Indian Institute of Technology Roorkee
Department of Hydro and Renewable Energy

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Floating PV in India: Progress, Challenges and Opportunities

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Introduction

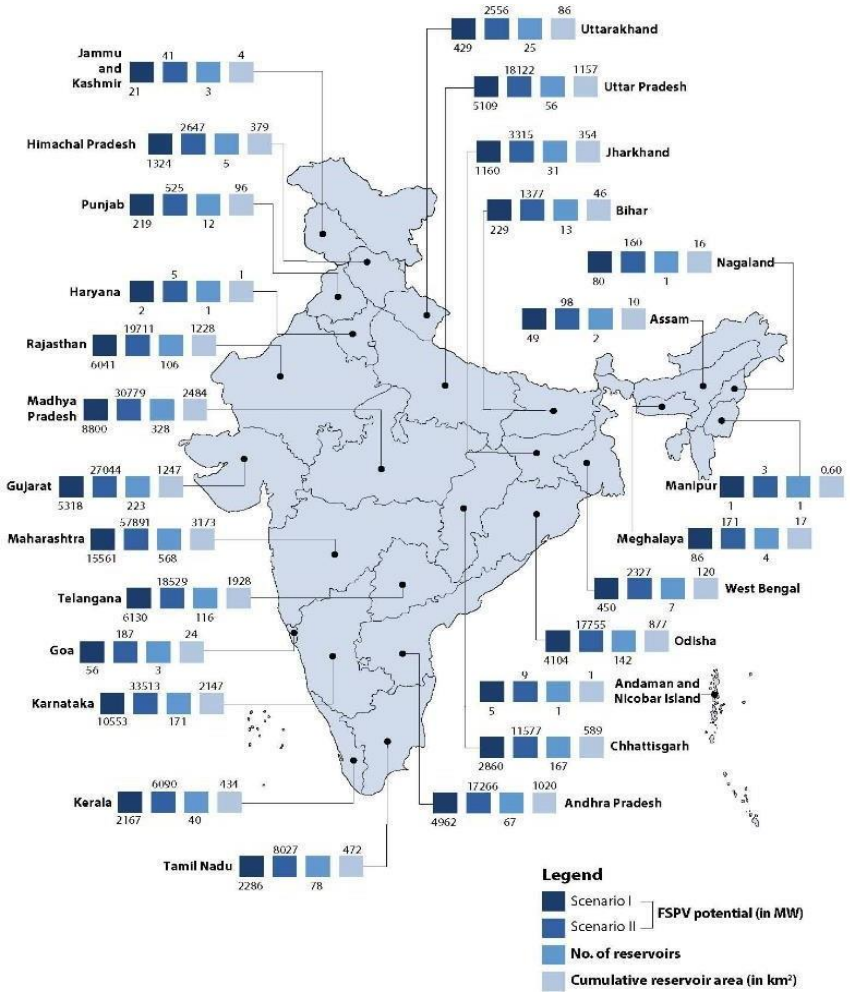
- India is the third largest producer and consumer of electricity globally, with annual electricity production between 1200-1350 TWh.
- As on April 2021, the installed generation capacity of the country stood at 382 GW, comprising 234 GW of thermal, 141 GW of renewable (Wind, Solar, Hydro, and Biomass), and 6.78 GW of nuclear.
- Out of the 141 GW of Renewable energy 36% is from hydro power, 28% is from wind generation and 28.4% is from solar power.
- The per capita electricity consumption has gone up from 592 kWh during 2003-04 to 1208 kWh during 2019-20 and is expected to exceed 1,300 kWh per capita by 2021.

RE Transition Vision: India

- 33-35% of its energy requirement from non-fossil fuel-based sources by 2030.
- 175 GW of renewable generation capacity by Dec 2022 and 450 GW by 2030

India Floating solar PV Potential

- About 18,000 sq.km area
- Approx. 280 GW potential
- 5,264 large dams and 437 are under construction.



Source: https://www.teriin.org/sites/default/files/2020-01/floating-solar-PV-report.pdf

Status of Floating Solar in India

- There are more than fifteen floating solar projects being executed in India by central power utilities of total 1832 MW are constructed / under construction/ planning stage.
- Many of the water bodies are part of hydro reservoirs.
- Greenko, IPP, executing Pinnapuram 1200 MW pumped storage plants with 9 hours storage along with 45 + 45 MW (upper + lower reservoir) floating solar, 3000 MW territorial solar and 500 MW wind energy under a recent peak power supply call (Jan 2020).

