

# The evolution of O&M

**Operations and maintenance** | The effective operation and maintenance of large PV power plants is critical to ensuring these facilities perform optimally. Sara Ver-Bruggen looks at the latest O&M technologies and strategies emerging as plant owners seek to maximise their investment returns



Credit: SunPower.

A multitude of factors and variables impact a PV power plant's levelised cost of energy (LCOE), a metric that accounts for all the costs associated with the build and the operation of any power plant. Planning, design, engineering and construction phases have all seen improvements and refinements over the years as the industry gathers more experience from building more megawatts of capacity. More recently, the falling cost of components – modules mainly – as well as efficiency improvements have contributed to dramatic reductions in the cost of PV-generated electricity.

But, the industry is turning its attention to what needs to be done to ensure plants are kept in the best condition over their operational lifetime so that PV LCOE is competitive with other forms of conventional and renewable energy generation. Getting the most from assets, through regular inspections, cleaning modules, cutting back vegetation or replacing components in inverters, before faults develop, are addressed by the operations and services (O&M) side of the industry.

PV power plants today must operate as reliably as existing, incumbent generation technologies in use for many decades. Jörg Heinemann, executive vice president, global power plants, customer operations and EPC at SunPower, says: "Clients and investors expect PV power plants to behave like conventional power plants." Good O&M strategies and investments are critical to this.

Black & Veatch renewable energy consultant Emily Leslie has reviewed 75-100 utility-scale PV projects in the US in the course of producing independent engineer reports, prerequisites for raising the financing needed to build these large plants. The reviews are carried out once the construction phase is completed and are focused heavily on O&M.

According to Leslie "base" O&M service packages for large and utility-scale PV plants typically include: preventive maintenance for modules, DC wiring, combiner boxes, disconnects, inverters and MV transformers, protective equipment, the maintenance building, mounting structure, civil works and grounds, storage of parts inventory, warranty management, monitoring and reporting, array washing (if any), onsite electricity, telecoms and water.

Leslie says: "About US\$20/kWp is a typical figure for base O&M services but when you add in other variables such as insurance or land leases this can increase to US\$40/kWp or more. If a utility or investor happens to own the land on which the plant will be built then this can reduce O&M costs. So, these figures are general but can vary widely."

## Reactive versus preventive maintenance

Maintenance can be split into two categories – reactive, or corrective, maintenance and preventive, or planned, maintenance. In the wind industry, for example, preventive maintenance forms a large part of O&M

## New strategies and technologies, such as SunPower's module-cleaning robots, are helping drive down the cost of O&M.

packages. If a gearbox breaks down, the resulting downtime from repairing or replacing such a large crucial component can be very costly.

Solichamba Consulting's Cedric Brehaut, who has authored GTM Research study 'Megawatt-Scale PV O&M and Asset Management: Services, Markets and Competitors 2014-2018', says: "In the PV industry preventive maintenance is important, though not as much as in the wind industry because PV plants have fewer mechanical components. But certainly inverters and also trackers – which are the only moving parts in a solar plant – require preventive maintenance.

"Tracker-specific preventative maintenance includes inspection and lubrication of moving parts (such as motors, gearboxes and jackscrews), while corrective maintenance consists of replacing components upon failure (such as drive motors, controller units, bearings, etc.)," says Brehaut. "The amount of preventative and corrective maintenance is highly dependent on the specific tracker make and model, and on the quality of installation."

Inspections are also part of most preventive maintenance plans, and use of technologies like infrared (IR) imaging to detect hotspots in inverters, combiners, and modules, are common practice. "System monitoring and performance analysis are key, and many large plants also require advanced control functions to support the grid," Brehaut adds.

Inverters, which convert DC to AC electricity, are a critical part of any PV plant and faults or breakdowns can directly impact the plant's productivity. Large central inverter cabinets for multi-megawatt farms contain lots of components that need regular checks.

Terry Oswald, vice president, systems performance and operations at Sunpower says: "Inverters, as they are electrical, require lots of IR scanning and torqueing while mounting/tracking systems require regular lubricating, calibrating and torqueing."

According to Florian Danner, managing

director of Conergy Services and globally responsible for the Germany-based firm's service business, central inverters require more preventive maintenance because of their complexity, whereas string inverters tend to demand reactive maintenance; when one goes it is simply replaced. "It's difficult to say which is the more cost-effective approach in terms of O&M as there tends to be cyclical swings between each inverter technology type every two to three years driven by technological improvements. At the moment the trend is going back to central inverters," Danner says.

### Module cleaning

Module cleaning and managing site vegetation can represent a significant portion of maintenance costs but is highly variable between locations, depending on climate. "In the south and south-west of the US, where the climate and conditions tend to be hotter, drier and dustier, then more panel cleaning is needed. In the eastern and north-eastern regions there is more rainfall that tends to keep panels clean," says Black & Veatch's Leslie.

