CENER
ADItech

CENTRO NACIONAL DE ENERGÍAS RENOVABLES

NATIONAL RENEWABLE ENERGY CENTRE

PHOTOVOLTAIC SOLAR ENERGY DEPARTMENT

QUALITY ASSURANCE OF PV MODULES AT ORIGIN AND DESTINATION

CENER OFFERS A SERVICE ORIENTED TO NEW PV INSTALLATIONS WITH THE FINAL GOAL OF GUARANTEEING THE QUALITY DURING ALL THE STAGES INVOLVED ALONG THE CONSTRUCTION OF THE FINAL PV PLANT

CENER´S PROCEDURE OR ADAPTATION OF TECHNICAL ADVISOR´S PROTOCOL

Monitoring at factory
- Quality & productive system
- In-line & out-line test
- Test in accredited lab.
- Supervision pre-shipment

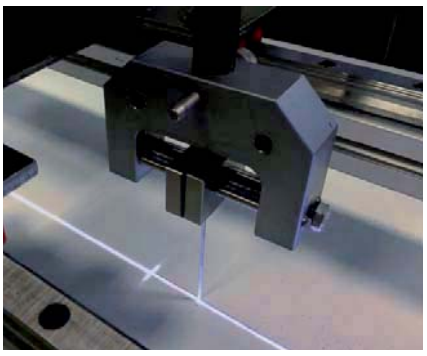
Warranty after transport
- Verification absence of damages after transport
- Characterization by EL
- Measurement just at the arrival of the PV modules

Warranty after installation
- Verification absence of damages after mounting
- Characterization by EL
- Use of special system (CELSOS) for measurements

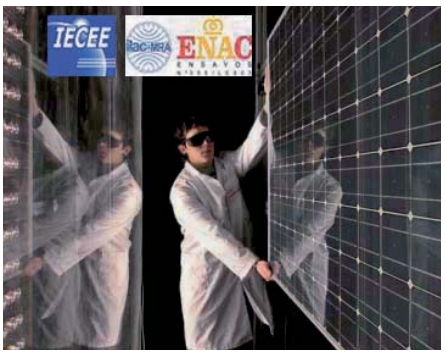
SUPERVISION AND CONTROL OF MODULES AT ORIGIN

- Previous auditory of quality and productive systems of the factory (according to standard IEC/TS62941)
- Monitoring during manufacturing of hired PV modules
  - According to contract supplied-customer or by CENER´s
  - Technical revision of materials, equipment, processes, documentation, etc.
  - Lot definition: sampling according to ISO2859-1
  - Delivery contract deadlines will not be altered
- "In-line" test: inserted in the manufacturing process
  - Applicable to the complete production (i.e.: Pmax, EL)
- "Off-line" test: outside the manufacturing process
  - Applicable to representative samples for MQS requirements
  - Some test can be carried out in-situ by technical personnel supervised by CENER experts
  - Other test (i.e.: LID, diodes, etc) must be imperative performed in accredited laboratory, such as CENER
- CENER has designed a specific protocol to ensure the quality of the manufactured PV modules
  - Adaptable to the specific project or client requirements
- Supervision shipment: documentation & packing revision

PV module during its manufacturing process



Peel test



LID test (performed inside)

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PHOTOVOLTAIC SOLAR ENERGY DEPARTMENT

WARRANTY AFTER MODULE´S TRANSPORT

- Verification of absence of potential damages during the transport of the modules to the PV plant
- Characterization of the modules just after their arrival to the PV plant
- Measurement of a representative sample for each lot/shipement
  - Application of standard ISO2859-1 to determine the size of the sampling
- Capture of high quality electroluminescence (EL) images
- Use of a special mobile laboratory to perform the EL measurements
- Modality of measurements adapted to the client´s needs:
  a) Measurements carried out by CENER´s technicians displaced to the PV plant
  b) Training client´s personnel, lab assembly, equipment release and on-site supervision during first measurements
- Analysis of results performed always by CENER´s expert technicians

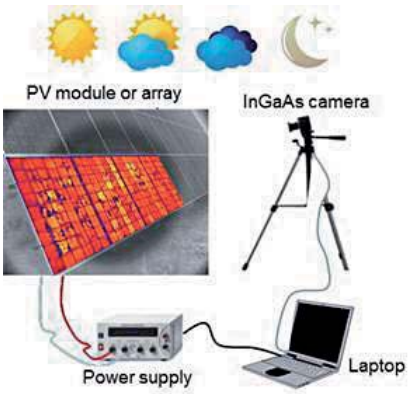
Mobile laboratory to capture EL images of modules at their arrival at the PV plant

CENER´s technician performing EL measurements inside the mobile laboratory

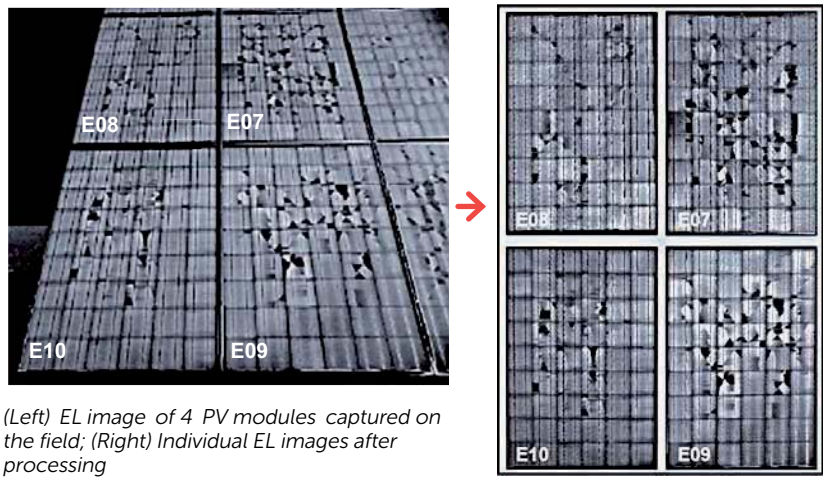
WARRANTY AFTER THE MODULE´S ASSEMBLY

- Verification of absence of damages during the final assembly
- Characterization of the modules already installed and connected
- Capture of high quality electroluminescence (EL) images
- Use of CELSOS system developed by CENER for measurements
  - Possibility of measuring during the entire day/night (24/7)
  - Suitable for measurements of PV plants up to 1500V of Vsys
  - Electrical biasing of the PV modules at array or inverter level
  - Advanced processing of EL images (sharpness improvement, borders detection, perspective correction, automatic detection of main defects, etc)
- Direct comparision with EL image captured at module´s arrival

CENER technician taking EL measurements on the field



Set-up schematic of CELSOS system



(Left) EL image of 4 PV modules captured on the field; (Right) Individual EL images after processing

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