Floating PV: A Novel Approach To Solar

A niche market has emerged within the solar industry as an alternative way to gather clean energy.

by Bernard Prouvost

As solar power becomes increasingly affordable, accessible and prevalent around the world, new technologies and methods of installation are emerging. Specifically, floating solar PV is becoming a competitive and viable niche in the solar market that offers a water-based alternative to traditional PV installed on the ground, rooftops or carports.

Floating PV projects are typically installed on inland compounded bodies of water, be they natural or man-made. The projects consist of a floating mounting system, which has a framing structure equivalent to a standard ground-mounted PV system that is used to support the PV modules above the water with consideration to a set pitch, azimuth and distance.

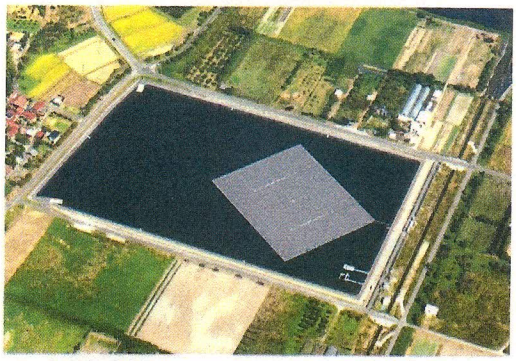


Photo courtesy of Ciel et Terre

Installation is surprisingly straightforward. First comes the assembly of the floating structure. On shore, modular Lego-type floats are assembled into rows using connection pins - each one of these "main floats" supports a PV module. The rows are held together by aisles of secondary floats, which ensure the overall structure's buoyancy and spacing between the PV panels, as well as double as maintenance alleys. PV panels are installed, and the structure is simply pushed out or towed into the water. As the solar island is being assembled, anchors are installed on the perimeter banks or at the bottom of the body of water in which the system will be placed.

The floating structure is anchored via mooring lines, which are adaptable to water level fluctuations, and cabling is put into place. Anchoring is a major component of any floating solar project, and accurate bathymetric information is crucial to the design of a long-lasting power plant. The entire system must be designed to withstand long-term environmental hazards, such as rain, snow and wind conditions. Wind has the strongest incidence on the structure's integrity and should be a design priority for any floating PV project. All electrical components must be strong enough for intense wind conditions, as well as waterproof, resistant to dust and able to function reliably in extreme temperatures.

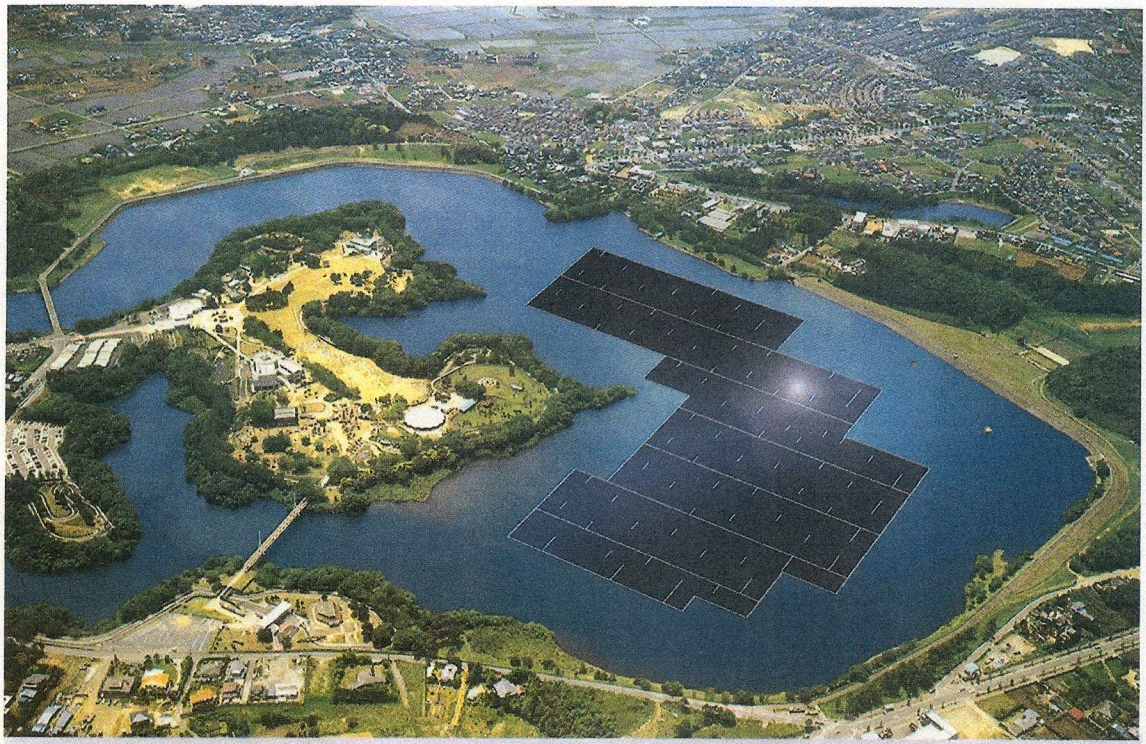
A floating PV system is cabled in the same way as ground-mounted systems, except that the junction boxes (NEMA 4 X minimum) mounted on the floating arrays are connected to onshore inverters using either a flexible marine DC cable or normal DC cable protected in an adapted waterproof and sealed floating conduit. The main electrical equipment is located on the embankment for easy and safe maintenance at all times.

