



PhotoVoltaic Plant Monitoring Solution



November 2010

Overview

- Integrated solution for monitoring, control and management of Solar Parks
- Features
 - Support of multiple and geographical distributed Photovoltaic (PV) plants through a common control center in real time
 - Production/interconnection monitoring – Performance measurements
 - Alarm detection - Operational failure diagnosis
 - SMS/email notification
 - Security and access control - CCTV integration
 - Historical data statistical analysis & presentation
 - Provision of integrated reports
 - Support of solar park equipment from multiple vendors



Total Control

A lot more than inverter monitoring:

Production Elements Monitoring
(Strings, Inverters)

PCC Elements Monitoring
(Substation, Transformers,
Protection Devices, Meters)

Weather Measurements
(Solar irradiation, Temperature, Wind, ...)

**Performance Measurements,
Real Time Failure Diagnosis**

Management of Supportive Electromechanical Equipment (pillars, shelters, ...)

CCTV, Access Control (RFID), Perimeter Control (infrared beams)

Problems solved

- Varying networking options
- Varying mix of data / video
- Manual or Semi-automatic data collection
- Manual or Semi-automatic compilation of data
- Limited capability to produce reports
- Difficulty to justify penalties
- Different inverters
- Different inverter models
- Different e/m equipment
- Different protocols
- Different access control
- Different topologies
- Different alarm systems per epc / partners / country / area
- Huge data sets

System Benefits

Production monitoring	<ul style="list-style-type: none">• Readily detects failures and performance degradation to minimize equipment/park downtime or underperformance and to maximize profit• Records the energy finally sold to the utility & the actual revenues• Provides on-line performance measurements
Grid inter-connection monitoring	<ul style="list-style-type: none">• Identifies problems originating from the utility provider• Monitors the output power quality characteristics
Security & safety	<ul style="list-style-type: none">• Secures the solar park perimeter and shelters• Allows the entrance to certain solar park facilities only to accredited personnel and monitor their presence• Readily detects fire and flood conditions in the solar park shelters or pilars

Vendor Independent

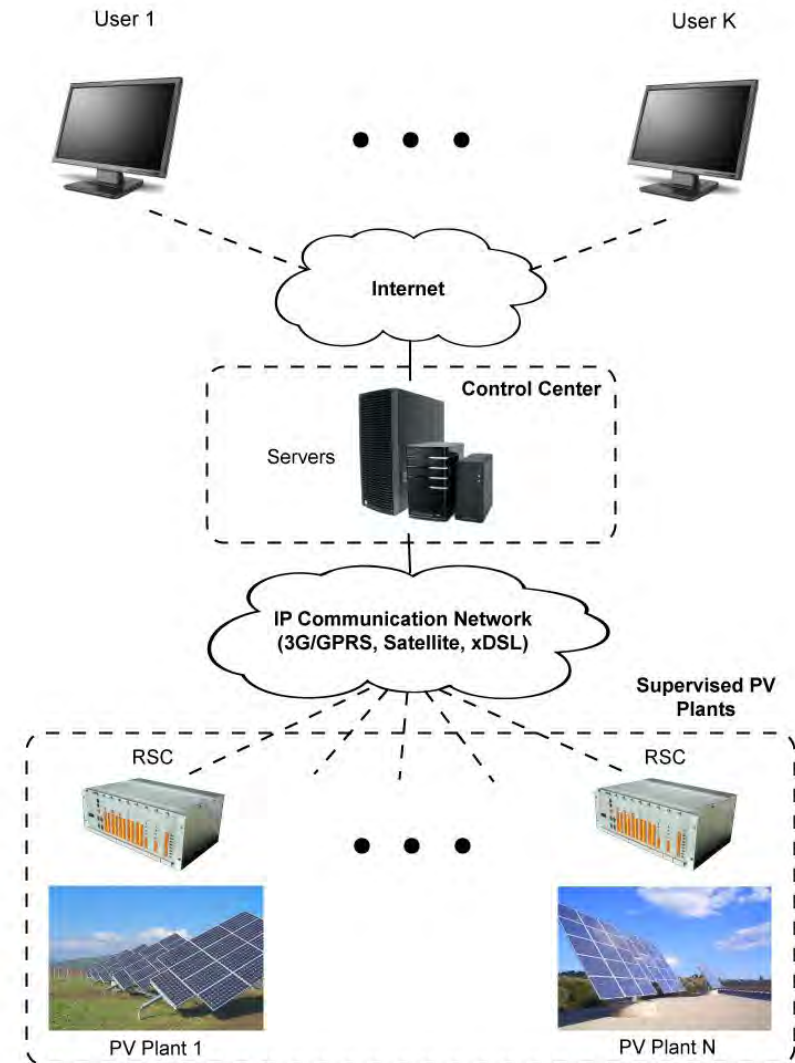
Support of solar park equipment from multiple vendors:

- Inverters
- Power Meters
- Protection Devices
- Meteorological devices
- Various Sensors
- Other E/M Equipment



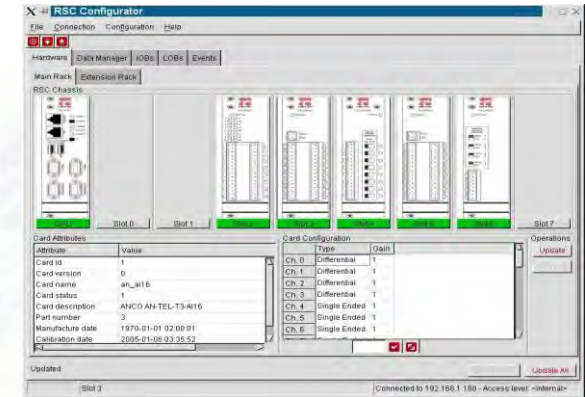
System Architecture

- **Control Centre (CC):** operator platform for managing all PV Sites
- **Solar Park Subsystem:** all peripheral monitoring and supervising systems (controller, sensors, cameras etc)



Solar Park subsystem

- RSC10: The intelligent Remote Site Controller
 - Embedded Linux operating system
 - Advanced control platform adopting modular application structure
 - Extensive control logic library tailored to solar park management
 - Network transparent control architecture with full networking and TCP/IP support
 - Native support of several field instrumentation buses including Modbus, Lonworks, BACnet, and EIB
 - Remotely managed software
- Sensors, actuators and measurement devices



Control Center

- Centralized management of all connected solar parks
- Based on web technologies
- Multilingual portal accessible over internet / intranet
- Database support for historical data
- Capability for SCADA connectivity
- System management tools
- Main and backup servers

