

## Floating solar photovoltaic (FSPV)

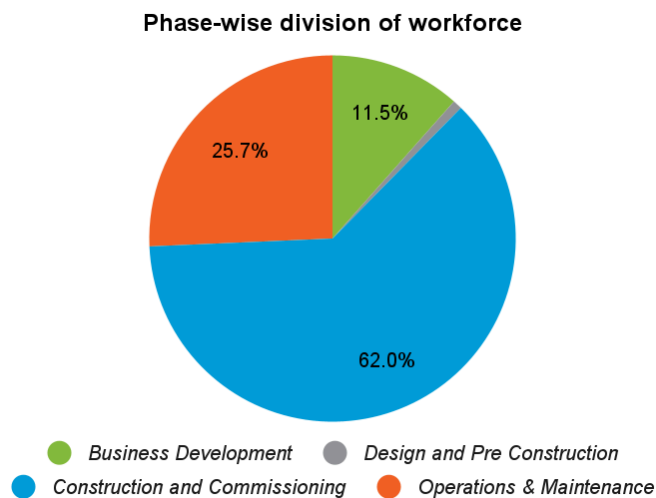
FSPVs, also known as *floatovoltaics*, are a form of solar photovoltaic (PV) application designed to be installed on water bodies such as reservoirs, industrial ponds, etc. It is gaining traction in India due to land neutrality<sup>1</sup> and higher electricity generation. India is said to have a potential of 207 GW capacity (STAAI 2024). Odisha, with its 1.8 lakh water bodies (Micensus 2022), is estimated to have a potential of 21 GW, the third highest technical potential in India (STAAI, 2024).

## Opportunities for 2030

### Jobs overview

- Based on CEEW employment coefficients (Tyagi et al. 2021), it is estimated that if Odisha meets its target of 5000 MW by 2030 as mentioned in the Odisha RE Policy, it can generate **16,800 full-time equivalent (FTE) jobs<sup>2</sup>**.

Figure 1: Phase-wise division of jobs



Source: Authors' analysis adapted from Tyagi et al., 2021

<sup>1</sup> Floating solar is land neutral since it does not take up any land except the limited surfaces necessary for electric cabinet and grid connections.

<sup>2</sup> Kindly refer to the Methodology note

~62 per cent of the jobs are created in the construction and commissioning phase of the deployment cycle of floating solar and there is a requirement of 60 per cent of the workforce in this phase to be semi-skilled. Further, in the Operations and Maintenance phase, where there is creation of permanent employment, it captures 26% of the workforce and has a high requirement of semi-skilled workforce. Thus, training becomes an important component to absorb the population into the workforce.

### Market opportunity

- The market opportunity for Odisha with an installed capacity of 5,000 MW in 2030 is **INR 3000 crore (USD 390<sup>3</sup> mn)** in terms of revenue accrued from electricity generation.
- **Sambalpur, Angur and Malkangiri** are the high-impact districts for FSPV, others include Upper Indravati in Nabrangpur, Jalaput in Koraput, Mandira in Sundargarh, Upper Kolab in Koraput, Tikilipada in Sambalpur, Hariharjore in Bolangir and Salandi in Bhadrak. Sambalpur and Angul have the highest potential of ~4.2 GW out of which Hirakud and Rengali have the highest potential of 3.7 GW. Reservoirs like Balimela and Upper Indravati also have a potential of ~ 1 - 1.5 GW (Singh et al., 2023).

### Investment opportunity

- The investment opportunity for Odisha with an installed capacity of 5,000 MW by 2030 is **INR 32,000 crore (USD<sup>4</sup> 3,800 mn<sup>5</sup>)**.

