Floating Photovoltaic Plant in India: Current Status and Future Prospect

Debajit Misra

1 Introduction

Rising power demand, rapid reduction of fossil fuels, increase of greenhouse gas emission, etc. are the major concern in the development of renewable energy technology. At present times, concerned countries all around the world are focusing on renewable energy technology for sustainable power generation, whereas the prime attention is given on solar energy, particularly in solar PV technology. Solar PV technology is being implemented in large scale compared to other renewable energy technology, and this technology is now growing rapidly. However, installation of solar PV requires enough land, which is, nowadays, very limited due to high population growth. Solar PV plants usually require four to five times more land than traditional power plants. In view of this, water surfaces are being utilized for power generation. Water reservoir, canal, lake, etc. are being used where floated structures are being placed on water surface to mount solar panels for generating electricity.

In India, FPV technology is a new and emerging concept. India is a place of huge population. Land in India is scarce, and it has multiple uses like land which is used for agriculture, for grazing, for industries and certain settlements. Land accusation is big problem here. Further, for installation of land-based PV plant, places should be plain and shadow free. Thus, in most of the cases, waste infertile lands are being used but again to convert these wastelands into power plant, lots of effort are required to convert these lands into making plain. Floating power plant on the other hand does away with these difficulties. Floating PV technology could be a very promising option as it requires water body, which is flat and even.

In regular (rooftop and land based) solar PV plant, one of the biggest adversary is the dust accumulation of the solar panel. In case of FPV plant, dust accumulation does not occur because it is placed on water body. Again, in India, most of the large-scale

D. Misra (✉)
Department of Mechanical Engineering, Techno India Group, Kolkata, West Bengal, India

S. K. Ghosh et al. (eds.), *Advances in Thermal Engineering, Manufacturing, and Production Management*, Lecture Notes in Mechanical Engineering,
https://doi.org/10.1007/978-981-16-2347-9_19

solar power plants exist in southern and western regions which receive high solar radiation. Solar PV provides optimum power at a temperature of 25 °C, and there is a constant relation between temperature and electrical efficiency. After 25 °C, in every 1 °C rise of temperature, the efficiency of a solar panel decreases by almost 0.5% [1]. Thus, solar PV at high ambient temperature means that its efficiency has been reduced by some extent. At present, we can get solar module in market with maximum 20% efficiency. Solar system in water body has natural evaporative cooling as water evaporates and cools the solar modules and keeps the temperature lower than that of the surroundings. This can increase the efficiency of a floating solar plant compared to the regular solar plant. Recently, India has decided to include solar and wind power in hydropower projects to create combined source of renewable energy. India has many lakes, large water reservoirs and hydropower plants, and thus, floating PV power generation can be an attractive alternative of renewable power generation by utilizing the surface of water bodies.

2 FPV Technology

2.1 Major Components

Typically, floating PV system is almost same as regular PV system, except that the PV panels and often inverters are fitted on a floating structure. The DC current generated by PV modules is collected by combiner boxes and converted to AC current by inverters. Generally, in small plants which are very close to shore, inverters can be placed on land. Some extra arrangements are very much necessary for floating PV system compared to regular PV system. The primary components of a floating PV system are the following: (Fig. 1).

(i) Pontoon: For installation of floating PV plant, firstly, pontoon (floating structure) is constructed which easily and safely holds solar panels. It is a sturdy structure which is placed on water surface carrying panels and other electrical equipments.
It also provides safety from wind velocity to a certain extent. Numerous hollow lightweight plastic floats made of fibre-reinforced plastic (FRP), high-density plastic (HDPE) or medium density plastic (MDPE) which are placed over the floating structures to form a pontoon. PV panels are fitted on these pontoons maintaining suitable inclination to receive highest possible solar radiation.
(ii) Mooring and anchoring system: The pontoon or floating structure is held securely with mooring and anchoring system. With the help of this system, floating structure can freely move or stay in a suitable position.
(iii) Waterproof cable and connector: All cables remain on water, and the cabling is designed to be shock and waterproof.
(iv) PV system components: It includes PV panels, string inverter and other electrical equipments which are essential for transmitting electricity.

