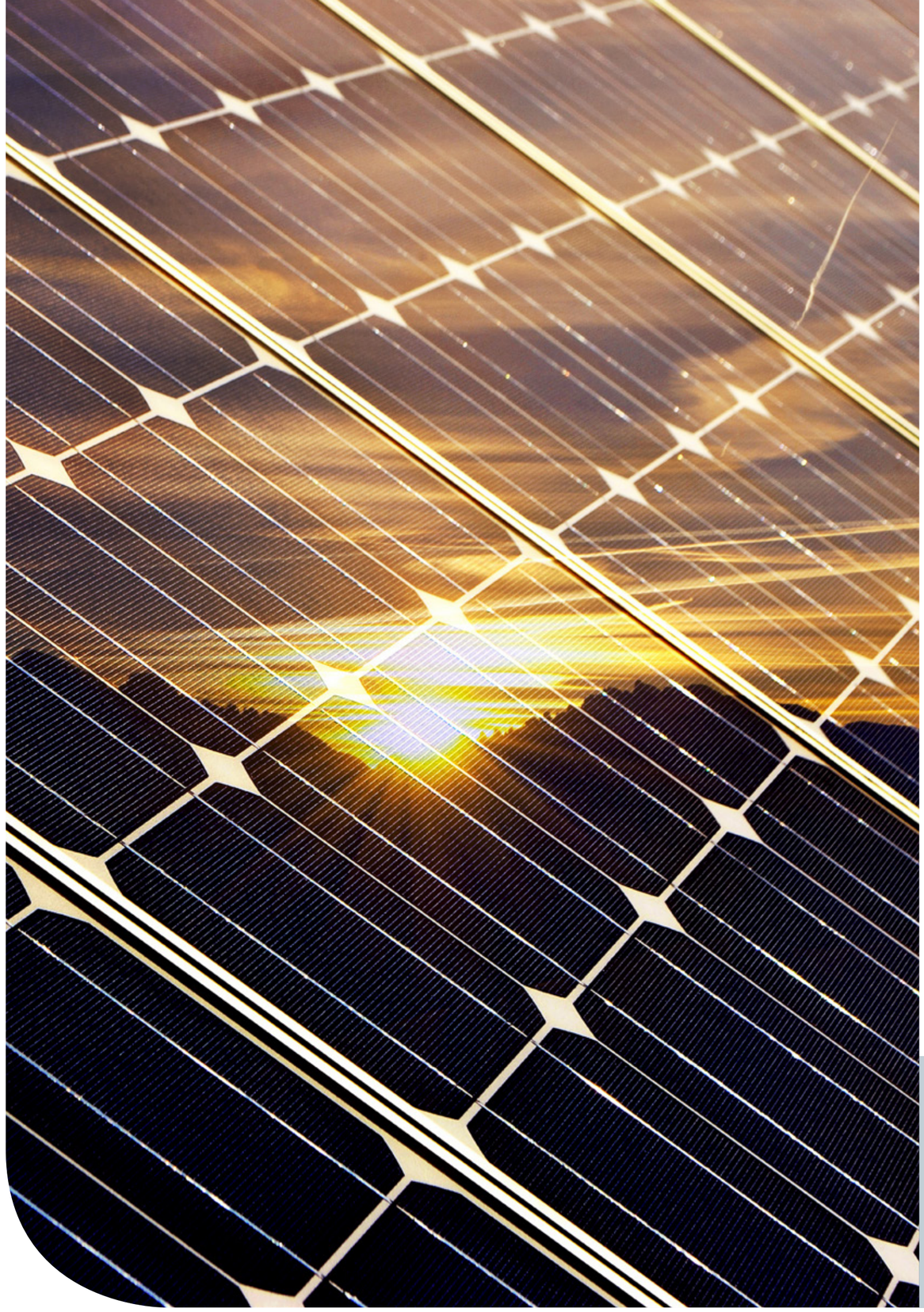
MANAGED SERVICES FOR THE SOLAR ENERGY SECTOR

Solar photovoltaic (PV) panels convert sunlight into electricity and the cost of the power they generate is falling as the technology matures, it is now well below the cost of nuclear and set to fall further. These panels don’t need direct sunlight to work and they can still generate some electricity on a cloudy day. A small PV system may provide energy to a single consumer, or to an isolated device like a lamp or a weather instrument.



Large grid-connected PV systems can provide the energy needed by many customers. In urban areas, PV arrays are commonly used on rooftops to supplement power use, feeding power back into the grid. In rural areas, they may be the sole source of electricity, used to directly power DC equipment or to charge a storage battery. Large PV power stations can cover tens or hundreds of hectares and have outputs of up to hundreds of megawatts. The drive to reduce GHGs and increase the sustainability of power supplies is leading many governments to offer incentives for solar energy to improve the return on investment, with attractive feed-in tariffs available for private installations connected to the grid.