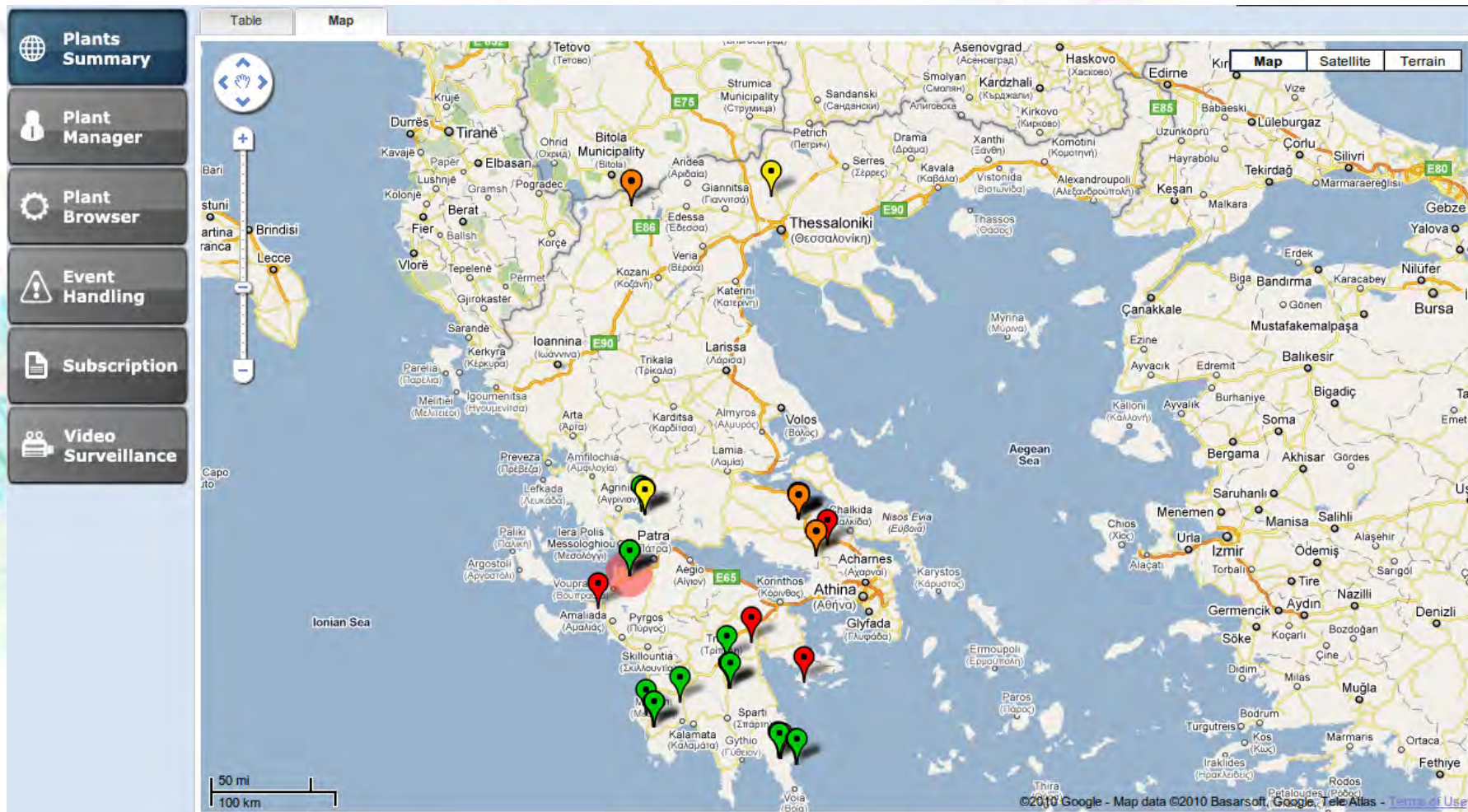


Reference installations

- in operation since **2008**, 60 parks of 100KWp – 4.3MWp, **25MWp in total**
- Major new release mid 2009
- **>50%** GR market share in large solar parks (from 150KW to several MWp)
- Project Pipeline of **~60MWp** for the next 12 months in Greece
- **~100MWp** under discussions in several European Countries (Germany, France, Czech Republic)
- **Reference grid connected PV plants:**
 - 4.3 MWp in Florina, 2 MWp in Argolida, 2 MWp in Arcadia, 2 MWp & 1.25 MWp in Viotia, 5 MWp in Viotia under construction