Floating solar installation by major power producers

Sl. No.	Owner	Project name	Capacity (MW)	Water body	Status
1	NTPC	Kawas	1	Raw Water Reservoir of thermal project	In operation July 2019
2	NTPC	Kayamkulam	0.1	Raw Water Reservoir of thermal project	In operation since March 2017
3	NTPC	Simhadri	25	Raw Water Reservoir of thermal project	Under execution
4	NTPC	Ramagundam	100	Raw Water Reservoir of thermal project	Under execution
5	NTPC	Kayamkulam	92	lagoon (salt water body)	Under execution Oct 2021
6	NTPC	Auraiya	20	raw water reservoir,	Under execution Jan 2022
7	NTPC	Kawas	25	raw water dead reservoir	Under execution Feb 2022
8	NTPC	Ujjani	140	Ujjani Dam Reservoir	Under planning
9	NHPC	Kerala floating	50	West Kallada lake	Under execution
10	NHPC	Odisha floating	500	Rengali reservoir	Under planning
11	NHPC	Telangana floating	500	Midmanair reservoir	Under planning
12	SECI	Getalsud	150	Getalsud Reservoir	DPR prepared, under NIT.
13	SECI / BBMB	BBMB Reservoir	15	Reservoir	Under tendering
14	SECI/ DVC	5 Locations	54	5 reservoirs	Under planning
15	Greenko	Pinnavaram	160	Pinnavaram PSP both Reservoir	Under planning
		TOTAL	**1832**		

Kayamkulam Plant (105 kW), Kerala

Kawas (1MW), Gujarat

Simadhari Floating (25 MW), Vizag

Floating PV solar installation at NTPC thermal water reservoir plants

Ramagundam (100 MW), AP

Kayamkulam (92 MW), Kerala

Floating PV solar installation at NTPC thermal water reservoir plants

Technological Challenges

- No historical evidences to understand the long-term impact of floating solar on plant components and aquatic life.
- The engineering design taking into consideration the water level variations, flow levels, wind speeds, water wave impact, mooring impact on sedimentation, trash and sediment handling etc. is complex.
- The safety requirement especially for electrical components is more stringent.
- Anchoring – Mooring constraints.
- Surveys and investigations like bathymetry, geotechnical parameters, seasonal flow, water level variation, quantum of trash and its movement, sediment movement are to be acquired.
- The material life, testing, certification and institutional mechanism is not uniform across the industry.
- The supply chain is fragmented and product varies across the suppliers.

Technological Challenges ....contd.

- In case of failure of anchors for floating installation, incidents of blocking the spillway may happen and lead to catastrophe.
- The expertise in design, installer and operator of floating solar is limited and may be in conflict with the dam owner.
- As various components including electrical and electronic components of floating solar plants are constantly exposed to harsh environmental conditions such as high humidity, salinity of water, high wind speed, etc., long run risks of operation could be relatively high in case of FPV plants.
- Components like floating platform, solar PV module, cables, etc., float upon the water surface are prone to degradation, corrosion, and bio-fouling and thus has initial hesitancy of the reservoir owners.
- Unexpected behaviour of these components can cause safety issues and standard safety norms is required at the earliest.

Regulatory Challenges

- The water bodies for use by floating solar may involve a number of owners such as water resources, irrigation, fisheries, drinking water supply, hydro power companies, environment, public works departments etc. in different states and seeking their permissions for setting up of floating PV is time consuming.
- The absence of standard agreement for water rights, policy for use of water body for floating solar delays the project allotment and implementation.
- The availability of standard technical specifications for materials of floats, mooring & anchoring, cables, solar panel technology and balance of plant etc. is a challenge and is the need of hour.
- Supply chain including manufacturing be planned and regulated for reducing transportation cost and early implementation.

Regulatory Challenges ....Contd.

- The preparation of pre-feasibility report / feasibility report for the floating solar with PSP projects be taken up expeditiously by government to create a shelf of projects for scaling up implementation.
- FPV potential would increase in future with the addition of off-river PSP schemes and non-traditional sites and be taken up immediately by the government and or other stakeholders.
- Experience sharing of existing or under execution floating solar PV from the consideration of environment impact, material life, generation performance, maintenance, evaporation reduction, water quality and disposal of floaters etc., should be facilitated.

Policy and Administrative Issues

- Opening up a single window clearance system by State Government to for setting up floating solar power projects on specific water bodies within a state.
- State Government to be sensitized to form a State Technical Committee (STC) comprising of members from all the interfacing State Government Departments to examine proposals within a specified time
- Preparation of data base and environmental impact studies for water bodies covering data on water currents, wave heights, reservoir details etc, study on impact on biodiversity and other environmental aspects etc.
- Water saved by the FPV systems should be counted to improve economic feasibilities and life cycle cost and the reservoir owner should not levy any charges for the use of water body.
- Capital costs of FPV are about 20-25% higher than ground SPV due to extra cost of floats, mooring & anchoring and reduces viability and thus may be supported initially by Government.

Environmental and Social Impact

- The floating solar panels may block sunlight and wind which will increase stratification and decrease the level of dissolved oxygen which will affect the water quality of the reservoir.
- Their may be leaching of materials, especially heavy metals like aluminum, copper, etc.
- Visual impact of floating solar may be positive or negative depending on the location and culture.
- Impact of glare from the solar panels on pilots landing on a local airport.
- In case of Hydro-FPV hybrid operation there is a chance of impact of change in operation regime of hydropower on downstream ecosystem.

Environmental and Social Impact ....Contd.

