QualifyingPhotoVoltaics

CORPORATE PRESENTATION. May 2017

QualifyingPhotoVoltaics

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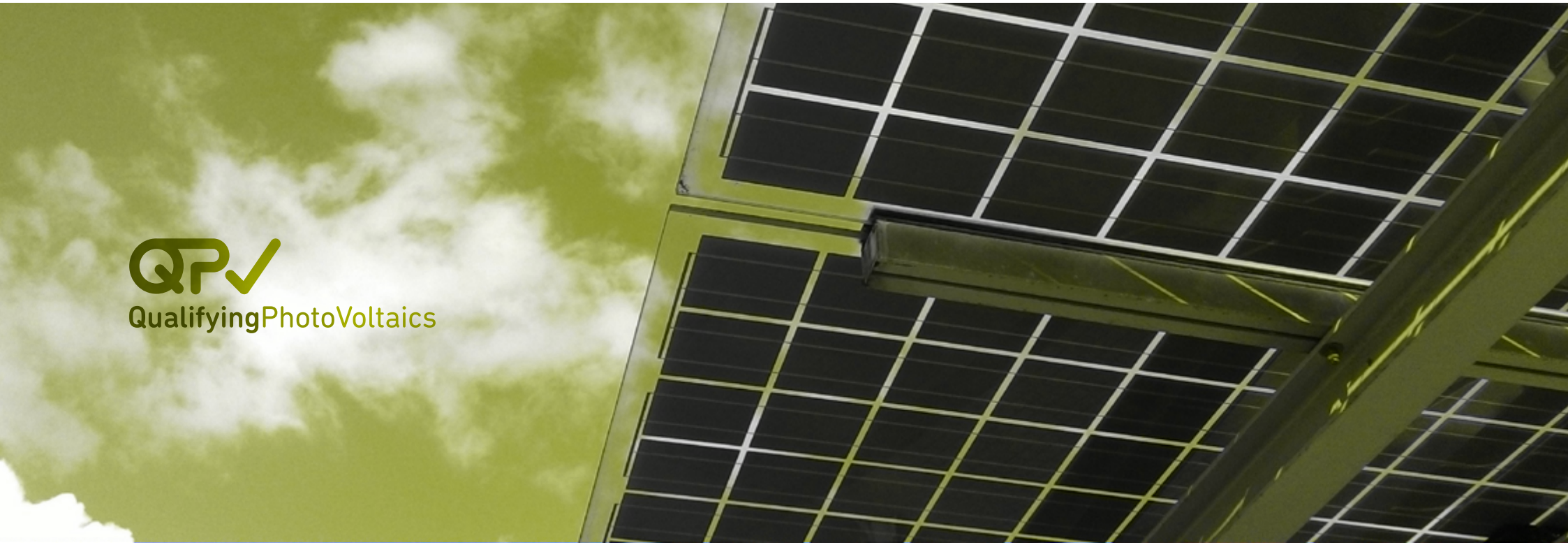
OUR MISSION: TO MAXIMIZE THE PROFITABILITY OF PHOTOVOLTAIC INVESTMENTS

QPV is a photovoltaic engineering and consultancy firm specialized in providing high added value services to maximize the profitability of PV investments.

We follow PV projects through their entire life cycle, guaranteeing the equipment's quality, optimizing their production capacity and reducing their performance uncertainty, which allows minimizing risks and improving the project's financing conditions.



WHY US?

- Our team is formed by photovoltaic solar energy PhD and engineers with **more than 10 years of experience** in the PV sector.
- We have a wide expertise as **independent consultants** in project financing audits.
- We have **provided engineering support** and accomplished quality control procedures in more than **80 installations** (**>700 MW**) in several countries of **Europe, America, Asia and Africa**.
- As a spin-off of the Solar Energy Institute, **QPV** incorporates **25 years of know-how** in the implementation of quality assurance procedures and the solution of novel problems in the field.