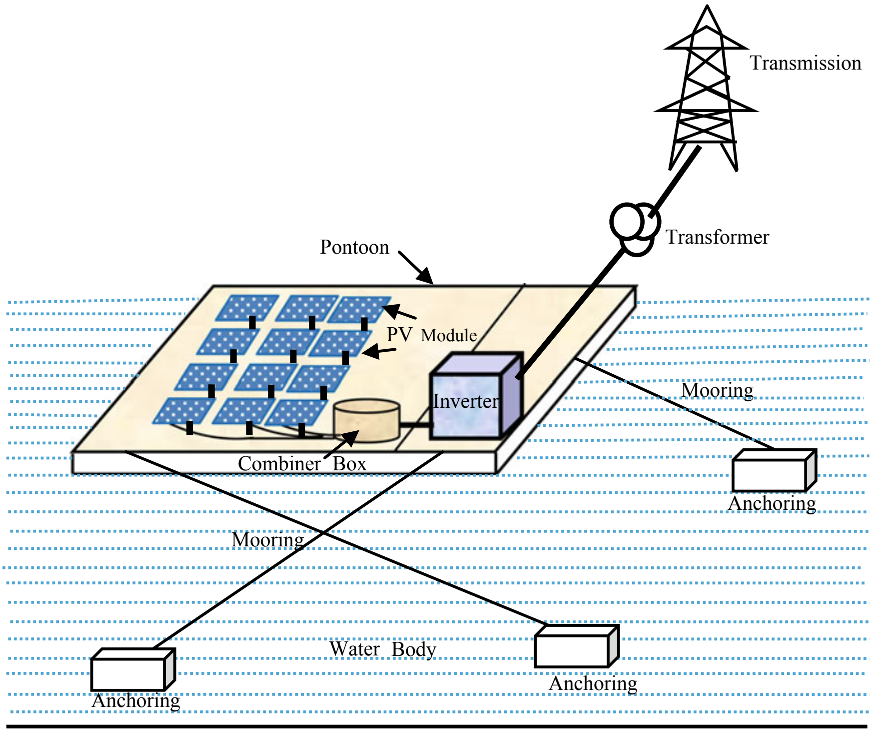

Fig. 1 Simplified schematic diagram of an FPV system

2.2 *Benefits of FPV Plant*

(i) Arable land can be conserved by using water body.
(ii) Unused water body can be converted into useful profitable renewable energy generation area.
(iii) There is no land acquisition issue.
(iv) More power can be generated by increasing the efficiency of PV panel.
(v) Floating PV panels require low maintenance cost.
(vi) Cleaning process of PV panels is very easy.
(vii) Water is conserved by reducing evaporation.
(viii) Reduced water evaporation decreases the possibility of drought in the near area.
(ix) Water clarity can be improved by reducing algae formation due to the constant shade on water surface.

2.3 Challenges

FPV technology is in growing stage, and lots of researches and studies are required to analyse its prospects and challenges ahead. Though it offers lots of advantages, there may be following challenges which should be considered with great attention before its implementation.

(i) As the FPV system design is complicated, its installation requires much more investment cost and long payback period than the regular PV system.
(ii) As entire FPV system remains on water surface, moisture content can affect on system components.
(iii) FPV plant is always prone to natural calamities like heavy wind, storm, cyclone, flood and tsunami.
(iv) Securing profitability is a challenging task as per unit generation cost is more than the regular PV plant.
(v) FPV system component's life span and durability can be affected by stress and vibration caused by water along with other environmental conditions.
(vi) Selected site's water surface should be clean and dirt free else it can affect the system.
(vii) The system installation in a sea is difficult.
(viii) Aquatic system's biodiversity may be affected.

3 Global Scenarios

FPV technology was started in Europe, Japan, South Korea and the USA for research purpose within the time periods from 2008 to 2014. The prime focus was to acquire knowledge that how this technology could utilize for large-scale power generation. Deployment of the global floating solar is growing very rapidly post 2014. According to the report by World Bank, this growth is almost exponential. The reason behind this growth is attributed to its vast expansion in South Asia, Europe and the USA. The total capacity of installed FPV globally was 1097 MW by end of 2018 [2].

