Floating Solar – Africa Focus

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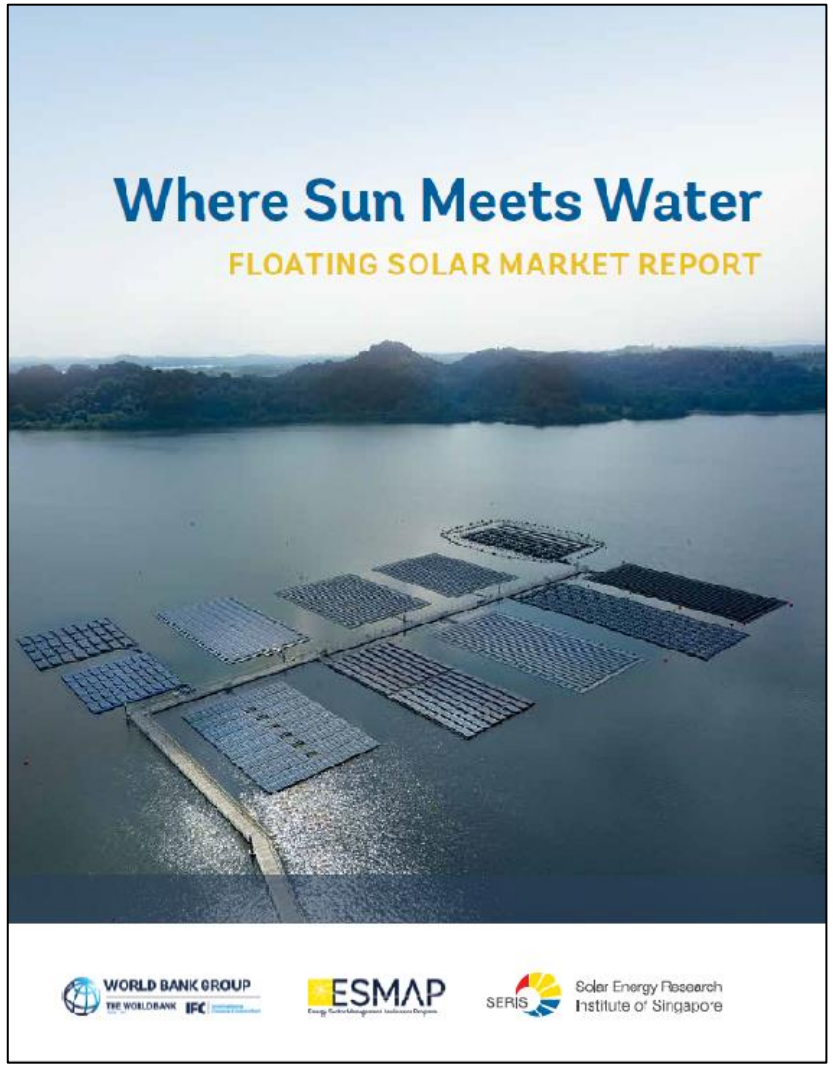
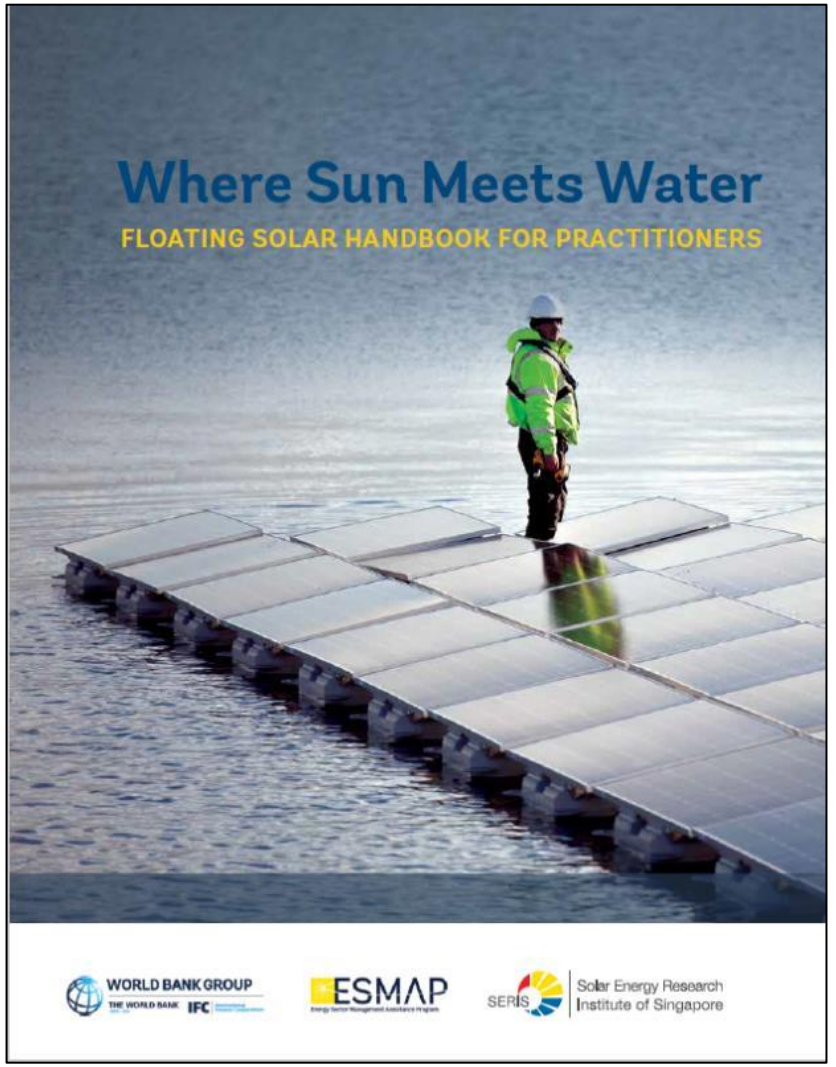
DEVELOPING COUNTRIES ARE INTERESTED IN FLOATING SOLAR