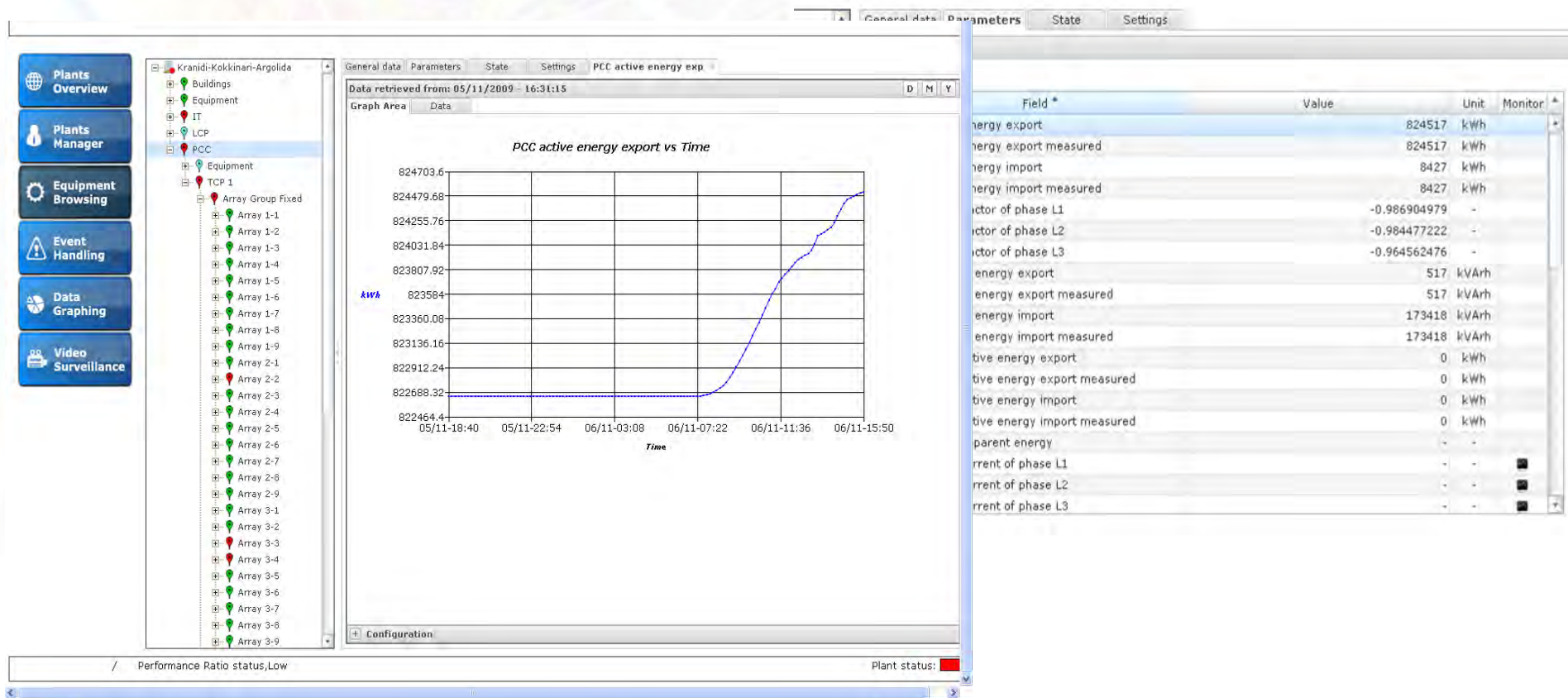
Centralized Management

- Support of multiple and geographical distributed PV plants through a common control center & internet portal in real time