Market applications

Floating PV systems can be installed for self-consumption by private or public entities to offset their on-site electrical needs (e.g., pumps, aerators, factories, refrigerated warehouses, etc.), or the electricity generated can also be fed into the grid and sold to local electric utilities.

Floating solar is ideal for energy- and water-intensive industries, such as water treatment plants and reclamation facilities. Industries using large quantities of water as part of their plant cooling process (e.g., steelworks), which tend to be energy-hungry, may also find a perfectly adapted renewable energy solution in floating PV.

Wherever conserving land is a concern, as for agricultural



At 13.7 MW, the world's largest floating power plant will be finalized on a dam in Chiba Prefecture, Japan, in spring 2017. With almost 51,000 PV modules, the power plant will generate 15 GWh/year, equivalent to the consumption of 4,700 households. In Japan, where land is scarce and there is a strong commitment to an energy transition, floating solar has become widely integrated with rice irrigation systems, industrial processes and water utilities. *Rendering courtesy of Ciel et Terre*

companies, wineries and dairy farms, combining floating solar with irrigation reservoirs can be preferable to ground-mounted installations, with the added benefit of limiting water evaporation.

There are also clear opportunities within the mining industry, where old quarries and mining pits leave vast water surfaces after material extraction. Here, floating solar provides a good solution for both site remediation and the ongoing energy demand from active operations nearby.

The synergy between hydroelectric dams and floating solar speaks for itself, as solar power can boost generation during the daytime and, where water storage is possible, allow more high-value hydropower to be produced at peak demand time. Although these hybrid solutions have yet to be perfected, the combination of floating PV and hydroelectric power shows potential to become a 100% renewable energy system.

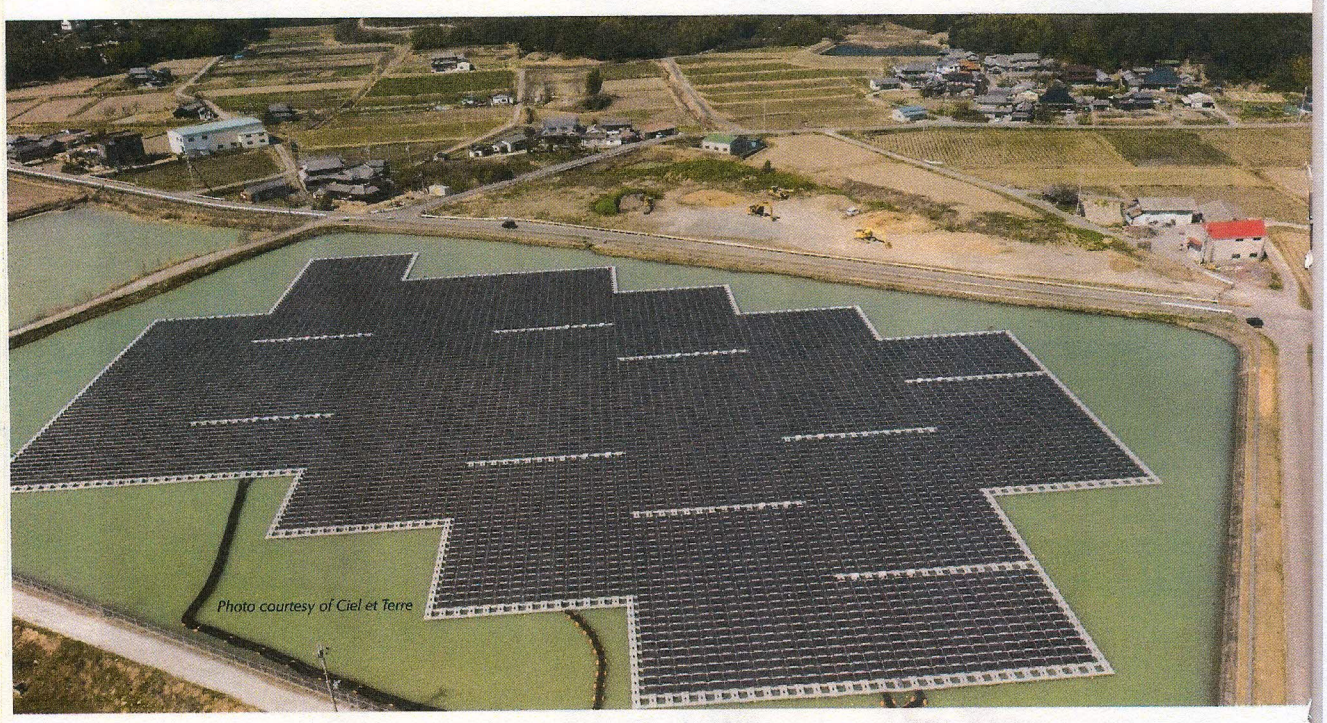
Floating solar is also finding applications on hydroelectric dams, a key opportunity in Brazil. The Balbina hydroelectric dam in the Amazonas region will be upgraded with a 4.9 MW floating power plant. As the dam is suffering from severe drought, dramatically reducing its nominal capacity, this project will resolve this issue by preventing water evaporation and generating 6.8 MWh/year (powering 4,500 homes) with 20,000 PV modules. *Photo courtesy of Ciel et Terre*

