SUCCESS STORY

SOLAR ELECTRIC PHOTOVOLTAIC SYSTEM

Solution for monitoring and control of Solar PV farms down to the string level with PcVue.

A performance monitoring system is very important to a solar electric photovoltaic (PV) system. The monitoring system must account for the amount of energy produced in real-time to be sure the system overall conversion efficiency remains intact over time and enable immediate response to any event that degrades the PV system performance.

We are all familiar with our residential electric meter used by the utility company to record and bill us monthly the kilowatt-hours consumed. Over the course of a year, these bills can be compared to determine monthly consumption. While this scenario illustrates usage consumption, it is different for monitoring production with PV systems.

A meter is also used to measure the energy produced but, instead of a monthly basis, we are interested in the amount of energy produced during short time intervals – perhaps every hour or every 5 minutes. The recording frequency requires more sophisticated meters than the residential ones called data loggers. Data loggers feed data into a memory system that can be archived for use at a later time. They also have communication interfaces, which allow a computer to connect to it and retrieve the data.

Most electric utilities in the United States have adopted standard criteria and guidelines for interconnection of distributed generation (DG) to their electric distribution systems. Photovoltaic system installations effectively reduce the customer load and, during minimum loading conditions, may export energy back to the utility in a transaction known as “net energy metering” (NEM). A set of guidelines (IEEE P1547.6) were recommended by the Institute of Electrical and Electronic Engineers (IEEE) to PV system integrators to support them designing systems operable in parallel with the utility systems.

Advanced SCADA (Supervisory Control and Data Acquisition) software find ideal application to support the operation of an electric utility. Automation sequences usually managed by means of SCADA system include: fault detection, localization, isolation, and load restoration (FDIR). These sequences will detect a fault, localize it to a segment of feeder, open the switches around the fault, and restore un-faulted sources via the substation and alternative sources as available.

SCADA implemented algorithms work to safely minimize the fault duration and extent, significantly improving the SAIDI (system average interruption duration index) and SAIFI (system average interruption frequency index) performance metric for the customers on those feeders. An additional important sequence is the automatic check of equipment loading and thermal limits to determine whether load transfers can safely take place.

Modern SCADAs communicate using standard protocols like IP and secure Ethernet LAN system, which provides significant improvement over a serial system, including supporting peer-to -peer communications, multiple access to tie switches, and simplify remote access by communications and automation maintenance personnel. Benefits to manage distributed generation include: higher efficiency; improved security of supply; improved demand-response capabilities; avoidance of overcapacity; better peak load management; reduction of grid losses; network infrastructure cost deferral; power quality support; improved reliability; and environmental monitoring.

BUSINESS OBJECTIVE

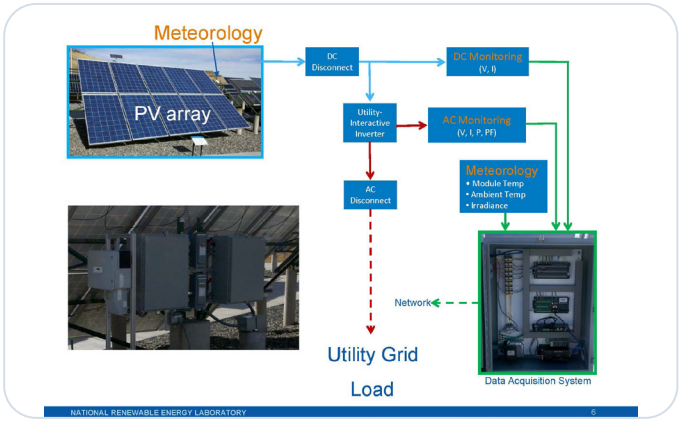
- Understand Maintain PV system conversion efficiency
- Respond immediately to any degradation of system performance

SCADA based applications offers extraordinary value because they provides a flexible range of combinations and customizable configurations that provides a balance between cost and reliability.

Distributed generation is considered a more desirable generation asset because it is “closer” to the customer and is more economical than central station generation and its associated transmission infrastructure.

While the disadvantages of distributed generation are in the electric utility perspective awkward remote operation, fuel delivery logistic (for combustion engine based distributed generation), cost of connection, dispatching, and production forecasting (wind and solar related), the SCADA system helps to offset such costs through automation, remote, real time monitoring capabilities.

PV systems monitoring due to the volatility of solar radiation at ground level, which is mainly due to atmospheric turbulence, stress SCADA real time capabilities requiring a fast sampling pace (5 seconds or less) of main physical variables.



As designer of PV plants monitoring systems Staer Sistemi, conducted tests on many industrial SCADA meeting requirements as fast sampling speeds, flexibility, scalability and ease to use and programming, selecting PcVue of ARC Informatique. This choice allowed designers to be confident to effortless manage data streams in the range of several thousand measures per second and concentrate on the most specific aspects of the application. PcVue capabilities allow monitoring and controlling of all the various plant component and subsystems operations, including trackers, inverters, grid substations and meters.

The PcVue based system logs any problem and triggers alarms so that the engineering staff can fix or change components or fine-tune the process of plant operation.