MILESTONES

- Discovery, measurement and solution proposal for PID affection in the field (2008).
- World record I-V curve (800 kW), 8 times larger than standard measurements (2011).
- First procedure for measuring and dealing with hot-spots in the field, which includes clear acceptance/rejection thresholds (2012).
- Production estimation methodology with an accuracy better than 1,5%, TSO oriented (2014), and incorporated to our advanced performance surveillance service (PVET).

QUALITY GUARANTEE

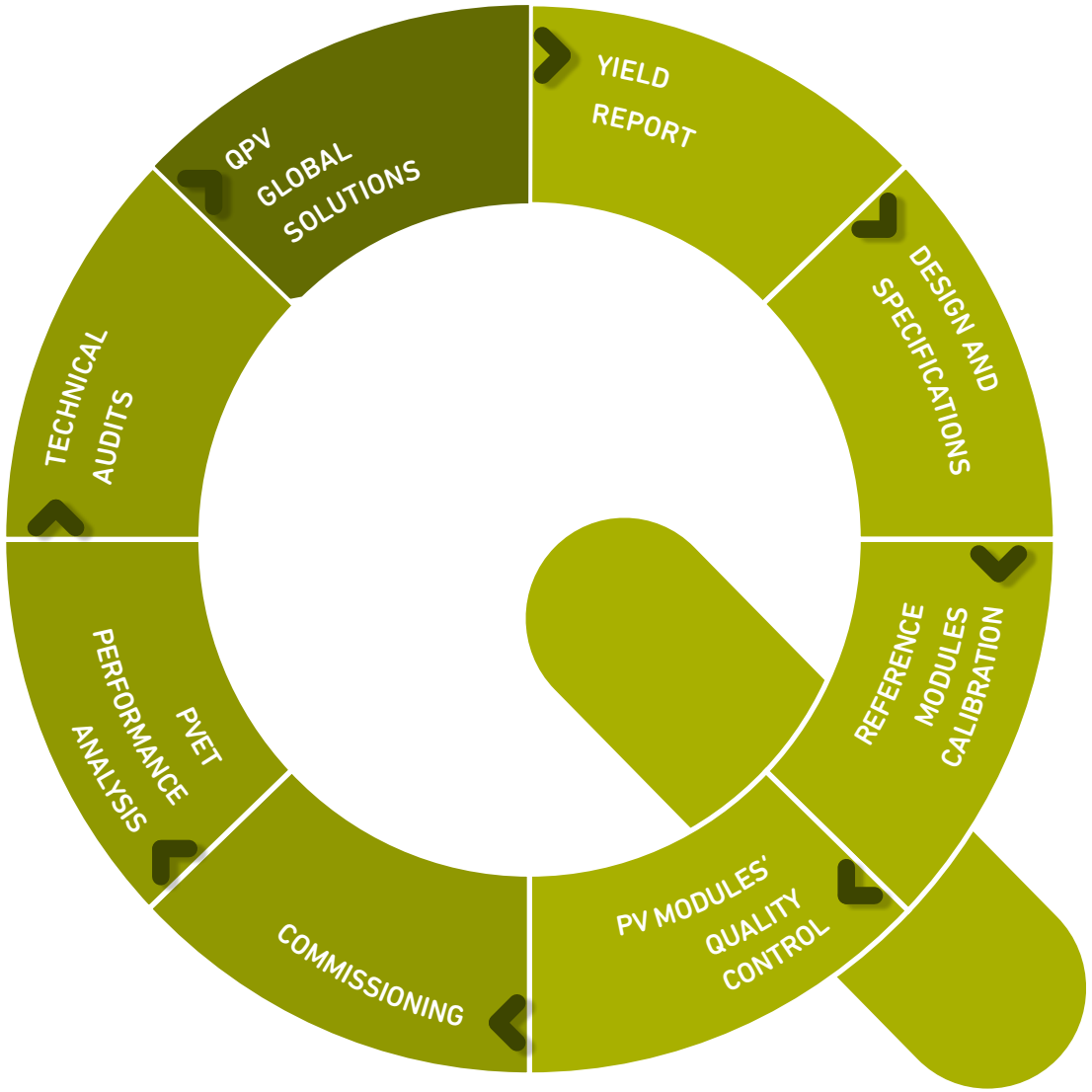
- ✓ Patented quality control methodology.
- ✓ Continuous upgrade by means of a collaboration agreement with the Solar Energy Institute (IES-UPM).
- ✓ Access to cutting-edge improvements due to our participation in the PVCROPS and MASLOWATEN projects, from the European Research Programme.
- ✓ Certified quality management system: ISO-9001.

