

WB-KIAT Collaboration Project Proposal

Project Overview

Project Title	Bowatenna Floating Solar and Battery Storage Hybrid Project		
Sector (sub-topics)	Small scale hybrid power plant (hydro + floating solar + battery)		
Country	Sri Lanka	Location	Central Province/Matale District
Project Duration	3 yrs	Budget	USD 10 Million
Association with Other Projects	Preliminary review of the targeted reservoir already completed with World Bank assistance. Also benefits from further World Bank pre-feasibility studies at other reservoirs and USAID technical assistance in the sector.		

Submitter's Information

WB (country office)	
Name	(details to be provided when selected)
Position	
E-mail	
Telephone	

Client country's Implementing Organization(s)

Client country Contact 1 (ministerial level)	
Name	(details to be provided when selected)
Position	
Organization	
E-mail	
Client country Contact 2 (implementing agency)	
Name	(details to be provided when selected)
Position	
Organization	Sri Lanka Sustainable Energy Authority
E-mail	

1. Project Background

Current Situation

Sri Lanka served a maximum electricity demand of 2,717 MW with an annual demand of 15,714 GWh at generation including rooftop solar PV systems in 2020. The generation mix of 2020 was (i) coal – 36.6%, (ii) oil – 26.6%, (iii) major hydro – 24.9% (share of hydro varies year to year depending on hydrology) and (iv) other renewable energy – 11.9%. The electricity generation mix of Sri Lanka changed from 100% hydro in mid-1990's to the present thermal dominant mix with the introduction of oil-fired independent power producers and later with the commissioning of the 900 MW Sri Lanka's only coal-fired power plant. Unavailability of potential large hydro sites to develop and, at the time, still emerging new renewable energy technologies, forced Sri Lanka to move to a thermal dominant generation mix in mid-1990 – 2014 period to serve the increasing demand.

Development of renewable energy resources other than large hydro resources in Sri Lanka began in 1996 with the introduction of a Feed In Tariff (FIT) and a Standardized Power Purchase Agreement for the private sector. Since 2016, PPAs for all renewable energy projects except for rooftop solar PV are awarded through competitive bidding by Ceylon Electricity Board (CEB), the vertically integrated electricity utility and Transmission Licensee. By the end of 2020, a total of almost 1,100 MW of renewables (410 MW of mini-hydro, 179 MW of wind, 75 MW of ground mounted solar PV, 40 MW of dendro and biomass, 10 MW of municipal solid waste and 374 MW of rooftop solar PV) were connected to the national grid at various voltage levels.

Sri Lanka reached near 100% electrification in 2016 as a result of extensive rural electrification programs conducted between 2010 and 2016. Despite reaching near 100% electrification, electricity demand of Sri Lanka is forecasted to grow together with economic development and improvements in quality of life to 28,146 GWh at generation in 2030 and 45,333 GWh at generation in 2040 by CEB in its Long Term Generation Expansion Plan 2022-2041.

As per Government policy, Sri Lanka plans to increase the share of renewable energy in the generation mix to 70% by 2030 in serving the demand, which is forecasted to increase rapidly, in order to improve energy security, self-reliance and sustainability. Most of this future

renewable energy capacity additions are expected to be from wind and solar energy. Being an island with high population density, land availability in Sri Lanka is limited and have many competing uses. Hence, it is challenging for Sri Lanka to fulfil extensive land requirements of solar energy development. However, Sri Lanka has many reservoirs built for irrigation and power generation purposes that can be used for floating solar energy facilities. But Sri Lanka is yet to commission a floating solar energy facility and lacks technical knowledge in designing and construction/erection of such facilities. The proposed demonstration project is expected to bridge the knowledge gap and inform development of large scale floating solar energy projects.

Relevant National Development Plans, Policies, and Strategies

The present energy policy of Sri Lanka is “National Energy Policies and Strategies of Sri Lanka” of 2019. This energy policy is based on ten pillars grouped under the energy trilemma energy security, energy sustainability and energy equity. The ten pillars include ensuring energy security, providing energy services at the optimum cost to the national economy, enhancing self-reliance, caring for the environment, and enhancing the share of renewable energy.

