy Policy or provisions within the existing legislation.

Tariffs for RERBEG

- Considering the fact that transparency in tariff setting goes a long way in establishing an enabling environment for RERBEG, SEA may facilitate expeditious legal measures in order to get PUCSL empowered to carry out the tariff setting. In the interim period, MoPE may constitute a 'Tariff Review Committee'.
- The new tariff regime, whenever notified, may be made applicable to only those Standardised Power Purchase Agreements (SPPAs), which come in to force after introduction of new tariff regime.
- In case the cost of grid system upgradation is being shared by the developers, PUCSL may take this aspect in to consideration while determining the tariff.

Letter of Intent and the related guidelines

- In order to encourage only genuine developers, SEA may develop suitable pre-qualification criteria in consultation with CEB and obtain PUCSL's approval.
- The pre-qualification criteria would give due weightage to factors such as (i) technical and financial capabilities of the project proponents and (ii) status of the land rights i.e. whether the developer has the land rights. To maintain the transparency, these criteria shall be placed in the public domain so that the potential developers know them beforehand. The sites, even on `first come first serve' basis would be allocated once the developer satisfy the pre-qualification criteria.
- The `Letter of Intent' (or Support) shall be issued to the developer by SEA after ensuring that (a) the technical and financial evaluation of the project proposal is positive, (b) grid clearance has been accorded by CEB, and (c) the developer has obtained approvals from the competent authorities. This LOI would also indicate CEB's formal acceptance for buying the electrical energy produced in that facility.
- In order to maintain the uniformity across the provinces, SEA may develop one standardized approval process applicable to all the provinces and authorities. Furthermore, it may be made obligatory for these bodies to provide the project clearance within a stipulated time frame, thereby minimizing procedural delays.
- SEA may make it mandatory for the developer to commence the construction within a reasonable time after the project clearance so that pace of RERBEG may be accelerated. In case of failure to do so, SEA will have rights to offer that site(s), after adequate notice period, to other developers through an open bidding. This approach may be adopted for (a) those old LOIs where the progress is unsatisfactory or (b) LOIs with lapsed validity.

SPPAs

- For motivating the potential investors to invest in RERBEG, SPPA with the utility may be of 15 years, signalling secure returns during the anticipated life of the SPP.
- In a situation when CEB is unbundled, the existing SPPAs between CEB and the developers may be treated as valid agreements for their remaining contract period even after unbundling of CEB. After unbundling of CEB, the Transmission Company (TRANSCO) may hold the SPPAs. PUCSL will make it obligatory for the TRANSCO to honour the terms and conditions of such SPPAs, including the tariff-related aspects.
- While the new SPPAs (that come up after cost based tariff regime has been put in place) will be based on the new norms, freedom may be accorded to the existing SPPAs to migrate to the proposed cost-based tariff regime.
- In the context of RERBEG, there are chances that many small power plants are connected to the low voltage distribution lines. In such cases, there may be a tripartite agreement among TRANSCO, distribution companies (DISCO), and the generator/developer. In such a scenario, DISCO may also take care of metering and network related aspects.
- The periodic 'power acquisition plan' submitted by TRANSCO to PUCSL will include targeted purchases of renewable energy resources based electricity; thereby indicating a firm commitment toward RERBEG.
- Considering that different renewable energy technologies are at different levels of maturity in Sri Lanka, it is considered appropriate to treat mature (e.g. mini hydro) and yet-to-be-introduced/just introduced technologies (e.g. dendro or wind) differently in SPPA. For instance, the relatively newer forms of RET, such as wind or biomass –owing to higher cost of generation – may be awarded a preferential tariff.
- Presently, in Sri Lanka, the RERBEG projects are awarded on the basis of 'first come first served (F-C-F-S)'. To encourage cost reduction through competition; SEA may adopt the bidding process for such projects. The bidding can be based on tariffs. In this scenario the technology specific cost based tariffs can be used as cap. Bids can be invited on the basis of tariff and the bidder with lowest tariff can be awarded the project. To facilitate the bidding, SEA will have to (a) identify the sites through resource assessment, (b) solicit the proposals, and (c) set some pre-qualification criteria for the developers. The resource assessment may be undertaken under a dedicated programme, funded by multilateral development agencies. Till this process of competitive bidding is established, the F-C-F-S basis of awarding projects may be retained for mini hydro plants as well as biomass/wind based electricity generation plants.
- It has been observed that in a sizable number of projects where even SPPAs have been signed; land is yet to be acquired by the developers. Considering the fact that the issue pertains to optimal utilization of national resources, the GOSL may itself acquire the land in accordance with the Land Acquisition Act; and offer that for RERBEG at an appropriate cost.

Grid access to RETs

- SEA may endeavour that round-the-clock access to grid is accorded to the developer. Furthermore, SEA may coordinate with CEB to ensure that the

planned transmission facilities are strengthened on priority, so that any inadequacies regarding the absorptive capacity of the grid are addressed well in time. Technical issues and grid strengthening requirements arising out of interconnection of SPPs with the national grid should be analysed upfront before deciding on the schedule of capacity addition of SPPs. This may be done in consultation with CEB. Further, PUCSL in consultation with CEB - and through public hearing - may come up with the grid code for renewable energy resources based electricity generation plants.

- The developer shall be required to set up facility till the interconnection point after establishing the technical feasibility of interconnection in accordance with the prescribed grid code. This interconnection facility may be constructed by CEB with cost recovered from the generator.

Licensing of grid-connected small renewable energy power plants

In order to encourage the renewable energy resources based, grid-connected small power plants (up to 10 MW), PUCSL may exempt such power plants from generation license by issuing an Order under Section 9 of ERA 2002. However, these plants shall abide by the grid code from the point of view of connectivity, and operation, etc. Besides, such power plants will have to meet all the safety standards irrespective of de-licensing.