garantía

COMMITMENT: WE ACCOMPANY PV PROJECTS THROUGH THEIR ENTIRE LIFE CYCLE

Advanced Quality Assurance Procedure: QPV's methodology reduces performance uncertainty by more than 50%, what allows minimizing risk investment and improving financing conditions. Main steps are:

1. YIELD REPORTING
   Initial calculation of the expected PV plant yield and the economic revenues along the project's lifetime.
2. DESIGN AND SPECIFICATIONS
   Project design and description of the equipment's technical requirements.
3. REFERENCE MODULES CALIBRATION
   Calibration of reference modules as irradiance and temperature sensors.
4. PV MODULES' QUALITY CONTROL
   Inspection and measurement of PV modules' state and performance at their delivery.
5. COMMISSIONING
   Analysis of the PV installation's performance and the fulfilment of the contractual specifications. It includes characterizing the main equipment and verifying the expected production.
6. PVET PERFORMANCE ANALYSIS
   Continuous audit service for the operation phase and advanced monitoring oriented to O&M, performance and asset management optimization. It includes failure detection and diagnosis and high accuracy energy forecasting.
7. TECHNICAL AUDITS
   Revision of the state-of-health of the installation at any moment of its lifetime: guarantee claims, performance anomalies, PV plant transactions.



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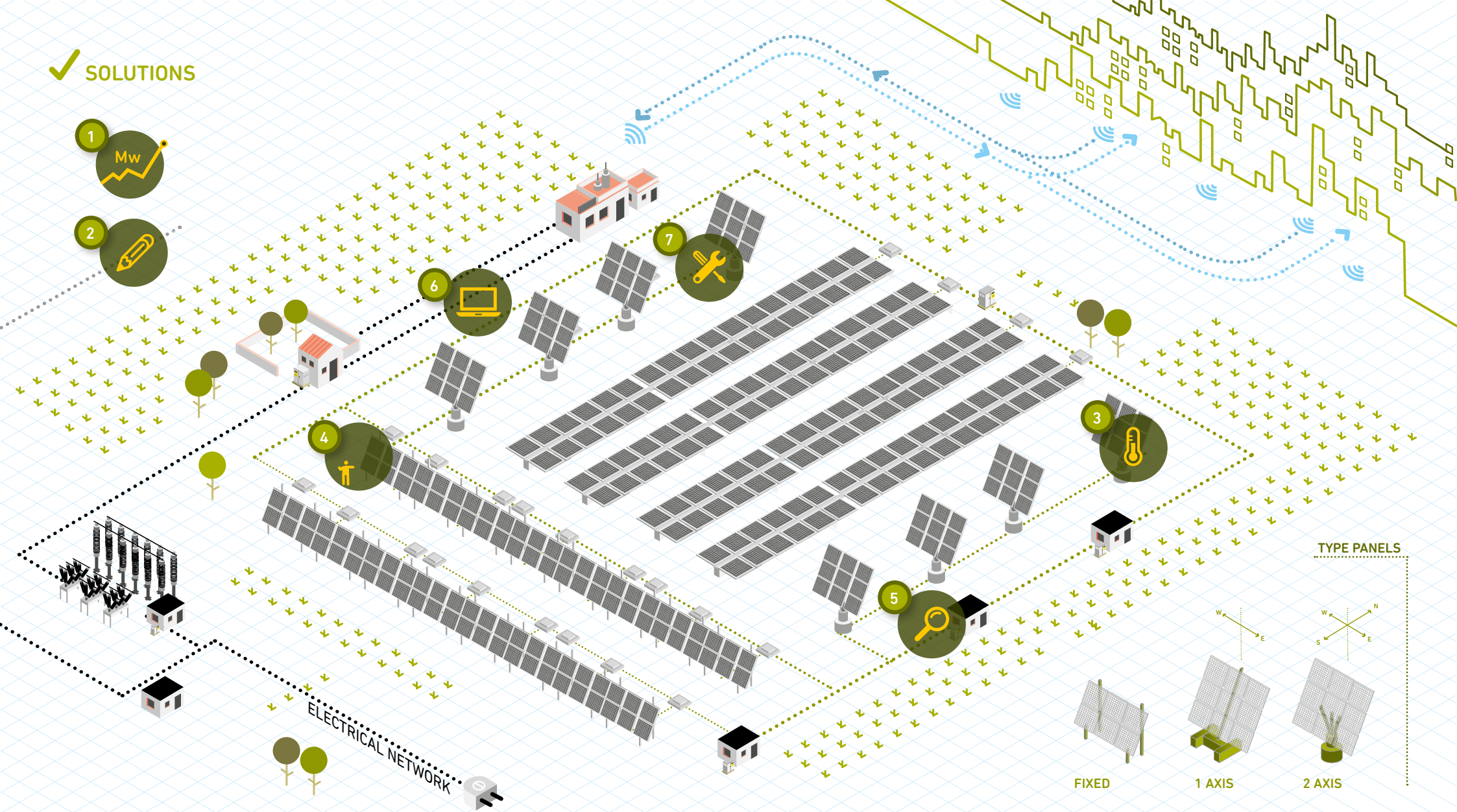
SOLUTIONS



