O&M REDEFINED. OUTPERFORMING EXPECTATIONS.SM

ALECTRIS

Improving Solar Plant Performance

Practical solutions for reducing OPEX costs in operational PV

A successful case of plants' turnaround

ALECTRIS

Who we are

- **Greece**:

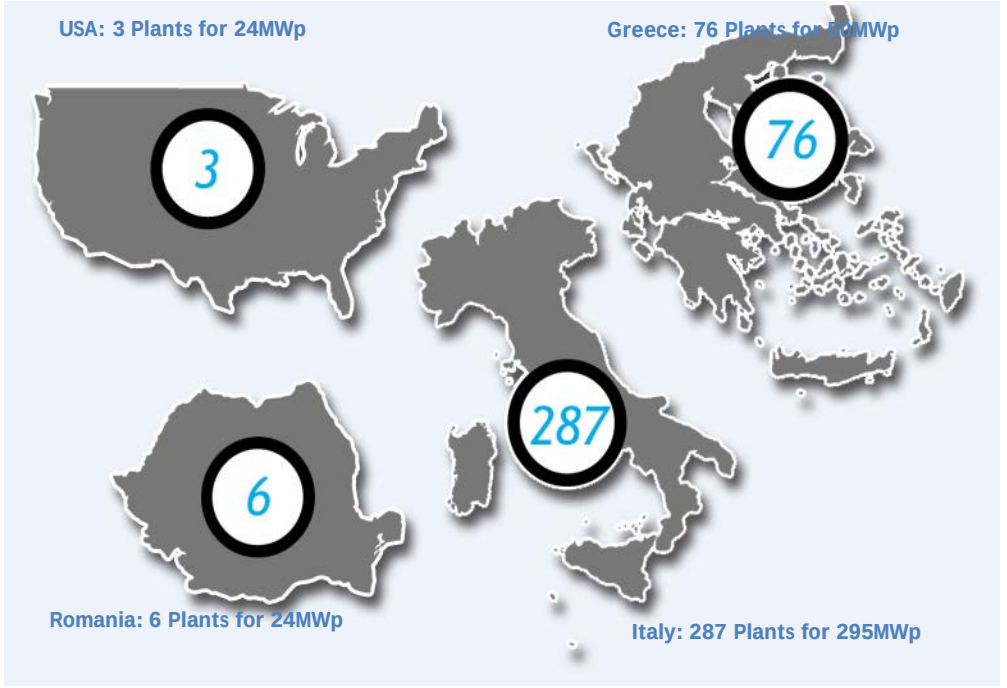
- Offices (Head Quarter&Control Room):
  - Industrial Area of Thessaloniki 57022 Sindos
  - 24G Papadiamantopoulou Str, 11528 Athens
- Resources:
  - 7 direct employees (Engineers)
  - 3 external
- Subcontractors

- **USA**

- Office:
  - 1200 Brickell Avenue Suite 1800 Miami, FL 33131
- Resources:
  - 2 direct employees (Engineers)
  - Subcontractors

- **Italy**

- Offices:
  - Piazzale Cadorna 10, 20123 Milano (MI)
  - Via Spinabella 7, 00047 Marino (RM)
- Resources:
  - 4 direct employees (Engineers)
  - 3 external
  - Subcontractors



Overview of the presentation:

i. Classification of Solar PV Plants

ii. Methodology

iii. Case Study

CLASSIFICATION OF SOLAR PV PLANTS

Classification of Solar PV Plants

i. Good or Adequately Performing

ii. Clearly Distressed

iii. Apparently Good Performing

Good Performing Plants:

Good Performing Plants are the ones that perform according to or above the Owners' expectations. Such expected energy output is calculated on the basis of average scenarios and by no means does it provide the maximum achievable performance.

Improvement through:

- ✓ More efficient response and shorter resolution times
- ✓ Predictive maintenance
- ✓ Cure of systemic faults
- ✓ Technical improvements also in case of faults due to external factors (e.g. grid fluctuations)

Clearly Distressed Plants:

Clearly Distressed Plants perform below the Owners' expectations and in some cases may lead to a default if such underperformance is not remedied. Such situations are encountered in cases where serious faults exist in engineering, construction and maintenance, especially in markets that have imploded.

Improvement through:

- ✓ Immediate identification and cure of acute problems
- ✓ First priority is Availability. Performance comes next.
- ✓ As soon as plants are stabilized, step-by-step approach in necessary, similar to Good Performing Plants

Apparently Good Performing Plants:

Apparently Good Performing Plants are Plants that seem to be operating in a satisfactory manner, but only because performance measurements are false or falsified. The underperformance is not so severe to create cash flow problems, but the room for improvement is not evident from the current measurements.

