Floating Solar: A Global Perspective

May 28, 2020

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Energy Sector Management Assistance Program

ESMAP IN SUMMARY

WHAT:

- Multi-donor trust fund administered by the World Bank established in 1983;
- Embedded in the Energy & Extractives Global Practice of the World Bank

HOW:

- Provides grants and technical support to World Bank in-country analytical and advisory work, and to inform investment lending;
- Delivers cutting-edge global knowledge products and services

WHY ARE COUNTRIES INTERESTED IN FLOATING SOLAR?

- No need for land is an important driver in densely populated countries
- Possibility to save water by decreasing evaporation in certain type of reservoirs
- Possibility to build in proximity of demand centers if suitable water bodies are available
- Adding floating solar capacity to existing hydropower plants is of particular interest:
  - Utilization of existing transmission infrastructure
  - Hydropower can smooth variable solar output by serving as storage asset
  - Solar can help to manage periods of low water availability bringing resilience

FLOATING SOLAR HAS RELATIVELY HIGH RISK PERCEPTION

- Floating solar still has a limited track record and therefore has a higher perceived risk than land-based PV
- Uncertainties remain about:
  - lifetime costs of floating solar
  - predicting long-term environmental impact
  - adequacy of warranties of the performance or reliability of critical components
- Technical aspects in a new operating environment: designing, building, and operating on and in water (electrical safety, anchoring and mooring issues, and operation and maintenance)
- Difficulties in selecting qualified suppliers and contractors

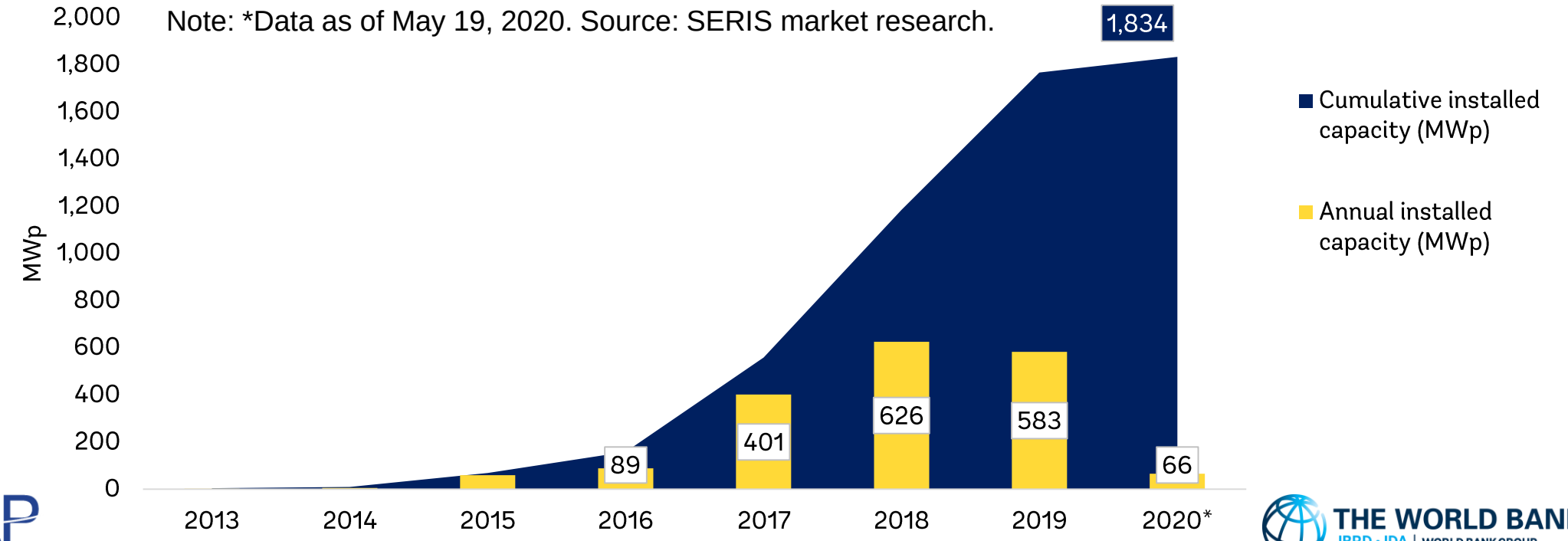
IS THIS A LARGE MARKET?