Floating solar fits the needs of numerous industries, and new market applications for these systems are emerging every day.

Potential benefits

Floating solar creates a new use for the surface area of commercial and industrial bodies of water, which are typically unobscured from the sun, kept out of sight and located near energy-intensive processes. Consumers, businesses and municipalities are facing the challenge of rising electricity costs and uncertainty of volatile power prices. Energy, depending on the industry, can be one of the major budget costs, and keeping those costs down is critical for everyone.

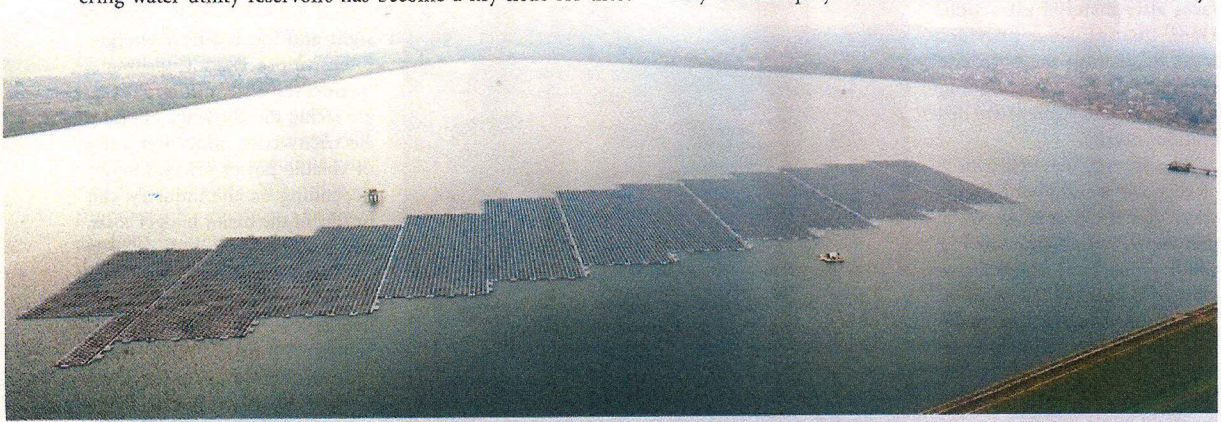
This, compounded with limited land or rooftop space availability, is why many water-related industries and businesses invest in floating solar infrastructure projects. Installing solar power on water allows industries to maximize the value of these underused spaces and yield higher



energy production, as the panels are naturally kept cooler by the temperature exchange between air and water. Contrary to popular belief, solar panel efficiency decreases when affected by temperature increases. Water temperature will be lower than that of the ground or air, and wind action cools the back of the panels. This also prevents overheating of cables in the floating conduits, which equally benefit from this exchange.