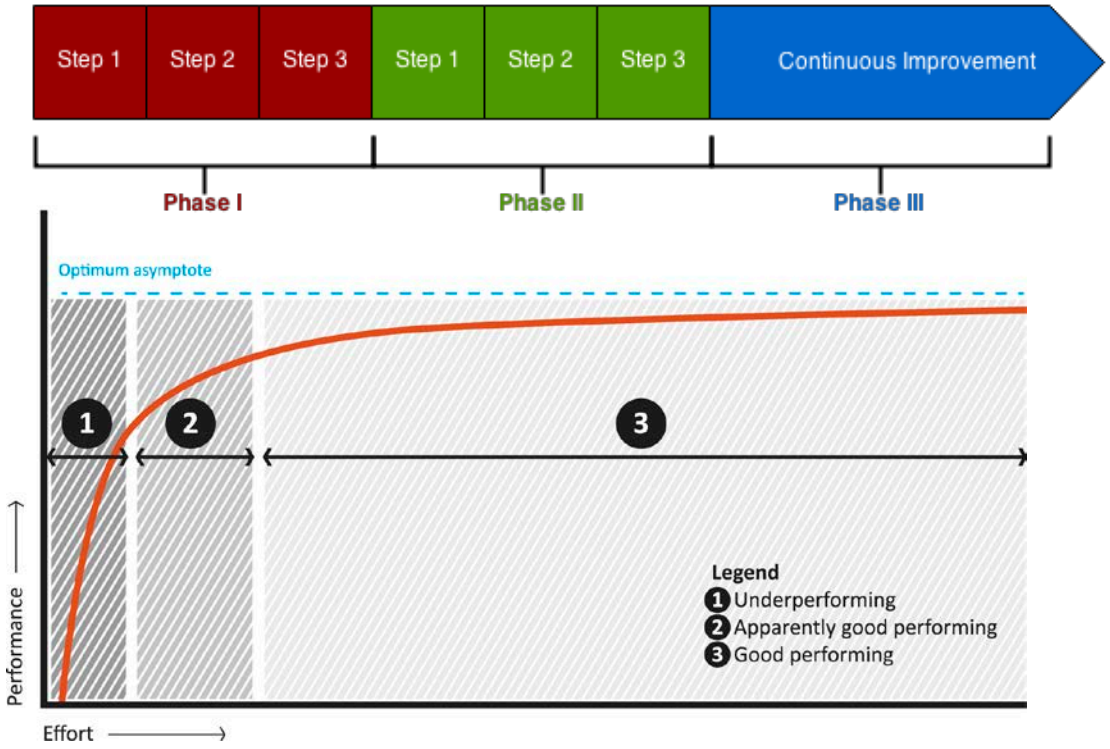
Improvement through:

- ✓ Installation of a reliable monitoring system to understand actual status
- ✓ Further troubleshooting similar to Good Performing or Clearly Distressed category

METHODOLOGY

Improvement Effort Chart

The closer to the optimum, the more effort is required to increase further performance and/or sustain it at high levels.



First Phase – Clearly Underperforming

Step 1

- Documentation Review
- Historical Data
- Very quick and low to zero cost

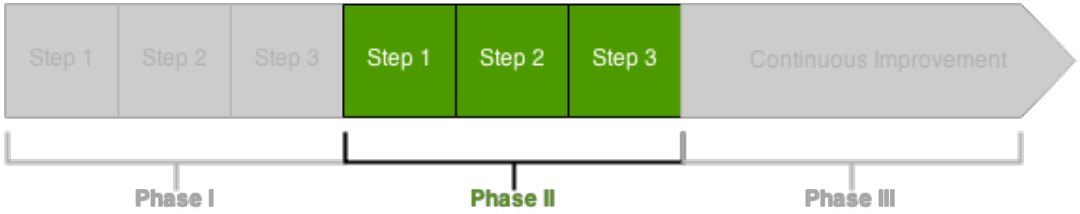
Step 2

- First Level technical survey
- Low level measurements on site
- First level curing actions
- Quick but some cost involved

Step 3

- Second Level technical survey
- In-depth measurements by skilled personnel
- In depth curing actions
- Slower process, costs involved

