FLOATING SOLAR – GLOBAL OPPORTUNITY

IN MID-2016 AIR PASSENGERS CIRCLING HEATHROW WAITING TO LAND MAY HAVE SPOTTED A NEW ADDITION TO THE LANDSCAPE – A FLOATING SOLAR POWER PROJECT ON THE QUEEN ELIZABETH II RESERVOIR. AT THE TIME, WITH A CAPACITY OF 6.3MW, THIS WAS ONE OF THE WORLD'S LARGEST FLOATING SOLAR PROJECTS. BY ALLAN BAKER, GLOBAL HEAD OF ADVISORY AND PROJECT FINANCE FOR THE ENERGY GROUP, AND CEDRIC CHATEL, MANAGING DIRECTOR, ENERGY FINANCE & ADVISORY, SOCIETE GENERALE.

Wind forward to the end of 2019, and the record for the world's largest floating array was taken by the CGN Dangtu floating solar project in China with a capacity of 260MW, and this is likely to be eclipsed by one of the many utility-scale projects currently being developed around the world, including the massive 2.1GW Saemangeum project being proposed for the tidal flats of the Yellow Sea in South Korea.

Unless you have been following this segment of the market you could be forgiven for being taken by surprise at the speed with which these large-scale projects have emerged, but in fact floating solar has been around since 2007 when the first demonstration project was installed at Aichi in Japan. The first commercial project followed in 2008 in California with the installation of a 175kW system on reservoir, a pragmatic way to avoid taking up land that could otherwise be used for growing grapes. The huge potential of floating solar is now widely recognised around the world, and offers a major opportunity for the project finance community, as we outline in this article.

Global opportunity

One of the pre-requisites for floating solar is the availability of a large expanse of relatively sheltered water, such as lakes, reservoirs, tidal mud flats etc. Based on the findings of the World Bank sponsored report "Where Sun Meets Water – Floating Solar market Report" (2019)[1] it is estimated that using 10% of the available surface area of man-made freshwater reservoirs globally could support 4TW of floating solar capacity, without including other suitable areas such as intertidal areas, harbours and fisheries, which offer significant potential in Asia. Clearly, not all this potential will be utilised or be economically viable. However, floating solar does offer advantages, including:

- Offering an alternative in areas of high population density, where terrain is mountainous or where land is better suited for agriculture, for example;
- Proximity to population (load) centres in many municipal water supply reservoirs;
- Providing shade to the host water body, which can help to reduce evaporation (valuable in areas that are prone to drought) and potentially limit algae bloom;
- From a technical perspective, floating solar arrays have demonstrated better efficiency at higher temperatures due to the cooling effect of the water.

Despite the advantages, there are also disadvantages, not least the safety and access challenges of maintaining water-based solar arrays, and currently higher costs, although the cost differential is reducing.

One specific area where floating solar offers a potentially game-changing opportunity is the co-location with existing hydro-electric generating facilities and pumped storage facilities. Hybrid hydro and floating solar facilities offer practical efficiencies in connection, transmission and land acquisition costs, but more importantly, could transform the role of hydro in the electricity system due to the potential synergies between hydro and solar generation.

For example, seasonal alignment in areas that suffer drought could see solar generation peaking in the hot dry season to replace constrained hydro production. Floating solar can also materially increase clean energy production from existing hydro facilities that would not otherwise be possible. Finally, co-location of solar allows for balancing of solar intermittency, the ability to better shape products for demand patterns and in some cases, the use of surplus or off-peak solar to power pumped storage facilities.

Despite the huge theoretical potential for floating solar, the practical capacity is driven by site, system and geographical factors as well as the availability of supportive regulation. Asia has been the primary market for floating solar to-date and is expected to remain the largest market according to HIS Markit forecasts, representing 70% of installations in the next five years – "Asia region to drive floating solar installation growth in next five years", May 28 2020. However, increasingly we see potential for utility-scale projects in North America and Europe, making this a global opportunity.

