# Maximising PV plant availability

**Asset management |** As one of the biggest utility PV owners in the UK, Foresight has extensive experience of getting the most out of operational solar plants. Its technical director Arnoud Klaren draws on some of the lessons the company has learned from minimising the risks that affect solar projects over their lifetime

Credit: First Solar

As a relatively young industry, the UK solar market is still developing when it comes to solutions on how best and most efficiently to manage asset performance and maximise availability.

For solar asset owners, the challenge lies in how best to mitigate risks that have the potential to impact upon a plant's availability – the amount of time it is able to produce electricity – during its operational lifetime after the engineering, procurement and construction (EPC) warranty. Experience from the field suggests that a simple preventive maintenance scope is no longer sufficient, but by actively looking at further enhancements, we can continue to make significant improvements.

So, as the market experiences increasing consolidation, what precisely are the preventative steps that asset owners should be taking to maximise availability?

Foresight looks at the overall preventative maintenance of plants in four stages:

1. Technical due diligence pre-acquisition
2. Technical due diligence during the two year EPC warranty period
3. Ongoing maintenance after two years defining common objectives for owner and Contractor.
4. Continuing plant improvements that help preventive maintenance measures

**Maximising the availability of PV power plants is a key aim of successful asset management**

## Pre-acquisition

Before completing the acquisition of a new asset, it is imperative to carry out a thorough technical due diligence since this is the last opportunity to identify risks and mitigate them, hence reducing unexpected costs during the operational lifetime. If the asset is still in construction phase, there's a real opportunity to get involved and mitigate risks at an early stage. Alternatively, if involvement happens post-construction there's typically a short timeframe so it's particularly important to have a well-defined process and a dedicated team.

When a thorough risk analysis has been conducted using documentation assessment, multiple site visits, analysis of plant data, laboratory tests and the possible involvement of other third-party specialists, mitigation can be achieved in several steps.

If the risk is deemed too large, it may be preferable to abandon the acquisition altogether. However, if the risk is considered manageable, the second step is to minimise those risks which can often be achieved by proposing changes in the design or equipment, or to the construction process. For example, if a certain inverter brand is known to be unreliable, the parties can reach agreement jointly to switch to a different brand which would reduce the risk of excessive corrective maintenance during the lifetime of the plant.

Once risks have been reduced as much as possible, it then falls to transferring risk to other parties. It is typical in the UK solar sector, for example, to establish a performance and defects guarantee by the EPC backed up with, for example, a retention, where a percentage of the acquisition price is held in an account during the EPC period to guarantee payment of liquidated damages, if applicable. In addition there is always insurance and product warranty. For example, inverters frequently come with a five-year product warranty. After those first five years it becomes statistically more likely for inverter parts to fail, which can be quite costly. This is especially the case when components become obsolete. It will be challenging for the owner to decide at each failure whether it's worth spending money again on a replacement part, or whether it's more economical to have the whole station replaced. To mitigate this risk the owner can try to negotiate a long-term warranty with the manufacturer which transfers these responsibilities and associated risk to the manufacturer while the owner pays a fixed annual fee, reducing risk and assuring more stable returns.

The remaining risk of course has to be accommodated, and is commonly dealt

with through financial budgeting and planning.

This risk mitigating process at acquisition can have an important impact on the operation and maintenance during the lifetime of the plant and can therefore be seen as part of the overall O&M strategy.

## EPC period

The two-year EPC period provides the next opportunity to assure that the plant is fully prepared for a lifetime of reliable operation. This is achieved by reassessing the asset and making sure that it still fully complies with all the contractual requirements of the EPC contract before the EPC warranty expires.

At Foresight, our in-house specialist technical team manages this process where every aspect is reassessed, often assisted by external specialists like accredited laboratories, technical advisers or high voltage specialists.

Questions considered include: are all the plant's data available on the monitoring system? Are the key performance indicators (KPIs) in line with the expectations and guarantees? Are all planning requirements correctly discharged – for example, has the landscaping and ecological management plan been followed up on? With the plant fully operational can we now confirm that the grid connection requirements are being respected, including the actual import capacity and power factor?

Sometimes small findings can be an indication of significant defects. After two years of operation it's not uncommon to find that a few strings have been left disconnected by the contractor. This can easily be dismissed as an oversight, but it can also mean that these strings are causing insulation faults on the inverter. If that is the case it is highly recommendable to check all strings on site for damage since this may be an indication of poor cable installation during construction.

Another example is potential-induced degradation (PID), a technical defect where stray currents in PV modules cause degradation. PID hasn't yet manifested itself on a large scale in the UK but this may be due to the fact that it can take a few years to develop. Whenever it does, it may cause power losses of up to 30% at plant level. It is advisable to take a proactive approach and test all modules before the EPC warranty expires. If PID is detected, a technical solution may be available depending on the plant-specific design, but such a solution is unlikely to recover

**Predicting failures in PV power plants before they occur is one way of maximising availability over its lifetime**

Credit: SMA Solar

full performance of the plant. Furthermore it changes the plant's design, which can lead to changes in its operational regime. If PID is detected, Foresight would take all the above into consideration and engage with the EPC contractor to have a solution implemented that makes the project whole again, either through technical or financial means, or a combination of both.

