1.5 Project Idea for Technology 4: Smart Grid Technology for Wind, Solar and Small Hydro for Grid Integration

1.5.1 Introduction and Background

The potential for wind and solar PV based electricity generation in Sri Lanka is very significant. The capital costs of these two technologies are gradually getting reduced. In the near future, these two technologies are likely to reach grid parity status. When that state is reached, these two technologies could play very significant roles in meeting the electrical energy needs of Sri Lanka and in fulfilling the policy of generating 10% and 20% of the total electricity generation through new renewable energy resources by the year 2015 and 2020 respectively.

However, recent experiences in Sri Lanka with these two technologies have resulted in difficulties in balancing the supply and demand of the national grid and maintaining system stability. The reason for this phenomenon is that unsteady or variability of energy outputs of these two energy sources. The speed of wind at any given location in Sri Lanka is constantly changing. This results in the output of wind turbines constantly fluctuating. Similarly, the passage of clouds in the sky in the locations where solar PV panels are installed results in rapidly changing the output of solar PV systems. Such variations in the output of these two sources have created difficulties in balancing the input-output entities in the national electricity grid.

In fact, granting approvals for Wind and Solar based electricity generating projects by the private sector are presently suspended until this issue of managing the variability in output of these two technologies is resolved.

The problem of variability in outputs of Wind and Solar PV technologies has been resolved in some of the industrialized countries. In these countries, the variability in the supply side of wind and solar PV systems are managed by adjusting the demand side by varying the loads of identified consumers through Smart Grid Technology. Such technology could be applied in Sri Lanka by varying the outputs of hydro power plants according the variability of outputs of the wind and solar power plants.

It is proposed to introduce these technologies to the electricity network in Sri Lanka with the view of increasing the share of wind, solar and small hydro based generation.

1.5.2 Objectives

- To develop a set of technologies to balance the varying outputs of wind, solar and small hydro power plants with varying demand in the electricity network in Sri Lanka.
- To enhance the capacity of various components in the electricity network to enable it accept a larger share of input from wind, solar and small hydro power sources.
- To enhance the capability of the Metrological Department in Sri Lanka to enable it to provide more accurate and early weather forecasts.
- To build the capacity of all relevant institutions in Sri Lanka to enable these institutions to acquire adequate knowledge to deploy modern technologies to enhance the share of energy from wind, solar and small hydro power plants.

1.5.3 Outputs of the Proposed Project

- A comprehensive feasibility report on the financial and technical viability of enhancing the share of wind, solar and small hydro through smart grid and infrastructure improvement and improved weather forecasting technologies.
- Enhancement of national electricity network with the ability to absorb (3761 GWh/y) 20% of the total generation capacity from solar, wind and small hydro sources.
- Enhancement of weather forecasting facility at the national Metrological Department with the ability to forecast accurately the weather parameters to enable the electricity producers of solar, wind and small hydro to optimize their electricity generation.
- Enhancement of knowledge base of officials in electricity generation and weather forecasting sectors to enable them to optimize electricity generation from solar, wind and small hydro power plants.

1.5.4 Relationship to the country's sustainable development priorities

According to the National Energy Policies and Strategies of Sri Lanka of October 2006, the policy is to generate at least 10% of the total electrical energy from new renewable energy resources by the year 2015. And as per "Mahinda Chinthanaya: Vision for a New Sri Lanka. A 10 Year Horizon Development Framework, 2006 -2016" this share is expected to be 20% by the year 2020. This project will enable the country to achieve these targets.

1.5.5 Project Deliverables

As a result of the introduction of this technology, the capacities of solar, wind and small hydro power plants and their respect generation capabilities will be increased as per the table given below.

Year	Generation Capacity (MW)			Annual Electricity Generation (GWh/y)		
	Solar	Wind	Small Hydro	Solar	Wind	Small Hydro
2011	0	47	194	0	118	604
2020	161	401	399	240	1124	1468
2037	410	1079	499	647	3026	1836

The government of Sri Lanka has set the above targets taking into consideration the following:

- The present share of indigenous resources Vs. imported resources based electricity generation in the country is 40:60. In a decade, as per the present plan, this situation is expected to worsen reaching a value of 20: 80. In respect of transport fuel, the entire requirements of fuel are imported. Such a large share of imported energy is very unhealthy for the energy security of this country. Hence the government wants to reduce the share on import based energy.
- Out of a total of nearly 10 billion US$ worth of annual exports, over 60% goes for the import of fuels. This compounded by the very adverse balance of payments issues experienced in the country, has made the government to encourage all concerned to develop indigenous sources of energy.
- The development and utilization of indigenous resources also lead to increased local value addition thus increase the generation of local wealth. Most of such wealth goes to the poorer segment of rural communities. This will enable the government objectives of achieving better wealth distribution.