At present, Asia possess leading position in terms of FPV installation. The implementation of FPV plant in Japan is the highest (130.59 MW) in the world owing to its dense population and low land availability. China, South Korea, Taiwan and India are the others major countries in Asia. Recently, Singapore, Malaysia, Indonesia, Vietnam and Bangladesh prepare plan to develop FPV plant. In Europe UK, France, Italy, the Netherlands, Belgium and Portugal are the major countries who are implementing FPV plants. Presently, world's largest FPV plant is situated in China on 86 hectare water body, and its capacity is 40 MW [3]. This plant was commissioned in the year 2017. In October 2019, France opened 17 MW FPV plant on 17 hectare water reservoir for electrifying 4733 households [4]. It is Europe's largest floating solar plant. In the same time, USA opened 4.4. MW FPV plant in Sayreville, New Jersey, the largest in North America [5]. In South America, Brazil, Chile and Mexico are investing on FPV plant. Brazil had just 305 KW FPV plant on Goias agricultural firm [2]. Presently, one 1.01 MW plant has been completed on the São Francisco river [6]. South Africa built continents first FPV plant in 2019, which was 60 KW in capacity and located at Marlenique fruit farm in Western Cape [7]. Ivory Coast also sets target for implementation of FPV plant. Australia soon launches their first floating plant in Jamestown, and it serves power for wastewater treatment facility.

4 FPV Plant in India

4.1 Present Status

In India, the concept of floating PV system was first initiated by Tata Power in 2011 with a small pilot project, and then, in 2012, a second pilot project was developed on the banks of the Sabarmati River in the state of Gujarat.

In 2014, India's first 10 KW floating PV plant was installed by Vikram-solar at Rajarhat in Kolkata [8]. This project was developed under supervision of Arka Renewable Energy College in Kolkata and New Town Kolkata Development Authority. The PV system comprises of 40 polycrystalline modules with 250 Wp each. The plant can produce more than 14 MWh power in a year (Fig. 2).

India's second floating PV plant was installed at Banasura sagar reservoir in January 2016 at Wayanad, Kerela. It spreaded on 111.5 m^2 water surface. The plant was built on hollow concrete platform which could carry 4500 tonnes load. In late 2017, it became the India's first large floating PV plant bearing 500 kWp capacity covering 1.25 acres of water surface. The PV plant comprises of 1938 solar modules which have been installed on 18 hollow ferro-cement floaters. The plant can generate 7.5 lakh units of power annually (Fig. 3).

Fig. 2 10 KW FPV plant at Rajarhat in Kolkata [8]

Fig. 3 500 KW FPV plant at Wayanad in Kerala [9]

In 2017, NTPC installed 100 kWp floating PV plant at Kayamkulam in Kerala, on the adjacent lake of NTPC's Rajiv Gandhi Combined Cycle Power Plant (RGCCPP) [10]. The system was installed at 0.32 acre water surface by Swelect Energy Systems Ltd., Chennai with support from NETRA and NTPC within a very short time of 22 days (Fig. 4).

In July 2016, Chandigarh Renewal Energy and Science and Technology Promotion Society (CREST) installed a 10 KW floating PV plant at Dhanas lake. Yellow 2 Gen Power, a Gurgaon-based company has completed this project aiming at solar power generation cum lake water aeration through fountains to improve the oxygen levels in the lake. The floating plant has been set up with 34 modules each of 300 W with dual axes tracking technology to get maximum solar insolation. The plant has been built on a platform that consists a large outer ring that floats on water (Fig. 5).

The Bhurbandha village, which is located at the Morigaon district Assam, has not been connected to the grid up to 2016. In 2017, 10.5 KW floating PV plant was built

Fig. 4 100 KW FPV plant at Kayamkulam, Kerala [10]

Fig. 5 10 KW FPV plant in Chandigarh [11]

to supply electricity to the villagers. This project was implemented by Quant Solar technology in association with Assam Energy Development Agency (AEDA). It is the first floating PV plant in North-Eastern region of India. In this FPV plant, the PV panels were fitted over bamboo platform with the help of metallic rods and floating surfaces (Fig. 6).