Potential

Continent	Total surface area available (km²)	Number of water bodies assessed	FPV potential (GWp) Percentage of total surface area used 1%	5%	10%	Possible annual energy generation (GWh/year) Percentage of total surface area used 1%	5%	10%
Africa	101,130	724	101	506	1,011	167,165	835,824	1,671,648
Middle East and Asia	115,621	2,041	116	578	1,156	128,691	643,456	1,286,911
Europe	20,424	1,082	20	102	204	19,574	97,868	195,736
North America	126,017	2,248	126	630	1,260	140,815	704,076	1,408,153
Australia and Oceania	4,991	254	5	25	50	6,713	33,565	67,131
South America	36,271	299	36	181	363	58,151	290,753	581,507
Total	**404,454**	**6,648**	**404**	**2,022**	**4,044**	**521,109**	**2,605,542**	**5,211,086**

Market

Note: *Data as of May 19, 2020. Source: SERIS market research.



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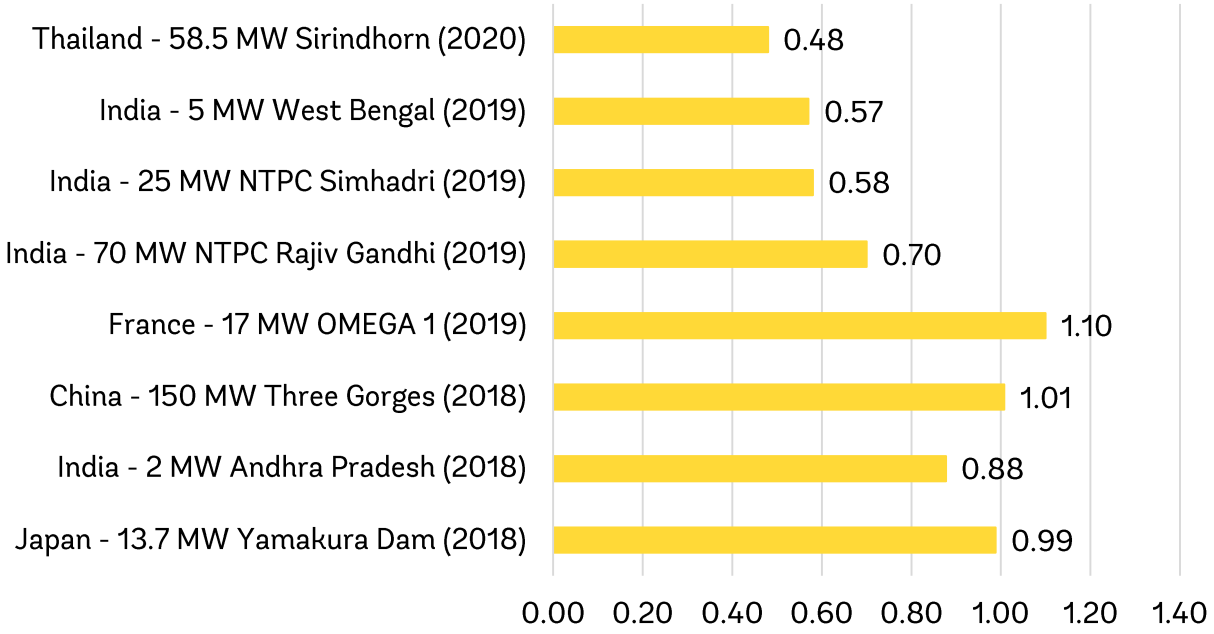
WHAT ARE THE COSTS OF FPV?

- Costs are very site specific and very from project to project. FPV project will differ from a land-based project in costs of floating structure, anchoring and mooring system, and to a certain extent balance of system (e.g. cabling)
- FPV-specific costs will reflect water level variation and water body depth, wind loads, distance to shore, water quality and salinity, etc.

