

SUNPOWER™



**4th International Renewable Energy
Smart Inverter Communication Workshop
Lars Johnson**

December 6, 2010

SunPower 2010 – 25th Anniversary

- 2010: Revenue \$2.15-\$2.25B
- 5,500+ Employees
- 550+ MW 2010 production
- >1.5 GW solar PV deployed
- World-leading solar conversion efficiency
- Diversified portfolio: roofs to power plants
- 1,500 dealer partners, #1 R&C USA
- 5 GW power plant pipeline



Residential



Commercial



Power Plants



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Residential Monitoring

Solar Panels

Monitoring

SunPower monitors every internet-connected system to ensure optimum performance. Homeowners can view their system data on our monitoring website.

Electric Meter

Primarily monitor kW

Inverter

Commonly serial communication interface.

SunPower Monitoring System (SMS) Overview

§ Hardware

- Commercial

 - § Various Configurations

 - Cellular connectivity in Better/Best
 - MET station in Best

 - § New Low Cost Data Logger

- Residential

 - § SMS 1.2 HW supported

§ Software

- CVAR + Residential systems in same UI
- Reports, Alerts, PDP support
- Dealer contact info visible to customer
- US + EU markets



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Power Plants

Groundbreaking	Name	Market	MW
2004	Solar Bavaria	Germany	10
2006	Serpa	Portugal	11
2007	Nellis Air Force Base	Nevada	14
2008	Olivenza	Spain	18
2009	Florida Power & Light	Florida, U.S.	35
2010	Montalto di Castro	Italy	85
2010	Xcel Energy	Colorado, U.S.	19
2011	Pacific Gas & Electric	California, U.S.	250

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SunPower Power Plants



Nellis AFB, Las Vegas, NV
14 MW SunPower T0/T20 Tracker



Bavaria Solar I&II, Germany,
10 MW SunPower T0 Tracker



Tinajeros, Spain
12 MW SunPower T0 Tracker



Olivenza, Spain
18 MW SunPower T0/T20 Tracker



Serpa, Portugal
11 MW SunPower T0 Tracker








FPL Desoto, Florida,
25 MW SunPower T0 Tracker
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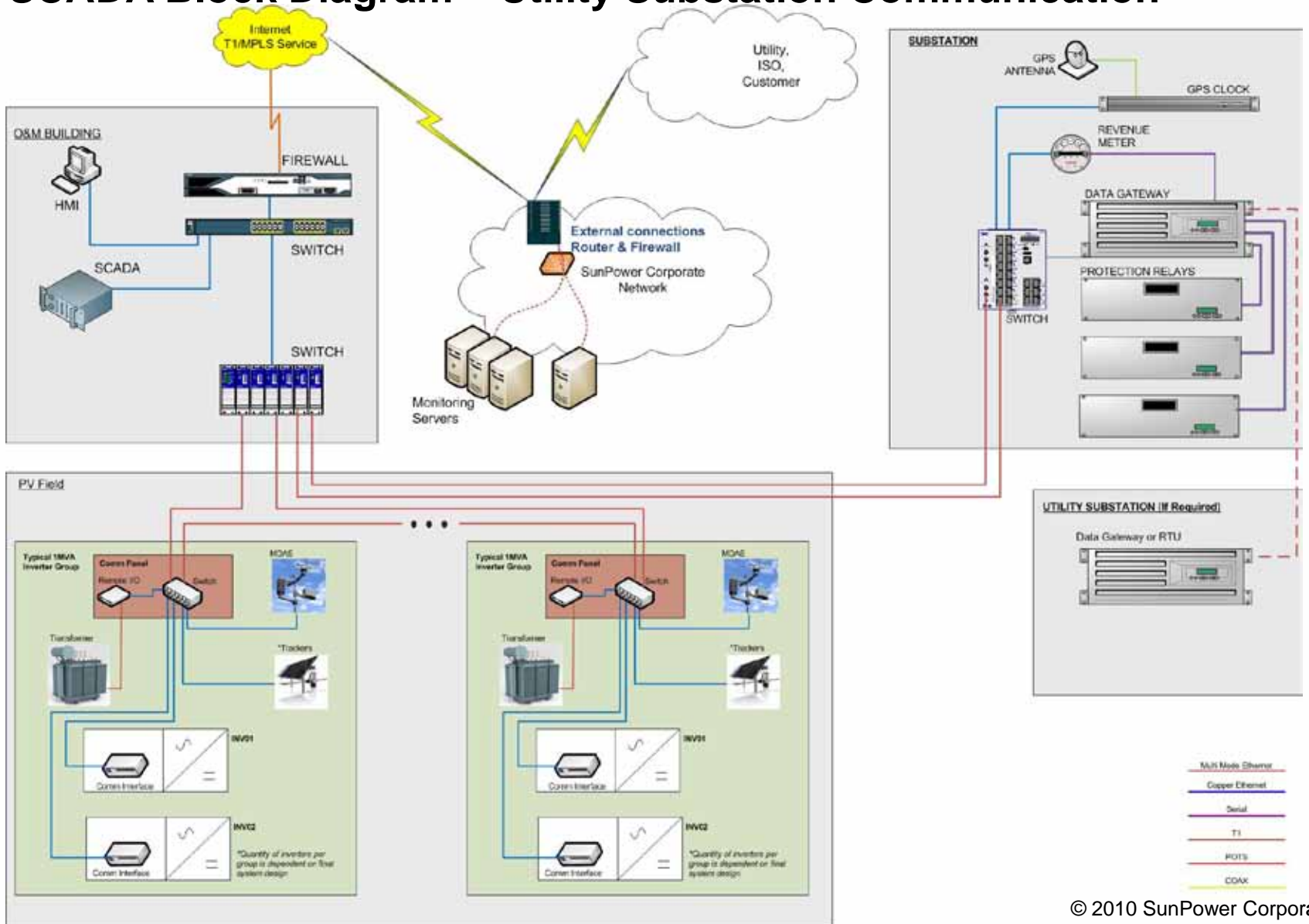
Standard SunPower SCADA Features

