Report on the operations of the first Floating Solar Pilot Plant in Sri Lanka installed at the Faculty of Engineering, University of Jaffna

1. Introduction:

Renewable energy resources have become unavoidable due to the rapid rise of power demand, economic advantages and environmental issues of fossil fuel usage. Solar power is the most popular and widely used one among all the renewable energy resources. The installation and integration of solar plant plays an important role in the modern power system.

The floating solar plant is recently introduce technology, which brought solution for two main factors of the ground mounted solar system. They are: (i) the solar power plants needed vast land area. The floating solar plant uses the surface area of the water, which is not used for any other purpose like vegetation. Instead the floating solar covers the water surface in such a way it prevent the water evaporation too. (ii) Operating efficiency of the solar panels gets improved due to cool condition above the water surface. The efficiency of the floating solar system increases due to the natural cooling effect from water which reduces the temperature effect.

Therefore, many countries chose to install floating solar power plants and also encourage the researchers to validate the efficiency improvement and economic benefits.

2. First floating solar pilot power plant in Sri Lanka:

2.1. Donors and Collaborators:

Sri Lanka's first floating solar power plant with a total capacity about 46 kWp had been installed recently in the ponds of the Killinochchi premises, University of Jaffna. This was done with the support of the Current Solar AS, a Norwegian developer of floating photovoltaic solar systems. This project is a collaboration between the Western Norway University of Applied Sciences and University of Jaffna and it is supported by the Royal Norwegian Embassy in Colombo.

Figure 1: Floating Solar Plant at Kilinochchi Premises of the University of Jaffna

2.2. Installation:

A 44 kWp East west floating system with 2.5 kWp south facing land - based reference plant was officially launched on 24th of January 2020 at Kilinochchi premises, University of Jaffna. Current Solar AS, the Norwegian developer of floating PV solutions, designed the system based on the experience from their test site in Singapore.

The first floating system is established as an experimental plant in the pond with the depth about 2 m. Floating pipes used in the design are made of high-density Poly Ethylene in order to lift the solar panel sets, upon the water surface. The beams are made of glass fiber, which is steady and well adapted to the water environment. Usually, the water level reduces continuously in the dry session. Therefore, four anchoring points are set to keep the panel system in the pond surface in order to avoid the structure to dim into the clay when the pond dries completely. Further it also provides the slope required for the solar panel installation. This floating solution is specifically based on low cost and easy installation. This installation was very simple and it does not require any heavy machineries.

The solar modular base unit was made with 24 basic 8 – 12 kWh modules depending on the module type and size. There are also 4 modules; 2 Twin Peak and 2 N-peak. One Twin Peak and one N-peak module were mounted on the floating system, and one of each was placed on the land-based reference system. 50 kW SMA inverters used here, which contains 6 MPPT units and 5 MPPT is used in the design as the data is collected separately for different type of module and different orientation. 1 MPPT is used for land-based PV system.

Figure 2: Floating solar plant Installation step by step

2.3. Operational experiences:

The data logger and the sensors are placed to collect the data and the data is being recorded at 10 minutes time interval. Solar irradiation sensors and module temperature sensors are placed on east west orientation. Humidity, water temperature and ambient temperature have also been measured separately.

As an example, variations in solar radiation for few days are shown in Figure 3. This floating solar system is expected to have 4 - 5% of more power yield (kWh/kWp) comparing to the land - based system. Data have been collected continuously to analyze the performance and the environmental effects of both the floating and land-based system. In the last summer session, floating solar generation had more power yield (kWh/kWp) comparing to the land - based system according to the collected data.

Figure 4 illustrates the daily variation on the energy production during the month of May in 2020. There is a variation daily as well as with the time especially in most cloudy periods.