Currently, Greater Visakhapatnam Smart City Corporation Limited (GVSCCL) has initiated country's largest floating PV plant of 2 MW capacity on the Mudasarlova reservoir in Visakhapatnam. The PV plant has been built over 20 acres area (Fig. 7).

Thermal power plant management authority Vidarbha Industries Private Limited (VIPL) at Butibori, Nagpur set up 4.8 KW floating solar PV plant which is an initiative of carbon-free green energy. The plant has 16 solar modules of 300 Wp each (Fig. 8).

Fig. 6 10.5 KW FPV plant in Assam [12]

Fig. 7 2 MW FPV plant in Visakhapatnam [13]

Fig. 8 4.8 KW FPV plant in Nagpur [14]

Indian Oil Corporation Ltd. (IOCL) developed grid-connected 100 kWp fixed tilt FPV Plant at Panipat in Haryana [11]. The power plant was a floating structure that supports multiple arrays of solar PV modules. The plant is housed in a raw water reservoir (RWH), located in the Naphtha Cracker unit of IOCL (Fig. 9).

4.2 Projects Under Development

In 2018, India has earned the fifth position in the world in the capacity of installation of solar power [15]. Solar Energy Corporation India Limited (SECI) reported that India set a big target in the development of floating solar plant in the states like Andhra Pradesh, Uttar Pradesh, Gujarat, Kerala and Rajasthan and is moving rapidly

Fig. 9 100 KW FPV plant at Panipat in Haryana [11]

to achieve this target. Those targets have become operational or are going through various developmental stages. Following are the projects in the country which are still under construction.

(i) NHPC is working to develop a 50 MW floating solar plant using a 350 acre water body at West Kallada in Kerala.
(ii) The Shapoorji Pallonji Group in collaboration with the Solar Energy Corporation of India (SECI) is initiating to develop a 50 MW plant which is a part of the proposed 150 MW floating solar power plant planned at Rihand Dam, Sonbhadra district, Uttar Pradesh.
(iii) National Thermal Power Corporation (NTPC) has taken initiative for the development of 25 MW floating solar PV project at NTPC Simhadri in Andhra Pradesh.
(iv) NTPC has also commissioned for development of 1 MW floating solar power plant on Kawas Reservoir in Aditya Nagar, Surat in Gujarat.
(v) Maharashtra State Electricity Distribution Company Ltd. (MSEDCL) has just started for the development of 1 GW of floating solar plant in the Ujjani Dam in Solapur district of Maharashtra.
(vi) In Gujarat, the government-owned Sardar Sarovar Narmada Nigam (SSNNL) has started to build a 100 MW canal-top solar power project atop the branch canals of river Narmada. It would cover nearly 40-km canal.
(vii) Hindustan Zinc, a group firm of the Vedanta Group, has almost completed their 1 MW floating solar power plant at Ghosunda Dam, near Chittorgarh, Rajasthan. The solar plant could be able to supply annually 1993 MWh of energy.
(viii) NHDC, a joint venture between NHPC and Madhya Pradesh State Government, has started to set up a 25 MW of floating solar plant on the Omkareshwar reservoir in Khandwa district of Madhya Pradesh.

(ix) NHPC has been working to develop 40 MW of floating capacity at the Chiplima hydropower facility in Odisha.

4.3 Recent Projects Proposal

Recently, ten floating solar projects proposal has been launched with capacity ranging from 100 KW to 1 GW. World Bank, through its Clean Technology Fund, has financed up to 10 MW for the development of some of these projects. The German Development Bank (KfW) is funding for the development of two projects of total capacity of 40 MW. The project proposals are listed below:

(i) In 2018, NTPC planned to expand their power generation capacity by grid-connected floating solar at its Rajiv Gandhi Combined Cycle Power Plant (RGCCPP) Kayamkulam in the southern state of Kerala. A tender was released of 70 MW capacity.
(ii) BHEL is constructing a 25 MW floating solar power plant at NTPC Simhadri Super Thermal Power Station in Deepanjalinagar, 40 km from Visakhapatnam. Once completed, this floating solar power plant would be the largest in Andhra Pradesh.
(iii) NHPC plans to set up a 600 MW floating solar cum hydroelectric project in the Satara district of Maharashtra.
(iv) In September 2019, the Bihar Renewable Energy Development Agency (BREDA) released tender inviting bidders to develop two floating solar PV power projects. One 2 MW project will be developed on private water bodies and another 2 MW to be developed on a government-owned water body.
(v) Solar Energy Corporation of India Ltd. (SECI) invites online bids for 100 MW floating solar power plant at the reservoir of Getalsud Dam, Ranchi, Jharkhand and 50 MW floating solar power plant at the reservoir of Dhurwa Dam, Ranchi, Jharkhand.
(vi) In 2019, government released a project proposal to develop 1GW floating solar plant on India's largest reservoir, the Indira Sagar Dam in Madhya Pradesh.
(vii) In January 2020, SECI requests for selection (RfS) for setting up a 4 MW grid-connected floating solar PV power project at Kalpong dam, Diglipur, North Andaman.
(viii) A tender has been accorded for 100 MW floating solar PV project at Ramagundam in Telangana.
(ix) In 2020, SECI has sent a proposal to State Government of Odisha for developing 500 MW FPV plant at the Hirakud reservoir.
(x) 100KW floating PV plant is still under process at Loktak Lake in Manipur, which is the largest fresh water lake in North-East India. The project for installation has been commissioned by Manipur Renewable Energy Development Agency (MANIREDA).

5 Future Prospect

India is in the third position in the World after China and the USA in terms of number of Dams. National Register of Large Dam (NRLD) reported that India has 5264 dams with an area of approximately 1.4 million hectares and 437 dams which are under construction. Again, according to Reservoir Fisheries of India, it has 56 large reservoirs covering 1,140,268 hectares, 180 medium reservoirs covering 527,541 hectares and 19,134 small reservoirs covering 1,485,557 hectares areas. Besides these, India has countless water bodies. Thus, India could utilize few portions of those water sources in the development of the huge hubs for FPV projects.

Currently, floating solar plants in the world acquire within 10–25% area of the water body. Thus, there is no major impact on aquatic habitats. The location of the plant should be selected according to the depth of the water body so that it keeps floating when water level falls during summer. To evaluate power generation capacity of 35 large water reservoirs in India, 10% area of water body has been considered. Again, it has been considered that 1 KW floating plant requires 40 m^2 area of water surface [13]. Indian large water reservoirs, lakes and reservoirs adjacent to dams are considered here for evaluation [16–18]. In this evaluation, only large water body, whose area is equal to 100 km^2 or above, has been taken under consideration. It is also considered that 1750 L/m^2/year of water could be saved due to reduction in evaporation, and the yearly saving of water has been calculated accordingly [19] (Table 1).

It is found that by utilizing FPV plants on 35 large water reservoirs, India potentially can generate 38.88 GW power. Besides this, it has the ability to save 2730 billion litres of water in every year. Normally, for coal-based thermal power plant, if G10 category coal is used having calorific value of 2615 kcal/KWh, 4528 tonnes coal would require generating 1 MW power per annum [20]. Thus, for the present case to generate 38.88 GW, 176.04 megatonnes coal could be saved yearly. Also, its equivalent greenhouse gas emission could be reduced in every year.

6 Conclusion and Remarks

It may be concluded that FPV system is a very effective renewable power generation system in the current scenario when fossil fuel is constantly reducing. This system, unlike the regular PV systems, is an eco-friendly power generation system for its efficiency in reducing water evaporation rate and thus helping in water conservation. It also can solve the persistent problem of land availability for installation of solar PV. Though its initial cost is higher than the regular PV system, a floating PV system generates almost 25% more power compared to the regular PV system. Its application can also be possible in aquaculture farms and effluent treatment centres, especially in remote areas which are not connected to the power grid. With proper government support and public awareness, the FPV technology could make a revolutionary

Table 1 Energy potential and water saving using FPV plant of major lakes, reservoirs and dams in India