### Why should Odisha invest in FSPV deployment?

1. **Land neutrality:** The primary benefit of FSPV is that land requirement is greatly reduced; hence, land acquisition and scarcity issues are not applicable (Tyagi et al. 2021). This is beneficial for Odisha wherein 76 per cent of the population is engaged in agricultural activities (NITI Aayog) and is heavily dependent on large land tracts for agriculture and allied activities. Further, to scale up nature-based solutions and bioeconomy, land is a highly sought-after natural resource. Floating solar offers an alternative to using land. Odisha also has the advantage of a vast reservoir of water bodies with 128 dams identified in Acharya and Devraj 2019 as potential sites for floating solar installations based on depth and size considerations.
2. **Complementarity with hydroelectric power plants:** Co-locating FSPV systems with hydroelectric plants can help overcome the intermittency of solar power. Power generated by solar can be supplied to the grid during solar hours and hydropower may be used during non-solar hours (Farfan & Breyer 2018). With Odisha's hydroelectric potential being close to

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<sup>3</sup> Kindly refer to the Annexure

<sup>4</sup> 1 USD = INR 83

<sup>5</sup> Kindly refer to the Annexure

complete utilisation (2099 MW already deployed out of the potential of 3314 MW mentioned in Odisha RE policy 2022), Odisha can look to enhance it with floating solar technology to make use of the complementarity in operation. Further, FSPV plants acting as a covering system for reservoirs could save 1.40 million cubic metres of water per year and avoid 3.30 million tons of CO<sub>2</sub> emissions annually (Ravichandran et al. 2021). This additional water availability could then be used to increase hydroelectric generation and the existing grid connection could aid cost reduction. However, a detailed study on water level variation will be needed to effectively design the anchoring and mooring for supporting the FSPV plant.

3. **Environmental benefits:** Possible environmental benefits include water conservation due to reduction in water evaporation since FSPV's shade water surfaces and cause a reduction in algae growth due to less exposure to the sun. Several studies report the effectiveness of FSPV systems in reducing water evaporation (Ravichandran and Panneerselvam 2021) - Agarwal et al. 2022 estimates 1385 cubic meter per MWh annual evaporation reduction due to FSPV whereas Nagananthini and Nagavinothini 2021 estimates that 90 per cent of water covered by floating platform is saved from being lost due to evaporation. Further, Ravichandran et al. 2021 conducted a numerical estimation of 20 FPV reservoirs with hydroelectric power and found that 3.30 million tons of CO<sub>2</sub> emissions can be saved annually by an FSPV system.
4. **Operational benefits:** These include ease of installation and deployment as compared to ground-mounted solar since no civil work is needed to prepare the site. The most important benefit is of higher efficiency in terms of energy generation as compared to ground-mounted solar (Acharya and Devraj 2019) wherein the improvement in energy yield may be as high as 10 per cent as compared to land-based solar (Choi, Young-Kwan 2013).

### Inspiration from a success story



Sembcorp's 60 MWp FSPV solar farm on the Tengeh Reservoir, spread across 45 hectares, powers five water treatment plants, making Singapore one of the few countries with a completely green waterworks system (World Bank (a)) During the development of the Sembcorp plant, special attention was paid to reduce any negative impact on the ecology and quality of water in the reservoir. It undertook various measures, including floats being placed with adequate gaps between them to ensure oxygen and sunlight reach aquatic life and deployed aerators to ensure proper airflow. In order to de-risk against quick degradation of floats and ensure longevity, a durable, UV and corrosion-resistant material was used (World Bank (b)). Further, the developer ensured conducting an Environmental Impact Assessment (EIA) before deployment to assess all environmental impacts.

