A Study on Floating SPV Power for Practical Utilization across the Globe

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ABSTRACT

This technology has been used by the different countries to save the traditional use of agricultural land and rooftop of the building. This paper has been studied the different methods used by the different countries. The main purposes of this studied are: (i) to save the agricultural land (ii) to reduce the greenhouse gases in order to have a clean environment sustainable for all the living beings of our planet and (iii) to provide electricity at the off-grid areas including along the coastal belt of Bangladesh. The novelty of this research paper is to see the preparation technology and the cost analysis of the PV floating system. From the study it is shown that most of the developed countries have been developed FPV (Floating Photovoltaic) system to reduce carbon dioxide emission and getting the green energy. It is also shown that this FPV technology is becoming popular day by day. This study will also show the guide line for use the FPV system at the off-grid areas people across the globe.

Keywords: *Floating, Solar, Photovoltaic, Electricity, Utilization, Cost analysis*

I. Introduction

Nowadays, many countries are embracing the use of renewable energy and have built large floating solar power plants which create new major opportunities to advance in using solar energy as a source of electricity. It is of great challenge for the 21st century to reduce the greenhouse gases in order to have a clean environment sustainable for all the living beings of our planet. Excess amount of CO_2 is one of the frontier candidates among those greenhouse gases responsible for the global warming. In order to reduce the CO_2 gas, Solar PV may play an important role. But for installation of SPV system needs land. People are using the agricultural land for these purposes. For this reason scientists are searching the alternative way to install SPV system. Floating SPV device can face to solve this problem. It can be set-up off-grid areas of Bangladesh. It can be set-up in the bill, rivers and canals also. Floating them on a lake is a great idea. It has wondered before why more nations dont so something to protect their water from evaporation. So you see multiple advantages. Water conservation, energy efficient to spin on a floating body, and maximizing energy production by following the sun, and even getting some reflected light.

II. Methods for the use of different countries

II(A). Floating PV in USA

America's largest floating solar project completed

Ciel & Terre USA has completed a 4.4. MW floating solar array in Sayreville, New Jersey, the largest of such a project in North America. This is an important step for a technology that NREL predicts could reach 9.6% of current electricity generation.

The "Solar Photovoltaic (PV) in the United States, Market Outlook to 2030, Update 2019 - Capacity, Generation, Investment Trends, Regulations and Company Profiles" report has been added to ResearchAndMarkets.com's offering.

- This report starts with a brief introduction on global carbon emissions and global primary energy consumption.
- An overview on the US renewable power market, highlighting installed capacity trends (2010-2030), generation trends (2010-2030) and installed capacity split by various renewable power sources in 2018.
- Detailed overview of the US solar PV market with installed capacity and generation trends and major active and upcoming solar PV projects.
- Deal analysis of the US solar PV market. Deals are analyzed on the basis of mergers, acquisitions, partnership, asset finance, debt offering, equity offering, private equity (PE) and venture capitalists (VC).
- Key policies and regulatory framework supporting the development of solar PV sources.
- Major Contracts and Collaborations related to solar PV sector in the US.
- Snapshots of some of the major market participants in the country.

II(B) Floating PV in Japan:

The world's first floating solar plant was built in Japan, in Aichi Prefecture in central Honshu. The country's many inland lakes and reservoirs are now home to 73 of the world's 100 largest floating solar plants and account for half of those plants' 246 megawatts of solar capacity.

They have compiled and analyzed the Top 100 Floating Solar PV Plants in the world. Although our overview represents global projects, in this article we primarily focus on Asia- and Japan specifically.

Floating PV Power plant in Japan

Floating solar headlines have been swirling around the industry particularly in the last year as a favorable and financially-sound alternative to ground-mounted solar. The floatovoltaics market is considered to be one of the most high-potential levers in accelerating the transition towards a solar-driven future. At the end of 2018, World Bank reported a total global capacity of 1.1 GW of floating solar PV. Although the global solar market has woken up to the idea of placing solar arrays on underutilized bodies of water to buoy growth in the solar energy sector, Asia is currently still leading the wave of floating solar. To take better stock of the capacities and locations of these projects, and prepare for Solar Asset Management Asia 2019, we have compiled and analyzed the Top 100 Floating Solar PV Plants in the world. Although our overview represents global projects, in this article we primarily focus on Asia- and Japan specifically - for reasons explained in this article. We have also added some insights regarding key considerations affecting the performance of such projects and the overall benefits associated with floating solar.