The Transmission Licensee, CEB, develops and publishes the generation development plan of Sri Lanka based on least cost principles every two years for the next twenty years. The most recent generation development plan is the Long Term Generation Expansion Plan 2022-2041 (LTGEP 2022-2041), which analyses five scenarios and compares three scenarios (i) Scenario 1 – compliance to existing General Policy Guidelines, (ii) Scenario 2 - achieve 70% of electricity from low carbon sources by 2030, including a minimum of 50% from renewable energy, and maintain 70% low carbon share up to 2041, and (iii) Scenario 3 - achieve 70% of electricity from low carbon sources by 2030, and increase the share of low carbon sources beyond 2030 by restricting coal power development, to determine the base case. Although Scenario 1 was derived as the scenario with the lowest present value cost, US \$ 16,147 million, the most expensive scenario, Scenario 3, with a present value cost of US\$ 16,280 million has been selected as the base case with the objective of complying with the perceived policy of the government to maximize generation from renewable energy sources according to the national policy framework “Vistas of Prosperity and Splendour”. The Public Utilities Commission of Sri Lanka, the power sector regulator, has approved the development of renewable energy projects identified in the plan and thermal energy projects that comply with the government policy and has advised CEB to develop a plan to achieve 70% of electricity generation through

renewable energy. CEB is presently updating the Long Term Generation Expansion Plan to achieve 70% of electricity generation from renewable energy resources.

According to the LTGEP 2022-2041, CEB will add 6,754 MW of renewable energy based electricity generating capacity during the planning horizon. LTGEP identifies generation capacity additions mostly in terms of technologies rather than specific projects, and most of the capacity additions planned are from wind and solar energy based generation. A Renewable Energy Development Plan that identifies specific projects to match capacities identified in the LTGEP 2022-2041 is being prepared by CEB at present, taking the Renewable Energy Development Plan 2021-2026 developed by Sri Lanka Sustainable Energy Authority (SLSEA) into consideration. The Renewable Energy Development Plan that is being prepared by CEB includes floating solar energy projects as well.

Updated Nationally Determined Contributions (NDC) targets of Sri Lanka require a 4% unconditional and an additional 10.5% conditional GHG emission reduction nationally by 2030 compared to the business-as-usual case. Electricity sector NDCs target a 5% unconditional and a 20% conditional reduction in sectoral GHG emissions equivalent to an estimated reduction of 9,819,000 MT and 39,274,000 MT of carbon dioxide equivalent unconditionally and conditionally during the period 2021-2030. Among NDC targets are to (i) develop an additional renewable energy capacity of 3,867 MW over the renewable energy capacity considered in the business-as-usual scenario, out of which approximately 950 MW are on an unconditional basis and 2,917 MW on a conditional basis, and (ii) conduct research and development activities to implement pilot-scale projects for renewable energy sources that have not yet reached commercial maturity and develop other grid supporting infrastructures as a conditional measure. Furthermore, Sri Lanka has committed to add no more unabated coal power plant capacities. In addition to NDC targets, going further, Sri Lanka has set a target of increasing the share of renewable energy to 70% by 2030 and achieving carbon neutrality by 2050 in electricity generation.

Association with Other Projects/Programs

A Floating Solar Energy Review for Sri Lanka was completed in two phases with financial assistance of the World Bank to prepare a short list of sites with a priority order for selection of sites for conducting pre-feasibility and feasibility studies. Phase A identified 40 sites with potential for floating solar PV projects in the second half of 2020, and in the first half of 2021

Phase B carried out a multi-criteria analysis on 23 sites selected from the list prepared in the Phase A to rank them in a priority order. Pre-feasibility studies are currently carried out with financial assistance Energy Sector Management Assistance Program (ESMAP) of the World Bank evaluating four sites (i) Ulhitiya, (ii) Rathkida, (iii) Maduruoya and (iv) Castlereigh reservoirs, all of which have potential for projects with capacities higher than 100 MW. The World Bank is also planning to conduct solar resource measurement at two selected floating solar PV sites with ESMAP funds. The United States Agency for International Development has agreed to compliment the studies financed by the World Bank with detailed feasibility studies and environmental and social impact assessments.

2. Project Objectives

Sri Lanka has committed to increase the share of renewable energy in electricity generation in medium to long term to 70%. For Sri Lanka to fulfill this commitment, solar energy is required to play a significant role despite difficulties Sri Lanka face in allocating large extents of land require for solar PV and wind development. However, there exist a large number of inland water bodies, mostly irrigation reservoirs, that can be utilized for floating solar energy development which requires comparatively small extents of land and is seen as a way forward in fulling national obligations. As Sri Lanka is yet to develop a MW-scale floating solar energy facility, Sri Lanka doesn't have the required technical know-how. The proposed project is expected to build capacity in Sri Lanka for floating solar energy development.