Regulations relevant to off- grid systems

- The off-grid generation and distribution may be exempted from license for plant capacities up to 50 kW, keeping in view the high transaction cost the community would have to bear for complying with the norms. PUCSL, therefore, may exempt off-grid generation (for plant capacities up to 50 kW) and distribution from license by issuing an Order under Section 9 of ERA 2002.
- Off-grid plant of the bigger capacity may be required to hold a license for distribution but with lower service standards. These plants, however, will meet safety and other critical technical standards as prescribed by PUCSL For this, appropriate amendment in Section 17 of the Electricity Reforms Act 2002 may be carried out. These specifications shall however ensure that the technical parameters of the distribution network are compatible with those of the grid, so that these could function as part of the grid-connected network, if necessary at a later date.

Self generation

Section 8(1) the Electricity Reforms Act 2002 (ERA) makes it obligatory on the part of generator to obtain a license for generation. ERA does not differentiate between generation for self-use and generation for sale of electricity to the generation licensee. Therefore, as per ERA, it is implied that license is required even for self-generation - unless it is exempted under Section 9 of ERA. However:

- The renewables based self-generation may be exempted from the requirement of licensing since such a self-generation would not only meet un-served demand; it also helps in conserving the outflow of foreign exchange.
- In cases where the renewable energy power plant and the point of consumption are at different locations, necessary provisions may be incorporated in ERA so as to facilitate wheeling of electricity. PUCSL may decide to impose appropriate 'wheeling charges' in lieu of providing this facility.

Stranded assets

In the context of RERBEG, the term `stranded asset' is essentially associated with the off-grid power plants. `Stranded assets' are those off-grid plants that become redundant on account of grid-extension. The following options may be considered for taking care of the stranded assets.

- SEA may ensure that even when the grid is extended, the off-grid plants do not become redundant. A techno-economic appraisal may be carried out to ascertain whether such plants can be integrated with the grid so as to form `distributed' power plants. Therefore, once the grid is extended, the `off-grid' power plants become `grid-connected' plants with the utility purchasing the electricity. The purchase price for off-grid plants, as and when they become grid-connected can be determined by PUCSL in the same manner as is done for other grid connected RERBEG projects.
- However, since it may not be possible to connect very small off-grid power plants with the national grid due to the technical limitations, it is inevitable that such plants would become redundant. The remaining life of such systems would be therefore, of no use to either community or the utility. Such circumstances being pertaining to unforeseeable risks, there would not be any justification for providing compensation for the developer's sunk cost as far as generation equipment is concerned. Nonetheless, after proper evaluation, adequate compensation can be provided for the distribution network if it is integrated with the national grid.

Royalty on natural resources

- SEA may impose a royalty (or resource charge) on natural resources such as water and wind with a specific purpose of ploughing back such funds for RERBEG in terms of (a) better infrastructure for RERBEG, (b) preferential or development tariff for the upcoming renewable energy technologies, and (c) R&D. However, a royalty may be imposed only after the developers have recovered their investment fully and the plant has got completely depreciated.
- The quantum and timing of imposing the royalty would be decided by PUCSL.

Research and development

- For mainstreaming RERBEG in a cost-effective and accelerated fashion, the need for a solid indigenous technology base can not be over-emphasized. This necessitates devising a comprehensive plan for research, development, and deployment. Therefore, SEA will accord high priority to R&D and indigenous technology development, based on local needs, followed by transfer to industry for local manufacturing.
- In the initial stages, it may be required to import the technological know-how. But technology induction would be facilitated, where necessary, with time-bound goals for technology transfer, indigenisation and local phased manufacturing.
- A network of public, private and non-governmental research organisations and specialised institutions would be engaged in resource and technology assessments as well as in technology development and upgradation.

- Quality being cornerstone of any sustainable programme, SEA may establish quality assurance processes and facilities for renewable energy devices and systems on priority. Guidelines for system/product performance and reliability would be developed by SEA and institutionalised in consultation with all relevant stakeholders.

Tariff

Considering the practical difficulties that are involved in determining a pure avoided cost based tariff setting and taking into account the merits of a cost based tariff setting methodology for RERBEG, a methodology that combines features of both approaches may be adopted for RERBEG for national grid application. In this approach, tariffs for all grid-connected RETs (including mini-hydro, wind, and biomass - which includes grown firewood, agro wastes, or municipal wastes - would be calculated as 'technology specific cost based three tier tariffs'. Thus,

- The developers would be offered three-tiered tariff:
  1.The first tier of the tariff would correspond to the debt repayment period
  2.The second tier of the tariff would be calculated for the subsequent period i.e. after the debt repayment period is over, till the introduction of royalty
  3.The third tier of the tariff would correspond to the tariff that will be offered after the PPA period
- The developers would be required to operate the power plant for a minimum of 15 years.
- The difference/benefit of buying power by CEB from SPPs may be shared between CEB and government.
- The mechanism of sharing of benefits will be determined by the PUCSL when empowered.

The similar tariff –setting methodology may be followed for other renewable technologies like solar PV whenever they become relatively competitive.

Institutional roles and responsibilities

As described earlier, the entities/ organizations that may be involved during the tariff setting process of RETs are: PUCSL, CEB, and Ministry of Finance apart from other relevant stakeholders. The roles of main organizations are outlined below.

CEB

The CEB will continue estimating the tariffs for SPPs based on the present methodology of calculating avoided costs. Price calculation methodology will be decided by PUCSL.The exercise of estimation of avoided costs will be carried out by CEB and approved by PUCSL. PUCSL will conduct a prudence check of the performance data of all conventional power plants, in terms of plant availability and energy generation that will be submitted by CEB to the Commission.

PUCSL

The PUCSL having the legal rights of regulating the power sector will have a key role in determination of tariffs for SPPs. These are described below.

- Determination of cost based two tier tariffs
  The PUCSL would have a central role while deciding tariffs using the cost based approach including benchmarking of the cost and performance parameters. The PUCSL will commission an independent study in order to assess the realistic cost and performance parameters, which will be used in estimation of tariffs for the three major renewable energy technologies viz. mini hydro, biomass and wind.