Name	Reservoir area (km^2)	Location	Potential (GW)	Water saving (mL/year)
Vembanad lake	2033	Kerala	5.08	355,775
Chilika lake	1165	Odisha	2.91	203,875
Indira Sagar	913.4	Madhya Pradesh	2.28	159,845
Shivsagar lake	891.78	Maharastra	2.22	156,060
Hirakud dam	743	Odisha	1.85	130,025
Gandhi Sagar dam	723	Madhya Pradesh	1.8	126,525
Getalsud dam	717	Jharkhand	1.79	125,475
Idukki dam	649.3	Kerala	1.62	113,626
Srisailam dam	616.4	Andhra Pradesh	1.54	107,870
Polavaram dam	600	Andhra Pradesh	1.5	105,000
Rihand dam	468	Uttar Pradesh	1.17	81,900
Sriram Sagar	450.82	Telengana	1.12	78,892
Pulicat lake	450	Andhra Pradesh	1.12	78,750
Tungabhadra dam	378	Karnataka	0.94	66,150
Sardar Sarovar	375.3	Gujarat	0.93	65,676
Jayakwadi dam	350	Maharastra	0.87	61,250
Ujjani dam	337	Maharastra	0.84	58,975
Linganamakki dam	316.65	Karnataka	0.79	55,413
Loktak lake	287	Manipur	0.71	50,225
Nagarjun Sagar	284.9	Andhra Pradesh	0.71	49,856
Bargi dam	267.97	Madhya Pradesh	0.66	46,894
Pong dam	260	Himachal Pradesh	0.65	45,500
Almatti dam	242.3	Karnataka	0.6	42,401
Maharana Pratap Sagar	240	Himachal Pradesh	0.6	42,000
Tawa reservoir	225	Madhya Pradesh	0.56	39,375
Somasila	221.28	Andhra Pradesh	0.55	38,724
Bisalpur dam	218.36	Rajasthan	0.54	38,213
Somasila dam	212.28	Andhra Pradesh	0.53	37,149
Ranapratap Sagar	198.3	Rajasthan	0.49	34,701
Bhakra dam	168.35	Himachal Pradesh	0.42	29,460
Mettur dam	153.46	Tamil Nadu	0.38	26,854
Kangsabati	124.32	West Bengal	0.31	21,756
Bhadra dam	112.5	Karnataka	0.28	19,686
Indravati	110	Odisha	0.27	19,250

(continued)

Table 1 (continued)

Name	Reservoir area (km^2)	Location	Potential (GW)	Water saving (mL/year)
Kolab dam	100	Odisha	0.25	17,500

change in renewable power generation in India. Recently, Indian cabinet addressed a long pending concern, The Dam Safety Bill, 2019, which could ensure safety to the currently existing dams and could pave the way for many more FPV projects in India. SECI, a government undertaking organization, took the responsibility for implementing the FPV projects in India. The organization has developed schemes 'Expression of Interest' (EoI) all over the country. The main feature of EoI is to understand the viability of developing large-scale FPV plant and to encourage the developers to develop FPV plants. The organization has addressed the government's intentions and objectives in front of the developers.

Owing to the large investment of the FPV projects, financial support is needed from government or private sectors. In India, as the concept of FPV technology is new, finding skilled workforce could be a problem. So, proper training programmes are necessary in the utilization of human resource to drive the project efficiently. Since it is a new technology, there is no historical evidence to acquire knowledge about the impact of water on PV system for long-term application. For large-scale installation, building public awareness is needed through seminar and workshop. In India, lots of research and development are required, and better financial infrastructure and manufacturing facilities are needed to develop large-scale projects. Again, in remote places, adequate transmission network is required. India is capable to manage above-mentioned challenges to make a huge FPV power hub in coming future.