Top 10 Floating Solar PV Plants

Sl. No.	Location	Scale (kW)	Country	City / Province	Operating from	Floating System Provider
1	Coal mining subsidence area of Huainan City	40000.00	China	*	*	*
2	Coal mining subsidence area of Huainan City	20000.00	China	*	*	*
3	Yamakura solar power plant	13700.00	Japan	*	*	*
4	Pei County	9982.00	China	*	*	*
5	Umenoki	7550.00	Japan	*	*	*
6	Jining GCL	6776.00	China	*	*	*
7	Hirotani Ike Floating Solar Plant	6800.00	Japan	*	*	*
8	Queen Elizabeth II Reservoir	6338.00	UK	*	*	*
9	Cheongpung Lake	3000.00	South Korea	*	*	*
10	Otae Province	3000.00	South Korea	*	*	*

*F.O. = See Full Overview

Where Are These Projects Located?

The cumulative capacity of the top 100 floating projects reaches over 246 MW, more than 50% of which is located in Japan. As shown in figure 1, in addition to Japan, other hot markets dominating the world of floating solar are China, South Korea, the United Kingdom and Taiwan. Considering this overview, the total capacity installed in the aforementioned countries stands at 244.6 MW, which is almost 99% of the capacity of the complete list altogether. The majority of the projects featured in this overview are placed on reservoirs.

II(C) Floating PV in India:

India plans world's largest floating solar power plant at 1GW

Array in state of Madhya Pradesh would cost $700m to build, says energy minister

The state of Madhya Pradesh is planning a 1GW floating solar array that would be the world's largest, according to reports from India.

The floating solar plant is planned for India's largest reservoir on the Indira Sagar Dam in Madhya Pradesh, in central India, said the Times of India, quoting the state's renewable energy minister.

"We have done preliminary studies and now [the] World Bank is preparing feasibility reports," Manu Shrivas A 1GW plant would dwarf the world's current largest floating PV array, a 150MW project in Anhui, China.

Development would cost around 50bn rupees ($700m), according to Shrivastava, who hopes work on the project can start in about 8 months. The Madhya Pradesh would act as offtaker for 200MW from the plant, the report said.

Floating solar arrays are an increasingly attractive option for large-scale PV deployment at reservoirs and alongside hydropower facilities, especially where land use is constrained elsewhere, according to a World Bank report on the sector published last year.

About 1.1GW of floating solar was in place globally by mid-2018, the World Bank said.

tava told the newspaper.

II (D) Floating PV in Singapore:

Singapore has a space constraint. In spite that they have set-up a floating PV plant.

Singapore plans huge 50MW floating solar project:

Singapore's national water agency will work with Norwegian technical consultancy DNV GL to develop what will be one of the largest single floting solar systems in the world – a 50MW project planned for the Tengeh Reservoir in the island's north-west.

DNV GL announced on Thursday that it had been contracted by Singapore's Public Utilities Board (PUB) as technical advisor for the 50MW floating solar PV project.

PUB will conduct a tender for development of the project, billed as Southeast Asia's largest public tender for floating PV and, according to DNV GL, use "a pioneering business model consisting of both conventional and renewable energy components."

DNV GL will work with PUB throughout the tender preparation, bidding, design, construction, and operational phases of the project.

"The scale of the Tengeh Reservoir project makes it an important milestone in the development of this rapidly emerging technology," said Nicolas Renon, Executive Vice President Asia Pacific, at DNV GL - Energy.

"We are looking forward to bringing our expertise across various forms of energy generation to this project and support the Singaporean government in meeting its ambitious solar generation targets."

The Tengeh Reservoir floating solar PV project is billed as being completed and operational by 2021 and will be used to power the reservoir's water treatment facilities, eliminating 28,000 tonnes of carbon dioxide emissions annually in the process.

An island city-state off the southern coast of Malaysia, Singapore is one of the world's global financial centres, but has limited renewable options and resources. According to Singapore's Energy Market Authority (EMA), the country has "no hydro resources, our wind speeds and mean tidal range are low, and geothermal energy is not economically viable."

Unsurprisingly, then, solar energy "remains the most viable renewable energy option for Singapore" as the country is located helpfully in the tropical sun belt and enjoys an average annual solar irradiance of 1,580 kWh/m2/year.