- No need for land is an important driver in densely populated areas
- Possibility to build in proximity of demand centers if suitable water bodies are available (e.g. ponds in cities, reservoirs of water utilities)
- Added benefit of saving water by decreasing evaporation in certain type of reservoirs (e.g. irrigation ponds, industrial ponds)
- Adding solar capacity (floating or land-based) 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

"WHERE SUN MEETS WATER" SERIES





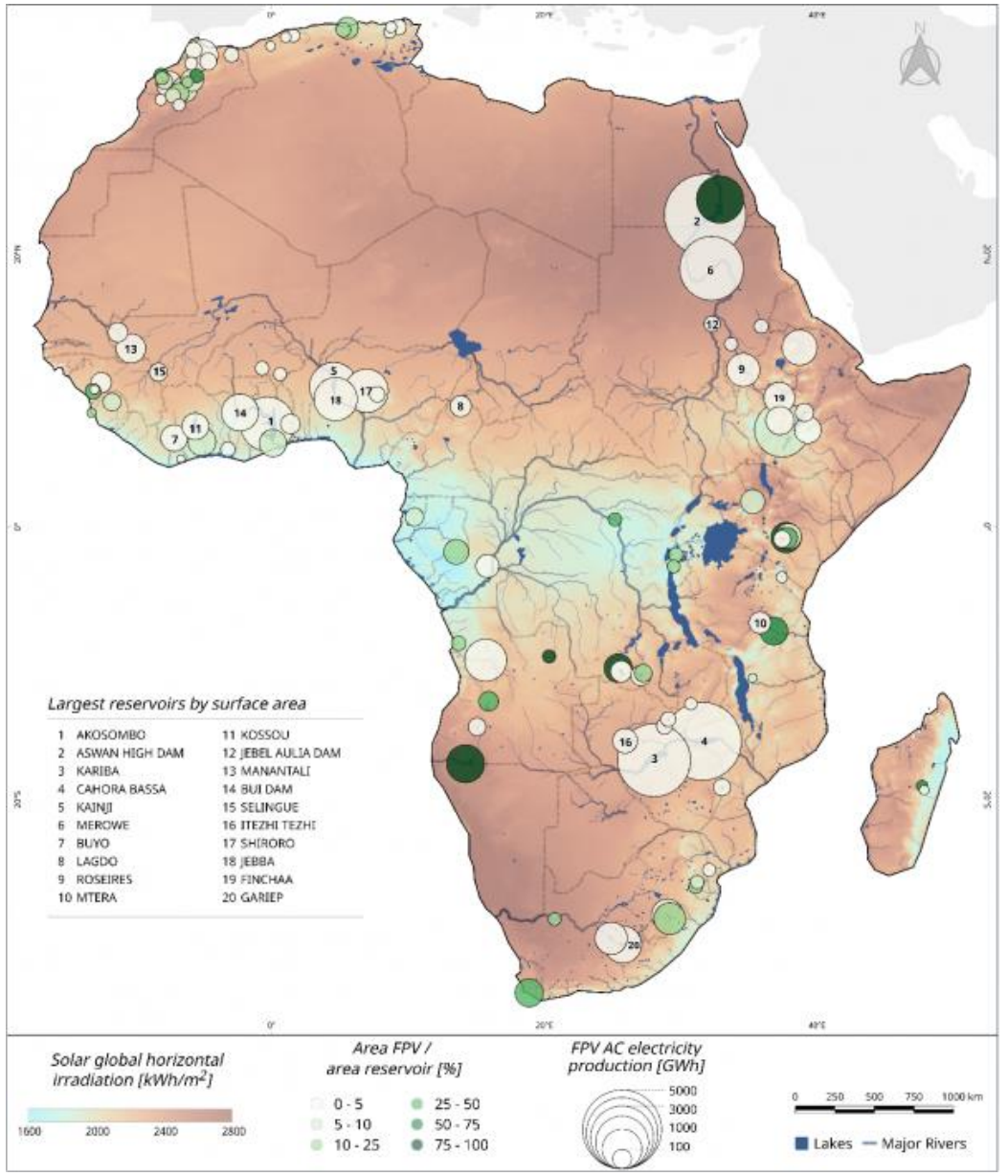
https://esmap.org/where_sun_meets_water_floating_solar_market_report