1. YIELD REPORT
2. DESIGN AND SPECIFICATIONS
3. REFERENCE MODULES CALIBRATION
4. PV MODULES' QUALITY CONTROL
5. COMMISSIONING
6. PVET PERFORMANCE ANALYSIS
7. TECHNICAL AUDITS

GLOBAL PROCESS

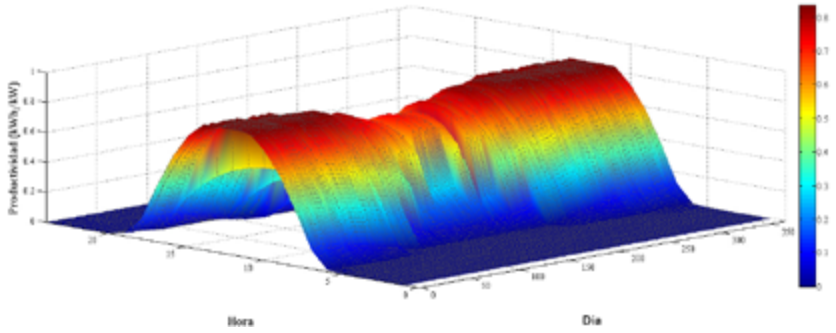
1

YIELD REPORT

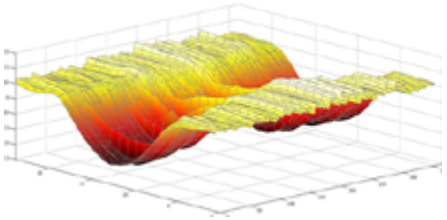
OBJECTIVE

calculation of the expected profit of the PV investment, oriented to its bankability.

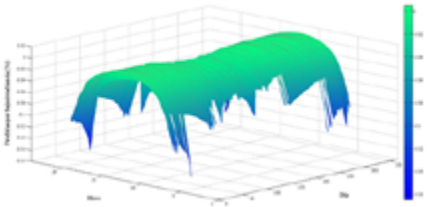
We provide an accurate and detailed estimation of the energy productivity along the project's lifetime.