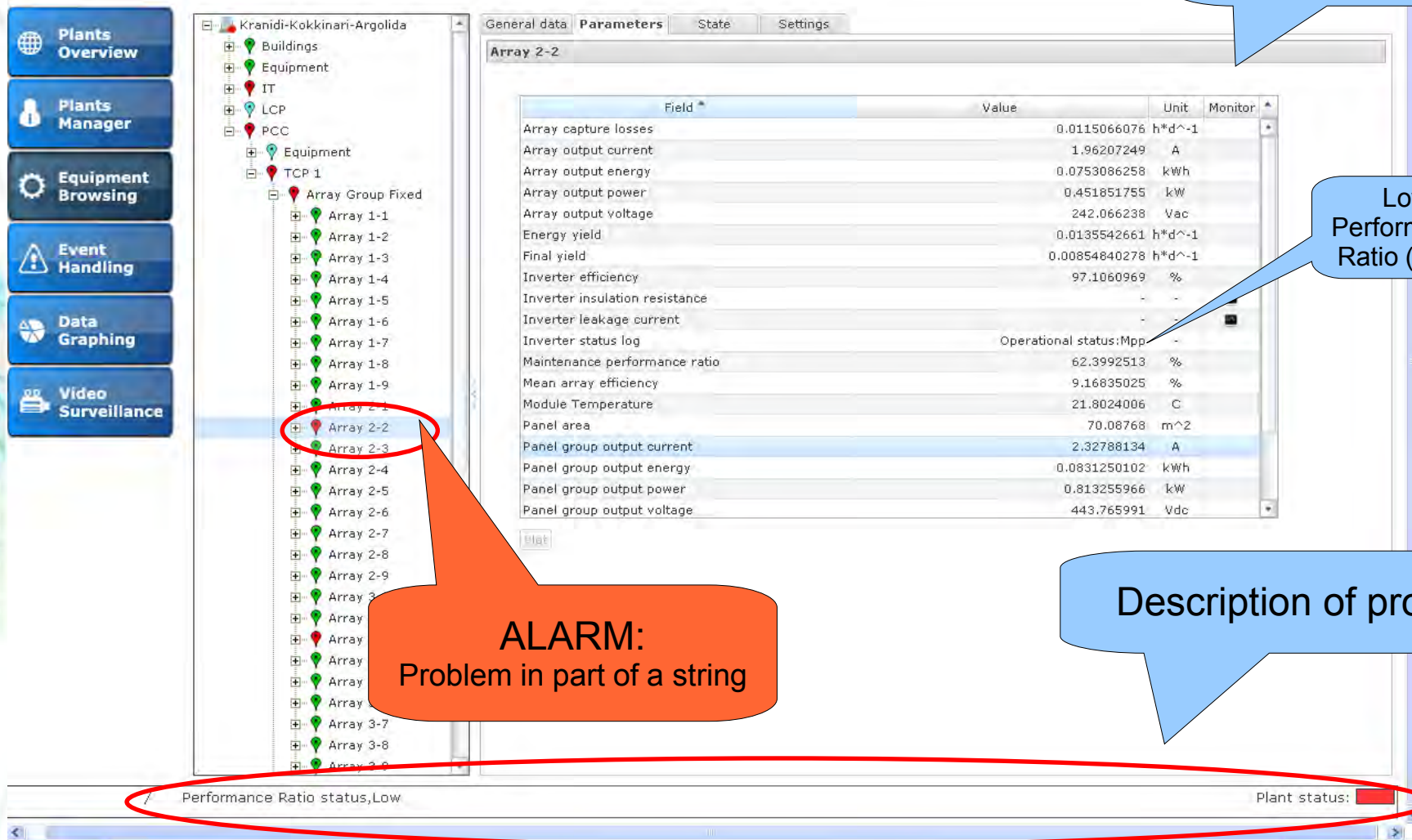
Production/grid interconnection monitoring

- **On line** production monitoring
- Recording of the **energy finally sold** to the utility & the **actual revenues**
- Monitoring of the **output power quality characteristics**
- Identification of **problems originating from the utility provider**



Alarm detection – SMS /email notification

- Immediate **detection of failures or performance degradation**
- **User notification by SMS or email**



The screenshot shows the inSolar monitoring software interface. On the left is a navigation menu with buttons for Plants Overview, Plants Manager, Equipment Browsing, Event Handling, Data Graphing, and Video Surveillance. The main area is divided into a tree view on the left and a data table on the right. The tree view shows a hierarchy of equipment, with 'Array 2-2' highlighted in red. The data table shows various parameters for 'Array 2-2', including 'Maintenance performance ratio' at 62.3992513%, which is annotated as 'Low Performance Ratio (62%)'. An orange callout points to 'Array 2-2' with the text 'ALARM: Problem in part of a string'. A blue callout points to the 'Maintenance performance ratio' row with the text 'Description of problem'. At the bottom, a status bar shows 'Performance Ratio status,Low' and 'Plant status:' with a red indicator.