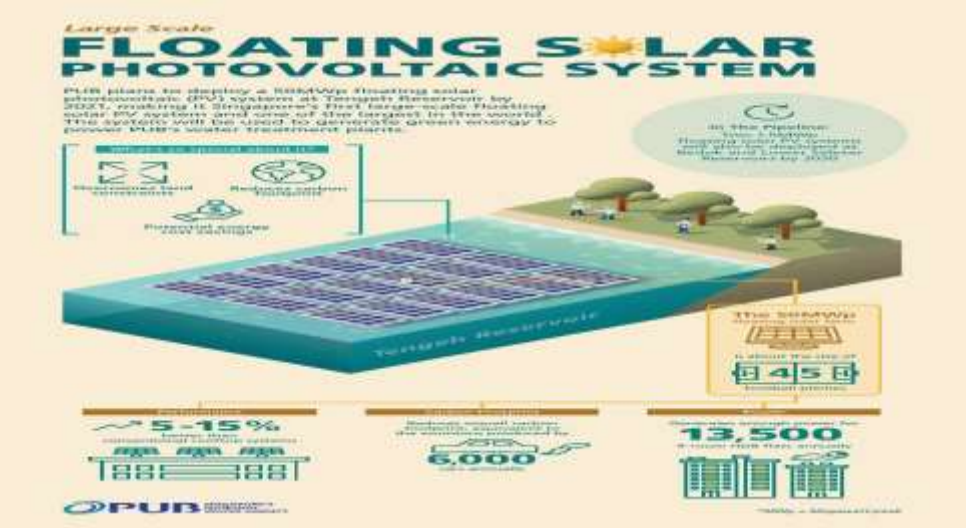
Nevertheless, Singapore is making significant strides towards achieving its Paris Agreement pledges, which include a pledge to reducing emissions by 16% by 2020 and reducing its Emissions Intensity by 36% from 2005 levels by 2030, and to stabilise their emissions with the aim of peaking around the 2030 mark. Singapore also hosts the Singapore International Energy Week, which will mark its 12th edition later this year and help meet the country's commitment to becoming a global leader among energy companies.

Singapore's PUB launched a public tender to seek proposals to design, build, own, and run the 50 MW floating solar PV project at Tengeh Reservoir on June 6. At the same time, PUB also confirmed it is in the process of implementing two smaller 1.5 MW floating solar PV systems on the Bedok and Lower Seletar reservoirs.

The tender for these two smaller projects has already closed and will be awarded in the third quarter for operations to begin in early 2020. PUB is also deploying rooftop solar PV installations across their water infrastructure and reservoirs in order to reduce their carbon footprint.

When the three floating solar projects are completed, PUB will boast solar capacity of around 57MW, and will add a further 5MW in 2025 when rooftop solar is installed atop the Tuas Water Reclamation Plant.

The first utility-scale public tender for floating PV in Southeast Asia, the Tengeh Reservoir project has already completed preliminary design, independent energy assessment, technology benchmarking, and business model studies, and will provide tender support and proposal evaluation during the bidding phase.



II (E) Floating PV in UK:

It is needed to be doing more in the UK and big energy businesses need to go for it if the UK is going to survive and keep up in the future, they are falling behind and really need to analyse why? There are good things happening but it is all too, too slow much Like brexit.

AN ARTIST'S IMPRESSION OF THE FLOATING SOLAR FARM AT GODLEY RESERVE, MANCHESTER. IMAGE COURTESY OF CORPORATE.UNITEDUTILITIES.COM.

The Godley Reservoir in the Hyde area of Greater Manchester is the setting for the new solar power farm. It will be composed of 12,000 panels, cover an area of 45,500 m^2 and generate 2.7GWh of energy per year, which will power a local water treatment plant. A solar farm with a difference is set to be launched in Manchester, UK in December 2015. Instead of being constructed in a field or on a roof, the solar panels will be placed on water – a reservoir to be exact. This project will be the largest of its kind in Europe and second largest in the world, after Japan.

The Godley Reservoir in the Hyde area of Greater Manchester is the setting for the new solar power farm. It will be composed of 12,000 panels, cover an area of 45,500 m2 and generate 2.7GWh of energy per year, which will power a local water treatment plant. The cost of the development is budgeted at £3.5 million (almost €5 million). United Utilities is behind the project, a water and wastewater treatment company serving the North West of England. The solar farm is being constructed within a period of weeks so that the company can avail of a generous UK Government grant, which is due to be cut drastically in 2016. Such cuts would likely dissuade the company from undertaking similar projects elsewhere, as indicated by Director of Energy Strategy for United Utilities, Neil Gillespie.

In constructing the solar energy farm, United Utilities hopes to generate more sustainable energy for its operations as part of its carbon reduction strategy, which includes the aim to generate 33% of its own energy by 2020. According to Chris Stubbs, Head of Renewable Energy at United Utilities: "While floating solar has been deployed elsewhere around the world, most notably in Japan, it is a new technology to the UK. Installations such as the Godley solar scheme will help us to keep energy costs and water customers' bills low."