CAPEX (USD/W_P)

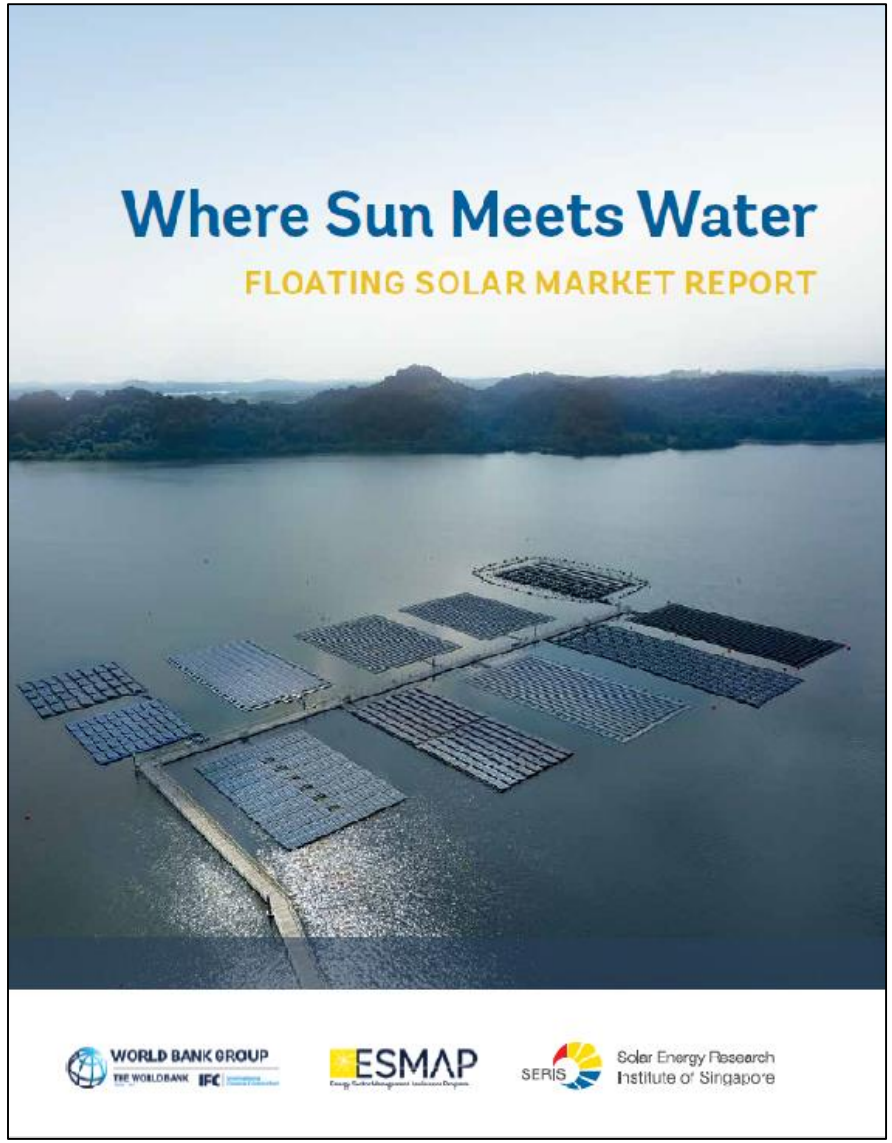


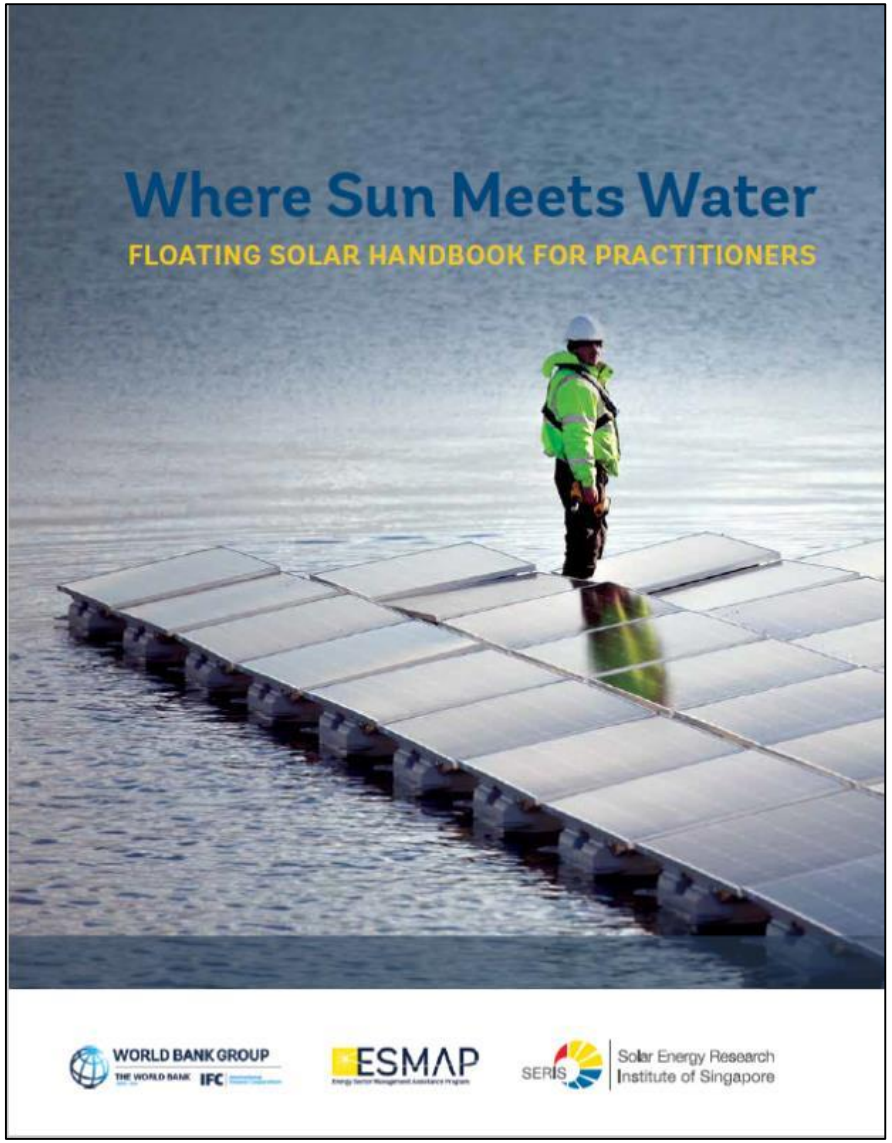
SELECTED TARIFFS FROM TENDERS IN 2019

Project	Tariff	Comment
2 MW in Albania	EUR 0.10/kWh **(~USD 0.11/kWh)**	FiT for solar projects not larger than 2 MW
2 MW in Darbhanga (India, Bihar)	₹4.15/kWh **(~USD 0.055/kWh)**	Approved tariff with Bihar Electricity Regulatory Commission