Energy efficiency of a plant



Pérdidas por temperatura



Losses due to low irradiance

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GLOBAL PROCESS

1

YIELD REPORT

PROCEDURE

- Meteorological data analysis and comparison between available data sources.
- Provision of the TMY and the TOY.
- Irradiance profile, angular and spectral response calculations
- Losses scenario: shadowing, saturation, low irradiance, self-consumption, grid constraints.
- Energy yield and the economic returns of the project.
- Interannual variability and degradation profiles.
- Bankable software comparison and uncertainty analysis.
- High versatility: all types of structures, equipment and configurations
- Multiple applications: grid connection, pumping, isolated installations and hybrid systems.
- Feed-back for design and O&M optimization

APPLIED REFERENCES

Sisifo methodology: calculation of irradiance profiles, angular and spectral response, impact of shadows and any electrical or physical configuration.

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2

DESIGN AND SPECIFICATIONS

OBJECTIVE

advisory during the projecting phase to optimize the installation design.

We provide a technical specification set to assure the maximum equipment quality and performance.

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2

DESIGN AND SPECIFICATIONS

PROCEDURE

- Electrical design and equipment sizing optimization
- Yield maximization dependent on GCR
- Peak versus nominal power analysis
- Analysis of the different tracking strategies and their mechanical limitations.
- Efficiency and durability equipment requirements
- Adapted and personalized coverage beyond the international standards
- Negotiation with providers

APPLIED REFERENCES

- IEC – 61215, IEC – 50530, IEC – 50380, IEC – 61646, IEC – 61724
- PVCROPS Standards

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GLOBAL PROCESS

3

CALIBRATION OF PV REFERENCE MODULES

OBJECTIVE

Calibration of PV modules as irradiance and temperature sensors to be used as reference in the field.

We guarantee the traceability to international primary references and the lowest result uncertainty.

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3

CALIBRATION OF PV REFERENCE MODULES

PROCEDURE

- Electroluminescence tests for physical defects detection
- Stabilization and calculation of the degradation due to initial exposition to the light (LID).
- I-V test under real sun conditions and calculation of the STC parameters.
- Measurement of the variation coefficients with irradiance and temperature.
- Traceability referred to international primary references.

APPLIED REFERENCES

- IEC–60904-1; IEC– 61829; IEC –60891

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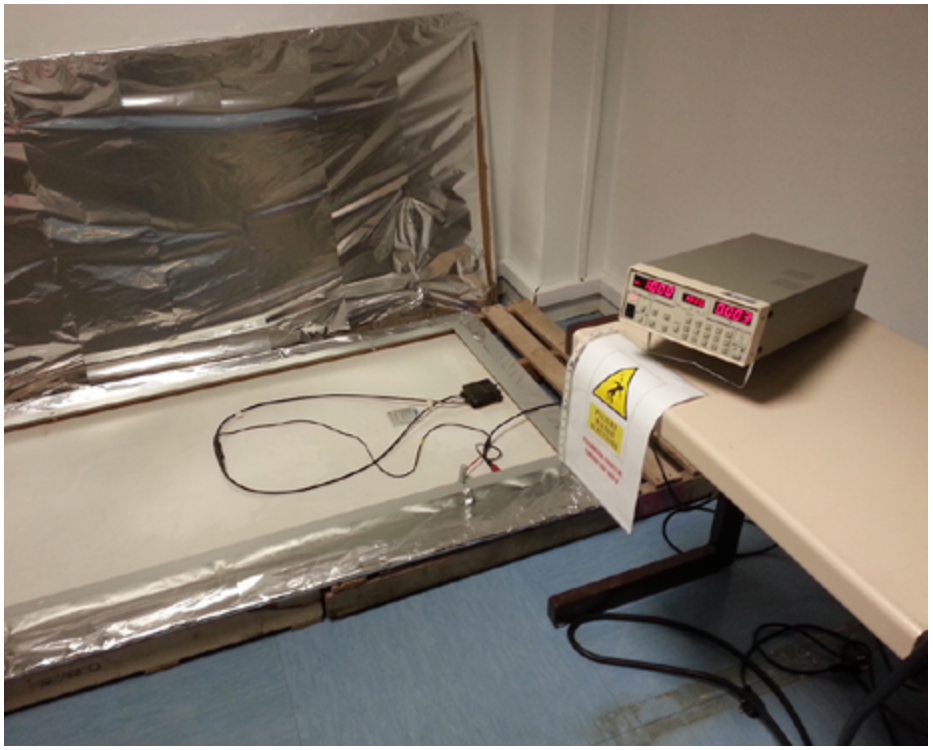
PV MODULES' QUALITY CONTROL

OBJECTIVE

Analysis of the PV modules' performance before and after their reception in the field.

