



CENER
ADItech

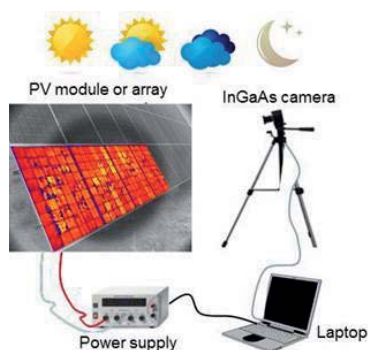
CENTRO NACIONAL DE
ENERGÍAS RENOVABLES
NATIONAL RENEWABLE
ENERGY CENTRE

PHOTOVOLTAIC SOLAR ENERGY DEPARTMENT

ELECTROLUMINESCENCE (EL) MEASUREMENT ON THE FIELD

CENER HAS DEVELOPED A NEW CHARACTERIZATION SYSTEM NAMED **CELSOS** (CENER'S **E**LECTROLUMINESCENCE **S**YSTEM **O**N-SITE) CAPABLE OF OBTAINING HIGH QUALITY ELECTROLUMINESCENCE (EL) IMAGES OF PV MODULES, CAPTURED DIRECTLY ON THE FIELD AND UNDER ANY LEVEL OF IRRADIANCE

Set-up schematic of CELSOS system



CENER technician taking EL measurement on the field



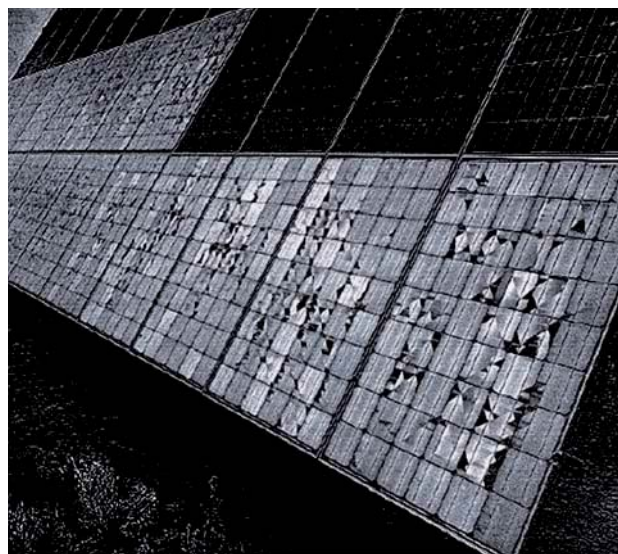
- The electroluminescence (EL) technique has emerged as one of the most important tools in order to identify the potential presence of defects or problems in PV modules, and the market is increasingly seeking options to undertake this type of characterization at the PV plant itself.
- CENER has made use of its wide experience performing electroluminescence measurements of different types of PV modules at laboratory level in order to fully develop a characterization system (CELSOS) that integrates a special controlling software implemented in CENER, joined to an own advanced analytical program to treat the images.
- CELSOS system allows the completion of EL measurements directly on PV modules installed on the field, without the need of demounting them, without the requisite of disconnecting them, and during the entire day time (24/7).

APPLICATION OF THE ELECTROLUMINESCENCE MEASUREMENT SERVICE

The service of EL measurements inside the own PV installation provides an important added value to the client during every phase along the lifetime of the PV plant.

CELSOS system is integrated as an essential tool in several services inside the CENER's general catalogue:

- **Service included inside the global O&M offer**
 - Detection of PV modules with defects in problematic arrays with low electrical production.
 - Period monitoring of representative PV modules.
- **Quality guarantee service for PV modules inside the origin/destination protocol.**
 - Assurance of complete absence of damages in the PV modules during the transport and mounting processes.
- **Independent service of EL measurements, advanced analysis, and interpretation of the images.**
 - Defect's detection: cracked cells, isolated areas, series resistance problems, PID presence, etc.