150 MW in Rihand Dam (India, Uttar Pradesh)	₹3.29 (~$0.044)/kWh + ₹0.07/kWh = ₹3.36 **(~USD 0.045/kWh)**	25-year PPA; ₹0.07/kWh = SECI trading margin
5 MW in Seychelles	**USD 0.095/kWh**	25-year PPA, first IPP, near-shore

Sources: SERIS market research (based on publicly available information).

"WHERE SUN MEETS WATER" SERIES





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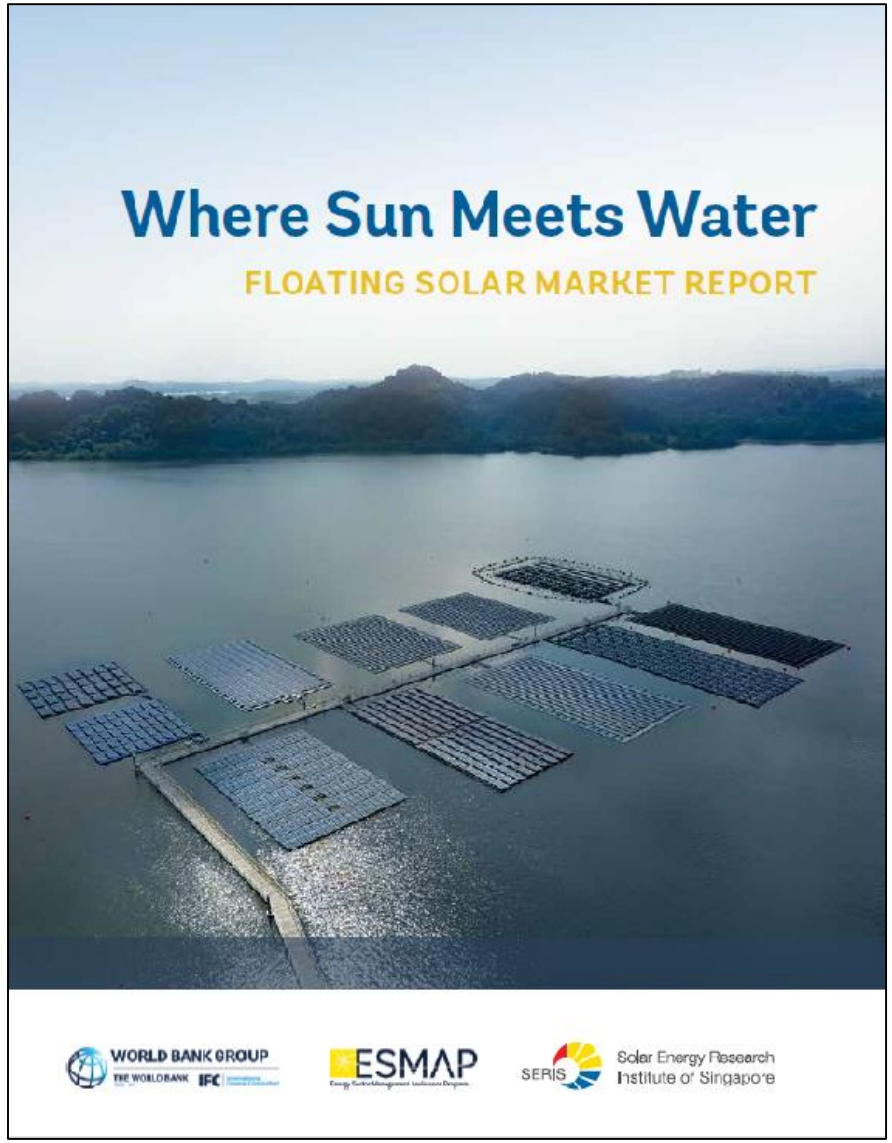
"Where Sun Meets Water" series – Market Report



