SATEC
Powerful Solutions

APPLICATION NOTE

PROFIT-EFFECTIVE MANAGEMENT OF RENEWABLE ENERGY

Renewable energy is gaining increased popularity and interest, expressed both in government financing and in investments from the private sector. Of the incentives driving this interest, one emerges from financial needs, influenced by today's unstable prices of fossil fuel. This drives the public and private sectors in search of alternative, reliable and affordable energy sources. The other being environmental awareness, which slowly but surely has become a cause for successful lobbying in government, politics and finance.

Two of the prominent methods for generation of electricity in methods referred to as renewable energy are solar power and wind energy, harvested by wind turbines.

The design of such systems, which are ultimately geared towards the income made off the energy generated and sold, often neglects, or overlooks, important aspects which help determine the ROI and, more importantly, the general profitability of these systems.

Among the parameters which considerably affect and reduce profitability and revenue are:

1. Inferior power quality introduced by the grid/utility (e.g. harmonics)
2. Erroneous utility readings
3. Failure of equipment
4. Failure to utilize systems at maximum capacity

With over 30 years' experience in power engineering in the different fields of energy metering and power quality SATEC has risen to the challenge of designing tailor-made solutions for renewable energy applications.

Implementing its advanced power meters and power quality analyzers, SATEC is a supplier of solutions for renewable energy projects such as the Siemens *GAMESA* (Spain) wind turbines and the *Sinovel* (China) wind turbines and for the *Perovo* solar park (the Ukraine), EDF (Electricity de France), IEC (Israel Electric Corporation) and Suzlon.

The SATEC system includes several functionalities, corresponding with the challenges mentioned.

Independent and Accurate Metering System

Utilities often process erroneous calculations, overcharging for miscalculated imported energy and miscalculating energy exported to the grid, resulting in partial crediting. Placing at the connection to the grid a high-accuracy (Class 0.2S), reliable, non-biased, revenue-grade meter guarantees supervision over the utility's energy billing and purchase.

Likewise, accurate metering has a direct impact on revenue: In financial terms, for a 1000 kVA transformer, operating at 80% load, 0.9 PF, with electricity purchase at a typical USD 0.15/kWh, the resulting difference between the allowed error for a Class 0.5 meter and a Class 0.5S reading using SATEC *HACS* (High Accuracy Current Sensors) would translate to USD 9,461 annually (!) (for details, please refer to SATEC's Accuracy Class application note).

Positioning energy meters at as many as possible junctions of energy production (individual wind turbines or grouped PV cells; see diagram) enables performing a comprehensive energy balance for the whole system by detecting and singling out energy leaks along the internal grid.

This comes as opposed to methods at which partial metering results in reliance on "virtual" calculated meters which won't necessarily detect or locate energy leaks.

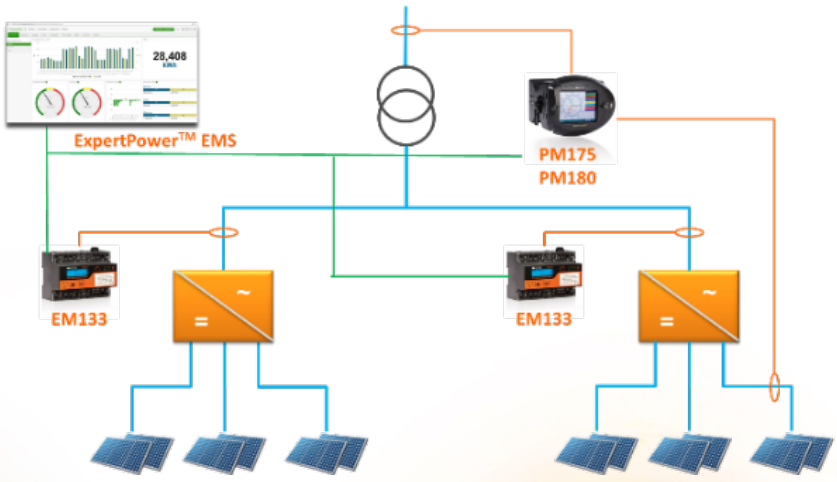
Power Quality

Positioning at the grid connection a SATEC Power Quality Analyzer, combined with the functionality of a revenue grade meter, such as the EM720/PM180, ensures a triple upshot:

1. **Power Quality Analyzer**: for detection of upstream harmonics and other power quality problems (outages, sags, swells etc.) which harm equipment and hamper production.
2. **"Check meter"** functionality against utility financial energy balance, as discussed above.
3. **Internal energy balance** checkpoint, as discussed above.

Improved System Reliability via real-time monitoring of operational parameters

SATEC system architecture



Integrated into an EMS (ExpertPower™, below), the metering points mentioned allow for real-time monitoring of voltage and current measurements and accordingly, real-time monitoring of system capacity.

This pervasive monitoring is also the way to ensure operational reliability:

The implementation of photovoltaic cells delivering DC power normally requires the installation of AC inverters at a certain ratio dictated by the inverter's rating. Inverters are designed to work above a certain voltage, under which they will shut down. Likewise, if they sense that the utility's grid frequency is even slightly out of sync – they will shut down.