https://esmap.org/where_sun_meets_water_handbook

Is this potentially a large market?

Continent	Total surface area available (km²)	Number of water bodies assessed	FPV potential (GWp) Percentage of total surface area used 1%	5%	10%
Africa	101,130	724	101	506	1,011
Middle East and Asia	115,621	2,041	116	578	1,156
Europe	20,424	1,082	20	102	204
North America	126,017	2,248	126	630	1,260
Australia and Oceania	4,991	254	5	25	50
South America	36,271	299	36	181	363
Total	**404,454**	**6,648**	**404**	**2,022**	**4,044**

- Some man-made reservoirs have very large potential, many such reservoirs exist in Africa (e.g. Akosombo Dam)
- Installing FPV on 1% of the area of African hydropower reservoirs, could double the current hydropower installed capacity and increase by 58% the electricity output (JRC research) →



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First FPV plants are emerging in Sub-Saharan Africa

- Smaller C&I installations in South Africa and Kenya (on farm ponds to fight power outages and water evaporation)
- 1MW installed on Bui Dam (Ghana), as a pilot, and to be enlarged
- 20MW FPV financed by AFD at Kossou Dam (Cote d'Ivoire)
- 5MW marine FPV project under development in the Seychelles (IPP)
- Pre-feasibility studies for FPV on hydro plants exist: Mt Coffee (Liberia), Manantali (Mali), Selingue (Mali), Bagre (Burkina Faso), Taabo (Cote d'Ivoire), Buyo (Cote d'Ivoire)
- Known interest in Uganda… and there is certainly more…

SPECIAL FOCUS: HYDRO+SOLAR HYBRID PLANTS

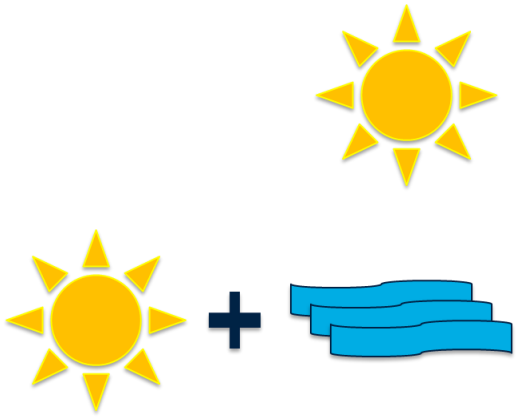
- Combining solar with hydropower installations and hybridizing their outputs is of interest in many countries, in particular in smaller and weaker grids in SSA and in places with big differences in water availability between dry and wet season
- Hybrid “hydro + solar PV” plant can behave as a PV+battery plant but can be more affordable and safer while bringing benefits also for hydropower

- World Bank is exploring technical and institutional structuring solutions for hydro+solar hybrids (upcoming publication in series Where Sun Meets Water)

BENEFITS OF HYBRID HYDRO+SOLAR SYSTEMS

- 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)