THE FIRST FLOATING SOLAR FARM IN THE UK ON MARK BENNETT'S FARM IN BERKSHIRE, UK. IMAGE COURTESY OF HTTPS://WWW.FLOATINGSOLARPANELS.CO.UK

The first floating solar farm in the UK was introduced in 2014 by entrepreneur Mark Bennett. He established the company Floating Solar Panels and partnered with French business Ciel et Terre, which had developed specialised solar panels to float on water called Hydrelio© in 2006. Bennett installed 800 Hydrelio© solar panels on his own farm in Berkshire, England. They generate 200Kw of power, which is used for a huge on-site irrigation system.

These floating solar panels were initially developed as an alternative to placing solar installations on land. Many countries have disused water bodies such as reservoirs, dams, irrigation canals and quarry lakes that are ideal locations for solar farms, instead of using up valuable farmland. Where applicable, the water from such bodies can still be used as it would not be affected by the solar panels. Wineries, dairy farms, fish farms, mining companies, wastewater treatment plants and irrigation districts are among those suitable for this alternative technology. According to Ciel et Terre, their panels have a 20+ year lifespan and they are continually trying to make the product more affordable and efficient.

As the threat of climate change grows, new developments in green technology are becoming more prevalent and are vital if we are serious about moving away from fossil fuels for good. Thus it is encouraging to see innovative schemes being undertaken by companies in the UK and beyond.

II(F) Floating PV in China

Chinese state-owned developer CECEP has completed a 70MW floating solar project - the largest in the world - at a former coal-mining area of Anhui Province, China, in collaboration with French floating solar specialist Ciel & Terre.

The project, spread across 13 separate islets on an area of 140 hectares, was completed in late 2018, with grid-connection, tests and commissioning carried out this month at the project site in the Lianghuai mining subsidence area, Yongqiao District, Suzhou City.

EPC services were provided by China Energy Conservation Solar Technology and the China Energy Engineering Group Shanxi Electric Power Design Institute. A brand new 18km 110V overhead line was also built for the grid connection of the plant, which is expected to generate up to 77,693MWh of electricity in its first year, equivalent to the power consumption of nearly 21,000 households.

While the complete facility in Anhui is said to currently be the largest floating PV plant on the same reservoir in the world, nearby, China-based firm Three Gorges New Energy has already partially connected a 150MW floating PV project to the grid, which is likely to become the largest plant globally once fully commissioned.

Equipment

The CECEP system was built using Ciel & Terre's Hydrelio floats, which are locally produced to minimize emissions, optimise logistics costs and offer local employment.

The project uses monocrystalline modules from Chinese manufacturer LONGi Solar, as confirmed by a C&T spokesperson to *PV Tech*. Central inverters have also been put on stilt platforms on the shoreline of the quarry lake so as not to interfere with neighbouring farm activity. Concrete poles support the electrical installation and 1,500 helical anchors were used for the project and buried at an 8-15 metre-depth to match the water body.

Ciel & Terre has already supplied its floating structure solution to GCL's 32MW FPV plant in Anhui province. It has also recently supplied a 9.8MW PV project featuring rooftop and floating elements in Cambodia.

III. Advantages

Bye bye coal and nuclear power! They are dirty for the planet!! Floating solar refers to a solar power production installation mounted on a structure that floats on a body of water, typically an artificial basin or a lake. Two systems can be distinguished: FPV or Floating photovoltaic: uses photovoltaic panels mounted on the platform. Floating solar technology available for nationwide installation on any body of water. Floating solar panel installation nationwide. High quality solar panels. British Manufacturing. Worldwide Installation. Large Solar Panel Stock. 25 Year Guarantee. Best Prices Nationwide.

IV. Disadvantages

This makes me wonder about the application of what's called "Co-generation" incorporated into this floating solar model. And more specifically, has anyone thought to build a floating array that does many more than just one or two functions. Someone is thinking of a array on salt water that a) powers a desalination that also floats, b) Energy production, C) sewage treatment, d) power generation, and with all that "salt," battery storage, etc.

V. Conclusions

- This work will enhance your decision making capability in a more rapid and time sensitive manner.
- Identify key growth and investment opportunities in the US and other solar PV market.
- Facilitate decision-making based on strong historic and forecast data for solar PV market.
- Position yourself to gain the maximum advantage of the industry's growth potential.
- Develop strategies based on the latest regulatory events.
- Identify key partners and business development avenues.
- Understand and respond to your competitors' business structure, strategy and prospects.

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