This is a new section of the Public-Private Partnership Resource Center website and is currently in draft form. Your feedback is welcome: If you would like to comment on the content of this section of the website or if you have suggestions for links or materials that could be included please contact us at ppp@worldbank.org.

Photo Credit

solar farm

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Sembcorp Tengeh Floating Solar Farm, Singapore

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On this page: *Renewable energy projects can provide governments with an additional source of revenue from leasing land or water bodies to developers. Find case studies below, or visit the Guidelines on Innovative Revenues for Infrastructure section.*

Project Summary:

Background

Floating solar photovoltaic (FPV) installations open up new opportunities for scaling up solar generating capacity, especially in countries with high population density and competing uses for available land. Further, FPVs can generally generate more energy because of the cooling effect of water and can eliminate major site preparation such as leveling or laying of foundations which need to be done for land-based installations.[1]

Other than contributing to the climate agenda, renewable energy projects bring security of energy supply, economic benefits and renewable energy developers can brand themselves as firms embracing sustainability. Furthermore, renewable energy projects can provide governments with an additional source of revenue from leasing land or water bodies to developers.

Project Structure

Singapore achieved its 2020 solar target of 350 megawatt-peak (MWp) in the first quarter of that year. In the longer term, Singapore is pursuing a new solar target of at least 2 gigawatt-peak (GWp) by 2030.[2]

Sembcorp Tengeh Floating Solar Farm is a 60MW floating solar farm installed at Tengeh Reservoir in 2021. With 122,000 solar panels spanning 45 hectares, the solar farm is one of the world's largest inland floating solar projects. Besides increasing Singapore's solar energy deployment, the solar farm enabled Singapore to adopt a 100% green waterworks system.[3]

The construction of Sembcorp Tengeh Floating Solar Farm has catalyzed Singapore's transition towards renewables, with the solar farm offsetting 7% of PUB's annual energy needs and significantly reducing PUB's carbon footprint. In addition, the electricity generated from the solar farm will be sufficient to power Singapore's five local water treatment plants.

Installing solar PV systems in the reservoir facilitates optimized land use while enabling the Singaporean government to generate funding from leasing out spaces to Sembcorp Industries. Furthermore, Sembcorp Industries signed a 25-year power purchase agreement (PPA) with Public Utilities Board (PUB), enabling the Sembcorp to generate stable revenue via the sale of electricity, whilst PUB has increased security of power supply.

What sets them apart?

- **Minimum impact on biodiversity**- Tengeh Solar Farm is carefully designed to minimize the impact on the reservoir's water quality, flora, and fauna. Sufficient gaps between solar panels were incorporated to improve the airflow and allow adequate sunlight to reach aquatic life. Additional aerators were also put in place to maintain oxygen levels in the reservoir. Floats deployed are made using high-density polyethylene (HDPE) - a certified food-grade, recyclable, UV, and corrosion-resistant material.
- **Practical construction to mitigate project delay risks -** New and innovative ways of working were deployed to mitigate the impact of project delays by implementing a new engineering and construction technique to design a custom-built jig that increased the rate of solar panel assembly by up to 50%. This project is also the first in the world to deploy advanced drone electroluminescence imaging technology on a utility-scale PV system. Drone electroluminescence imaging captures X-ray-like signals emitted by PV modules to accurately and rapidly pinpoint defects that could be caused by various factors from the manufacturing to the installation stage. Identifying and replacing defective modules has ensured that the PV system runs optimally.

Key players for delivering improved services

Sembcorp Tengeh Floating Solar Farm is owned by Sembcorp Floating Solar Singapore a wholly owned subsidiary of Sembcorp Industries. Temasek Holdings have a 49.5% equity stake in Sembcorp Industries.

In addition to collecting rental revenue from leasing out spaces in Tengeh Reservoir, the government also receives a portion of the revenue generated by Sembcorp Industries for the sale of electricity.

