

Introduction

A proceeding to perform a quality inspection of a PV plant under mismatch loss due to the installation of different classes of PV, has been proposed. The PV plant was composed by a total of 18 classes of different PV modules from 5 different manufacturers, which electrical features were analyzed by a database. The procedure established has been based on 3 test; visual inspection, IR thermography and electrical monitorization.

PV plant features:

- Rated power: 2.85 MW.
- N° of PV modules: 13485
- Technology: polycrystalline
- PV module classes: 18

Methodology

Based on →

IEC 61215-1

IEC 62446-3

IEC 61724-1

Inspection time: 3 days

1. Physical location of PV modules



2. Visual inspection



4. Electrical monitorization & mismatch



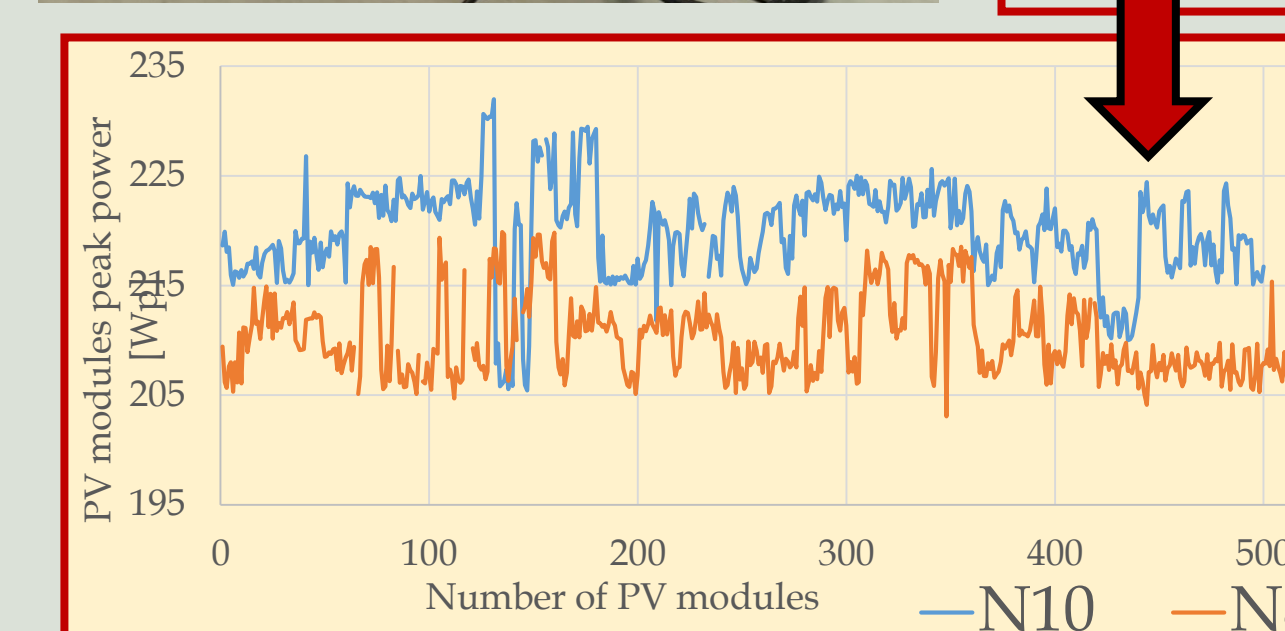
Inverter	Brand	Class	N° of PV Modules	PV A PP
N20	Brand 2	225Wp 200Wp	494	111.15 kWp
N28	Brand 2	205Wp 210Wp 215Wp	540	112.10 kWp
N27	Brand 2	215Wp 220Wp 225Wp	520	109.30 kWp
N18	Brand 3	210Wp 230Wp	446	102.00 kWp
N1	Brand 1	270Wp 205Wp	408	110.16 kWp
N6	Brand 2	210Wp 215Wp	540	112.50 kWp
N10	Brand 2	215Wp 220Wp	500	109.90 kWp
N8	Brand 2	210Wp	520	109.20 kWp

3. Infrared (IR) thermography at the rear of the PV modules

More than 800 IR thermography images.
IR camera: FLIR ThermoCAM S60
Software: ThermoCAM Researcher Pro 2.7.