- There may be impact of FPV on local bird population but few data is available regarding this.
- Some environmental impact during construction phase due to vehicular movements, road construction, etc.
- Impact on aquatic life due to shading by floating PV system.
- In some places in pontoons, water pockets may form which may act as a breeding place for mosquitos.
- There may be a leakage of lubricants and chemicals during O&M phase.
- There may also be conflict with some other leisure activities in the reservoir.

Mitigation Measures

- Spacing can be provided between panels to allow some sunlight and reduce shading.
- The impact on water quality depends on water retention time, which can be reduced to reduce impact of FPV on water quality.
- Constant monitoring of change in microbiology, algae, local bird population, water quality etc. is needed to gather more data on the environmental and social impact of FPV.
- High Copper level directly below the solar panels may suppress the growth of organisms.
- To reduce impact on downstream ecosystem in case of hybrid operation, may construct a downstream regulating pond, distribute peaking capacity on several hydropower plants or impose some restriction on peaking and ramping rates.

Investment Scenario

- Investment climate is conducive for renewable energy i.e. for solar and wind
- FPV systems contribute towards reduction in water evaporation and improvement in water quality by slowing algal growth and thus improves financial and social viability.
- FPV is still considered risky by commercial banks and difficult to mobilize private investments.
- World Bank (WB) supporting SECI to leverage international knowledge and best practices in the emerging technologies such as Floating PV for their deployment and project management leading to successful demonstration projects:
  - Mapping of floating solar potential in the country
  - Detailed assessment of selected 100 water bodies with historical variations in water levels for 5 years
  - *Understanding Floating Solar Pre-Feasibility based on a case study of Omkareshwar* reservoir, MP
  - Studies on unlocking Floating Solar Potential in the country

Way Forward

For speedy and upscaling of floating solar PV installations in the country:

- Governments both central and states need to design clear policy and regulatory framework under which solar-hydro plants are allowed and remunerated.
- Floating solar as part of the solar-hydro hybrid plants be designed to minimize environmental impacts while keeping down the cost of floating solar installation.
- Performance evaluation in terms of power generation and environmental and social impacts for the Initial floating solar installations be studied, documented and shared widely.
- Creation of a shelf of floating solar PV including off river and non-traditional sites, be taken up immediately by the stakeholders to reduce the implementation time and scaling up the technology.

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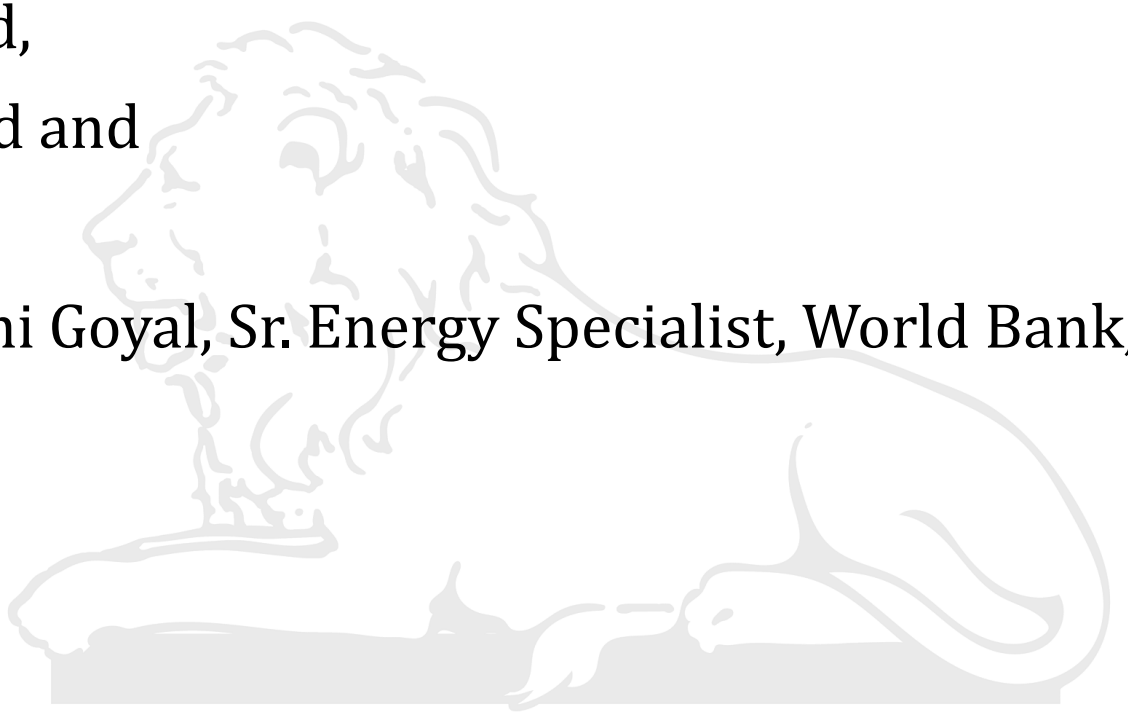

Thank You