Contents:

- Why floating solar?
- Technology overview
- Global market and potential
- Policy considerations and project structuring
- Costs of floating solar
- Suppliers of floating PV systems

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https://esmap.org/where_sun_meets_water_floating_solar_market_report

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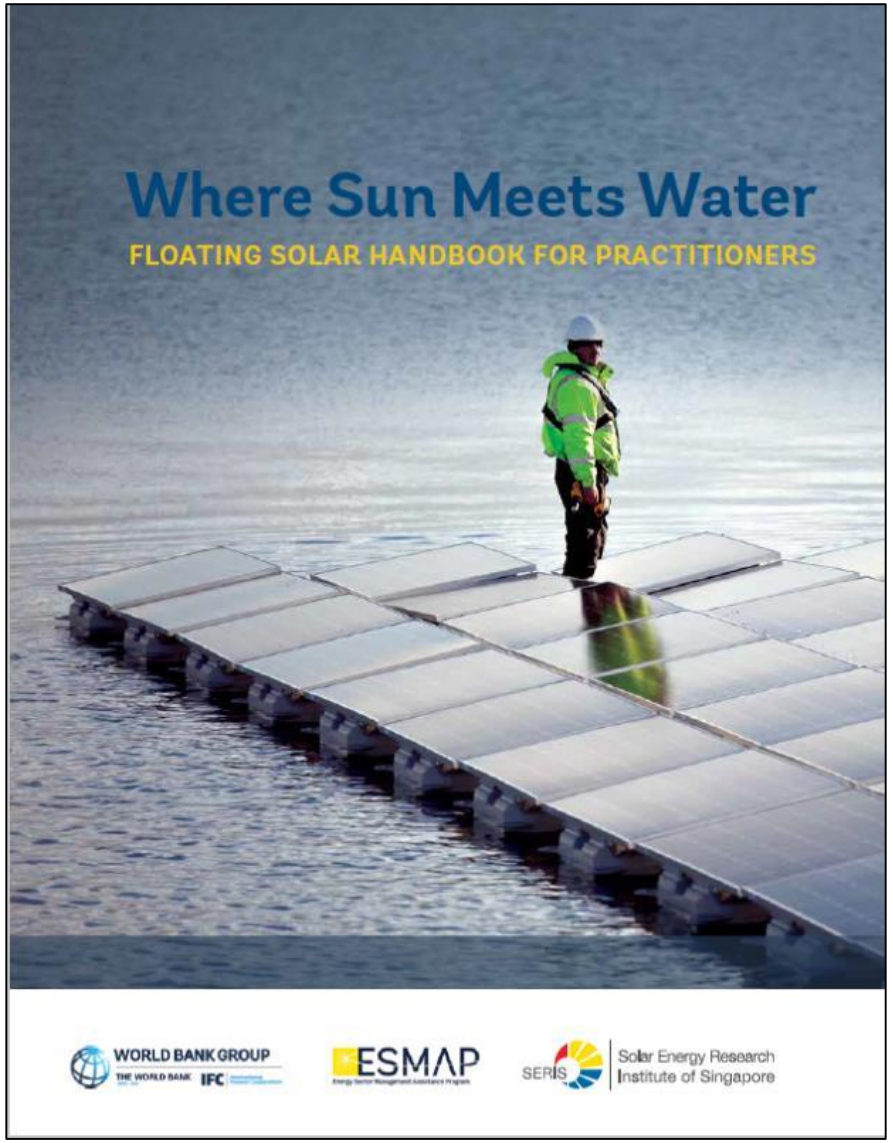
"Where Sun Meets Water" series – FPV Handbook