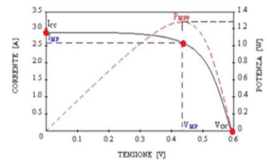
The automatic comparison between the calculated and the real production figures (supplied by the data logger) provides a precise indication of the plant performance or plant health every minute or less.

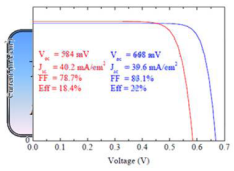
Today monitoring and performance analysis of solar PV plants has become extremely critical due to the increasing cost of operation and maintenance as well as reducing yield due to possible performance degradation during the lifecycle of the plant equipment.

Staer Sistemi PV model: algorithm

Model parameters ($I_{L,REF}$, Rs, γ, $I_{0,REF}$) are processed to obtain:

1. **(Voc, Isc, Vmp, Imp) in three point of I – V curve**
2. **Temperature coefficient (μ_{ISC}, β_{VOC})**
3. **Panel Power at STC**
4. **Cell Temperature at STC**
5. **Irradiance at STC**





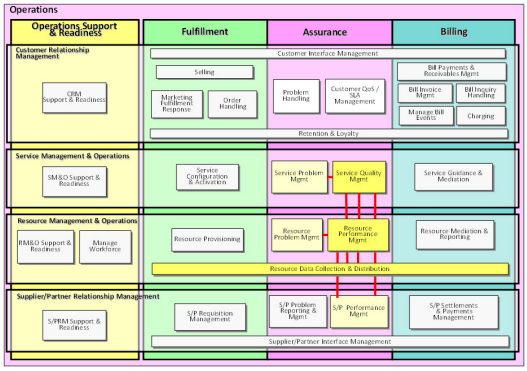
- **An autocalibration by means of retro-tuning of builder parameters is performed to enhance model accurancy**
- **Influence of Temperature on Voc, Isc, Iph is high**

This means that the use of a monitoring system can become essential to ensure high performance, low downtime and fault detection of a solar PV power plant during the entire lifecycle.

At the AC level, inverters expose RS485, CAN or Ethernet ports to allow a simple connection using the native communication drivers from the SCADA. PcVue support a large collection of standard protocols to manage any kind of inverters.

All data collected are augmented by the SCADA system with a time stamp for real-time processing: alarming and displaying, trend analysis and storage for reporting activities. The SCADA capabilities are further used in monitoring of grid protection relays, energy meters, weather monitoring station/sensors, LT (low tension) and HT (high tension) control panels, DC Switches, transformers and in general any devices capable of affecting - directly or indirectly- plant production.

Additionally, to make PV management applications as effective as possible, its important take into consideration other aspects of the SCADA applications features in order to support plant operations.



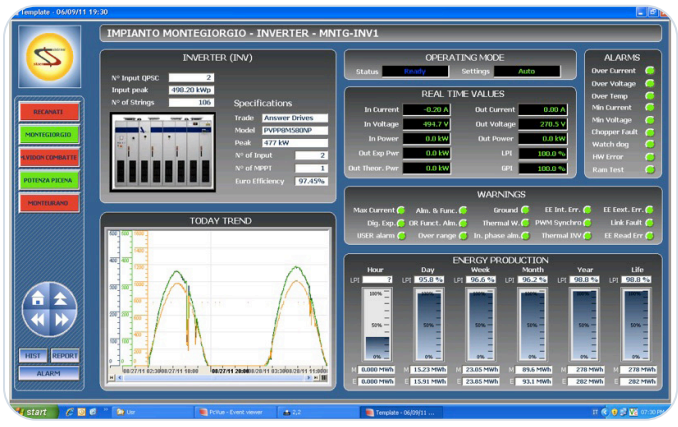
Performance Management scope tmforum

PcVue as an example, provides dynamic configuration, stand-alone and client-server and web configurations architectures, redundancy, historical and real-time trends analysis support as well as advanced alarm management.

Looking further at compliance, the support of such protocols as IEC 61850 and DNP3 enable communications with various electric sub-station devices, which becomes essential when the local electrical utility is engaged in Smart Grid implementation.

User-friendly graphical interface with 2D and 3D displays, scheduler, and an event-driven engine all make the management processes much smoother.

Finally, web access capabilities provide mobility and access to remote devices to make PcVue the SCADA of choice for PV Monitoring.



KEYS TO SUCCESS

- Fault detection, localization, isolation and load restoration (FDIR)
- Minimize fault duration and extent while maintaining safety
- Improve SAIDI and SAIFI indices for customers on the feeder
- Monitor equipment loads and thermal limits to enable safe load transfers
- Scalable to several thousand measures per second with capability to automatically filter to most critical aspects of the system
- Monitor and control trackers, inverters, grid substations and meters
- Log operations and provide alarms for maintenance and fine-tuning of plant performance
- Track real-time production versus predicted production and provide real-time performance metrics

RESULTS

Conversion efficiency

Security of supply

Power quality

Reliability

Peak load management

Demand response capability

Environmental monitoring capability

Over capacity

Grid losses

Network infrastructure costs

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