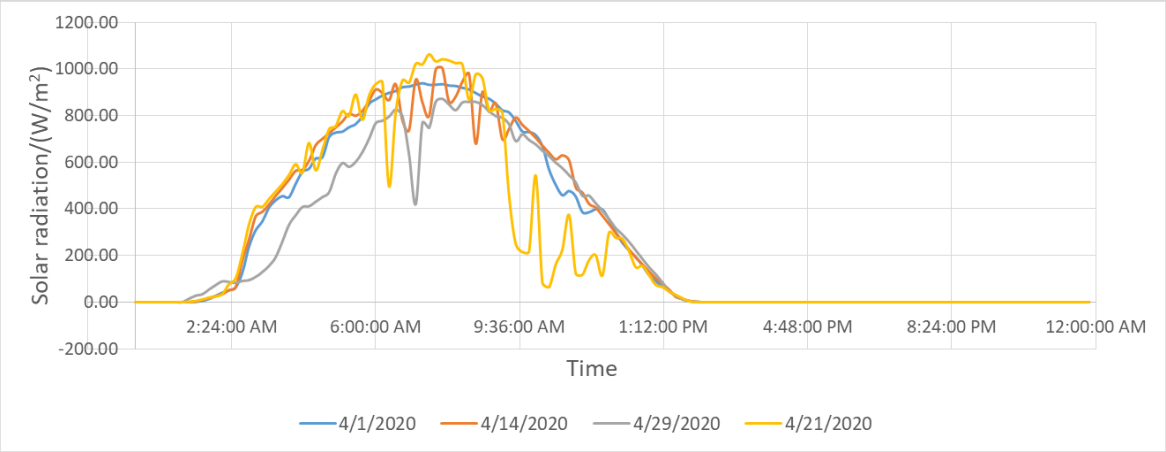

Figure 3: Variation in solar irradiation in four different days selected randomly

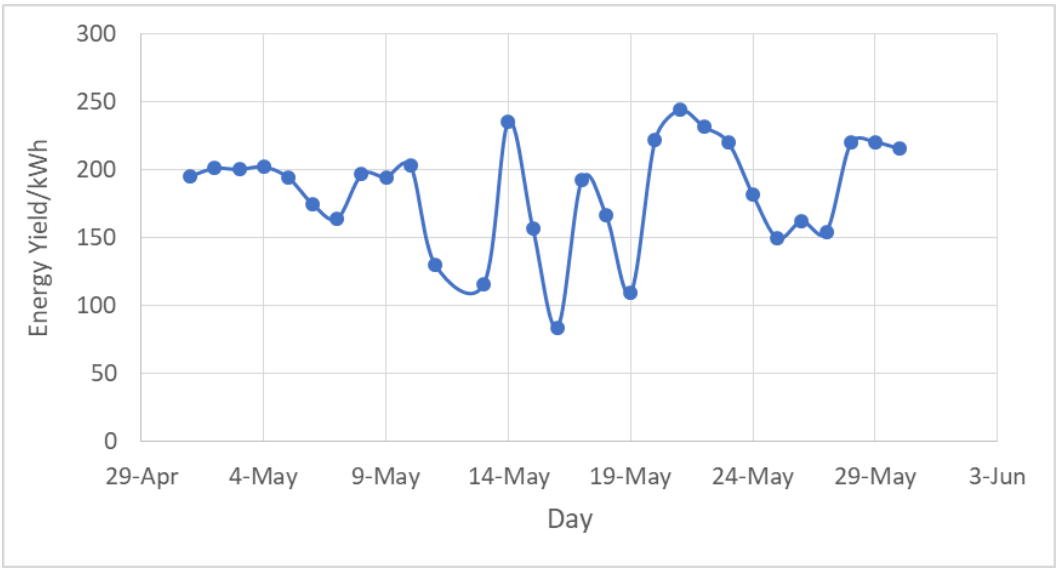

Figure 4: Variation of daily energy generation during the May 2020

Figure 5 shows the monthly variation on the energy production during the years 2020 and 2021. Here it can be seen, during the summer period, the energy production is high and winter season it low due to most of these time the sky is covered by clouds most of the time.