Feature	Description
HMI – Human Machine Interface	A set of graphical screens that allows the operator to easily navigate to devices: <ul style="list-style-type: none"> üSingle Line & Substation üInverter Level üMeteorological Data üControl Execution
Onsite and Remote Data Storage	<ul style="list-style-type: none"> ü3 years of storage locally with Raid1 backup üDisaster recovery systems üAutomated backups on Network Attached Storage (NAS) üMirrored data via the PI Historian üDevice level memory for revenue meters and Meteorological data loggers
System Access	Secure Access through VPN tunnel, Remote Desktop Protocol, and HTTP pages
Alarms & Events	System Operator receives alarms and events locally in HMI System Operator received alarms and events remotely via Email and SMS
Trending & Reporting	Ad hoc displays of system data for performance analysis Regular reporting of daily, monthly ,and annual production
Plant Control	Operator control of Inverters, regional ancillary services. (if necessary)

What does the Standard SunPower SCADA Monitor?

Monitored Equipment		Description
	Inverters	<ul style="list-style-type: none"> •Major inverter parameters such as AC and DC voltages and currents, operating status, temperature, faults and alerts
	Meters	<ul style="list-style-type: none"> •Revenue Meters: kWh, Voltage, kVAR •Tie-in Meter at Substation: still being developed by Terna for Montalto Substation
	Meteorological System	<ul style="list-style-type: none"> •New MDAS product provides high accuracy, industry standard sensors •MDAS provides reliable storage of mission critical data with power backup •Data used for performance guarantees and system validation
	Switchgear & Transformers	<ul style="list-style-type: none"> •Operational and Alarm status monitored •Control of breakers optional – adds additional cost
	Auxiliary Equipment	<ul style="list-style-type: none"> •Distribution Panels and UPS status monitored •Additional equipment monitoring can be considered at additional cost, but approach is not recommended since it adds significant cost to do custom integrations

SCADA Block Diagram – Utility Substation Communication



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Power Plant Existing Inverter Communication

- § Integrated with many protocols, but desire to reduce this list
 - ModbusTCP, ModbusRS485, OPC Servers, Various inverter proprietary communications, etc.
- § Scan Times
 - 1 sec desired, 10 sec acceptable.
- § Monitoring
 - DC Voltage, Current, Power
 - AC Voltage, Current, Power, Hz
 - Inverter Status, Alarms, Runtime counters
- § Control
 - Remote Inverter Stop / Start
 - Ancillary Services as required by LGIA or other utility requirements

Power Plant Desired Inverter Communication

- § Standard industry communication interface from project to project
 - Consistent data mapping implementation.
 - Standard, but allow for future enhancements. Tricky.
- § Fast interface to local host e.g. SCADA, Plant Controller, Data Logger
 - 1 second monitoring (Reading of values)
 - 100ms or better (Writing of setpoints). Inverter may not respond within 100ms, but it will initiate action within 100ms of receipt of command.
- § Event Log
 - Rolling time stamped FIFO (First In First Out) log of disturbances or inverter faults. What caused the inverter to trip offline?
 - This would require a time synchronization capability
- § Standard implementations for curtailment, reactive power, etc control
- § Security

Difficulties Seen with Proposed Protocol

§ In Residential and Commercial systems,

- SunPower has already created the inverter communication interfaces to inverters. The work has already been done.
- 61850 and DNP3 protocols are more complicated and will take more time and effort to implement in the SMS datalogger.
- What is the value of supporting new protocols?

§ In large power plants,

- We use off-the-shelf industrial automation hardware and controllers. Will off the shelf hardware support this new protocol?
- Documentation, configuration, testing, and site commissioning maybe more complicated related to inverter communications when compared to other protocols. However, after first deployments, may be easier.

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