Positioning at each such inverter a SATEC EM133, communicating with the central ExpertPower™ energy management system, ensures that alerts will be sent out in case of inverter shutdown, and in case of downstream harmonics, flagging inverters which are malfunctioning.

Positioning a power quality analyzer at the grid connection can also allow a producer to claim compensation from the utility for loss of production due to such shutdowns of inverters, imposed by irregular grid frequency or other power quality issues.

System Accuracy

The inverters mentioned, although equipped with basic functionalities of power metering, provide readings which are often far from accurate, starting at 2% for ideal loads, running through a typical 5% permissible error, reaching at times up to 50% permissible (!) error. The above data is non-biased and is stated in the inverters' handbooks.

Score Card

	Today	This week	This month	This year
Energy				
Solar Production	469 kWh	17501 kWh	37720 kWh	1170231 kWh
Import from Grid	441 kWh	14853 kWh	31194 kWh	1377048 kWh
Export to Grid	379 kWh	11237 kWh	24393 kWh	439334 kWh
Total Consumption	531 kWh	21117 kWh	44521 kWh	2107945 kWh
Avoided Emissions				
CO_2 (1,536.8 lb/Mwh)	720.7592	26895.5368	57968.096	1798411.000
CH_4 (115.41 lb/Gwh)	0.0541226	2.0196154	4.352888	135.0446574
N_2O (18.09 lb/Gwh)	0.00848421	0.31659309	0.6823548	21.16947879
$ Savings				
Solar Energy Consumed	$14.85	$1033.56	$2198.95	$120608
SREC Income	$660	$11880	$25080	$772860
Total savings	$674.85	$12913.56	$27278.95	$893468

System Efficiency

Furthermore, A solid metering network ensures monitoring the real-time performance of a system vs. its optimal capacity which will often be hampered by equipment in need of maintenance, dirty solar cells and so forth.

Exceptional Accuracy in Frequency Readings

There is a reason for SATEC being implemented in all GAMESA hybrid parks. The nature of the complicated integration of wind, solar and battery-stored energy into the utility grid requires rigorous monitoring of readings coming from all energy sources, and of the grid frequency at which the AC power is introduced. This monitoring requires a standard of accuracy which delivers reading resolution down to 0.001 Hz. SATEC takes pride in owning a unique power quality analyzer – the PM180 – which is a truly rare breed in answering to this requirement.

ExpertPower™ Energy Management System (EMS)

Installation of all the above metering points and functionalities will not be complete without integration into a smart system, providing analysis and alerts. This is where ExpertPower™ comes in.

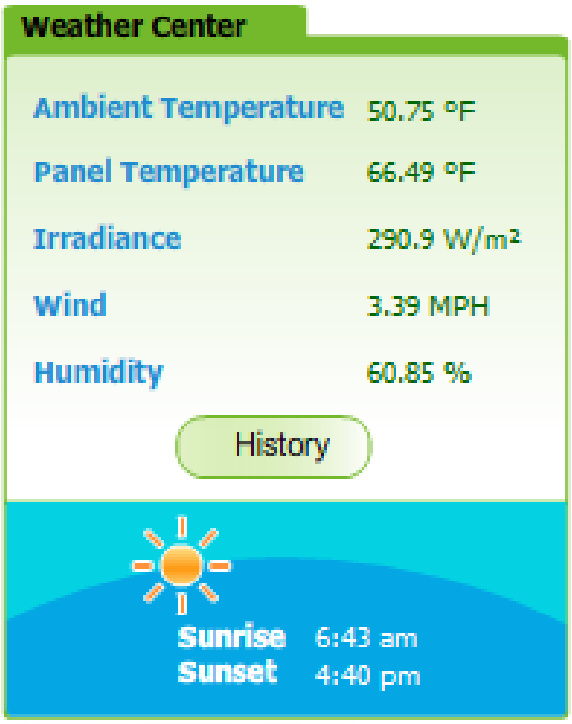
A product of years of development for users from an array of sectors, from power plants to distribution utilities, ExpertPower™ is a browser operated platform for real-time data collection and analysis, for any energy system. Interoperable with equipment of any make it is adapted and well-used with renewable energy production as well.

Real-time financial data

The combined system (metering and EMS) allows the monitoring of real-time data regarding immediate and accumulative saving in energy, money and carbon emissions.

User Specified Information Control

ExpertPower is designed to be viewed and utilized by a variety of users with different access levels. While some users might have full access to full critical/operational data such as alerts regarding equipment malfunction, maintenance and system efficiency, other users may be restricted to designated information, such as energy production.
The system is modular and extremely flexible in its settings.



Forecasting Energy Production

Monitoring system data enables predicted energy production based on system capacity, efficiency and weather forecasting. Production forecasting is extremely important for energy retail.

Conclusion

With profitability and ROI being decisive factors in justifying renewable energy projects any factors such as those described above must be addressed when designing and integrating a SATEC control system which will promote your energy production facility to the level of a true profit center.