Second Phase – Apparently Good Performing

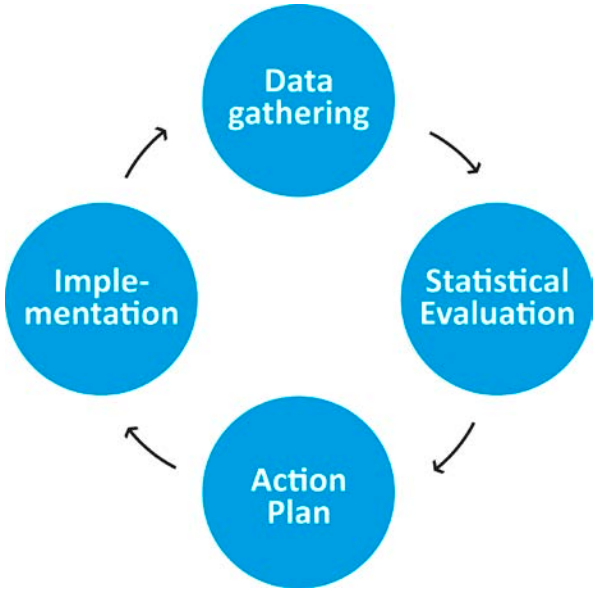


Step 1
- Upgrade of tracking system's hardware and software
- Installation of reliable monitoring system (Actis)
- Installation and/or replacement of additional sensors

Step 2
- Collection and analysis of telemetry data
- Discovery of "hidden" issues

Step 3
- Drafting of action plants with priorities
- Calculation of cost & benefit
- Implementation and monitoring of progress

Third Phase – Continuous Improvement



- Medium to long term process
- Gathering information and data from DAS (Data Acquisition System) but also day-to-day activities and observations
- Statistical evaluation of data (usually on yearly basis)
- Action plan and prioritization based on impact of (set of) failures

CASE STUDY

Plant Identity

Size:	7X1 MWp
Location:	Puglia and Marche, Italy
Type:	Double axis trackers
Inverters:	Kaco, Ingeteam
Panels:	Sunpower, Suntech, CEEG

The Challenges – Severe underperformance and Safety

- Trackers' control and management system written in proprietary language;
- Trackers' movement inefficiently organized and performed;
- Trackers' control and management system highly sensitive to even short time power outage;
- Wind alarm reposition of the tracker sails not secured and incorrectly set up → major issues regarding safety and security repositioning;
- Mechanical parts of the tracker engines not correctly maintained and with clear damages;
- No monitoring capabilities included in the initial design of the tracker control system.

- High costs of continuous interventions
- Severe underperformance (up to 25% below base case scenario)
- Average yearly loss of revenues of 150.000€/MW

	€/y/MW
Costs of materials for plants' fixing	12.000
Cost of manhour for manual intervention	6.000
Loss of revenues	150.000

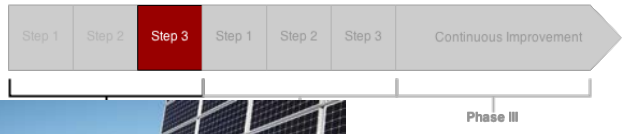
Process

- Broken mechanical components (cradles, gears, engines, encoders)
- Disabled strings
- Communication issues between junction boxes and central cabinets
- Insufficient grounding
- Critical events for inverters which limit/stop their production (e.g. insulation errors)

- Immediate replacement of defective mechanical components
- Immediate replacement of defective string cables
- Immediate replacement of defective communication cables
- Fixing of insulation faults

Availability of 98% reached

Process

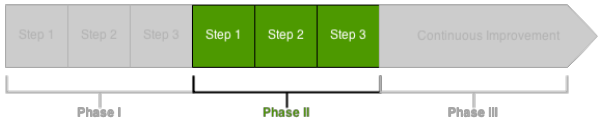


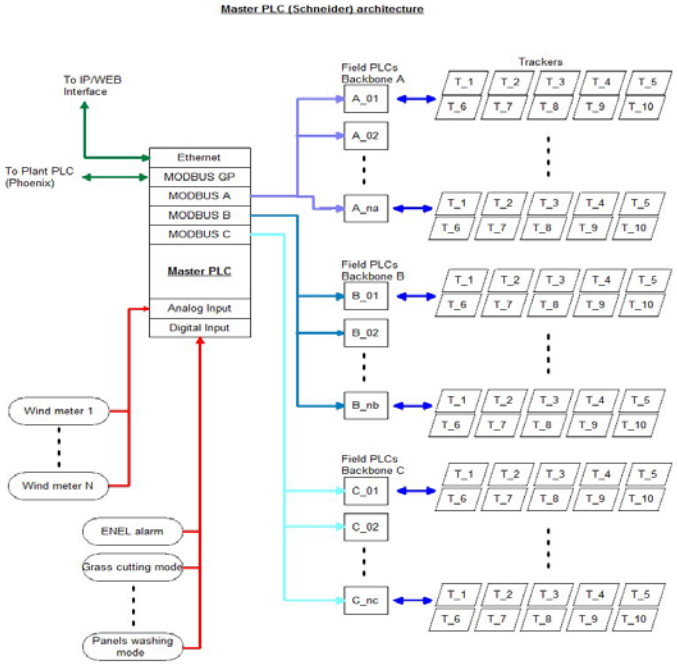
- Usage of a proprietary communication protocol →bottleneck for maintenance, potential upgrades, parts replacements;
- Usage of a rabbit microprocessor working with a dedicated board (ETH01)→not a commercial one;
- Difficult and prolonged procedure for control box (re)startup;
- Low memory of the rabbit microprocessor;
- Unreliable calculation of trackers positions, pre-calculated, and embedded into the rabbit and not adjustable.