- Determination of quantum of Incentive Payment and Royalty amount
  Those power plants that are operating beyond 15 years, an incentive for generation will be given over and above the O&M costs. The quantum of this incentive will be determined and decided by PUCSL. Further, a Royalty or Resource Charges may be imposed on mini hydro and wind based power plants after the 15th year of their operation and the payments received from Royalty shall be transferred to the renewable energy fund that is developed by the GOSL (Sri Lanka Energy Fund[1], SLEF). The quantum of the Royalty payment shall be determined by the PUCSL.

- Determination of avoided cost
  Since the tariff approach is a combination of the technology specific cost based tariffs and the avoided costs, the CEB will continue estimating the tariffs for SPPs based on the present methodology of calculating avoided costs. Price calculation methodology will be decided by PUCSL.

- Tariff Review
  The tariff regulations may be announced by the PUCSL with a provision to review the methodology and/ or tariff after a time period of 3 (three) years. The tariffs, however, can be reviewed during the interim period in case of major change in assumptions.

Ministry of Finance and Planning

- Since the draft National Energy Policy of the GOSL indicates the promotion of non-conventional renewable energy based electricity in the grid, the additional cost of promoting alternative, more expensive non-conventional renewable energy sources (such as wind and biomass) will have to be borne by the Ministry of Finance and Planning, GOSL, taking in to consideration the national priorities.
- The Long Term RERBEG Plan prepared by the SEA will also be closely monitored by the Ministry.
- Further, any benefit that accrues to CEB on account of lower cost of generation of particular non-conventional renewable energy sources (such as mini hydro) will have to be shared with the Government.
- If the tariff provided for a particular technology is higher than the avoided cost, the additional costs may come from government.
- Similarly in case of technologies with tariffs lower than the avoided cost the benefit may go to the government account. It is also possible that at the end of the year a net revenue, of benefits as well as additional costs, is estimated which can either come from government or go to government depending upon whether the benefits are more or less than the additional cost. The

[1] Proposal for establishing the SLEF has been forwarded to the General Treasury, GOSL in May 2006.

computation of subsidy amount to bridge the difference between the avoided cost and the cost based tariffs is explained in the sub-section on Subsidy.

A diagrammatic illustration of the roles of the different entities as described above is given below.

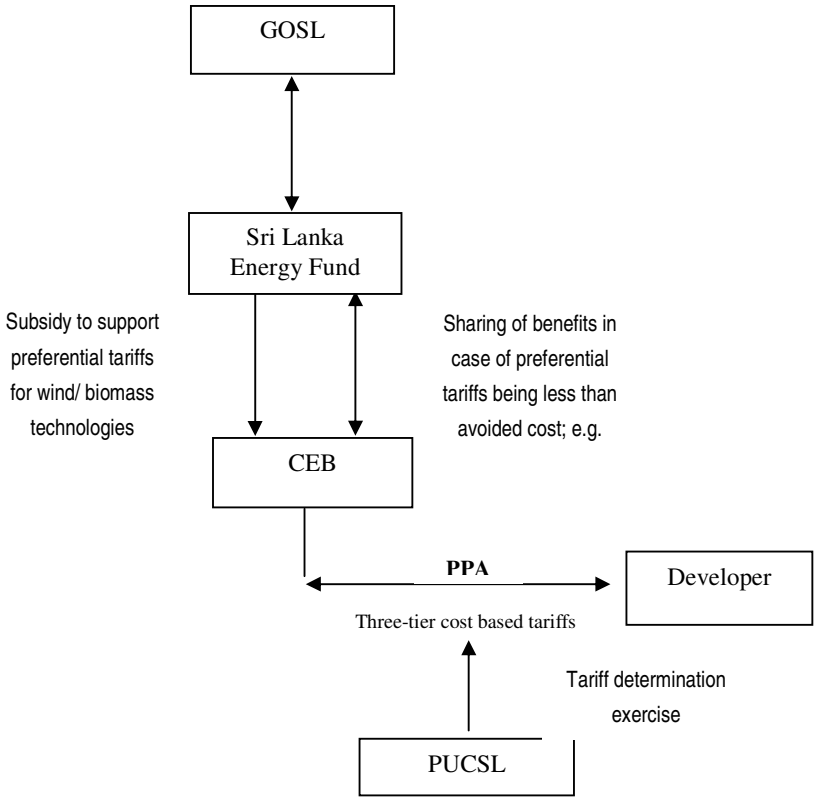


Figure 2: Institutional Roles of different entities

Subsidies

The subsidy for each year is estimated based on the difference between the avoided cost and the cost based tariff. The earlier section gives the possible contribution from each of the three main renewable energy technologies towards achieving the goal of 10% generation in two possible scenarios i.e. base case and the high hydro case. The subsidy requirement has been estimated by converting the goals in to annual capacity additions from each technology. The detailed estimation of subsidy based on the annual generation from different technologies is given in Annex II.

Sustainably grown fuel wood plantation development

- For promoting the Sustainbly Grown Fuel wood (SGF) or energy plantation, SEA may work closely with relevant Ministries to bring about the necessary changes in the existing laws and regulations governing allocation of land for SGF plantation.

- National Livestock Development Board may be encouraged to take up energy plantation on its land as a mean to supplement fodder-supply; apart from utilizing waste land and land presently under conventional plantation.
- With an estimated availability of 1.6 million hectare [1]of degraded marginal land suitable for SGF, the same may be leased by the national/provincial governments for commercial SGF plantation at a nominal cost.