Contents:

- Site identification
- Energy yield analysis
- Engineering design
- Financial and legal considerations
- Enviro and social considerations
- Procurement and construction
- Field testing and commissioning
- Operation and maintenance

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https://esmap.org/where_sun_meets_water_handbook

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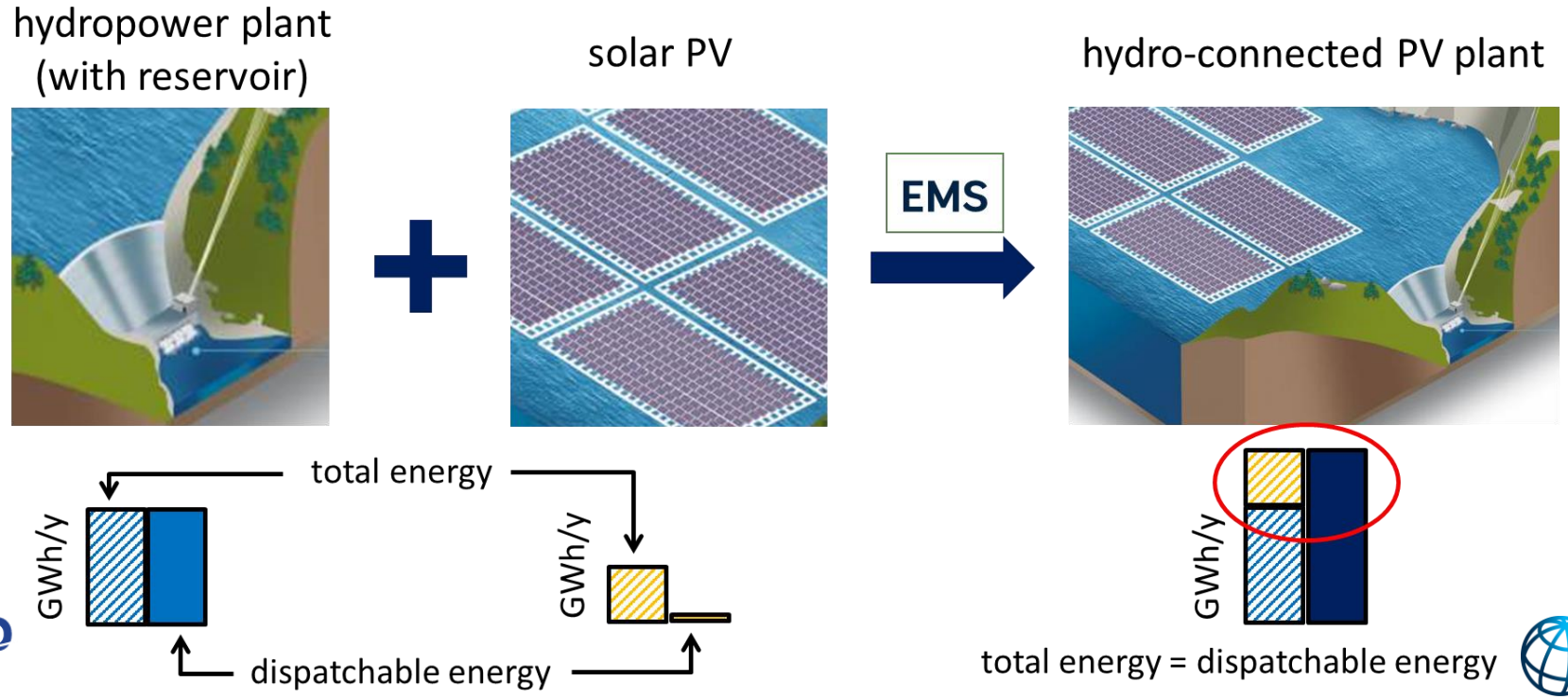
THE ROLE OF DEVELOPMENT BANKS IN FLOATING SOLAR MARKET