## Who could support in scaling FSPV deployment?

### 1. Role of departments

- a. Department of Water Resources: Department of Water Resources to identify water bodies, areas for acquisition (leasing or sale), etc. Further, clarity on waterbody ownership is important and the conduction of bathymetric/hydrographic studies on chosen waterbodies can aid uptake and minimise risk.
- b. Department of Energy (DoE) & Grid Corporation of Odisha (GRIDCO): Department of Energy (DoE) & Grid Corporation of Odisha (GRIDCO) to set periodic targets for FSPV, play a pivotal role in project execution in terms of ensuring fast-tracking of approvals, permissions, etc. and enable a single window clearance system - to be aided by Odisha Hydro Power Corporation (OHPC). DoE may aggregate demand (combine identified sites in one tender) during tendering, enabling developers to benefit from economies of scale. DoE should also encourage developers to conduct environmental and social assessments at the project planning stage and prepare plans to mitigate the assessed risks. The department may monitor the adherence of developers to these plans. Further, in order to aid cost reduction, DoE could offer financial incentives such as (i) a Technology Fund<sup>6</sup> to encourage R&D among developers to reduce cost (STAAI, 2024) (ii) generation-based incentives or equivalent to promote initial adoption (iii) higher clearing tariffs. Measures such as viability gap funding for floating solar projects may also be considered (Baruah 2023). DoE to also coordinate with the Fisheries and Animal Resources Development Department for the co-use of reservoirs.
- c. Industries Department & the Industrial Promotion and Investment Corporation of Odisha Ltd. (IPICOL): Industries Department & the Industrial Promotion and Investment Corporation of Odisha Ltd. (IPICOL) to undertake measures to promote the manufacturing of supporting structures like floats, mooring & anchor systems, necessary for FSPV plants. These measures include supply chain strengthening for material availability, supporting the rise of MSMEs by ensuring enhanced credit access, providing skills training, etc.
- d. Odisha Skill Development Authority (OSDA): Odisha Skill Development Authority (OSDA) to conduct training programmes and re-skill the existing workforce in hydraulics and marine architecture, covering the science and operation of plastic production technologies for manufacturing floats. This has to be done in close coordination with industry and academia via joint programmes, seminars, etc., to ensure that training modules are more practical and implementable.
- e. Odisha Electricity Regulatory Commission (OERC): Odisha Electricity Regulatory

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<sup>6</sup> Technology fund is seen as a way to de-risk technological investment by providing financial support for research, development and deployment. The interest and repayment obligations begin only after servicing the requirements of commercial lenders.

Commission (OERC) to play an important role in tariff discovery and ensuring competitive tariffs for the sector. Given that FSPV is more expensive than land-based solar, more support is needed to find takers for it and attract private investment.

## 2. Role of the private sector

- a. Enabling developers to actively participate in R&D efforts to improve technological processes, spur innovation for cost reduction, and enhance the generation profile of FSPV plants. Further, given that it is a comparatively newer sector, it will also become important to share learnings within the industry via regular conferences, seminars, etc.
- b. Enabling private players to invest in the manufacturing of FSPV components to build indigenous capacity and lower costs. This is important to operationalise Odisha's effort to attract manufacturers for renewable energy equipment manufacturers in the state.
- c. Additionally, as a guide to designing these skilling programmes, industry players should report employment data and skilling gaps to ensure relevant training modules and sectoral employment growth (Tyagi et al. 2021).

## 3. Role of local administration and civil society organisations (CSOs)

- a. CSOs to assist in social impact assessments carried out to understand the implications of FSPV on local fishermen, coastal communities, etc. They may assist developers in designing ESMP and ensure that mitigation strategies address risks to all sections of the community. Further, CSOs need to coordinate with skilling agencies to enable the training of local individuals for the uptake of jobs in the sector as well as enable the development of local industries to support manufacturing of supporting structures by enabling enhanced access to finance, credit, etc.
- b. Think tanks, and academic institutions to prioritise understanding the ecological impacts of FSPV on water bodies and marine aquatic systems.

## Overcoming challenges to scale FSPV deployment

### 1. Technical/technological barriers - Lack of adequate research, standards and understanding of FSPV

- a. Although the floating solar deployment costs have come down in the last few years, it is still about 7 to 10 per cent more costly than ground mounted PV (Jha, Sumit 2023). Financial incentives such as (i) a Technology Fund to reduce technology risks among developers and aid cost reduction (STAAI 2024), (ii) generation-based incentives or equivalent to promote initial adoption, and (iii) higher clearing tariffs could be offered to reduce costs. Demand aggregation (combine identified sites in

one tender) may be offered during tendering, enabling developers to benefit from economies of scale.

- b. Further, it is estimated that 35 per cent of the project cost is associated with the construction of floating platforms. This can be effectively compensated by cost reduction due to existing grid connection of the hydroelectric power plant if installed complementarity (Ravichandran et al. 2021).
- c. Another limitation in uptake of FSPV is the lack of proper bathymetric / hydrographic surveys on water to understand the topography of waterbeds, and lack of waterbody data in terms of water level variation, local biodiversity, water surface area, etc. makes designing of FSPV and estimating its true potential difficult. Currently, there are no standards / guidelines to conduct this survey. Further, lack of studies on its environmental impacts poses a huge risk to the biodiversity and marine ecosystem (Kumar and Gupta 2021). It is recommended that the Department of Water Resources along with the Department of Energy and Department of Fisheries help conduct these surveys and studies to solidify FSPV potential estimation and understand the true impacts.