Human resource development

- Significant thrust will be provided by SEA to capacity building and development of human resources and training at all levels. In this context, SEA may take up entrepreneurship development in relatively new technologies like wind, dendro, and biomass power on priority. Support from the UN agencies, bilateral agencies as well as multilateral development banks would be sought to augment such capacity building endeavour.
- To help create a cadre of technically-qualified personnel, SEA may facilitate development of curricula for renewable energy courses for different levels viz. from school up to university level. Besides, SEA may also support focussed efforts to enhance and expand consultancy capabilities at all levels.

Institutional development

- For creating a positive and enabling environment for RERBEG in the country, SEA may embark on awareness creation at the national as well as provincial levels about the potential and relevance of RERBEG in the emerging energy scenario, particularly among policy and decision makers in Government, industry, financial institutions, and utilities.
- Considering the important role and active participation of the provincial institutions in RERBEG, these institutions may be strengthened and empowered to act as executive agencies for development and diffusion of RERBEG, apart from vesting them with the statutory powers to facilitate expedited clearance for RERBEG.
- SEA may make concerted efforts to encourage involvement and participation of local communities, NGOs/ NGO networks, co-operatives and informal financing institutions to bring about speedy implementation of RERBEG projects.

RERBEG Information Centre

To facilitate access of all the relevant information at one source, and thereby reducing the transaction time, SEA may establish a `RERBEG Information Centre'. Considering the fact that Sri Lanka is already in the process of utilizing ICT (Information and Communication Technologies) for its economic and social development; the proposed `Information Centre' may be established in the form of a RERBEG Clearinghouse. SEA may collaborate with `Information and Communication Technology Agency (ICTA) of Sri Lanka' for establishing and maintaining the RERBEG Clearinghouse.

[1] Bio Energy Association of Sri Lanka. `The Dendro Option for Future Energy Security of Sri Lanka'. 2004

Resource mobilization

In order to meet the goals of supplying 10% grid - electricity and electrifying 15% households through renewables resources, adequate financial resources would need to be mobilised. The main source would be government resources through direct subsidies.

In case of renewable energy projects supplying power to the national grid, the benefits (if the tariff payable by the CEB to embedded generators is higher than the technology specific cost based tariff) should go to the Government, since the promotional tariff (if it is higher than the tariff paid by the CEB) will also be borne by the Government. As approximate estimation of annual subsidy requirement till 2009 is shown in table below. The details of the subsidy estimation are given in Annex II.

Table 4 Subsidy requirements for RERBEG for grid application

	Total subsidy requirement (million LKR)		
	2007	2008	2009
Base case	218.06	532.01	742.52
High mini-hydro case	234.23	550.46	754.58

In case of off grid electrification, clearly there is need for subsidy. The estimation of subsidy requirement is based on the assumption that, in case of mini-grid based electrification the rural consumer will pay equivalent to the lowest slab of urban national grid consumer. Though the actual requirement of subsidy would depend on the mix of different resources like village hydro, biomass, wind for mini-grids and Solar PV for individual households; an approximate estimation of subsidy requirement to meet the goal of 6% electrification by 2010 is given in table below. Details of this estimation and assumptions are given in Annex II.

Table 5 Subsidy requirement for off grid renewable energy systems

Year	2007	2008	2009	2010
Subsidy (million LKR)	170.78	250.78	363.93	587.05

In addition to the direct subsidies for grid connected and off grid renewable energy systems, resources would be required for other activities of the SEA. These activities include the resource assessment, planning, research and development, capacity building, awareness creation etc. These activities are critical for achieving the goals mentioned above.

- To address this, a dedicated fund for the promotion of renewable energy and energy conservation activities, namely, `Sri Lanka Energy Fund' (SLEF) may be established. SLEF may be managed by SEA. Resources for SLEF may be generated through various sources:
  - From government for off grid subsidies, and other activities of SEA like resource assessment, R&D, planning etc.
  - Through a cess on fossil fuels, which can be used meet, the resource requirement of subsidy for grid connected projects. A cess of LKR 0.10/lit of petroleum products (except kerosene) can generate resources sufficient to meet the subsidy requirement of grid connected renewables energy projects as estimated in table 4 above.

  - SLEF may also be supplemented from the proceeds received under Clean Development Mechanism (CDM).
  - To facilitate the commercial banks to continue to provide long-term credit, SLEF may provide the refinancing. For this, SEA may avail concessionary lines of credit through the multilateral development banks.
- To ensure financing of RERBEG at various levels; new and appropriate methods will be evolved for financing through banks, financial institutions and the private sector, including the provision of rural credit, and credit for working capital.
- Especially for the benefit of rural communities, the reach of the credit mechanisms will be enhanced by developing appropriate partnerships with the rural financing institutions, commercial banks - particularly, with the lead banks in rural and backward areas - thereby multiplying 'participating credit institution' (PCI) multi-fold. SEA would endeavour to get RERBEG included in the priority sector lending norms of banks.
- Innovative approaches to link formal credit mechanisms with informal mechanisms, such as micro-credit schemes and self-help groups, will be encouraged in order to reach out to potential borrowers who are normally out of the ambit of regular credit programmes. Central fund/mechanisms for risk coverage, risk sharing and guarantees will also be established.
- To supplement the budgetary outlay of the GOSL, other sources of finances, such as those available under international financial mechanisms will be tapped aggressively.

Plan of action

The following 'Plan of Action' (Table 6) has been prepared on the basis of strategy and approach discussed in earlier sections, and covers the key actions that are required to be taken for providing thrust to renewable energy resources based power generation for (i) national grid and (ii) off-grid applications.