We verify if there is any manufacturing, transport or installation defect, and guarantee their production capacity.



PID sensitivity test

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PV MODULES' QUALITY CONTROL

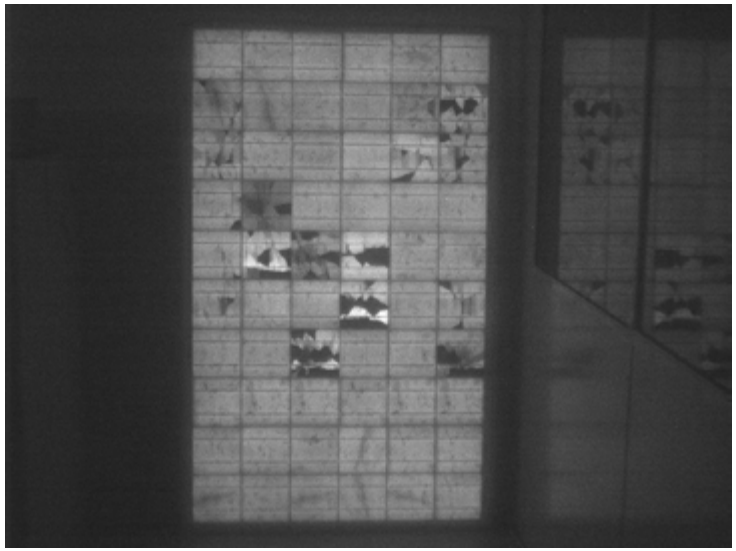
PROCEDURE

- ✓ Visual inspection according to international standards and the manufacturer's requirements.
- ✓ Electroluminescence tests and revision of any possible defects.
- ✓ I-V tests under real sun conditions and calculation of the STC parameters.
- ✓ Electric isolation and withstanding tests
- ✓ Light Induced Degradation (LID) test
- ✓ Potential Induced Degradation (PID) test

APPLIED REFERENCES

- ✓ IEC–61215, IEC–60904-1, IEC–61646, IEC–61646, IEC–50380, IEC-62804.

Electroluminescence of a module with fractured cells



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COMMISSIONING

OBJECTIVE

Verify, measure and analyse the main components of the installation to assure their quality and production capacity.

Supervision of the installation performance and the compliance of the initial production estimations.

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COMMISSIONING

PROCEDURE

- ✓ Determination of the STC power of the generator.
- ✓ Measurement of the inverter's efficiency.
- ✓ Analysis of the AC signal's quality and power control strategies.
- ✓ I-V curve measurements at module, array and generator levels (up to 2 MW).
- ✓ Visual inspection.
- ✓ Thermographic inspection: modules, combiner boxes, inverters...
- ✓ Production capability test.
- ✓ Quality indexes calculation (PR, PRSTC,...) and energetic availability.
- ✓ Losses breakdown: dust, shadowing, low irradiance, temperature, wiring, grid constrictions...
- ✓ Recalibration of measurement sensors.
- ✓ Revision of the monitoring system.
- ✓ Historic data analysis.
- ✓ Reclaim management.
- ✓ Revision of the yield reports and estimation of the future energy production.

REFERENCIAS APLICADAS

- ✓ IEC– 60904-1; IEC –61829; IEC –60891; IEC –62446; IEC –61724.