Benefits at every time scale …

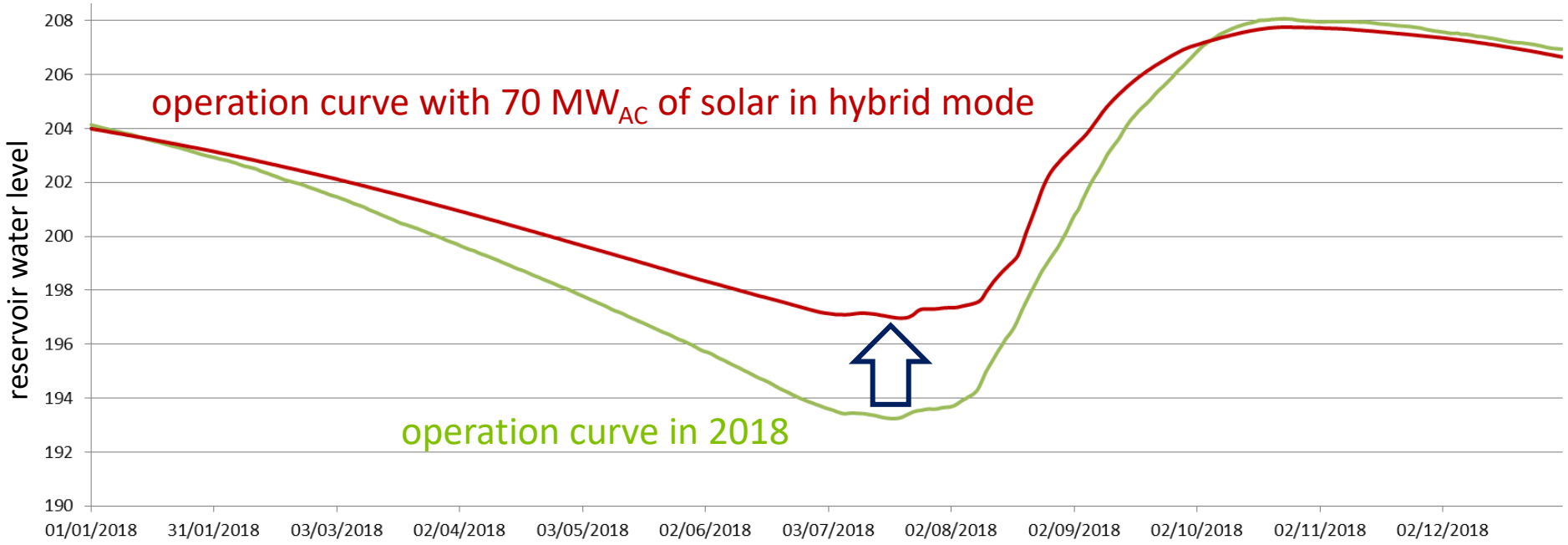


minutes	hours	months
Cloud effect	**Daily load adjustment**	**Seasonal mix**
Fast variations of solar power	Daily solar production vs. daily load curve	Most countries: sunny season max solar power
Regulation by turbine gates*	Daily storage using the hydro reservoir	rainy season max hydro power

*depending on the hydropower plant specific features

MANANTALI DAM EXAMPLE

- 5x41 MW hydro plant (840 GWh/year)
- adding 70MW of PV (↑992 GWh/year)
- adding 170MW of PV (↑1,165 GWh/year) with supplementary investments on substation and compensation basin