Table 6 Plan of action

S.No.	Task description	Institutional responsibility	Time frame
1	Enactment of the National Energy Policy	Ministry of Power & Energy	Immediate: within 2006
2	Upgradation of ECF in to SEA and its empowerment	ECF & Ministry of Power & Energy	Immediate: within 2006
3	Establishment of `Sri Lanka Energy Fund'	ECF, Ministry of Power & Energy, and Ministry of Finance and Planning	Immediate: within 2006
4	Constitution of the interim Tariff Review Committee	SEA & PUCSL	Immediate: within 2006
5	Empowerment of PUCSL for tariff setting	Ministry of Power & Energy	Near term: within first quarter of 2007
6	Preparation of a Long-term Non-conventional Renewable Energy Plan (LTNREP) for 20 years	SEA & CEB	Short term: by the end of 2007
7	Carry out need assessment and preparation of roadmap for the capacity building	SEA	Near term: within first quarter of 2007
8	Development of simplified procedures and formats for approvals	SEA	Immediate: within 2006
9	Development of simplified environmental clearance procedures	SEA & Central Environmental Authority	Immediate: within 2006
10	Development of pre-qualification criteria for project	SEA	Immediate: within 2006

S.No.	Task description	Institutional responsibility	Time frame
	developers of grid-connected RERBEG		
11	Development of standardized packages for off-grid applications	SEA	Short term: by the end of 2007
12	Development of standards and codes for off-grid RERBEG	SEA & PUCSL	Near term: within first quarter of 2007
13	Preparation of biomass & mini hydro resource atlas	SEA, Ministry of Science & Technology, Provincial Agencies	Medium term: by the end of 2009
14	Land assessment and preparation of Sustainably Grown Fuel wood plantation plan	SEA, Ministry of Science & Technology, Provincial Agencies	Short term: by the end of 2007
15	Assessment of R&D needs and preparation of R&D roadmap	SEA & Ministry of Science & Technology	Near term: within first quarter of 2007
16	Development of simplified licensing procedures RERBEG plants for off-grid applications	PUCSL	Near term: within first quarter of 2007
17	Exemption of RERBEG plants for self-generation	PUCSL	Near term: within first quarter of 2007
18	Development of quality assurance guidelines and processes	SEA & PUCSL	Short term: by the end of 2007
19	Development of curricula for renewable energy	SEA	Short term: by the end of 2007
20	Establishment of RERBEG Information Centre	SEA & ICTA	Near term: within first quarter of 2007

References

1. Ceylon Electricity Board. Long Term Generation Expansion Plan (2005-2019). November 2004.
2. Ministry of Power and Energy, Sri Lanka. National Energy Policy and Strategies of Sri Lanka (draft). 2006
3. Tittawella M. Government initiative towards enterprise reform within the overall state ownership. Sri Lanka Development Forum (Background Papers). 2005

Annex I: Goal setting approach

Grid connected renewable energy technology targets

Approach

The approach that has been used for estimating a target of 10% electricity generation from non-conventional renewable energy by 2015, as outlined in the National Energy Policy, is that the time-frame from 2005-2015 has been divided into two phases, (i) period up to 2010 and (ii) period from 2010-2015. The targets have been estimated as technology-wise targets (mini hydro, wind and biomass) and overall renewable energy targets for two scenarios – scenario 1, where it has been assumed that installed capacity of mini-hydro grows at a constant rate during the period, 2005-15, installed capacity of wind grows at the rate of 10 MW blocks annually and installed capacity of biomass grows at the rate of 5 MW blocks annually and scenario 2, where it has been assumed that capacity of mini-hydro plants increases rapidly over the period, 2005-10 and thereafter, i.e. post 2010, there is a gradual fall in cumulative capacity from such plants, till the point the entire mini hydro exploitable potential is harnessed.

Assumptions

For estimating the overall target of 10% electricity generation from non-conventional renewable energy by 2015 as well as to estimate the interim target for the year 2010, some of the assumptions that have been used in the analysis are:

19. The forecast data of total system generation (in GWh) for the period 2005-15 has been based on the 'CEB Long Term Generation Expansion Plan', 2005-19, base load forecast – 2004 data
20. The exploitable renewable energy resource potential up to 2015 for the three RETs have been assumed as:
    (i) Mini hydro power = 300 MW
    (ii) Biomass = 81 MW
    (iii) Wind =83 MW

    Thus the total capacity addition by the year 2015 would be 464 MW, which is less than the projected grid capacity of 690MW that can be absorbed by the national grid as per the "Overview of Technical Requirements, Connection and Management of Embedded Generation" report by Siemens Power Technologies Limited.

21. The Capacity Utilization Factor that has been used for estimating the technology wise gross annual generation is:
    (i) Mini hydro power = 43%
    (ii) Biomass = 80%
    (iii) Wind = 27%
22. The installed capacity, technology-wise for the year 2005 has been taken as per actual data, i.e. 74 MW of mini hydropower, 1 MW of dendro power and 3 MW of wind power.

Analysis: setting the renewable energy target

For estimating the renewable energy target for the period 2005-15, the growth of the three renewable energy technologies viz. mini hydro, biomass and wind have been analyzed in 2 scenarios – (i) Scenario 1: base case and (ii) Scenario 2: high hydro growth case.

Scenario 1: Base case

In this scenario, for the year 2005, actual installed capacity data has been taken for the three RETs, i.e., 74 MW of mini hydropower, 1 MW of dendro power and 3 MW of wind power. Thereafter from year 2006 onwards, the cumulative installed capacity for the three RETs has been given below. To estimate the annual gross generation from the three RETs, capacity utilization factors for mini hydro, biomass and wind have been assumed as 43%, 80% and 27% respectively.