## **2. Loss of livelihood**

- a. Another challenge associated with floating solar is the social impact it has on the lives of fishermen and people living in surrounding villages. The 600 MW Omkeshwar floating solar plant was seen to impact the livelihood of 317 fishermen and ~1,800 lives in total in the three surrounding villages (Jain 2024). It is extremely important to not just undertake environment and social impact assessments but also follow through with the livelihood restoration plan and the Environment and Social Management Plan (ESMP).

## **3. Lack of standards for PV modules used in FSPV**

- a. Currently, national and international standards such as IS 14286-1-1: 2019/IEC 61215-1-1:2016, IS 14286-1-Sec 2: 2019/IEC 61215-1-2:2016 and IEC 61701:2020 are specific to conditions faced by ground mount solar. The two technologies (ground-mount and floating solar) differ in humidity and salt mist which induces module corrosion. FSPV technology requires high-humidity and corrosion resistant PV modules for which standards do not exist currently. It is thus recommended that the Ministry of New and Renewable Energy (MNRE) implement IEC standards for PV modules used in FSPV plants to improve their performance and durability as well as boost domestic production of these modules.

#### **4. Skilling and employment growth in industry**

- a. FPV is an engineering driven industry and needs highly skilled individuals for proper functioning. Training programmes in hydraulics and marine architecture are necessary to understand the entire ecosystem. Additionally, even the float manufacturing industry requires training programs designed around the science and operations of plastic production technologies (Tyagi et al., 2021). It is recommended that the Odisha Skill Development Authority take up these skilling programmes to boost deployment.
- b. As seen in Figure 1, there is large employment potential in the construction and commissioning phase. This, combined with the high proportion of semi-skilled workforce requirement (Tyagi et al. 2021), requires re-skilling of the existing workforce to achieve the full potential and arrest migration from the state. Long-term courses would be needed to provide 'high skills' and will require dedicated intervention from skilling agencies like the Odisha Skill Development Authority (OSDA) Lastly, FSPV also provides high opportunity for long term O&M jobs with high semi-skilled requirements which can further aid reducing migration and create sustainable employment within the state.

#### **5. Periodic ambition setting**

- a. To ensure higher uptake of FSPV, it is important to set periodic targets of desired capacity in the state of Odisha (Tyagi et al. 2021). GRIDCO Odisha should thus, take up setting yearly targets for FSPV in addition to the long-term policy target to attract investment in the sector.

#### **6. Installation and O&M challenges**

- a. Lack of proper information on waterbody ownership and guidelines for clearance process adds to installation challenges. It is recommended that clear policies and procedures are put in place for setting up of projects, easy clearance mechanisms and streamlined project approval systems.
- b. Further, O&M is complex given its presence on a water body and certain parts like anchoring and mooring that lie inside the water are required to be inspected on a regular basis (Acharya and Devraj. 2019). There needs to be adequate training of personnel who understand complex equipment and are proficient in diving as well (Tyagi et al. 2021).

#### **7. High imports and requirement of indigenization of manufacturing**

- a. Currently, supporting structures and PV modules are largely imported for development of floating solar. Indigenous manufacturing of supporting structures like float, anchor and mooring systems will further open up a host of employment

opportunities as well as aid reducing FSPV costs. Industries Department and IPICOI, Odisha to undertake measures to support domestic manufacturing of supporting structures via supply chain strengthening, etc.

### Risk-proofing the scale-up of FSPV deployment

- 1. Environmental risks:** Floating solar panels may impact marine aquaculture and marine biodiversity. They block out sunlight and oxygen, which can impact the growth of various organisms. Similarly, the floating solar apparatus could block the surface's hunting ground for birds (Acharya & Devraj 2019). Studies have found that the leaching of heavy materials and leaching of organic micropollutants may happen in limited quantities. Monitoring of water is critical to avoid disruptions to water quality (Mathijssen et al. 2020). Since floating solar covers up a part of the reservoir, there may be disruptions to transport and fishing activities (Kumar & Majid 2023).