Field	Value	Unit	Monitor
Array capture losses	0.0115066076	h*d^-1	
Array output current	1.96207249	A	
Array output energy	0.0753086258	kWh	
Array output power	0.451851755	kW	
Array output voltage	242.066238	Vac	
Energy yield	0.0135542661	h*d^-1	
Final yield	0.00854840278	h*d^-1	
Inverter efficiency	97.1060969	%	
Inverter insulation resistance	-	-	
Inverter leakage current	-	-	
Inverter status log	Operational status:Mpp	-	
Maintenance performance ratio	62.3992513	%	
Mean array efficiency	9.16835025	%	
Module Temperature	21.8024006	C	
Panel area	70.08768	m^2	
Panel group output current	2.32788134	A	
Panel group output energy	0.0831250102	kWh	
Panel group output power	0.813255966	kW	
Panel group output voltage	443.765991	Vdc	

All available data

Low Performance Ratio (62%)

ALARM:
Problem in part of a string

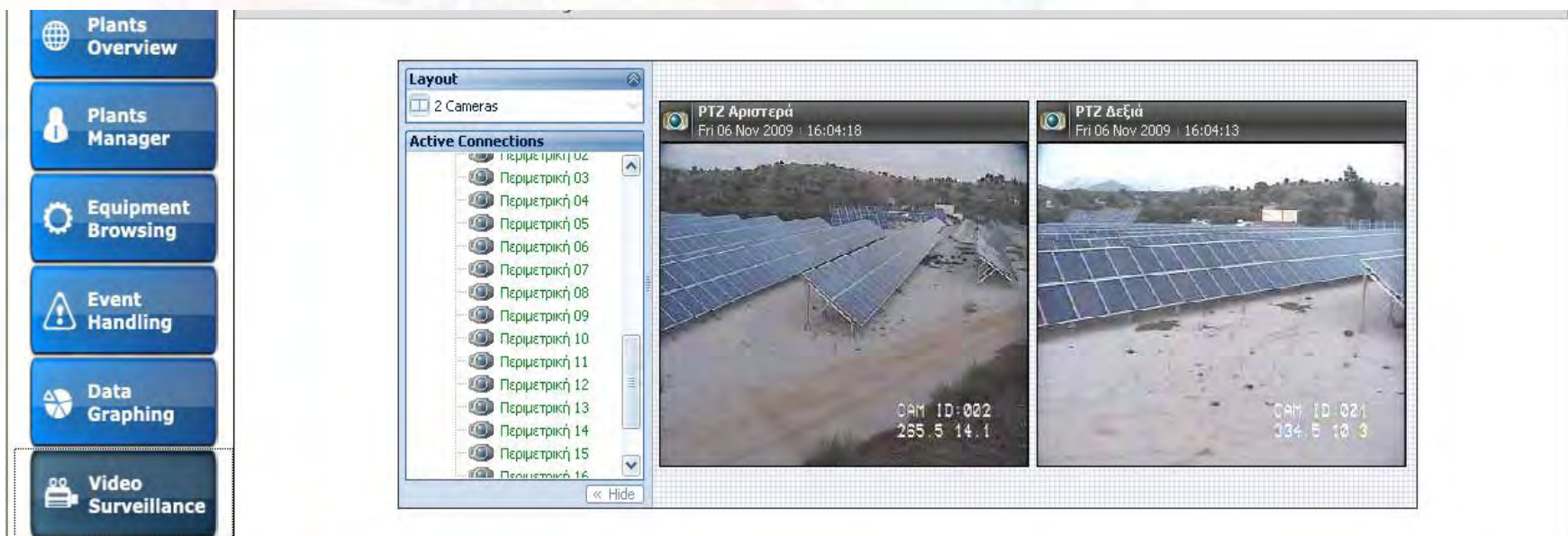
Description of problem

Performance Ratio status,Low

Plant status: ■

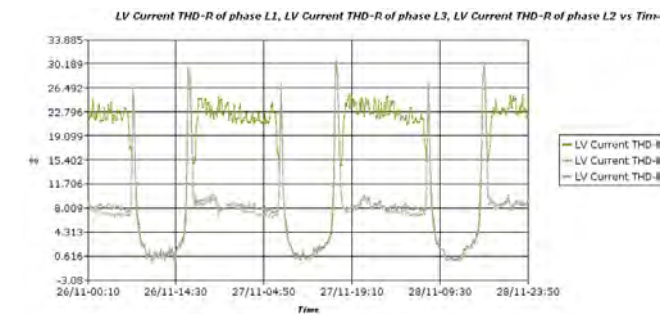