Table 1.1 Renewable energy targets for Scenario 1

Year	Small hydro			Wind			Dendro			Total
	Installed Capacity (MW)	Generation (GWh)	Percentage of total energy generation	Installed Capacity (MW)	Generation (GWh)	Percentage of total energy generation	Installed Capacity (MW)	Generation (GWh)	Percentage of total energy generation	
2004	40		2.6%	3			0			
2005	74	278.74	3.3%	3	3.42	0.04%	1	7.008	0.1%	**3.38%**
2006	98	369.15	4.1%	3	7.10	0.08%	1	7.008	0.1%	**4.29%**
2007	122	459.55	4.8%	3	7.10	0.07%	6	42.048	0.4%	**5.32%**
2008	146	549.95	5.4%	13	30.75	0.30%	11	77.088	0.8%	**6.42%**
2009	170	640.36	5.8%	23	54.40	0.49%	16	112.128	1.0%	**7.29%**
2010	194	730.76	**6.1%**	33	78.05	**0.65%**	21	147.168	**1.2%**	**7.99%**
2011	218	821.16	6.4%	43	101.70	0.79%	31	217.248	1.7%	**8.82%**
2012	242	911.57	6.5%	53	125.36	0.90%	41	287.328	2.1%	**9.48%**
2013	266	1001.97	6.6%	63	149.01	0.99%	56	392.448	2.6%	**10.23%**
2014	290	1092.37	6.7%	73	172.66	1.06%	71	497.568	3.1%	**10.82%**
2015	300	1130.04	**6.4%**	83	196.31	**1.12%**	81	567.648	**3.2%**	**10.78%**

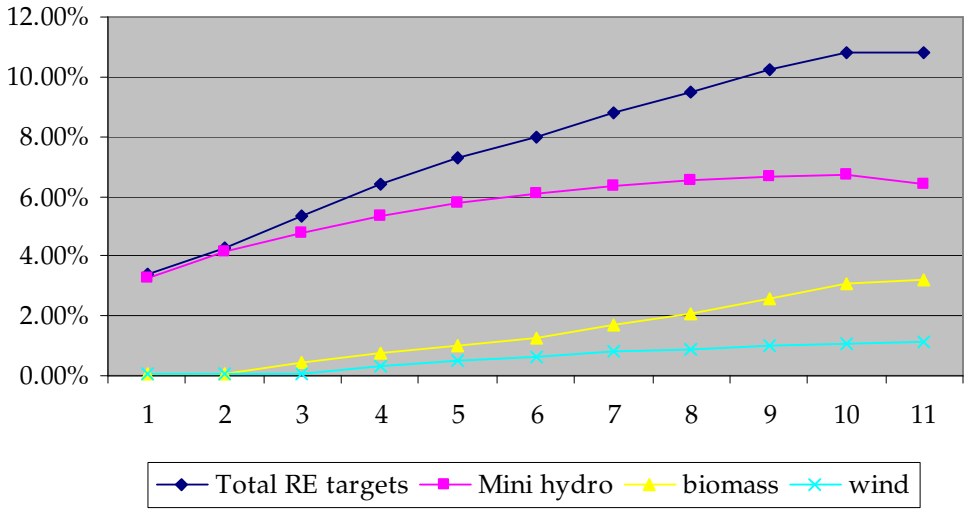


Figure 1.1: Annual renewable energy targets – aggregate and technology wise

From the table and figure above, it can be inferred that the aggregate renewable energy target in the base case scenario for the period 2005-15 with 300 MW mini hydropower, 81 MW biomass based power and 83 MW of wind power capacity, are –

1. Period up to 2010: 7.99%
2. Period up to 2015: 10.78%

Technology-wise targets are summarized in Table 1.2.

Table 1.2 Technology-wise targets

S.No.	RETs	Period up to 2010	Period up to 2015
1	Mini hydro	6.1%	6.4%
2	Biomass	1.2%	3.2%
3	Wind	0.65%	1.12%

Scenario 2: High hydro growth case

In this scenario, for the year 2005, actual installed capacity data has been taken for the three RETs, i.e., 74 MW of mini hydropower, 1 MW of dendro power and 3 MW of wind power. Thereafter from year 2006 onwards, the cumulative installed capacity of mini hydro increases up to year 2010 and thereafter from 2011 onwards it has been assumed the mini hydro capacity gradually decreases. For wind and biomass the growth in installed capacity has been retained as in the base case scenario. To estimate the annual gross generation from the three RETs, capacity utilization factors for mini hydro, biomass and wind have been assumed as 43%, 80% and 27% respectively. The annual aggregate targets and technology-wise targets in Scenario 2 are summarized in the Table 1.3 and Figure 1.2 below.

Table 1.3 Renewable energy targets for Scenario 2

Year	**Small hydro**			**Wind**			**Dendro**			**Total**
	Installed Capacity (MW)	Generation (GWh)	Percentage of total energy generation	Installed Capacity (MW)	Generation (GWh)	Percentage of total energy generation	Installed Capacity (MW)	Generation (GWh)	Percentage of total energy generation	
2004	40		2.6%	3			0			
2005	74	278.74	3.3%	3	3.42	0.04%	1	7.008	0.1%	**3.38%**
2006	99	372.91	4.2%	3	7.10	0.08%	1	7.008	0.1%	**4.33%**
2007	129	485.92	5.1%	3	7.10	0.07%	6	42.048	0.4%	**5.59%**
2008	159	598.92	5.8%	13	30.75	0.30%	11	77.088	0.8%	**6.90%**
2009	189	711.93	6.4%	23	54.40	0.49%	16	112.128	1.0%	**7.93%**
2010	**219**	**824.93**	**6.9%**	**33**	**78.05**	**0.65%**	**21**	**147.168**	**1.2%**	**8.78%**
2011	244	919.10	7.1%	43	101.70	0.79%	31	217.248	1.7%	**9.57%**
2012	264	994.44	7.1%	53	125.36	0.90%	41	287.328	2.1%	**10.07%**
2013	279	1050.94	7.0%	63	149.01	0.99%	56	392.448	2.6%	**10.55%**
2014	290	1092.37	6.7%	73	172.66	1.06%	71	497.568	3.1%	**10.82%**
2015	**300**	**1130.04**	**6.4%**	**83**	**196.31**	**1.12%**	**81**	**567.648**	**3.2%**	**10.78%**