Mitigation: Ensure the development of extensive monitoring programmes such as assessing the baseline and monitoring of microbiological parameters, algal composition, oxygen levels and other chemical parameters and birds along with aquatic flora and fauna (Mathijssen et al. 2020). At the same time, ensure there is enough space between floats/panels so as to ensure sunlight and oxygen reach the water and utilise aerators (World Bank). The Department of Energy may mandate conducting an Environmental and Social Impact Assessment (ESIA) as a first step during project development and design, and monitor the plans made by developers to mitigate any social or environmental risks.

## Annexure

### Scoping of the floating solar value chain

This section focuses on estimating jobs and markets only for ‘deployment’ of floating solar and does not include manufacturing of components or end-of-life management.

The deployment segment of the floating solar value chain, further consists of four phases: 1) business development, 2) design and pre-construction, 3) construction and commissioning, and 4) operations and maintenance. All these sub-phases have been considered for jobs estimation.

### Jobs and market estimation

*Jobs estimation:*

Total number of jobs that can be created through floating solar deployment in Odisha by 2030 is calculated using phase-wise full-time equivalent (FTE) per MW coefficients and potential market size:

$$\text{Total FTE jobs} = \text{FTE jobs per MW} \times \text{potential market size (MW)}$$

**Table 1:** The phase-wise FTE considered are as follows:

| Sl. No.   | Phase                          | FTE/MW       |
|-----------|--------------------------------|--------------|
| 1.        | Business Development           | 2.52         |
| 2.        | Design and Pre-Construction    | 0.05         |
| 3.        | Construction and Commissioning | 6.96         |
| 4.        | Operations and Maintenance     | 2.00         |
| <b>5.</b> | <b>Total</b>                   | <b>11.53</b> |

*Source: Adapted from Tyagi et al. 2021, taking the values only for the mid-scale plant*

The first three phases of project deployment (i.e. business development, design and pre-construction, as well as construction and pre-commissioning) create one-time jobs whereas in the last phase of the project (i.e. operations and maintenance), the employment generated lasts for the lifetime of the project.

A linear trajectory of floating solar deployment is assumed and jobs are calculated in a manner that the workforce employed in one year will be reabsorbed in the deployment of floating solar in the next year for the first three phases of project deployment. This would help avoid double counting of jobs and align with the aim of creation of a renewable energy workforce that can offer sustained employment by accelerated deployments.

*Market sizing (in units):*

The market potential of 5,000 MW was taken from the Floating Solar potential mentioned in the Odisha RE policy 2022. The entirety of the 5,000 MW is assumed to be deployed by 2030 given that it was expected to be implemented in the first phase as per the policy.

**Market opportunity (in value) estimation**

The market value of floating solar deployment through an ambitious scenario set for Odisha has been estimated through forecasting the revenue generated from the sales of power in 2030. In order to convert MW ambitious scenario to MWh in terms of electricity generation, the following formula was used:

$$\text{Capacity Utilisation Factor (CUF)} = \frac{\text{Injected energy (MWh)}}{\text{Project capacity (MW)} \times 8766} \times 100$$

$$\text{Revenue potential} = \text{Tariff rate (USD/kWh)} \times \text{Injected energy (kWh)}^7$$

Further, a degradation rate of 0.7 per cent and a performance ratio of 80 per cent (taken as per the Indian Technology Catalogue (CEA 2022)) have also been applied to account for generation losses.