In addition, Sri Lanka has taken a policy decision that all future renewable energy projects will be developed with private sector investments. Again, as Sri Lanka is yet to develop a floating solar energy project of MW scale, attracting private sector investments for a project larger than 100 MW would be difficult. Hence, a pilot project about 10 MW in capacity will demonstrate the viability as well as assist in identifying and assessing risks associated.

The Bowatenna Reservoir which is owned by the Mahaweli Authority and has a 40 MW hydro power plant operated by CEB (Bowatenna Hydro Power Plant) connected through a tunnel is suitable for a floating solar energy facility of 8-10 MW. According to findings of the Floating Solar Energy Review, Phase B: Multi-criteria Analysis and Ranking a floating solar energy facility of 8-10 MW will occupy 40-50% of the reservoir surface at the minimum operating level leaving area for public activities such as fishing and various leisure activities. Furthermore, transmission infrastructure is available in the vicinity as a hydropower plant exist nearby. Based on findings of studies carried out so far, the floating solar energy facility can be connected to the 132/33 kV Naula Grid Substation by a 4.2 km long 33 kV transmission line. The possibility of connecting the floating solar energy facility to the substation of the Bowatenna Hydro Power Plant with a much shorter transmission line need to be studied at the

detailed feasibility study, which is part of the proposed project. The floating solar energy facility is expected to operate in conjunction with the Bowatenna Hydropower Plant. Both Mahaweli Authority and CEB participated in previous studies carried out with ESMAP funds and have expressed interest in floating solar energy facilities in their reservoirs.

Furthermore, in addition to solar energy being available only during daytime, intermittency of solar energy is high in Sri Lanka due to high cloud movements as Sri Lanka is a tropical island. Plans to increase the share of renewable energy in the generation mix with a significant contribution from solar energy will require energy storage to play a pivotal role in the power system. As Sri Lanka does not have transmission interconnections to any of the neighboring countries, export and import of electricity is also not an option yet. Hence, a battery energy storage system for demonstration purposes on overcoming intermittency of electricity generation and supplying the grid during the evening peak period is also included in the project.

3. Project Components

The project will include (i) detailed feasibility study, (ii) detailed designing, engineering and project management, (iii) procurement, construction and commissioning and (iv) capacity building related to the floating solar energy facility and related transmission infrastructure.

(i) Detailed Feasibility Study

The detailed feasibility study is expected to conduct detailed site surveys, measurements and analysis to improve the findings of preliminary studies the Floating Solar Energy Review has carried out and ascertain the project viability and provide inputs required for the detailed designing activities.

(ii) Detailed Designing, Engineering and Project Management

This will include detailed designing work of the floating solar energy facility, construction supervision and supervision of commissioning tests.

(iii) Procurement, Construction and Commissioning

This component will include procurement of material and equipment, shipping of foreign supplied equipment, customs clearance and inland transportation, construction of foundations and structures, erection of equipment and commissioning of the system.

(iv) Capacity Building

Capacity building to train staff of the SLSEA, CEB and other relevant stakeholders is expected to take place in parallel to project activities. Capacity building on conducting detailed feasibility studies, detailed engineering designs, erection of equipment and commissioning are expected.

4. Project Location, Period and Estimated Cost

Bowatenna reservoir situated in the Matale District of Sri Lanka is the proposed for the demonstration project. This reservoir is owned by the Mahaweli Authority of Sri Lanka and was built in 1981 for the primary use of irrigation. The Bowatenna Hydro Power Plant is located downstream and is operated with water from the Bowatenna Reservoir. (Note: In case that upon further investigation the Bowatenna reservoir is found not suitable for this demonstration project, the other reservoirs already assessed by the World Bank and/or USAID can also be considered as alternative locations.)

The project is expected to be completed in 36 months and a tentative project schedule is provided in Figure 1.

Figure 1 – Draft Project Schedule

	Activity	Months											
		3	6	9	12	15	18	21	24	27	30	33	36
1	Detailed Feasibility study												
2	Detailed Design and Engineering												
3	Project Management												
4	Procurement of Material and Equipment												
5	Construction												
6	Erection of Equipment												
7	Commissioning												
8	Capacity Building												

The estimated cost is as provided in Table 1.