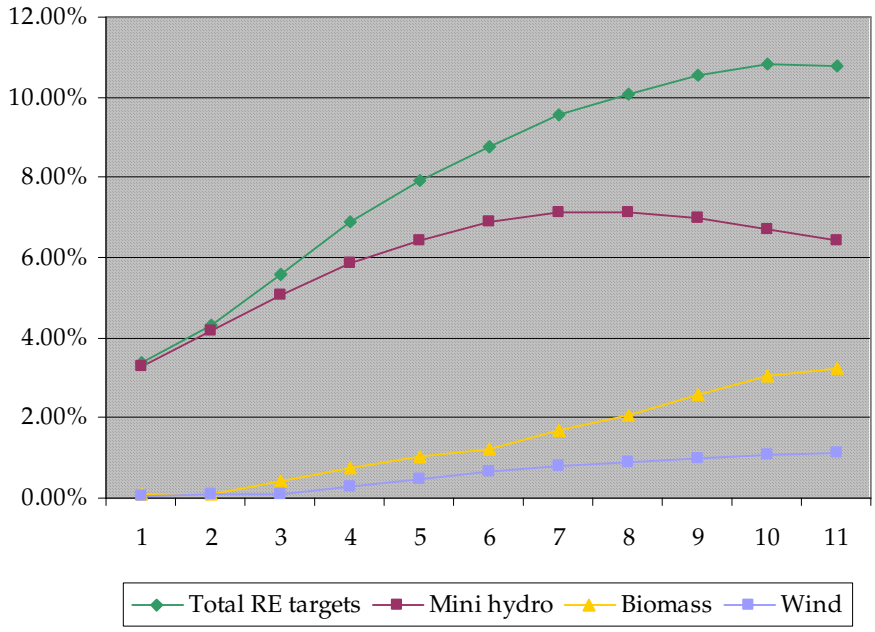


Figure 1.2: Annual renewable energy targets – aggregate and technology wise

From the table and figure above, it can be inferred that the aggregate renewable energy target in the high hydro growth case scenario for the period 2005-15 with 300 MW mini hydropower, 81 MW biomass based power and 83 MW of wind power capacity, are:

1. Period up to 2010: 8.78%
2. Period up to 2015: 10.78%

Technology-wise targets are summarized in Table 1.4.

Table 1.4 Technology-wise targets

S.No.	RETs	Period up to 2010	Period up to 2015
1	Mini hydro	6.9%	6.4%
2	Biomass	1.2%	3.2%
3	Wind	0.65%	1.12%

Annex II: Estimation of subsidy

Estimation of subsidy for grid-connected technologies

IN case of grid connected plants the difference between the cost based tariff and the avoided cost for CEB comes from government as subsidy. The subsidy for each year is estimated based on the difference between the avoided cost and the cost based tariff. The indicative cost based tariff, as shown in Table 2.1 below, estimated in the Report on Deliverable 6 has been used.

Table 2.1 Indicative cost based tariffs

		Non escalable component	
RETs	Escalable component (O&M) (LKR/kWh)	Tier I (up to Debt repayment period) (LKR/ kWh)	Tier II (after repayment period) (LKR/ kWh)
Mini Hydro	0.53	6.48	2.30
Wind	1.52	12.39	4.40
Biomass	0.80	9.88	6.73

The avoided cost for 2006 is used with expected annual escalation of 5% for subsequent years, up to 2009. In each financial year the tariff received by power plants would depend on the year of commissioning in case of cost based tariff, whereas the avoided cost would be the avoided cost estimated for that year. While estimating the annual subsidy requirement, the technology-wise goals that have been estimated in annex 1, with regard to capacity additions for the respective RETs, for both Scenarios 1 and 2 have been analyzed. The step by step procedure followed to estimate the annual subsidy is given below.

The subsidy requirement in the year 2008 for a small hydro power plants commissioned in the year 2007:

The cost based tariffs received in 2008 (cost based tariff for small hydro for the second year) = 7.03 LKR/kWh
The avoided cost in the year 2008 = 6.62 LKR/kWh
Per unit subsidy required = Cost based tariff- avoided cost = 0.73LKR/kWh
Total annual installation in 2007 as per the goals (base case) = 24MW

Total annual generation in 2008 from mini hydro plants commissioned in 2007 = 90.40 GWh (using the capacity factor of 43% as per the tariff report)

Subsidy required in 2008 for small hydro plants commissioned in 2007 = annual generation x subsidy requirement
= 90.40 GWh x 0.73 million LKR/GWh
= 37.61 million LKR

The total subsidy required for small hydro plants in 2008 is sum of subsidy requirement for power plants commissioned in previous years (i.e. 2007 and 2008).

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The cumulative subsidy estimation using the above methodology is summarized in Table 2.1.

Table 2.2 Avoided cost (actual and estimated upto 2009)

Year	2006	2007	2008	2009
Avoided cost (LKR/ kWh)	6.00	6.30	6.62	6.95

Scenario 1: Base case

A. Mini hydro

Table 2.3 Cost based technology tariffs for mini hydro projects

Year since commissioning	1	2	3	4
Tariff (LKR/ kWh)	7.02	7.03	7.05	7.06

Table 2.4 Mini hydro capacity additions based on estimation of RET goals

Year	Capacity added (MW)	Annual generation from new capacity (GWh)
2007	24	90.40
2008	24	90.40
2009	24	90.40

Table 2.5 Annual subsidy estimation for mini hydropower projects based on difference between avoided cost and cost based tariffs

Annual subsidy required for plants commissioned in	Annual subsidy (in million LKR) 2007	2008	2009
2007	64.65	37.61	9.19
2008		36.17	7.71
2009			6.27
Total annual subsidy requirement for mini hydro projects (in million LKR)	64.65	73.78	16.90

B. Biomass

Table 2.6 Cost based technology tariffs for biomass based projects

Year since commissioning	1	2	3
Tariff (LKR/ kWh)	10.68	10.70	10.73

Table 2.7 Biomass capacity additions based on estimation of RET goals

Year	Capacity added (MW)	Annual generation from new capacity (GWh)
2007	5	35.04
2008	5	35.04