**Table 2:** Input values and rationale for each parameter:

| Sl. No. | Parameter             | Value          | Rationale/Source  |
|---------|-----------------------|----------------|---|
| 1.      | CUF                   | 20.26 per cent | Average CUF of two projects - Indravati (160 M) and Hirakud (500 MW) FSPV in Odisha |
| 2.      | Project capacity (MW) | 5000           | Built as per the scenario mentioned   |
| 3.      | Tariff rate (USD/kWh) | 0.056          | Average CUF of two projects - Indravati (160 M) and Hirakud (500 MW) FSPV in Odisha |

Source: Author’s analysis

**Investment opportunity estimation**

To arrive at the investment opportunity when deploying the ambitious target for wind in Odisha by 2030, we multiplied the cost of pumped storage hydro per MW to the total additional capacity to be installed:

$$\text{Investment opportunity (USD)} = \text{Capital cost of small hydro per MW} \times \text{Total additional capacity to be installed}$$

<sup>7</sup> 1 USD = INR 83

**Table: Cost per MW calculation**

| Sl. No. | Project site                 | State  | INR Mn/MW    |
|---------|------------------------------|--------|--------------|
| 1       | Hirakud reservoir - 500 MW   | Odisha | 62.39        |
| 2       | Indravati reservoir - 160 MW | Odisha | 63.42        |
| 3       | <b>Average</b>               |        | <b>62.91</b> |

*Source: Author's analysis*

## References

Acharya, Mohit , and Sarvesh Devraj. 2019. Floating Solar Photovoltaic (FSPV):A Third Pillar to Solar PV Sector? TERI Discussion paper: Output of the ETC India Project , New Delhi: The Energy and Resources Institute (TERI)

Agrawal, K. K., Jha, S. K., Mittal, R. K., & Vashishtha, S. 2022. Assessment of floating solar PV (FSPV) potential and water conservation: Case study on Rajghat Dam in Uttar Pradesh, India. Energy for Sustainable Development, 66, 287–295.

<https://doi.org/10.1016/j.esd.2021.12.007>

Baruah, R. 2023. Centre weighs financial aid for nascent floating solar projects | Mint. Mint.

<https://www.livemint.com/economy/centre-weighs-financial-aid-for-nascent-floating-solar-projects-11685729001350.html>

Central Electricity Authority (CEA), Government of India 2022. - Indian Technology Catalogue : Generation and Storage of Electricity.

[https://cea.nic.in/wp-content/uploads/irp/2022/02/First\\_Indian\\_Technology\\_Catalogue\\_Generation\\_and\\_Storage\\_of\\_Electricity-2.pdf](https://cea.nic.in/wp-content/uploads/irp/2022/02/First_Indian_Technology_Catalogue_Generation_and_Storage_of_Electricity-2.pdf)

Choi, Young-Kwan. 2013. “Empirical Research on the Efficiency of Floating PV Systems Compared with Overland PV Systems.

<https://www.semanticscholar.org/paper/Empirical-Research-on-the-efficiency-of-Floating-PV-Choi-Le/a38910b49973d099603974c24cd55f43a8b0f64c?sort=relevance&citationIntent=background>.

EU-India Clean Energy and Climate Partnership (CECP). 2022. “Detailed Project Report 500 MW Floating PV Plant in Hirakud Reservoir in Odisha State, India.” Page 171.

[https://www.cecp-eu.in/uploads/documents/events/65/DPR\\_Hirakud\\_final\\_V5\\_total\\_2.pdf](https://www.cecp-eu.in/uploads/documents/events/65/DPR_Hirakud_final_V5_total_2.pdf).

Farfan, J., & Breyer, C. 2018. Combining floating solar photovoltaic power plants and hydropower reservoirs: a virtual battery of great global potential. Energy Procedia, 155, 403–411.

<https://doi.org/10.1016/j.egypro.2018.11.038>

Jain, P. 2024. “We are made homeless”: Fishermen lose their livelihood and home due to Omkareshwar Floating Solar. Ground Report.

<https://groundreport.in/groundreport/omkareshwar-floating-solar-and-fishermen-livelihood-question-4536539>

Jha, Sumit. 2023. “Higher Generation and Lower Landed Cost Make Floating Solar Appealing: Interview.” Mercomindia.Com.

<https://www.mercomindia.com/floating-solar-appealing-interview>.

Kenning, Tom. 2018. PV Tech

<https://www.pv-tech.org/gvscccl-inaugurates-2mw-floating-solar-plant-in-andhra-pradesh/>.

Kumar, J. Charles Rajesh, and MA Majid. 2023. "Floating solar photovoltaic plants in India – A rapid transition to a green energy market and sustainable future." *Energy & Environment*. 304: 358.