Any defects that are discovered as a result of this rigorous process are notified to the EPC with the request to be rectified under the EPC warranty. This is crucial because after the EPC warranty comes to an end, the plant will face a lifetime of operation under an O&M contract only. With all defects resolved, we have mitigated the risk of excessive failures during the operational phase, which is why this can also be considered as part of the overall O&M strategy.

## O&M period and plant improvements

During the EPC period, the plant owner is generally covered by a performance ratio (PR) and defects guarantee with the EPC contractor. The challenge now is that since many UK solar assets have seen their EPC warranty period expire, plants are only covered by an O&M contract, often with lesser guarantees and a lower liability cap. This can leave the plant owner much more exposed to operational risks which can lead to more volatile returns.

The main hurdle to overcome when negotiating with O&M contractors is the fact that the owner and contractor have opposing objectives. The owner is looking for the highest possible performance of the plant at the lowest cost, while the contractor is looking to increase his income though additional services and reduce his expenses. So how can it be possible to align the owner and the contractor to ensure they work towards the same goal?

Let's first look at the costs that are incurred whenever there's a failure at a solar plant.

The first cost is related to the labour the contractor spends on assessing and fixing the failure. By assuming this within the scope under the fixed fee, call-outs no longer present a profit opportunity for the contractor. Instead, the contractor becomes incentivised to continue with preventative maintenance to a good standard to avoid costly call-outs.

The second cost is related to replacement parts. Replacement parts can be expensive, and it's also difficult to predict how often parts fail and how their purchase price evolves over time. Contractors would need to increase their flat fee significantly to cope with this unknown risk. By reaching agreement with the contractor that these parts can be recharged without a margin, the owner effectively removes the risk for the contractor but again avoids turning corrective maintenance into a profit centre for the contractor.

The third cost is represented by the loss of production during the failure. Typically this is covered by the availability guarantee offered by the O&M contractor. Although owners may feel protected by this guarantee, it's often the case that many scenarios are excluded from this guarantee, or the associated liquidated damages are low or capped to a low amount. It is only if the contractor feels the financial pain of the outages associated to the failures that he will be fully incentivised to correct the failures as soon as possible. He would also put more emphasis on maintaining relationships with his suppliers to receive replacement parts sooner, receive training from the manufacturer to fix equipment

himself and reduce dependency of the manufacturer's aftersales department, and adequately manage his stock.

Notwithstanding the strategy described above to align both parties, the owner still needs to supervise the contractor's performance. Again, the above-mentioned exclusions from the availability guarantee can cause some discussion between the parties in the case of a failure-by-failure. An example is when O&M contractors are able to claim exclusion on the basis of the grid being unavailable. In this instance, the contractor would want to see proof of this in order to accept the claim, which is achievable by contacting the relevant distribution network operator (DNO). It is hence advised to come to an agreement on a monthly basis to avoid escalation when the annual availability calculation is due, especially when liquidated damages are at stake.

The ideal situation for PV owners would be to eliminate corrective maintenance altogether and maximise the plant's availability over its operational life. One way of working towards this objective is by trying to predict failures before they occur, allowing time for correction before damage occurs.

An example is the use of temperature sensors in transformers. In the early days of solar, such sensors were not always installed which left the transformer exposed to overheating and failure. It soon became common practice to install these sensors which would switch off the transformer automatically in case of overheating. It would be even more useful however, if the temperature values were also logged onto the monitoring system and their evolution over time analysed, it would be possible to predict failure before it happens. Similarly, sensors that detect potential discharge (PD) activity could be used to predict failure in high-voltage equipment.

Finally, if we take a peek into the near future we see National Grid and the DNOs taking an interest in the capabilities of solar plants in providing stability to the grid, for example through the provision or consumption of reactive power. New service opportunities may be implemented to take advantage of these capabilities, which require further collaboration between the owner and the contractor.

With more and more UK solar assets coming out of their EPC warranty, the O&M market is very active with many new contracts being signed. Owners will need to become comfortable with this new operating environment where the EPC warranty is no longer providing overall cover. Both the owners and contractors should consider carefully the approach they want to take, their ongoing relationship and how to cover their operational risks. On top of this the future presents new opportunities, like the ability for solar plants to provide services to the grid.

At Foresight, we believe that there is still scope to improve the maintenance and associated performance and availability of solar plants in the UK and beyond. At the same time the landscape in which solar sits keeps changing, which requires foresight and flexibility from those involved. ■

Author

Arnoud Klaren is Foresight's senior portfolio manager and technical director for UK and Spain. He joined Foresight in 2011 from SolFocus, where he spent four years managing solar projects in Spain, Saudi Arabia and Greece based on concentrated PV technology. Prior to SolFocus he founded and managed ThinkSpectrally, a spin-off company of the University of Valencia in Spain, dedicated to quality assurance in PV manufacturing.