2009	5	35.04

Table 2.8 Annual subsidy estimation for biomass projects based on difference between avoided cost and cost based tariffs

Annual subsidy required for plants commissioned in	Annual subsidy (in million LKR)		
	2007	2008	2009
2007	153.42	143.22	132.50
2008		142.38	131.63
2009			130.79
Total annual subsidy for biomass projects (in million LKR)	153.42	285.60	394.92

C. Wind

Table 2.9 Cost based technology tariffs for wind based projects

Year since commissioning	1	2	3
Tariff (LKR/ kWh)	13.91	13.96	14.01

Table 2.10 Wind capacity additions based on estimation of RET goals

Year	Capacity added (MW)	Annual generation from new capacity (GWh)
2007	0	0
2008	10	23.65
2009	10	23.65

Table 2.11 Annual subsidy estimation for wind projects based on difference between avoided cost and cost based tariffs

Annual subsidy required for plants commissioned in	Annual subsidy (in million LKR)		
	2007	2008	2009
2007	0	0	0
2008		172.63	165.89
2009			164.81
Total annual subsidy requirement for wind power projects (in million LKR)	0	172.63	330.70

Table 2.12 Total revenue requirement due to RET capacity additions

Year	2007	2008	2009
Total revenue requirement (million LKR)	218.06	532.01	742.52

Scenario 2: High hydro growth

A. Mini hydro

Table 2.13 Mini hydro capacity additions based on estimation of RET goals

Year	Capacity added (MW)	Annual generation from new capacity (GWh)
2007	30	113.00
2008	30	113.00
2009	30	113.00

Table 2.14 Annual subsidy estimation for mini hydropower projects based on difference between avoided cost and cost based tariffs

Annual subsidy required for plants commissioned in	Annual subsidy (in million LKR) 2007	2008	2009
2007	80.81	47.01	11.49
2008		45.21	9.63
2009			7.83
Total annual subsidy requirement for wind power projects (in million LKR)	80.81	92.22	28.96

B. Biomass

Table 2.15 Biomass capacity additions based on estimation of RET goals

Year	Capacity added (MW)	Annual generation from new capacity (GWh)
2007	5	35.04
2008	5	35.04
2009	5	35.04

Table 2.16 Annual subsidy estimation for biomass projects based on difference between avoided cost and cost based tariffs

Annual subsidy required for plants commissioned in	Annual subsidy (in million LKR) 2007	2008	2009
2007	153.42	143.22	132.50
2008		142.38	131.63
2009			130.79
Total annual subsidy requirement for biomss hydro projects (in million LKR)	153.42	285.60	394.92

C. Wind

Table 2.17 Wind capacity additions based on estimation of RET goals

Year	Capacity added (MW)	Annual generation from new capacity (GWh)
2007	0	0
2008	10	23.65
2009	10	23.65

Table 2.18 Annual subsidy estimation for wind projects based on difference between avoided cost and cost based tariff

Annual subsidy required for plants commissioned in	Annual subsidy (in million LKR) 2007	2008	2009
2007	0	0	0
2008		172.63	165.89
2009			164.81
Total annual subsidy requirement for mini hydro projects (in million LKR)	0	172.63	330.70

Table 2.19 Total revenue requirement to provide subsidy to meet the difference between cost based tariff and avoided cost (million LKR)

Year	2007	2008	2009
Net Subsidy	234.23	550.46	754.58

Estimation of subsidy for off-grid technologies

There is already a proposal on off-grid energy delivery, focussing on the 500 million proposal submitted to the Treasury. There shall be an O&M fund on the basis of 'matching' the fund collected by a user group with equal amount of funds by the GoSL. To meet the requirements of grant and project financing, GoSL may utilize (a) part of Sri Lanka Energy Fund, (b) funding from multilateral agencies, (c) CDM proceeds, and (d) concessionary lines of credit through the multilateral development banks. The off grid renewable energy systems for providing energy services in the village have higher generation costs, mainly as a result of smaller size, smaller load and remote locations. The technology options for off grid, considered for the analysis are village hydro, biomass gasification and solar photovoltaic (although this analysis can also be extended to other forms of off-grid renewable energy technologies). These three technologies have different cost structure and hence the generation costs are different. The generation cost estimates of the above-mentioned technologies have been based on the off-grid cost estimation that was undertaken in the Report on Deliverable 6, titled, "Review of tariff setting methodologies for grid-connected small power producers", June 2006.

The subsidy amount for different renewable energy technologies has been estimated on the basis of generation costs for a typical size of the system and load. The

difference between the cost of generation from such RETs and the domestic tariff for consumers served by the national grid has been computed as subsidy.

In the Report on Deliverable 6, the government's subsidy component has been estimated based on per unit cost difference between generation cost and the domestic consumer tariff. The total annual cost difference has been estimated by multiplying the annual generation by per unit cost difference.

Assuming that a 25kW capacity off-grid system serves 100 households in a village, per household subsidy can be computed from the capital subsidy requirement that has been computed in the Report on Deliverable 6. This is summarized technology-wise in Table 2.20. A community based rural energy project usually supplies a 200W demand per household and 25kWh of energy per month.

Table 2.20 Per household subsidy estimation

RETs	US$/system of 25kW	LKR/system	LKR/ household
Village hydro	9099	909908	9099
biomass	23665	2366542	23665
SPV	236635	23663525	236635

Based on the per household subsidy amount that has been computed above and the number of households that are targeted to be electrified using off-grid systems, the annual subsidy requirement for the period upto 2010 has been computed and is given in Table 2.21.

Table 2.21 Annual Subsidy requirement (in million LKR) for electrifying households with off-grid systems

Off-grid system/ Year	2007	2008	2009	2010
Village hydro	15	25	35	45
Biomass	7.11	28.44	59.25	130.35
Solar minigrid	23.67	47.34	94.68	236.7
SHS	125	150	175	175
Total	170.78	250.78	363.93	587.05