Kumar, Manish, Humaid Mohammed Niyaz, and Rajesh Gupta. 2021. "Challenges and Opportunities towards the Development of Floating Photovoltaic Systems." *Solar Energy Materials and Solar Cells* 233. 11408. <https://doi.org/10.1016/j.solmat.2021.111408>.

Mathijssen, D. , B Hofs, E. Spierenburg-Sack, R. van Asperen, B. van der Wal, J. Vreeburg, and H. Ketelaars. 2020. "Potential impact of floating solar panels on water quality in reservoirs; pathogens and leaching." *Water Practice & Technology* 807:811.

Micensus, 2022. Year wise reports: Water Bodies report.  
<https://micensus.gov.in/odisha>

Nagananthini, R., & Nagavinothini, R. 2021. Investigation on floating photovoltaic covering systems in rural Indian reservoirs to minimize evaporation loss. *International Journal of Sustainable Energy*, 40(8), 781–805.  
<https://doi.org/10.1080/14786451.2020.1870975>

"EoI For taking up Reservoir Cage Culture in Hirakud Reservoir." Odisha.gov.in. Accessed 10 23, 2023.  
<https://odisha.gov.in/sites/default/files/2022-04/EoI%20For%20taking%20up%20Reservoir%20Cage%20Culture%20in%20Hirakud%20Reservoir.pdf>.

Nagananthini Ravichandran, Nagavinothini Ravichandran, Balamurugan Panneerselvam, 2021. Performance analysis of a floating photovoltaic covering system in an Indian reservoir, *Clean Energy*, Volume 5, Issue 2, Pages 208–228,  
<https://doi.org/10.1093/ce/zkab006>

Prateek, Saumy. 2018. Mercom.  
<https://www.mercomindia.com/india-largest-2mw-floating-solar-vishakhapatnam>

Ravichandran, N., & Panneerselvam, B. 2021. Floating photovoltaic system for Indian artificial reservoirs—an effective approach to reduce evaporation and carbon emission. *International Journal of Environmental Science and Technology*, 19(8), 7951–7968.  
<https://doi.org/10.1007/s13762-021-03686-4>

Santos, B. 2022. Floating solar cost-competitive with ground-mounted PV in southern Europe. *Pv Magazine International*.  
<https://www.pv-magazine.com/2022/11/29/floating-solar-cost-competitive-with-ground-mounted-pv-in-southern-europe/>

"Sembcorp Tengeh Floating Solar Farm," RWDI Consulting Engineers and Scientists, December 20, 2023, [https://rwdi.com/en\\_ca/projects/sembcorp-tengeh-floating-solar-farm/](https://rwdi.com/en_ca/projects/sembcorp-tengeh-floating-solar-farm/).

Singh, Mandvi, Chaudhuri Ritwik Ray, Mukherjee Arpo. 2023. “Renewable Energy Potential in Odisha” IFOREST - International Forum for Environment, Sustainability & Technology.

Smart Cities Mission 2021. – Initiatives, “Visakhapatnam - 2 MW Floating Solar Farm in Mudasarlova”, YouTube Video, 1.43 ,  
<https://www.youtube.com/watch?v=c2MEgXzYFLI>

STAAI. 2024.  
<https://staai.cstep.in/staai/#/home>

Tyagi, Akanksha, Neeraj Kuldeep, and Madhura Joshi. 2021. Employment potential of emerging renewable energy technologies: Insights from the floating solar industry. New Delhi: Council on Energy, Environment, and Water; Natural Resources Defense Council; and Skill Council for Green Jobs.

World Bank (a) "Leveraging Climate Opportunities - Sembcorp Tengeh Floating Solar Farm." World Bank. Accessed November 6, 2023.  
<https://ppp.worldbank.org/public-private-partnership/leveraging-climate-opportunities>.

World Bank (b). Sembcorp Tengeh Floating Solar Farm, Singapore. Public-Private-Partnership Legal Resource Centre, accessed May 16, 2024  
<https://ppp.worldbank.org/public-private-partnership/energy-and-power/sembcorp-tengeh-floating-solar-farm-singapore>.