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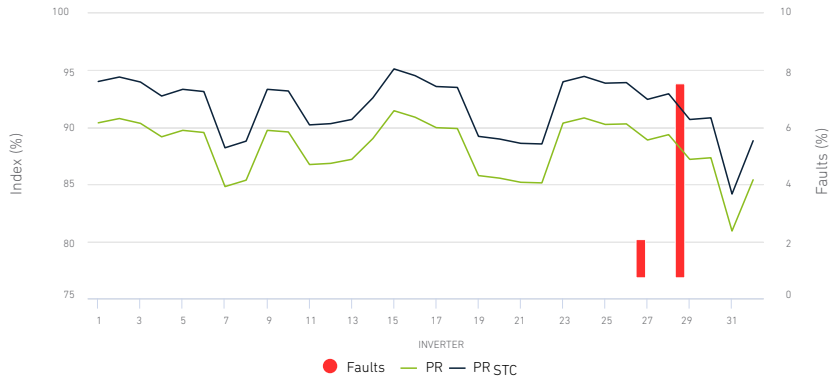
PVET PERFORMANCE ANALYSIS

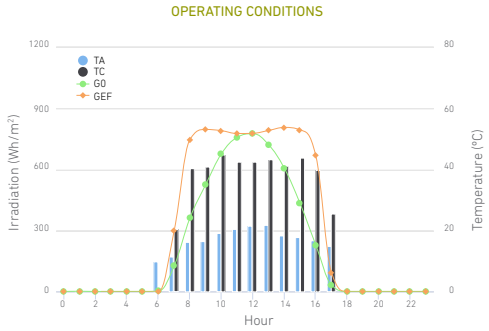
PVET
PhotoVoltaics
EvaluationTool

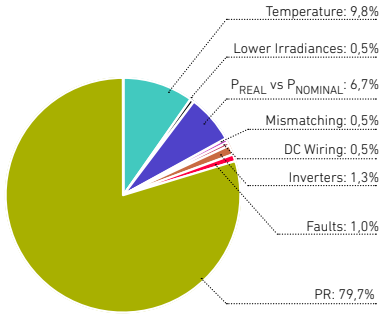
OBJECTIVE

Continuous performance analysis and audit through a reliable tool that assures an integral supervision of all photovoltaic assets.

We detect and diagnose anomalies and propose solutions to optimize production and O&M interventions.







6

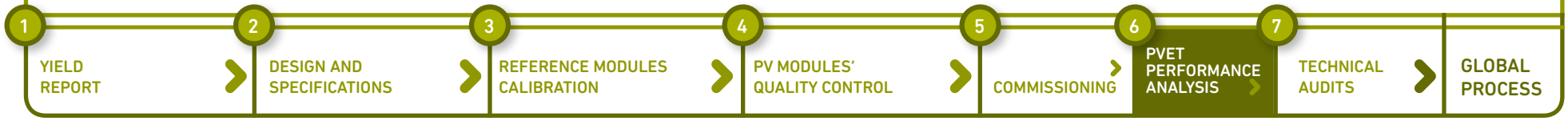
PVET PERFORMANCE ANALYSIS

PROCEDURE

- ✓ Monitoring data validation
- ✓ Production analysis and main calculation of the main Key Performance Indicators
- ✓ Losses breakdown analysis
- ✓ Reliable detection and advance diagnosis of any performance failure, and solution proposals.
- ✓ Comparison with the contractual commitments and initial estimations.
- ✓ Production forecasting to comply with market requirements.
- ✓ Long term production evolution and equipment degradation analysis.
- ✓ Analysis of the AC signal quality and the power control strategies.
- ✓ Low development failures tracking: PID, dirtiness, hot-spots.
- ✓ Asset management
- ✓ Continuous consultancy from our PV expert team.
- ✓ O&M strategies management
- ✓ Data management and control centre service.

APPLIED REFERENCES

- ✓ IEC – 61724



7

TECHNICAL AUDITS

OBJECTIVE

Measure and evaluate the performance of a PV installation during any moment of its life time.

We analyse any specific anomalies, propose solutions and update the yield estimations.