Specific maintenance practices can vary around the world. Much of Sunpower's portfolio in the US can be found in states such as California. Regular cleaning of panels forms a core part of the company's maintenance service activities, so much so that this led to the company's acquisition in 2013 of Greenbotics, which builds robots designed to clean solar panels. The technology is also important as Sunpower targets new markets outside the US, in places such as Latin America, Africa and the Middle East where dry dusty conditions often prevail.

The robotic system uses 90% less water, is three times faster than conventional cleaning and also operates at night for minimal interruption. The system is being installed as part of the Solar Star projects, which are two co-located solar installations in Kern and Los Angeles Counties in California that will have a capacity of 579MW when completed at the end of 2015. The company uses other advanced technology such as drones to identify what portion of the plant needs cleaning and reveal what part of plants need more regular cleaning or vegetation management. This means that SunPower can meet the high performance guarantees that it has in place with its investors and clients.

"The maintenance instrumentation we use feeds into a centralised structure – we do a lot of remote monitoring and despatch technicians to the site where they

are needed. Everything is centralised and scalable for every location," says SunPower's Heinemann.

"However it's important that we not only flag problems and fix them in the field but that we use these to inform development upstream of our technologies. We're on our sixth generation tracking system which has been developed to resolve issues with earlier versions and we also incorporate learning and knowledge gathered from our other operational plants into the ones we are currently building"

Conergy has a portfolio of over 500MW under O&M management, largely in Europe, but increasing globally.

The full scope of O&M activities including maintenance on central inverters is offered by the company in separated service packages. "We will provide module cleaning if it is something that clients specifically require."

For its EPC business, Conergy will only use equipment from tier-one OEMs and suppliers, and carries out regular warranty assessments. "Supplier warranties are key. For central inverters it is a precondition that preventive maintenance is carried out on them. We assess thoroughly per country and service whether to perform the work with our own personnel or contract maintenance work out," Danner says.

Using high-quality products with good warranties from tier-one suppliers means clients can be offered higher performance guarantees for the total park. Danner expects to see this trend continue. "Additionally to high-quality products, O&M plays a key role in sustaining the PV plants' high performance throughout the investment period and beyond, as well as reducing the time of break even."

In the US market PV EPC firms tend also to be the O&M provider for new plants for the first few years matching the initial warranty period, and vertically integrated firms such as First Solar, SunEdison and Sunpower often sign long-term O&M contracts. Other O&M providers include independent power producers, inverter manufacturers and third-party firms also known as independent O&M providers. Some EPCs also offer O&M services for plants they did not build.

"When the initial warranty periods fizzle out and O&M contracts are up for renewal, the asset owner may decide to switch to a different provider. But these aftermarket O&M agreements do not come with the same warranties because an O&M provider is usually reluctant to take on risks related to hardware reliability or plant construction

quality," says Brehaut. In the US a hybrid model has emerged in the last two years. "Some EPCs are partnering with independent providers to perform the O&M work right from the plant's start of operation. This model requires a tight collaboration during the design and construction phase," Brehaut explains.

Last year saw mergers and acquisitions of O&M businesses in the PV industry, such as First Solar's acquisition of Skytron Energy. Brehaut expects the trend to continue. The fast-growing markets are the US as well as Asia-Pacific, in countries such as Japan and in future China, where the installed base of large-scale PV has grown rapidly. "China has not really emerged yet as an O&M market – utilities tend to do the O&M themselves or contract out to the EPC, so for now the US is a key O&M market to watch. Even though the PV market is happening on a global basis it is really a collection of local markets, and this creates strong challenges for providers that attempt to expand their O&M business globally."

How to replicate a successful O&M business and strategy in one market in new ones is going to be important in future. "This is what will continue to drive the M&A trend," Brehaut concludes. "In Europe there is little construction of new utility-scale PV plants, except in France and the UK, so you have many providers fighting over a finite O&M market."

What is certain, though, is that the value of O&M will only grow in the coming years. The solar PV industry has managed to achieve dramatic cost reductions in recent years. In south-western US states such as California, for instance, PV power purchase agreements (PPA) prices are almost as competitive as those of wind. But as the industry takes its next steps as a growing mainstream source of energy, investors have high expectations for these power plants to operate effectively and maximise returns over their 25-year lifetimes. Good O&M approaches, as much as high quality components, plant design and other factors, are going to be critical.

Investing in O&M staff, resources and technologies will enable developers and EPC firms to grow the services side of their businesses in the coming years as this portion of the global PV market grows when more large-scale plants come out of warranty. ■

### Author

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