Mechanism/s for Maximizing Funding for Infrastructure

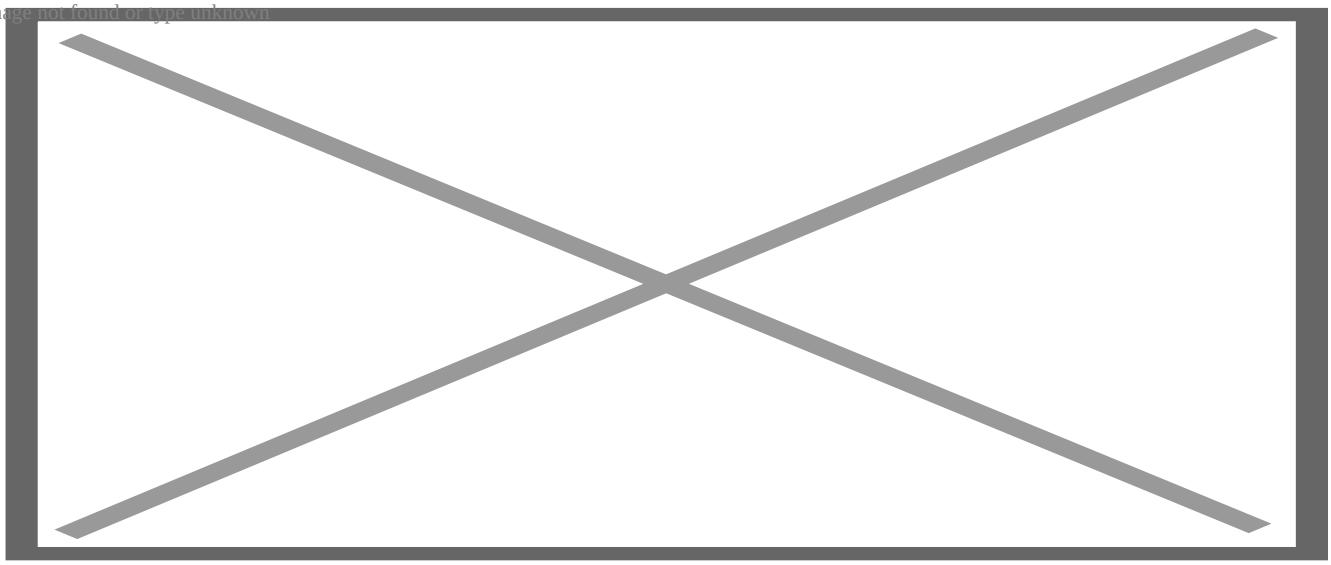
Typically, greenfield renewable energy projects face several hurdles that can affect project viability, including securing a robust power offtake agreement to mitigate revenue risk, land acquisition and the associated costs, obtaining planning permissions and environmental permits, and a high capital investment to create the power generation assets. The Project structure mitigated all these risks. Consequently, Sembcorp Tengeh Floating Solar Farm was able to raise finance for the capital investment of SGD 40 million which Sembcorp Industries was able to secure funding via a project finance loan from DBS Bank.[4]

Sembcorp Industries signed a Power Purchase Agreement (PPA) with Public Utilities Board (PUB) for 25 years, enabling them to achieve revenue certainty in the long run.[5] Sembcorp Industries was appointed to design, build own and operate the solar farm. The project will generate green energy to power water treatment and is expected to offset 7% of PUB's (Public Utilities Board) current energy needs.[6]

PUB benefits from leasing space on its reservoir, plus long-term secure supply of renewable power at preferential rates. The Singapore government benefits from Sembcorp Industries revenues through taxes, dividends, and Net Investment Returns (NIR) paid by Temasek.

Typical Business Model

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Sembcorp	Responsible for the core services
Public Utility Board	Through PPA, ensures the effectiveness of the energy usage for water utilities
Users	Pays to the PUB for services

Water is priced not only to recover the full costs of its supply and production, but also to incorporate the higher cost of producing water from unconventional sources, specifically NEWater and desalinated water.[7]

There can also be a water-lease contract between PUB and Sembcorp but such information has not been disclosed.

Lessons Learned

Managing the risks

- *Site risk and Revenue risk:* Greenfield renewable energy projects are complex projects requiring integration and operation by specialists, the Singapore government's rigorous tender process mitigated the key project risks. Especially, by PUB both providing the project site and a long-term power offtake agreement, the project was considered have an elevated 'bankability'.

Leveraging Climate Opportunities

- Tengeh Solar Farm benefits from PUB being the primary client, securing revenues for at least the next 25 years.
- Strong support from major banks such as DBS Bank that saw domestic renewable energy projects as core to strengthening their brand.
- Renewable energy projects may involve rigorous testing as new technologies utilized in the projects will have to meet national or global technical standards
- Solar panels can be deployed in reservoirs and natural water bodies whilst mitigating adverse impacts on the surrounding environment, biodiversity, and water quality.
- Cooperation of entities responsible for managing water bodies is crucial. Positive examples include tenders of water-lease contracts in Korea with K-water, and in Singapore with PUB.[8]

Footnote 1: Where Sun Meets Water: Floating Solar Market Report

Footnote 2: Singapore's Energy Story

Footnote 3: Tengeh Reservoir floating solar farm officially opens, 'big step' towards environmental sustainability

Footnote 4: DBS Bank provides SGD40 million loan facility to Sembcorp Industries for Singapore's first single large-scale floating solar photovoltaic system

Footnote 5: https://www.inframationnews.com/deals/3788286/tengeh-60mw-floating-solar-project.thtml

Footnote 6: Ibid

Footnote 7: Singapore - Water Price

Footnote 8: Where Sun Meets Water: Floating Solar Market Report

Related Content

- **Selected World Bank Tools**

Additional Resources

- Climate-Smart PPPs
- Finance Structures for PPP

The Guidelines on Innovative Revenues for Infrastructure (IRI) is intended to be a living document and will be reviewed at regular intervals. They have not been prepared with any specific transaction in mind and are meant to serve only as general guidance. It is therefore critical that the Guidelines be reviewed and adapted for specific transactions.

To find more, visit the Innovative Revenues for Infrastructure section and the Content Outline, or Download the Full Report. For feedback on the content of this section of the website or suggestions for links or materials that could be included, please contact the Public-Private Partnership Resource Center at ppp@worldbank.org.

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