7

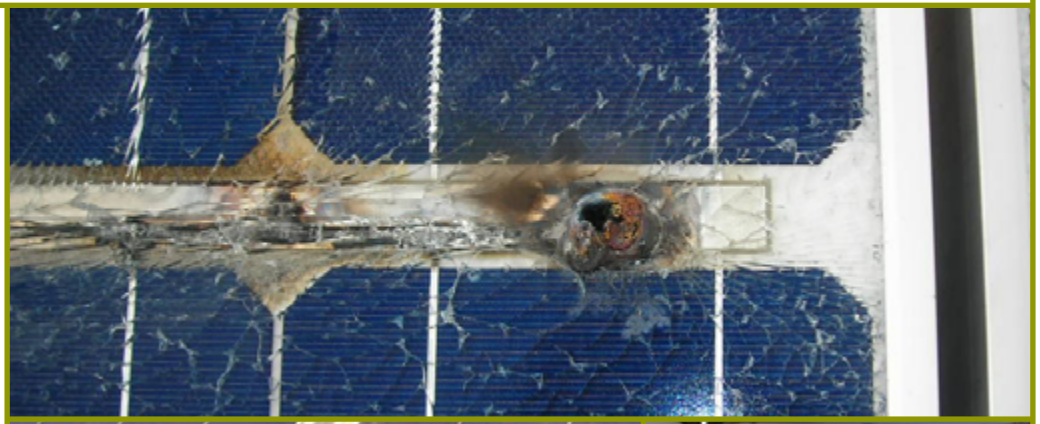
TECHNICAL AUDITS

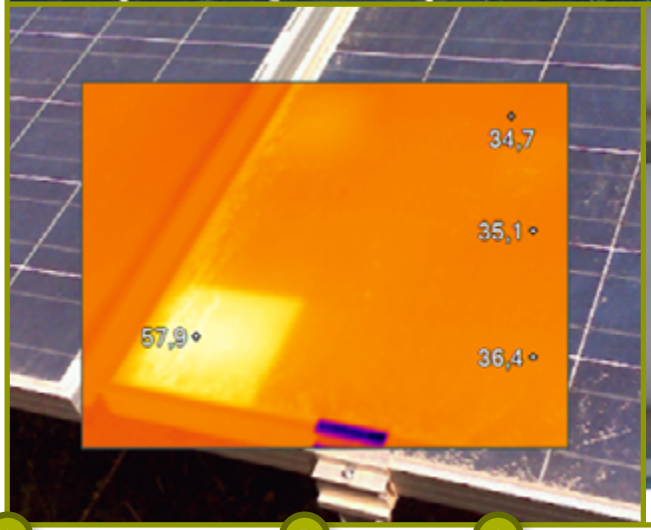
PROCEDURE

- ✓ Visual inspection and control during the construction phases.
- ✓ Hot-spot impact measurement: early degradation, individual and operating power losses.
- ✓ Diodes and connecting boxes anomalies.
- ✓ Losses due to potential induced degradation
- ✓ Equipment ageing analysis
- ✓ Dust impact on individual and operating power and mismatching increase. Cleaning campaigns planning
- ✓ Revision and recalibration of the meteorological stations and the operating conditions' sensor
- ✓ Monitoring system validation

APPLIED REFERENCES

- ✓ IEC –60904-1; IEC –61829; IEC –60891; IEC –62446; IEC –61724





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PROJECTS OF THE QPV TEAM

TOTAL
POWER AUDITED

742,7 MW

Number of installations	Country	Power (MW)	Year
6	Spain	13	2006
5	Spain	17,6	2007
22	Spain	84,8	2008
1	Portugal	45,8	2009
5	Spain	32,4	2009
6	Spain	16,6	2010
5	Italy	14,9	2011
1	France	4,5	2011
6	Spain	15,6	2011
4	Spain	18,3	2012
3	Italy	10,9	2012
1	Brazil	1	2012
1	Spain	38	2013
1	Italy	2,6	2013
1	Spain	2	2014
4	Italy	7,9	2014
1	Ecuador	3,5	2014
1	Spain	6	2015
1	Peru	20	2015
1	Honduras	49	2015
2	South Africa	30	2016
1	Turkey	1	2016
1	Kuwait	10	2017
2	Chile	296	2017
1	Spain	1,3	2017

CONTACT