In Asia, there are a wide range of suitable sites, both on man-made reservoirs and in the large intertidal areas found in many countries. In many cases, suitable sites on land are either scarce and/or better used for other purposes. Leading the development in terms of installed capacity so far are China, Japan, South Korea and Taiwan, but other countries in the region are expected to grow strongly, including Vietnam, Thailand and India, which is expected to represent 24% of the market by 2025.

In Europe, the Netherlands has already awarded SDE+ contracts for 500MW of capacity, with an ambition to develop up to 2GW, and studies in Germany suggest up to 2.7GW, particularly on former lignite mining sites, with similar potential in other countries.

The Americas is a step behind in development of floating solar but given the potential addressable sites – 1.6TW based on World Bank Estimates – we expect to see both the number and scale of projects increasing as the energy transitions gathers momentum supported by the more climate-focused agenda of the new US administration.

Floating solar technology

One of the challenges of floating solar has been the relatively high cost compared with land-based systems. Both floating and land-based projects have benefited equally from the rapid price reduction and technology improvements of panels and inverters, but the challenge for floating has been the incremental cost of floats, anchoring systems and other specific technical requirements of the floating environment.

Recognising this, a number of FPV developers, floating structure suppliers as well as anchoring and mooring suppliers have intensified their efforts to explore technological solutions and business models to close this gap, with the ultimate objective of delivering FPV with an LCOE at par, or even below that of ground-mounted PV.

One aspect common to all the advantages of FPV outlined above is that they are very much site-specific. The same applies also to the risks inherent to a FPV project: the durability of the various project components and the long-term performance in terms of energy yield and cashflows will depend on the site bathymetry, the salinity of the water, the distance from shore, the exposure to extreme weather conditions, the adverse impact on water quality, etc.

One of the challenges resulting from the site specificity and, to a certain extent, from the early stage of the industry, is the diversity of FPV technical solutions developed over the past ten years. More than twenty technology providers are now active in the floating structures market, with varying types of floating structures, and floater materials – HDPE, other plastics, metals etc.

All technology providers are striving to deliver, first, systems that meet cost reduction objectives, while also delivering adequate resistance to fatigue and other wear caused by the asset environment and movement of the system and, second, high performance in terms of energy yield when applied to specific site conditions. Anchoring and mooring system providers are faced with similar challenges, particularly as they must deal with changing water levels as well as wind shear and water surface movement.

The consequence of this complexity is that we see a recent trend towards a transversal approach where the various project packages, ie, the floaters, the anchoring and mooring, the modules, the inverters and the electrical infrastructure, are sourced individually. This allows project developers to select the most appropriate packages for the specific site in order to extract as much value as possible from the site conditions, by optimising risk allocation and return on investment.

This is not dissimilar from the approach taken in offshore wind, but from a lenders' perspective specific attention is paid to the underlying supply chain and to the interface risk among the various packages, even in case an EPC or completion wrap would be proposed by the FPV main contractor or project developer.

Changhua floating solar

In April 2020, an international syndicate of seven banks closed a NT$7.2bn project finance debt facility for a 180MW floating solar project in the Changbin Lunwei East district of Changhua province in Taiwan for Chenya Energy Co Ltd. This represents a major milestone for floating solar as not only will this become the largest floating solar farm in the world when commissioned this year, but it is also the first commercial project financing in the sector.

The project is financed under a six-year mini-perm scheme, with an underlying 18-year nominal tenor, which is typical for solar financing in Taiwan. The debt is arranged as a non-recourse project finance debt, with a structure designed to take into account the specific project risk profile of the solar plant.

Societe Generale played a key role in delivering this financing milestone as mandated lead arranger, technical bank and hedge provider in the syndicate including KGI Bank, Bank Sinopac, E Sun Commercial Bank and First Commercial Bank from Taiwan, and international banks and DBS and SMBC. The project comprises two adjacent sites of 88MWp and 92MWp within an inter-tidal area, which was originally zoned for industrial use, but reallocated to solar. As an intertidal area, the site is partially dry during the day, which has significant advantages for both construction and operation.

The project was financed in April 2020 and the commercial operation date is planned for Q1 2021. The project was developed by Chenya Energy, then owned by I Squared Infrastructure, but Marubeni subsequently acquired Chenya and therefore the project in a transaction that closed in parallel with the financing. The project benefits from contracted revenues in the form of a 20-year power purchase agreement (PPA) entered into with Taipower, covering full volume and price risks, based on a dedicated feed-in-tariff for floating solar assets that is higher than the standard ground-mounted solar tariff.