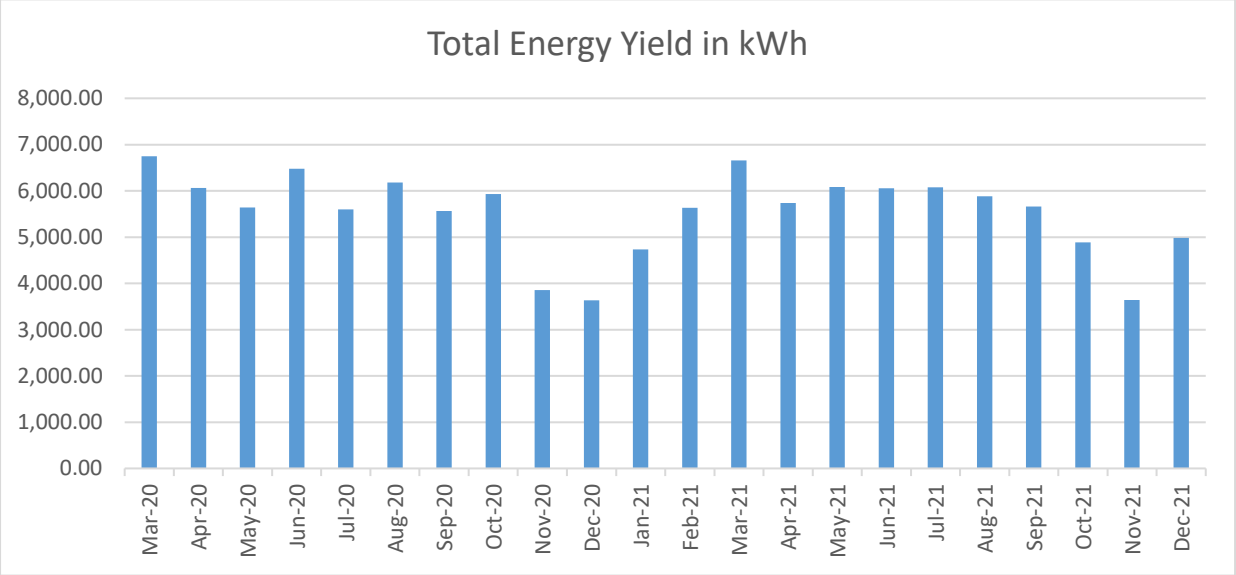

Figure 5: Variation of monthly energy generation during the years 2020 to 2021

2.4. Economical aspect of this floating solar project:

Total cost of the floating solar project (component cost) is around 9,500,000 Sri Lankan Rupees (SLR), which includes 157 Solar Panels (295 Wp & 315 Wp), 50kW SMA Inverter, Beams and breakers, 13 PE Pipes, Data logger and sensors and ground mounted PV system.

The average generated power per month is around 5000 kWh as per shown in Figure 5. The floating pilot power plant system is connected through a net metering connection to the utility. This is the University supply under the General purpose tariff system of the Ceylon Electricity Board. Accordingly the unit average cost will be about 14.50 SLR.

Accordingly, expected yearly income is 870,000 SLR. Therefore the simple payback period is expected to be around 11 years as it is first and small power plant. It is expected reduce the cost of this plant with the technological advancement and when implementing the larger power plant. Accordingly the payback period will be reduced further.

3. Impact on this first floating solar pilot power plant:

The faculty of Engineering of the University of Jaffna has disseminate the knowledge and experience of this floating solar power plant to many professionals in Sri Lanka. There were many consultants, Engineers and Managers visited and see through the development process of this power plant. Further school children also visited to visualize this power plant. Further officers from the Sri Lanka Sustainable Energy Authority and Ministry of Power and Energy also visited to this power plant. Also few industrial engineers including Public Utility Commission of Sri Lanka, Ceylon Electricity Board, Lanka Electric Company, etc. were also visited to see this power plant. On the visit to the Jaffna, The director Energy of the South Asian division of the ADB and his team also visited to see through this power plant.

Further in the Institution of Engineering Sri Lanka events, the information about this power plant was disseminated through presentations. Further THREE Lanka project (Erasmus supported project with 11 partner institutions, http://www.threelanka.com/) talks and seminar also it was disseminated. This has been empowering many professionals and continue to empower many more member as it is the first and a pilot project in Sri Lanka.