1.5.6 Project Scope and Possible Implementation

The scope of this project is to enhance the capability of the national electricity network to be able to absorb the large potential of electricity generation capacity from solar, wind and small hydro on a very long term basis (for the next 25 years). The electrical energy demand of the country is expected to grow around 8% per annum for the next 25 years. The utility is planning to generate at least 80% of these requirements

through coal based generation. The scope of this project is to maintain the share of electricity generation from solar, wind, small hydro and biomass at 20% of the total generation for the next 25 years.

1.5.7 Project Activities

The project activities are divided into two categories as direct activities and supporting activities. Direct activities include activities directly relevant to transfer and diffusion of the technology. Supporting activities include activities related to government policies which are important in promoting the diffusion of the technology.

Direct activities: (Activities relevant to the direct implementation of this technology)

1. Preparation and publication of a Feasibility Report on the Financial and Technical viability of enhancing the capability of the electricity network to be able to absorb 20% of the total electricity generation from solar, wind, small hydro and biomass starting from the year 2020 till about 2037. This enhanced capability is to be achieved through smart grid technology and optimization generation through better weather forecasting.
2. Technical colleges and universities should include Smart Grid/ Smart Meter technologies in their curricula.
3. Relevant officials of institutions involved in the implementation of these technologies to be sent for training to countries where these technologies are practiced.
4. Enhance the facilities at Meteorological Department to enable it to forecast accurately and quickly the weather parameters to facilitate the energy sector to optimize electricity generation from solar, wind and small hydro.
5. Improve the shape of the daily electricity load curve by combinations of measures such as: smart grid/ smart meter technologies, appropriate dynamic time based tariffs, regulatory measures and energy storage technologies including ice manufacturing during off-peak hours to be used for refrigeration during peak load time.
6. Ensure wider consultations prior to environmental legislations.

Supporting Activities: (Activities indirectly affect the implementation of the technology - Government policies which are important in promoting the diffusion of the technology)

1. Eliminating the taxes imposed on local construction in respect of renewable energy and energy efficiency projects.
2. Donor Agencies to provide funds at low interest rate for renewable and energy efficiency project.

3. Sustainable Energy Authority to invoke the provision in the Act to impose a levy on fossil fuels and use this revenue to finance renewable energy and energy efficiency projects.
4. During generation planning the costs of impacts fossil fuel use on external entities (such as health, agriculture) to be added to the direct costs of electricity generation.

1.5.8 Timelines for the Proposed Activities

Table 1.11: Timelines for the Proposed Activities of Project 4

The time frames of year 1, year 2 and year 3 to 25 are chosen taking into account the project initiation, commissioning and operational phases of the project.

No.	Activity	Year 1	Year 2	Year 3 to Year 25
Direct activities:				
1.	Feasibility Report on the Financial and Technical viability of enhancing the capability of the electricity network (As described in activity 1).			
2.	Technical colleges and universities should include Smart Grid/ Smart Meter technologies in their curricula.			
3.	Relevant officials of institutions involved in the implementation of these technologies to be provided with relevant training (As described in activity 3).			
4.	Enhance the facilities at Meteorological Department to enable it to forecast accurately and quickly the weather parameters to facilitate the energy sector.			
5.	Improve the shape of the daily electricity load curve as described in activity 5.			
6.	Ensure wider consultations prior to environmental legislations.			
Supporting Activities:				
1.	Eliminating the taxes imposed on local construction in respect of renewable energy and energy efficiency projects.			
2.	Donor Agencies to provide funds at low interest rate for renewable and energy efficiency project.			
3.	SEA to invoke the provision in the Act to impose a levy on fossil fuels and use this revenue to finance renewable energy and energy efficiency projects.			

4.	During generation planning the costs of impacts fossil fuel use on external entities (such as health, agriculture) to be added to the direct costs of electricity generation.			

1.5.9 Budget/Resource requirements

Table 1.12: Budget Estimate for Proposed Activities of Project 4

The budget values assigned for "international" are expected to be raised as grant component from donor agencies without burdening the national consumers. The "local" component of the budget is ultimately expected to be provided by the consumers and citizens of this country.