Table 1 – Estimated Cost

Component	Amount (US\$)
Detailed Feasibility Study	150,000.00
Detailed Design, Engineering and Project Management	250,000.00
Floating Solar Energy Facility	7,300,000.00
Transmission Line and Substation	600,000.00
Access Roads	200,000.00
Land Acquisition	100,000.00
Battery Energy Storage System	1,400,000.00
Total	10,000,000.00

Note: The transmission line and substation cost may reduce if connection to the Bowetenna Hydro Power Plant substation is feasible

5. Project Implementing Organization

The Ministry of Power and Energy will be the responsible ministry while SLSEA, established by the Sri Lanka Sustainable Energy Authority Act No. 35 of 2007, will be the implementing entity under the supervision of the State Ministry of Solar, Wind and Hydro Power Generation Projects

Development. The State Ministry of Solar, Wind and Hydro Power Generation Projects Development is under the purview of the cabinet ministry Ministry of Power and Energy. The Sri Lanka Sustainable Energy Authority Act mandates the SLSEA to “identify, assess and develop renewable energy resources with a view to enhancing energy security and thereby derive economic and social benefits to the country”. Hence, implementing the proposed demonstration project is well within the mandate of the SLSEA.

Furthermore, the SLSEA has successfully implemented demonstration projects in the past from which stakeholders of the renewable energy sector have greatly benefited. SLSEA implemented the first ground mounted solar PV project in Sri Lanka, the 1,237 kW Hambantota Solar Power Station, in two phases. The first phase of 737 kW was financed by the Government of Japan while the second phase of 500 kW was financed by the Government of Korea. This project was instrumental in triggering the development of ground mounted solar PV projects in Sri Lanka.

6. Required Coordination at National/Regional Level

As explained under national policies and strategies in Section 1, Sri Lanka has committed to reduce GHG emissions in the energy sector by 5% unconditionally and 20% conditionally during the period 2021-2030 as NDCs. Furthermore, Sri Lanka identifies developing an additional renewable energy capacity of 3,867 MW over the renewable energy capacity considered in the business-as-usual scenario as an action to achieve NDC targets. Sri Lanka’s target of 70% renewable energy in electricity generation would require an estimated total of 9,000 MW (about 6,500 MW of new capacity additions) of renewable energy based electricity generating capacity connected to the national grid by 2030. This was estimated assuming an average plant factor of 25% for the renewable energy pool, which will vary depending on the renewable energy composition.

Floating solar energy is a renewable energy technology that can be scaled up and replicated in Sri Lanka. In addition, battery energy storage systems too support Sri Lanka’s mission to increase the renewable energy share in the generation mix and can be scaled up and replicated as well. Hence, the proposed project is part of Sri Lanka’s NDC action.

The SLSEA was a key institution in preparing energy sector NDCs of Sri Lanka and has representation in the Sectoral Planning and Monitoring Committee in NDC implementation. Hence, the SLSEA is well positioned to coordinate this project at a national level.

7. Risks and Opportunities

All organizations involved, the implementing entity (SLSEA), the owner of the reservoir (Mahaweli Authority) and electricity off-taker (CEB), are government owned entities. This is

expected to make obtaining various approvals less time consuming and project coordination implementation easier.

Road infrastructure required for equipment/material transportation is available in close proximity as the Bowatenna Reservoir is an irrigation reservoir currently in operation and a 40 MW hydro power plant is operational nearby. The need to construct new roads will be minimum depending on the site identified for the floating solar energy facility and some existing roads may need rehabilitation.

As both the World Bank and USAID are currently conducting feasibility assessments at other reservoirs for large scale floating solar projects, this demonstration project has a high likelihood of informing and helping significant scale up in the coming years. Further, as noted above, in case Bowatenna reservoir is found to be unsuitable for any reason upon further investigation, one of the other reservoirs assessed by the World Bank or USAID can be considered, lowering the risk of the proposed project not achieving its desired demonstration effect.

The risk of Covid-19 in Sri Lanka is less as a majority of the population have had two doses of the Covid-19 vaccine and a significant percentage of the population have had the booster dose as well.

The social, economic and political environment of Sri Lanka is uncertain at present. However, the situation is expected to improve by 2024.