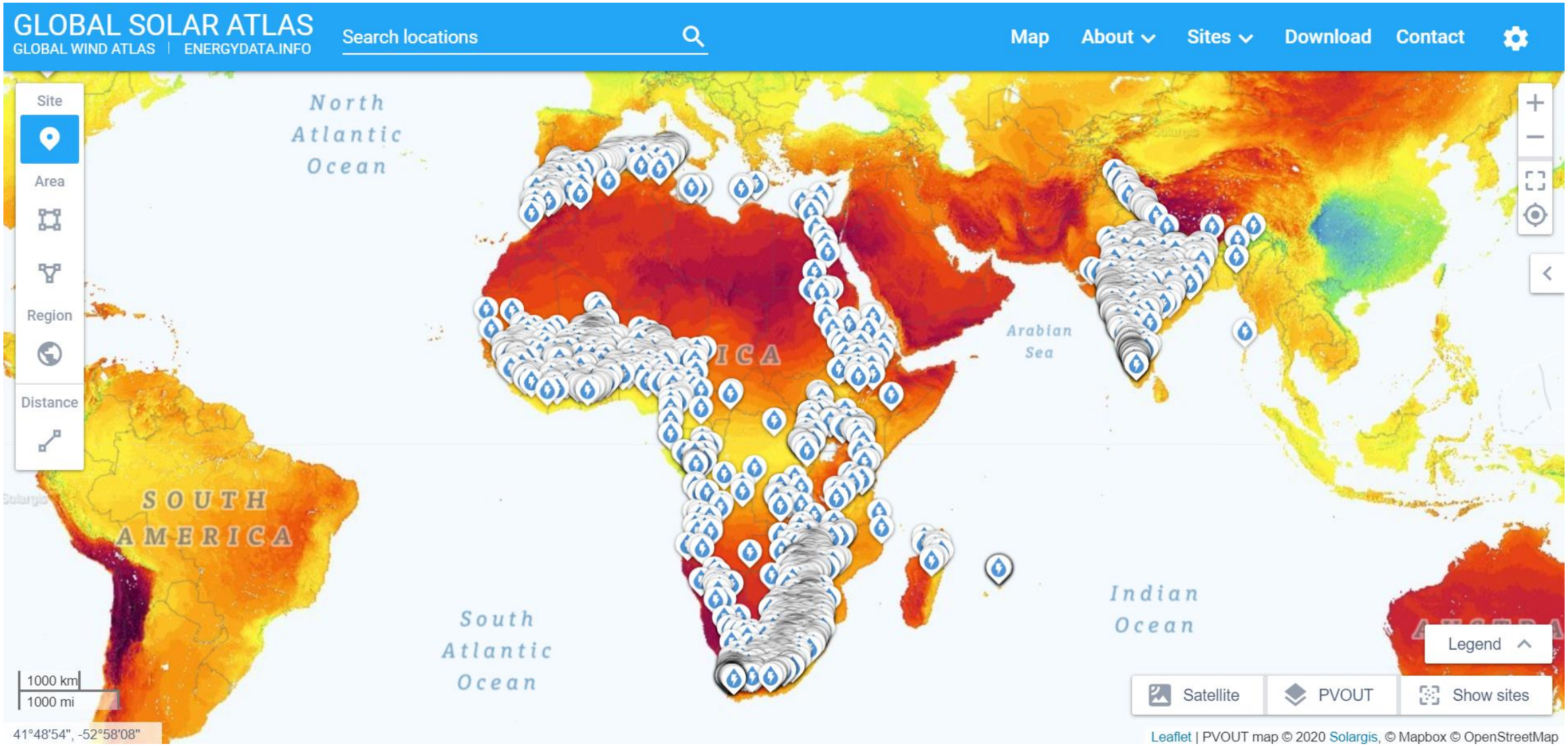
- Support to development of regulatory and policy environment:
  - Coordination of permitting and licensing that necessitate interagency cooperation (energy and water authorities), including water/water-surface rights and permits
  - Regulations for and permitting of access to existing transmission infrastructure
- Support to regulatory considerations for hydro-connected PV plants:
  - Regulations and permitting for hydropower plants' owners/operators to add a floating solar installation or provide concession
  - Management of risks of floating installations on hydropower dam; management of liabilities between hydropower and floating solar plants
  - Rules of dispatch of the solar and the hydropower plants' outputs and management of other water uses (e.g. irrigation)
- De-risking of investments in first "demonstration" plants
  - Structuring for best risk allocation
  - Access to concessional financing
  - Environmental and social practices and their monitoring and evaluation for better design