- Installation of a master PLC for monitoring and remote control of trackers;
- Upgrade of the field PLCs installed in the JBs with a new firmware;
- Installation of two anemometers, connected to the master PLC;
- Implementation of Modbus protocol for the communication between JBs PLC and master PLC;
- Installation of specialized inverters for the trackers engine→read total operation time of each engine and create alarms of overcurrent.

PR of >82% reached

Process





- Actis installation
- Discovered hidden problems with preventative maintenance interventions (ie trackers greasing)
- Dramatic decrease of intervention times
- Identification of tendencies of failures before they actually occur

Process

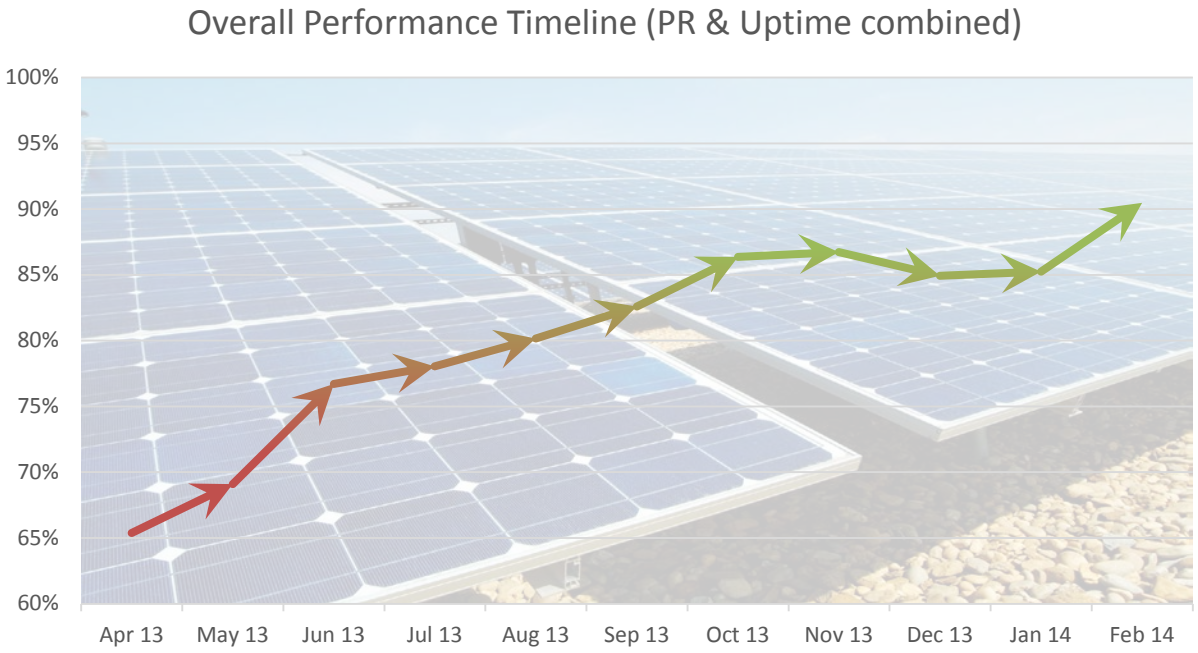
Already planned:

- Further optimization of the backtracking capabilities of the installed firmware

Further actions:

- Statistical analysis of repetitive failures and targeted interventions
- Predictive maintenance

Outcome



- Yield increase: + 27% →33% reachable with new backtracking capabilities
- Optimized returns: payback time of 2 months
- Further plans (implementation of the further actions) : +3-7% PR

Customer's Quote

"Investors need O&M suppliers who care about their solar power plants as if they were their own. Alectris has demonstrated that level of care and ability to deliver sophisticated O&M services for the solar investor»

Guy Vanderhaegen – Managing Director – Origis Energy.

Thank You!

For further info, please visit alectris.com

Cyprus
155 Spyrou Kyprianou Avenue
Ersi Court, Office 201, 3083
Limassol

Greece
Industrial Area
of Thessaloniki
57022 Sindos

Italy
Piazzale Cadorna
10
20121 Milano

USA
1200 Brickell Avenue
Suite 1800
Miami, FL 33131