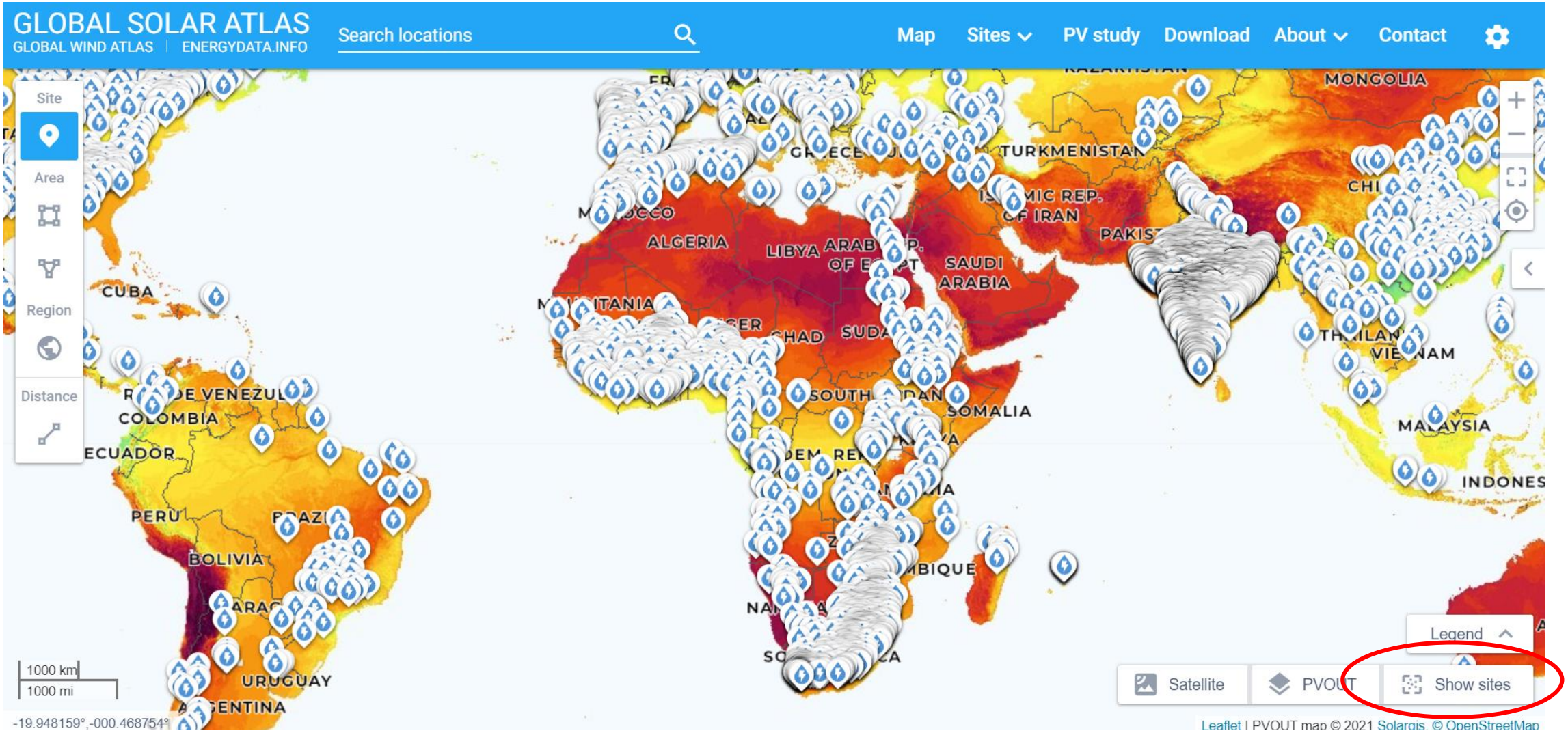
FLOATING SOLAR STILL HAS RELATIVELY HIGH RISK PERCEPTION

- 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, such as electrical safety, anchoring and mooring issues (in particular in hydro dams with large variations of water level) and operation and maintenance (particularly challenging in marine environment)
- Difficulties in selecting qualified developers, suppliers and other contractors, and attract them to Africa (even land-based PV is still complex to do in Africa)

ROLE OF THE WORLD BANK IN FLOATING SOLAR

- Raising awareness about floating solar in diverse settings (irrigation dams, hydro dams, industrial ponds, water utility reservoirs, near-shore marine FPV, etc) - through knowledge work and geospatial tools
- 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
- Support to regulatory considerations for hydro+solar hybrid plants:
  - Regulations and permitting for hydropower plants’ owners/operators to add a 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)

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

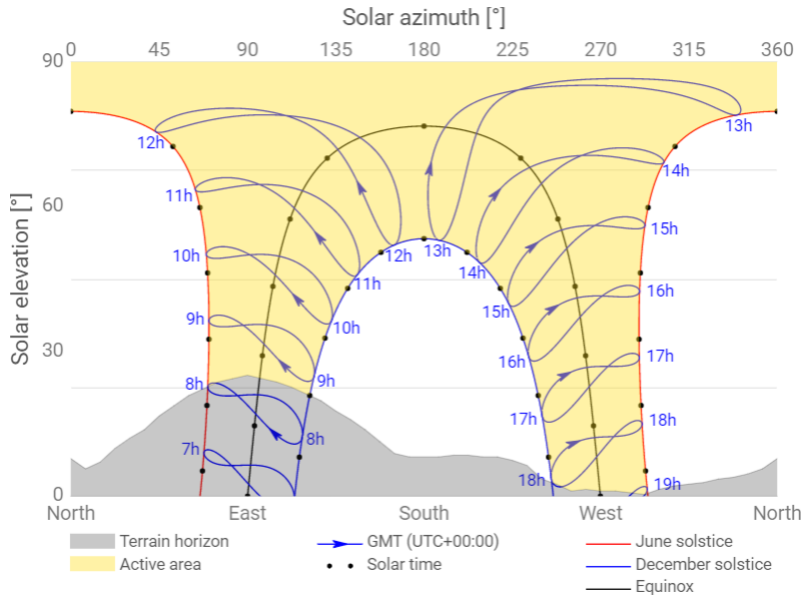
Map data Per year

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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Thank you!

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