Accordingly the floating solar power plant is also considered as one of the RE power plant technologies to achieve this Government target as one of the technologies. This has been reported in the Ceylon Electricity Board Long Term Generation plan 2022 to 2041 in page number 116 under section 3.4.4.5 (https://ceb.lk/front_img/img_reports/1636539187LTGEP_2022-2041_Web_compressed.pdf), Refer page 116 out of 282 under section 3.4.4.5. This portion is shown below too:

3.4.4.5 Potential to develop Floating Solar PV Plants

Floating solar technology alternative has the potential to resolve the land limitation issues for developing solar power plants. In this, solar panels are usually mounted upon a floating structure and to keep its location fixed, floating structure is anchored and moored. Direct advantages of floating solar technologies are

- Higher gains in energy production due to lower PV array temperature
- Minimal Land requirement compared to ground-mounted solar PV
- Reduction in water evaporation of reservoirs
- Possibility of sharing existing electrical infrastructure

A Floating solar power plant with a capacity of 42 kW was installed at the University of Jaffna in 2020 marking the country's first such project as a pilot project. Moreover, the Sri Lanka Sustainable Energy Authority has identified multiple potential reservoir locations to develop large scale floating solar projects and detailed techno-economic assessments for each resource sites are required for long term investment decisions.

Further to this there are many RE technology based power plant development is going to take place in Sri Lanka. There are about 100 MW solar power plant including the floating solar power plant technology will be taking place soon. Related to this the below paragraph is also listed in the Ceylon Electricity Board's Long term Generation plan 2022 to 2041, Page number 213 under section of "Renewable Energy Power Projects: in section (ii) solar power Development". The content is also listed below:

Renewable Energy Power Projects:

(i) Other Multipurpose Hydro Power Projects (Gin Ganga, Thalpitigala)

Gin Gaga and Thalpitigala Hydro power projects are to be developed by Ministry of Irrigation and Water Resource Management. The preliminary feasibility studies and EIA studies of the Thalpitigala Hydro Power Project have been finalized and approved. However due to difficulties in securing project finances, the project is on hold at present.

(ii) Solar Power Development

The SEA and CEB has conducted initial studies to identify potential locations to develop large scale solar parks in the country. These include 100 MW ground mounted solar parks and floating solar power plants. As first phase, large scale solar power parks are planned to be developed in Siyambalanduwa, Hambantota and Trincomalee. The land acquisition and initial prefeasibility studies for these projects are to be done.

(iii) Wind Power Development

4. Conclusion:

4.1. Northern Province and RE pilot plants:

In summary, The Northern Province is blessed with huge Renewable Energy Sources. Therefore, the faculty of engineering is developing a Renewable Energy Park for demonstrating the new technologies to the business developers and community. Accordingly, the faculty has already developed grid connected roof-top demonstrating plant, grid connected wind turbine, etc. The last development on this direction was a very successful implementation of the first grid connected floating solar power pilot plant.

4.2. Advantages of floating power plant:

This has proven that (i) the operational efficiency of the solar power plant is increased due to cooling effect when it is floating, (ii) land use is effectively utilized as it was placed on top of the free water surface, (iii) evaporation of water is expected to be reduced – studies are carried out on this matter to be proven and (iv) environmental effect are expected to be in satisfied level – studies are carried out on this too. For the analysis on the environmental impact with time, some multi-disciplinary researches are being initiated.

4.3. Impact on this power plant on the national policy or guidance:

This power plant operations has been checked by visiting to the site by many officers from the Ministry of Power and Energy – Sri Lanka Sustainable Energy Authority, Public Utility Commission Sri Lanka, Ceylon Electricity Board, Industries, Consultants, etc. Further the according to the HE President manifesto on generating 70% of the electricity generation from the RE power plants in 2030 has been activated fast development on the RE sector. Accordingly the floating solar power plant is also considered as one of the RE power plant technologies to achieve this Government target. This has been reported in the Ceylon Electricity Board Long Term Generation plan 2022 to 2041

(https://ceb.lk/front_img/img_reports/1636539187LTGEP_2022-2041_Web_compressed.pdf), Refer page 116 out of 282 under section 3.4.4.5.

4.4. Overall advantages of RE technologies:

The RE technologies or any proven technologies, if they are installed in a right way, then it will definitely be beneficial to the human life.