References

1. Moharram KA, Abd-Elhady MS, Kandil HA, El-Sherif H (2013) Enhancing the performance of photovoltaic panels by water cooling. Ain Shams Eng J 4(4):869–877
2. World Bank Group, ESMAP, and SERIS (2018) Where sun meets water: floating solar market report—executive summary. Washington, DC: World Bank. Available at: http://documents.worldbank.org/curated/en/579941540407455831/pdf/Floating-Solar-Market-Report-Executive-Summary.pdf
3. PV Magazine (2017) 40 MW floating PV plant in China connected with sungrow's inverters (Online). Available at: https://www.pv-magazine.com/2017/05/19/floating-pv-plant-in-china-connected-with-sungrows-inverters/
4. PV-Tech (2018) Akuo energy starts construction on 17 MW floating solar plant in France [Online]. Available at: https://www.pv-tech.org/news/akuo-energy-starts-construction-on-17mw-floating-solar-plant-in-france
5. PV Magazine (2019) America's largest floating solar project completed (Online). Available at: https://pv-magazine-usa.com/2019/10/23/americas-largest-floating-solar-project-completed/
6. PV-Tech (2019) Ciel & Terre's 1.01MW floating plant completed in Bahia, Brazil (Online). Available at: https://www.pv-tech.org/news/ciel-terres-1.1mw-floating-plant-completed-in-bahia-brazil

7. PV-Tech (2019) New Southern Energy completes first floating PV project in South Africa (Online). Available at: https://www.pv-tech.org/news/new-southern-energy-completes-first-floating-pv-project-in-south-africa
8. Floating solar power plant in West Bengal, India. Available at: https://www.vikramsolar.com/case-studies/floating-solar-power-plant-in-west-bengal-india/
9. Solarplaza, (2019) Top 100 floating solar projects. Available at: https://www.solarplaza.com/channels/markets/11968/top-100-floating-solar-projects/#accesstop100
10. NTPC installs India's first largest solar PV plant in Kerala. Available at: https://economictimes.indiatimes.com/industry/energy/power/ntpc-installs-indias-largest-floating-solar-pv-plant-in-kerala/articleshow/57577004.cms
11. A bellwether for floating solar industry in India (Online). Available at: http://www.yellow.org.in/project.html
12. Clean Future (2017) Assam village uses floating solar platform for electric generation (Online). Available at: http://www.cleanfuture.co.in/2017/08/02/assam-village-uses-solar-for-electric-generation/
13. PV-Tech (2018) GVSCCL inaugurates 2 MW floating solar plant in Andhra Pradesh (Online). Available at: https://www.pv-tech.org/news/gvsccl-inaugurates-2mw-floating-solar-plant-in-andhra-pradesh
14. Energetica (Power generation magazine, India) Nagpur's first floating solar PV plant installed using delta inverter. Available at: http://www.energetica-india.net/news/nagpurs-first-floating-solar-pv-plant-installed-using-delta-inverters
15. Ministry of new and renewable energy. Available at: https://mnre.gov.in/
16. National register of large dams. Available at: http://www.indiaenvironmentportal.org.in/files/file/NRLD%202018.pdf
17. Reservoir fisheries of India. Available at: http://www.fao.org/3/V5930E/V5930E01.htm#ch1
18. Dam in India (Online). Available at: https://www.mapsofindia.com/maps/dams/tungabhadra-dam.html
19. CWC (2011) Evaporation control in reservoirs. Basin Planning and Management Organisation, Central Water Commission, New Delhi
20. Norms for coal consumption. Available at: http://www.cea.nic.in/reports/others/thermal/tppd/coal_cons_norms.pdf
21. Solar energy corporation India Limited (SECI). https://seci.co.in/tenders.php
22. National Thermal Power Corporation (NTPC) Floating solar. https://www.ntpc.co.in/en/search/node/floating%20language%3Aen
23. BHEL to commence work on floating solar plant at NTPC. Available at: https://www.thehindu.com/news/cities/Visakhapatnam/bhel-to-commence-work-on-floating-solar-plant-at-ntpc/article29858452.ece
24. India planning 1 GW floating solar project in Madhya Pradesh. Available at: https://ieefa.org/india-planning-1gw-floating-solar-project-in-madhya-pradesh/
25. Central Water Commission. Available at: www.cwc.gov.org
26. Hartzell T (2016) Evaluating potential for floating solar installations on Arizona water management infrastructure. University of Arizona, Tucson (Arizona)
27. PV-Tech (2018) NTPC tenders 70MW of floating solar at combined cycle power plant in Kerala. Available at: https://www.pv-tech.org/news/ntpc-tenders-70mw-of-floating-solar-at-combined-cycle-power-plant-in-kerala