Countries wanting to protect their water resources will also find synergies between floating PV and their conservation programs, as covering water bodies with PV modules limits evaporation and algae growth. In states such as California, covering water utility reservoirs has become a key issue for these very reasons, with concerns over drought and algae bloom. Because floating PV covers a large surface area of reservoirs, it limits evaporation problems and the sun's UV rays into the water. Therefore, it naturally prevents algae growth; typically, chemicals are used to control this issue. If designed using drinking-water-compliant materials, floating PV can be a turnkey solution that brings together water (and land) conservation and clean power generation.

Speed of deployment is also one of a floating PV system's great advantages, as incentives and political landscapes can change quickly. Due to the installation's simplicity, local labor is typically used and projects contribute back to the local community.



Located in the U.K., the Queen Elizabeth II drinking water reservoir has been upgraded with a 6.3 MW, 23,000-module floating power plant producing 5,800 MWh/year - enough electricity to power 1,800 homes - which the Thames Water utility uses to treat water distributed to 10 million people in the London area. Floating solar is considered highly suited to the U.K.'s geography, as the region's many inland bodies of water can be developed into valuable areas. *Photo courtesy of Ciel et Terre*

Furthermore, the low profiles of these systems over large bodies of water have little to no visual impact and create an environmentally friendly solution, with limited ground disturbance during installation. No civil works, terracing, use of heavy equipment or removal of vegetation occur during installation. Some systems using HDPE plastic are 100% dismountable and recyclable, and after dismantlement, premises are left as they were before the site's development, with no direct impact on property value. Floating PV systems are guaranteed to last 25 years, on average, and have the potential to perform better with a longer life span, as the panels and wires typically do not suffer from overheating like they might when installed on a rooftop.

> Floating PV can benefit aquatic life.

Misconceptions

Floating PV systems also boast good environmental performances and have a neutral or positive impact on the water bodies on which they are installed, especially when designed using materials such as food-grade and drinking-water-compliant HDPE. Sensitive wildlife is also not usually present in man-made water bodies, where most floating PV installations are developed. Nevertheless, floating PV can benefit aquatic life, as shading from PV modules limits algae growth and water eutrophication and can provide natural shelter for various species.

Unfortunately, though, other major misconceptions about floating PV still exist, including the following:

Installing floating PV is complicated. With no foundation work required, floating PV can actually face fewer barriers to installation than ground-mounted PV. Deployment itself, as described earlier, is quite straightforward - with the right organization and technology, a floating PV structure can be deployed with little training or equipment at a rate of 1 kW/worker/hour. Ideal sites for floating PV often also feature grid-connection infrastructure nearby, making deployment even simpler and more economical.

Water and electricity do not work together. It seems intuitive that water and electricity don't go together. However, perfectly safe electric installations have been implemented for decades on marinas, reservoirs, boats and floating houses, as well as in offshore and aquatic environments. Using equipment such as waterproof junction boxes and cables (IP65-67) ensures safe installation, operation and maintenance.

Floating PV is more expensive and too exotic. Like all other renewable energies, floating solar is enjoying rapidly diminishing costs as the technology evolves, and it is already profitable in many countries. Floating solar installations are easily financeable in many places and benefit from the same options as traditional PV, such as power purchase agreements, leases and bank loans. However, as with any new technology, some financing parties will be pioneers, while others will focus on only traditional systems and wait for floating PV to build up its track record before they invest. As the floating solar market grows, it will become increasingly clear that these projects are long-term, low-risk investments.

Adoption hurdles

Confidence may be the main barrier for adoption facing floating solar. This often takes the form of financing difficulties linked to perceived risk, and people sometimes need to be convinced that floating solar is technically viable. Nonetheless, these fears are usually dispelled quickly, and funds become easier to secure once a working pilot is installed in a region.

Although vast man-made water bodies represent ideal opportunities for floating solar, the largest sites also tend to be owned by public entities, making it sometimes very slow to approve more ambitious projects. In this sense, floating solar is essentially faced by the same issues as any other renewable energy.

Visibility is another challenge the floating PV industry faces. At present, floating solar remains a fairly young "niche" market in which few companies have a proven track record and real expertise. In some regions, it is simply not known that installing PV power on water is a workable possibility.

Again, this challenge will surely be resolved as the industry grows, and it is only a matter of time before floating solar is recognized as having a fully fledged role to play in the global transition to clean energy.

Bernard Prouvost is founder and chairman of the board at Ciel et Terre, a France-based provider and developer of floating PV solutions and projects that recently entered the U.S. market.