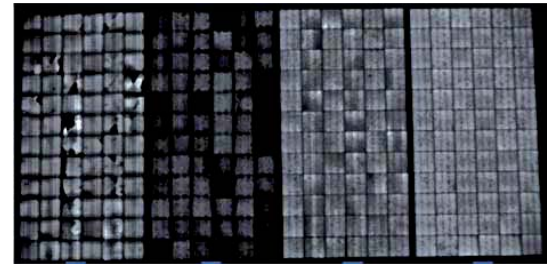


EL image of a PV array of modules with cracked cells

ADVANTAGES OF USING CELSOS SYSTEM

- Significant reduction of cost and risks in the characterization process
 - No need of disassembling the modules from the structure
 - Decrease in the risk of potential damage in the module during the complete process (disassembling, transport, unpacking, re-mounting...).
 - No need of stopping the electrical production of the PV installation during long periods.
- Electrical biasing is performed at PV array or inverter level
 - No need of disconnecting the PV modules individually.
 - Several modules can be captured in the same EL image.
- Acquisition of high quality images even in high irradiance conditions
 - Simultaneous integration with other techniques of measurements of the field (i.e.: arrays, I-V curves measurement, thermography images, etc).

EL image of 4 PV modules with different defects and captured at the same time with CELSOS system



↓ Crack Presence ↓ PID Pattern ↓ Series resistance problem ↓ No defects

TECHNICAL FEATURES OF CELSOS SYSTEM

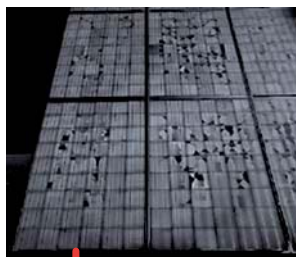


- Control software completely implemented by CENER
 - Measurement's parameters fit to the concrete conditions
 - Potential integration of different kinds of cameras (InGaAs - Silicon)
- Multi-range power supplies up to 15kW (up to 1500V)
- Integration of different optical filters and objectives
- Simultaneous capturing of visible and EL images
- Own detection algorithm to measure with the best quality during the 24 hours of the day.

Overlay of visible and EL images of a PV array in a fixed installation integrated in the building facade

FEATURES OF CENER'S ANALYTICAL SOFTWARE

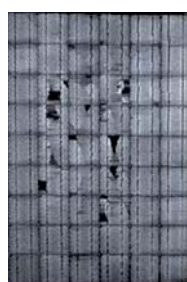
EL image of 4 PV modules



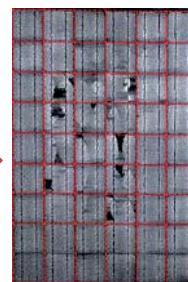
Module to be analyzed



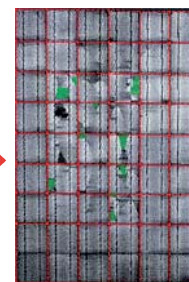
Detection of module's border



Perspective correction



Detection of cell's limits



Detection of isolated areas



0%	0%	0%	0%	0%	0%
0%	0%	0%	0%	0%	0%
0%	17%	0%	13%	0%	0%
0%	0%	3%	0%	0%	0%
0%	0%	6%	12%	0%	0%
0%	9%	0%	9%	0%	0%
0%	0%	0%	14%	0%	0%
0%	0%	0%	0%	0%	0%
0%	0%	0%	0%	0%	0%

Estimation of inactive area percentage

CENER has implemented an advanced analytical program to process the EL images captured on the field, and for the automatic detection of potential defects

- Advanced processing of the EL image: noise reduction and sharpness improvement
- Automatic detection of module's and cell's borders
- Automatic correction of the original image's perspective
- Direct overlay of the visible and EL image
- Automatic detection of the main defects: cracks, isolated areas, PID pattern, etc.
- Automatic generation of a complete record with all the measurement's data