PRESENT FOCUS: HYDRO-SOLAR HYBRID PLANTS

- Combining solar with hydropower generation is of interest in many developing countries, in particular in small and weak grids
- Hybrid operation is beneficial for solar and hydro:
  - Solar is variable => hydropower might provide flexibility to deal with variations
  - Solar helps the management of water level in the reservoir (dry-wet seasons), and can help saving water for alternative uses (e.g. irrigation)



GLOBAL SOLAR ATLAS: HYDRO-CONNECTED POTENTIAL FEATURE



https://globalsolaratlas.info/map

GSA: SITE-SPECIFIC INFO

Manantali, Mali

13°11'44", -10°25'48"
Manantali, Mali
Time zone: UTC+00, Africa/Bamako [GMT]

Hydro-connected solar PV potential type

Purpose	Hydropower
Status	Operational since 1988
Dam height	70 m
Reservoir area	477 km²
Reservoir capacity	11270 km³
River	Bafing
Storage type	Storage

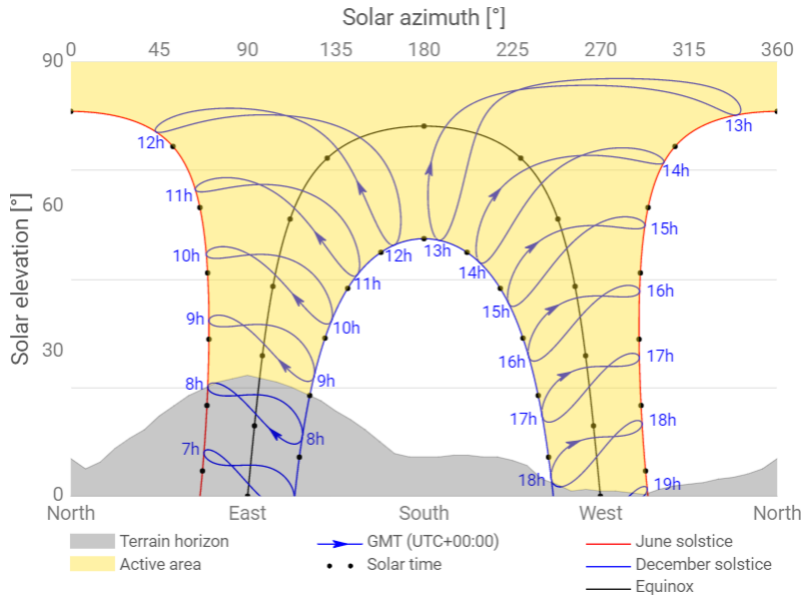
Map data Per year

Specific photovoltaic power output	PVOUT specific	1658	kWh/kWp
Direct normal irradiation	DNI	1536	kWh/m²
Global horizontal irradiation	GHI	2112	kWh/m²
Diffuse horizontal irradiation	DIF	981	kWh/m²
Global tilted irradiation at optimum angle	GTI opta	2173	kWh/m²
Air temperature	TEMP	29.4	°C
Optimum tilt of PV modules	OPTA	16 / 180	°
Terrain elevation	ELE	189	m

PVOUT map

Map Swich to map

Horizon and sunpath



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PLANNED FOCUS: SUPPORT TO NEAR-SHORE FPV

- There is a keen interest in floating solar in small island states that have little space for land-based solar
- Going off-shore represents not only technical challenges but brings also new environmental and social challenges
- ESMAP plans to work with PROBLUE (a World Bank Trust fund that supports the sustainable and integrated development of marine and coastal resources in healthy oceans) to develop:
  - Environmental framework guidance for nearshore marine FPV
  - Social framework guidance for nearshore marine FPV (including gender considerations)
  - Comprehensive methodology for geospatial mapping of nearshore marine FPV potential to be included in wider marine spatial plans of countries

Thank you!

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