PV cells are made from layers of semi-conducting material, usually silicon. When light shines on the cell it creates an electric field across these layers. The stronger the sunshine, the more electricity is produced. Groups of cells are mounted together in panels or modules that can be mounted on a roof. Each panel is rated by its DC output power measured in kilowatts peak (kWp). This is the rate at which it generates energy at peak performance in full direct sunlight during the summer. The efficiency of a panel determines the area needed to produce the same rated output: an 10% efficient panel will have twice the area of a 20% efficient panel with the same rating. An inverter is used in order to convert the DC output to AC to feed into the grid, which reduces the efficiency further. The biggest challenge the industry faces is to deliver higher efficiencies at affordable cost, and several companies have begun to embed ICT electronics into PV modules in order to optimise performance.

Optimising PV Performance Using ICT

There are a number of systems available for improving the output of solar PV arrays by ensuring that the maximum possible electricity is generated from the available sunshine. These include:

- Solar trackers that tilt a solar panel throughout the day using a technique known as Maximum Power Point Tracking (MPPT). Depending on the type of tracking system, the panel is either aimed directly at the sun or the brightest area of a partly clouded sky. The panel receives more light on its surface if it is perpendicular to the sun's rays, as direct light is used more efficiently than angled light. Trackers substantially increase the power produced by a system in the early morning and late afternoon, but are of little value in cloud or fog. Special anti-reflective coatings can improve solar panel efficiency for direct and angled light, however, this does reduce the benefit of tracking. Trackers and sensors that optimise PV performance are often seen as optional, but tracking systems can increase viable output by up to 100%. PV arrays that approach or exceed one megawatt often use solar trackers.

- Solar Inverters are a vital part of a PV system, there may be one for an array of panels or, in small installations, a micro-inverter for each panel. The inverter will continually monitor the panel's DC output and automatically convert it to AC as efficiently as possible. On the AC side, these inverters must provide a sinusoidal voltage synchronised to the grid frequency, and limit feed in voltage to no higher than the grid voltage. The inverter must disconnect from the grid if the grid voltage is turned off. AC output may be connected through a meter that must be able to run in both directions. In some countries, for installations over 30kWp, a frequency and a voltage monitor is required, with the ability to disconnect all phases if out of specification.

- Power optimisers are used in some solar PV systems, a DC-to-DC converter technology developed to maximise the power harvest. These, when connected to a panel with the right features, can also compensate for the effect of shadows by allowing the unshaded cells in a panel to continue to generate power while part of it is shaded.

A commercial PV system represents a significant investment for the system owner. This investment needs to be recouped over time by maximising energy production and using ICT can help to achieve this.

Pacific Controls Managed Services for Solar Power Generation

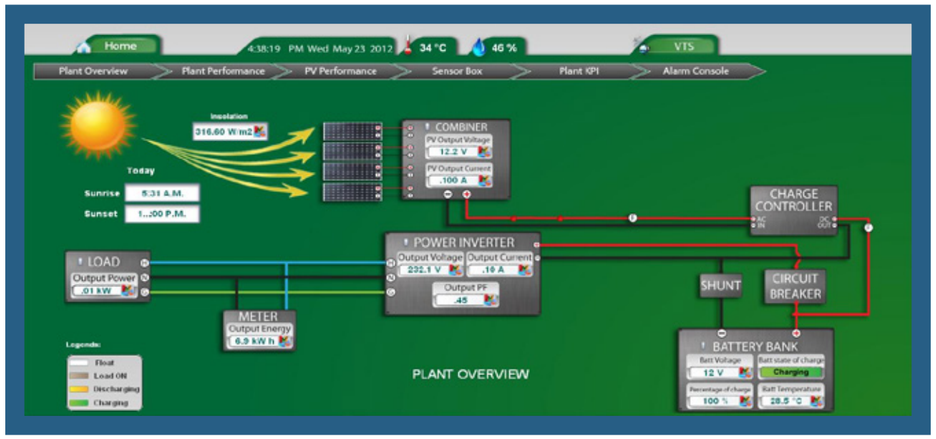
Monitoring PV systems is essential to achieve maximum energy production and to detect breakdowns. Using Pacific Controls Managed Services for Critical Assets Monitoring to monitor and control PV panels allows the use of MPPT, monitoring and fault detection for each module individually. Pacific Controls managed services will alert staff quickly to system outages or underperformance. Data monitoring tools are also essential to capture historic production data,

and to produce verifiable data to qualify for payments from renewable energy schemes such as REC payments. There are several possible strategies depending on the output of the installation and its nature:

- Monitoring can be performed on site or remotely.
- It can measure production only, retrieve all the data available from the inverter or retrieve all of the data from a range of sensors connected to the system.
- Monitoring tools can be dedicated to supervision only, or offer additional functions such as managing trackers.
- Individual inverters may use proprietary monitoring protocols and software. Pacific Controls data acquisition system can monitor multiple inverters, whatever the protocols, and also acquire weather-related information.
- Energy metering supplied with the inverter may be of limited accuracy and not suitable for revenue metering purposes. Pacific Controls smart meters can measure the total energy production of a PV array system.
- Separate measures such as satellite image analysis or a solar radiation meter (a pyranometer) can be integrated with the monitoring system and used to estimate total insolation, which is important for calculating efficiency.
- Sunlight can be absorbed by dust, snow, or other impurities at the surface of the module and this can reduce output by as much as half. There is now an electrostatic system available to remove dust and this can be managed remotely using Pacific Controls system.

Solar PV suppliers can offer their customers wireless monitoring systems using Pacific Controls cloud computing service so that owners can check the performance of their PV array using a web browser from any location. This is valuable both for commercial solar power stations, which need to maximise returns and for residential users who wish to check performance from their living rooms.

The system includes the data monitoring module, which is installed on site, and provides user access to the PV panels performance information from any location on a password protected website. The system offers more information



Solar power plant monitoring system

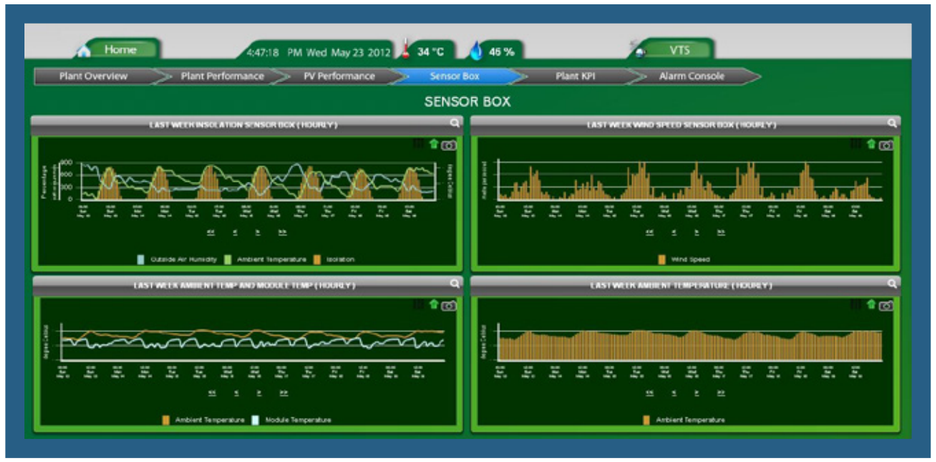
and flexibility than a stand-alone data logging meter and communication interface, but also without the cost and inconvenience of installation and maintenance of a separate metering system.

Small residential systems may have minimal data analysis requirements other than total energy production; larger grid-connected power plants can benefit from more detailed investigations of performance

Pacific Controls Managed Services for Critical Assets Monitoring integrate both the PV solar system and inverters for all installed PV systems in a global portfolio from any location. It carries out performance analysis using advanced data mining techniques and artificial intelligence, combining the panel data with that from external sensors such as pyranometers and provides proactive and predictive FDD.

Benefits for Solar Panel Manufacturers

Using Pacific Controls Managed Services for Critical Assets Monitoring, solar panel manufacturers can offer their customers monitoring and management services to ensure that solar PV installations are generating power whenever there is sunshine at their location.



Performance monitoring and trends analysis

Benefits and ROI studies

They can offer predictive maintenance services to minimise downtime. The service operates through a single interface that connects all the PV panels deployed globally allowing them to analyse data across their whole portfolio. This allows them to have an on-going relationship with panel users and provides a central data depository for analysis that will enhance R&D.

Benefits for Solar Panel Owners

Connecting solar panels to Pacific Controls ICT Enabled Managed Services For Business Process Integration optimises every step of solar PV generation. Efficiency monitoring ensures that the panels are tracking the sun, the inverters are operating at peak efficiency and that there are no losses from module mismatch or undervoltage operation. Users can also predict the power likely to be generated in the future, based on past performance and weather forecasts.

Pacific Controls advanced FDD capabilities ensure that potential faults are identified before they occur and that problems are dealt with in a timely manner. The systems will have higher uptime and users will be proactively notified of any deterioration in performance.