No.	Activity	Proposed Budget (US$)		Remarks
		International	Local	
	Direct activities:			
1.	Preparation and publication of a Feasibility Report on the Financial and Technical viability of enhancing the capability of the electricity network (As described in activity 1).	150,000	Nil	Outright Grant
2.	Technical colleges and universities should include Smart Grid/ Smart Meter technologies in their curricula.	Nil	Nil	Vote of the Ministries of HE/VT
3.	Relevant officials of institutions involved in the implementation of these technologies to be sent for training (As described in activity 3).	1,000,000	Nil	Outright grant by donor agencies
4.	Enhance the facilities at Meteorological Department to enable it to forecast accurately and quickly the weather parameters to facilitate the energy sector.	20,000,000	Nil	
5.	Improve the shape of the daily electricity load curve as described in activity 5.	Nil	Nil	Through tariff and regulatory measures
6.	Ensure wider consultations prior to environmental legislations.	Nil	Nil	Policy
Sub total		**21,150,000**		
	Supporting Activities:			
1.	Eliminating the taxes imposed on local construction in	Nil	Nil	Policy

	respect of renewable energy and energy efficiency projects.			
2.	Donor Agencies to provide funds at low interest rate for renewable and energy efficiency project.	50,000,000	Nil	Out right grant
3.	SEA to invoke the provision in the Act to impose a levy on fossil fuels and use this revenue to finance renewable energy and energy efficiency projects.	50,000,000	Nil	
4.	During generation planning the costs of impacts fossil fuel use on external entities to be added to the direct costs of electricity generation.	150,000	Nil	
Sub total		**100,150,000**		
	Total	**121,300,000**	**Nil**	

1.5.10 Measurement/Evaluation

Monitoring: The progress of project activities will be monitored periodically by the committee coordinating the project. This committee will be constituted with representatives from the following institutions:

- Ceylon Electricity Board
- Ministry of Power and Energy
- Ministry of Finance
- Sustainable Energy Authority
- Department of Meteorology
- Ministry of Environment
- Ministry of Higher Education

Evaluation: The Monitoring Committee is expected to nominate a suitable team to evaluate the performance and progress of the project and recommend appropriate corrective measures.
The monitoring and evaluation committee is expected to formulate quantitative and measurable indicators such as the share of renewable in the electricity mix on a timely and regular basis.

1.5.11 Possible Complications/Challenges

The following complications and challenges need to be met:

- Although Smart Grid / Smart Meter technology in conjunction with hydropower storage is practiced extensively in many parts of the world, in Sri Lanka this is a new phenomenon. Hence the introduction of this technology is bound to face many teething problems.

- The cost of implementation of this technology as perceived by the primary stakeholder – Ceylon Electricity Board (CEB) is extremely high, as it requires large amount of money for infrastructure developments of the CEB and the Meteorological Department. Moreover, CEB is also of the view that this cost should not be passed on to the electricity consumers. Raising such large amount of money as grant fund is very challenging.
- Inadequate support from some government institutions in the energy sector for full implementation of supporting activities proposed in the project may cause obstructions for implementation of these activities. Without full implementation of supporting activities it may not be possible to achieve proposed project targets as expected. Therefore it has to be treated as a risk factor.

1.5.12 Responsibilities and Coordination

Table 1.13: Responsibilities of Project Coordination

Institution/ Stakeholder	Responsibilities
Ceylon Electricity Board/ Ministry of Power & Energy	• Primary Implementing Agency – implementation of all aspects of electricity infrastructure expansion, incorporation of smart grid/ smart metering technology with the existing network, introduction of appropriate tariffs and enhancing knowledge and skills of employees.
Department Meteorology	• Enhancing the resources and providing accurate and quick forecasts of weather parameters with the view to optimize energy generation from solar, wind and small hydro sources.
Sustainable Energy Authority	• Collection of levy from fossil fuels and creation and operation of a renewable energy/energy efficiency guarantee fund.
Ministry of Finance	• Receipt and disbursement of donor contributions
Ministry of Environment	• Ensure that all environmental regulations are complied with.
Ministries of Higher Education and Vocational Training	• Introduction of these technologies in the respective curricula.

Implementing Agency:

Ceylon Electricity Board (CEB) has been identified as the Implementing Agency of this project. This project is all about optimization of the energy generation resources within the CEB's network. It also involves the managing the demands of over 5 million different consumers in a dynamic manner on a continuous manner. This institution should also receive data/ information from the Meteorological Department and integrate that with the operation and management of its generation resources. In addition, this institution should also enhance the knowledge and skills of its employees on Smart Grid/ Smart Meter technologies.

1.5.13 List of References

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