One of the many lessons learnt from the technical due diligence and project risk assessment for this transaction is that, while the individual components do not appear to be technically complex or sophisticated, one challenge for financing lies in the lack of a standard certification process for the floating structures and the integrated asset as a whole, unlike more traditional renewables.

As a result, a significant part of the due diligence has therefore been focused on the assessment of the durability of the key components, ie, the assessment of fatigue, wear and tear, corrosion, the impact of the saline water and UV impact. The objective was, among others, to determine reliable degradation rates and an operating costs budget relevant in terms of assumptions for the bank base case, and to ensure appropriate contingencies to cope with remaining uncertainties in construction and operation. The following points had to be particularly considered when performing this exercise:

- Maintenance costs (per kW) are now relatively well known for small-scale FPV projects, eg, <10MW. However, the business case here had to factor in the economies of scale that can be expected to apply due to the much larger size of this project. Consequently, to benchmark the operating costs budget against the ones of smaller scale projects was not a sufficient exercise, it had to be completed by further O&M costs assessment and forecast based on the specific project configuration, equipment and size;

- Site conditions have a significant bearing on project costs and operations – in the case of this project, the site is a positive feature as mentioned above. There is here a clear benefit derived from the ability to carry out O&M activities when the tide is out, rather than over water, although anchoring has to accommodate these tidal movements. This compares favourably with floating solar on industrial ponds, lakes or dams; and
- The exposure to extreme weather conditions – as is common for Asian infrastructure projects – had to be carefully considered in the equipment design, the insurance package and the commercial structure, and again anchoring was a key part of this assessment.

These and other very specific aspects of FPV follow through into the financing structure, which in this case was genuinely tailor made to take into account the outcome of the due diligence process; much more so than traditional ground-mounted solar projects. While the specifics of each project will vary, the approach taken on this Changhua project financing should set a template for future financings in the sector.

Finally, the date of financial close, April 2020, is significant. The Covid-19 virus sweeping through Asia during the financing process presented an unexpected further challenge to overcome. In this context, the local supply chain for key components, the extensive due diligence and the experience of the parties, both on the equity and debt side, in dealing with complex projects, were critical factors in allowing the financing to be closed as planned despite the challenges encountered.

As a first of a kind for the project finance banks, detailed monthly construction progress monitoring and subsequent operational reporting will be a key part of validating the due diligence and financing assumptions in order to allow us to inform financing of future projects. We would expect this experience to lead to improving terms for the sector as experience grows, as we have seen in other segments of the market. So far, things are going well – a key milestone for the sponsors and project was the completion of the grid connection in November 2020 as planned. We are extremely pleased to have contributed to this success.

Conclusions

The FPV market has until now been characterised by relatively small developments (10MW or less) concentrated in a few Asian markets (China, South Korea, Vietnam and Japan) but in the last two years, the increasing number of large projects being developed in an increasing number of countries suggests that we are at a tipping point for this industry.

We are now experiencing a clear switch to industry-scale projects, pushed not only by developers but also by public authorities that perceive positively the impacts of FPV in terms of land usage, while the E&S impact of FPV can be considered as very much under control. Floating solar on hydropower dams is expected to enhance the further growth of the FPV market, and to present potential on a global scale.

When it comes to the expected geographical developments, there is clearly, as demonstrated by the World Bank Report, a strong potential for FPV on a global scale. We expect, however, that Asia will play a predominant role in the medium-term developments of FPV, with other markets following not far behind. FPV is a fascinating industry due the significant potential it offers globally, but also due to the project-specific approach required to assess the feasibility and bankability of each and every project, driven by site conditions, accessibility, the regulatory regime applicable to it, and of course the technological choices opted for by the project developers. ■

Footnote

1 Where Sun Meets Water – Floating Solar Market Report (https://openknowledge.worldbank.org/handle/10986/31880)

> The project is financed under a six-year mini-perm scheme with an underlying 18- year nominal tenor