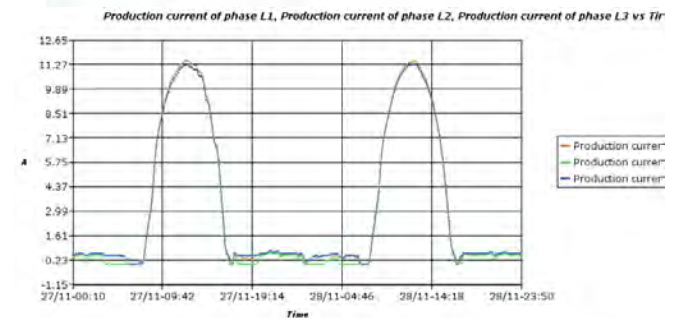
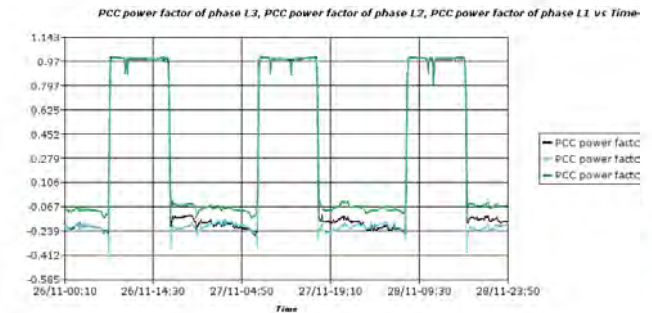
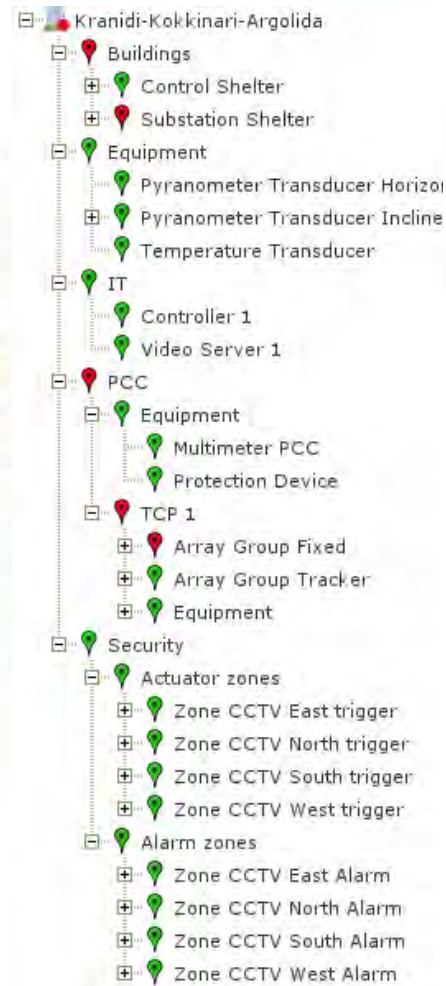
Security and access control

- Secures the solar park perimeter and shelters
- Allows the entrance to certain solar park facilities only to accredited personnel and monitor their presence
- Readily detects fire and flood conditions in the solar park shelters or pilars
- **CCTV integration with Live Video Feed**



Value Added Online Services

- Detailed Hierarchical Browsing
- Alarms, Notifications
- Custom Severity Levels
- Primary Data / Derived KPIs for each park element
- Online Functions:
 - Exporting
 - Importing
 - Reporting
 - Graphing
 - Processing



Stakeholder Benefits

- **Management reporting:** easy, timely & accurate
- **Park performance optimization:** detailed engineering info
- **Stakeholder relationship management:**
 - Maintenance Subcontractors
 - Security Companies
 - Guarantees
 - Penalties
 - Billing disputes
 - Insurance