IR camera configuration according to G. Alvarez-Tey, R. Jimenez-Castañeda, and J. Carpio "Analysis of the configuration and the location of thermographic equipment for the inspection in photovoltaic systems," Infrared Phys. Technol., vol. 87, no. C, pp. 40-46, Oct. 2017.



$$MPF = \frac{HVMP(Wp) - LVMP(Wp)}{HVMP(Wp)}$$

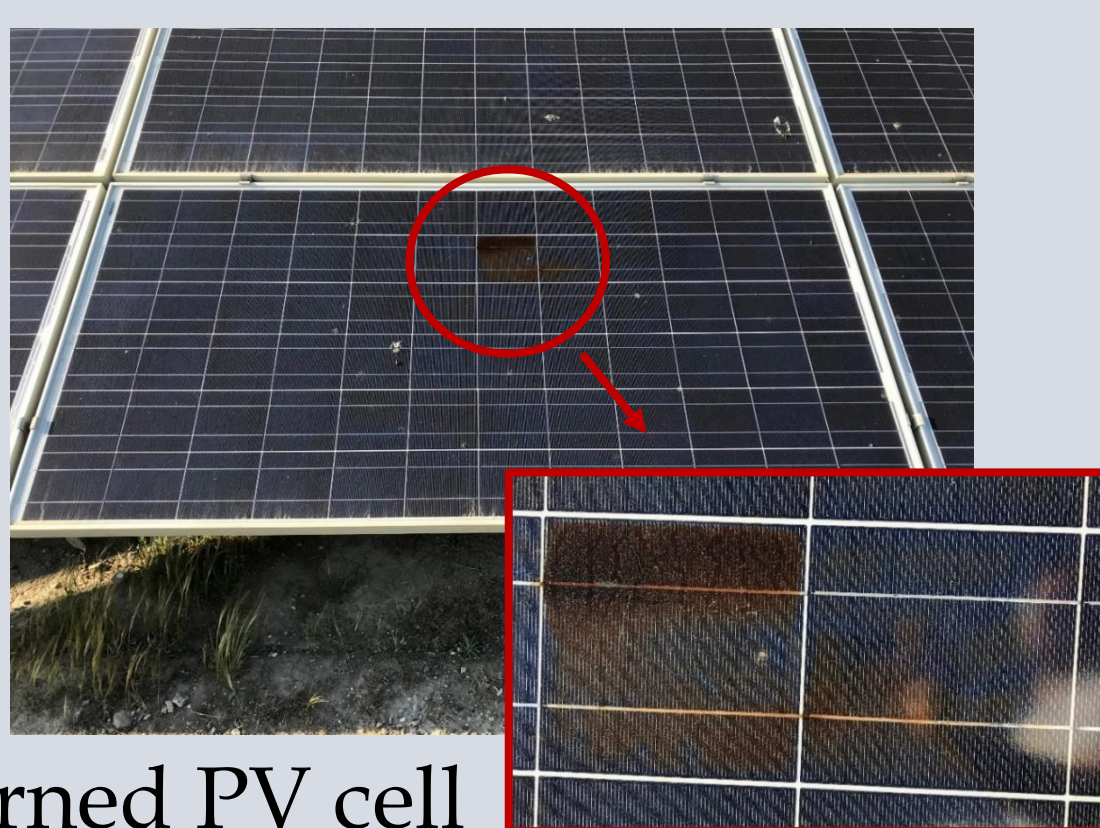
- MPF mismatch power factor
- HVMP highest value of PV peak power connected in each inverter.
- LVMP lowest value of PV peak power connected in each inverter.

Results

2. Visual inspection



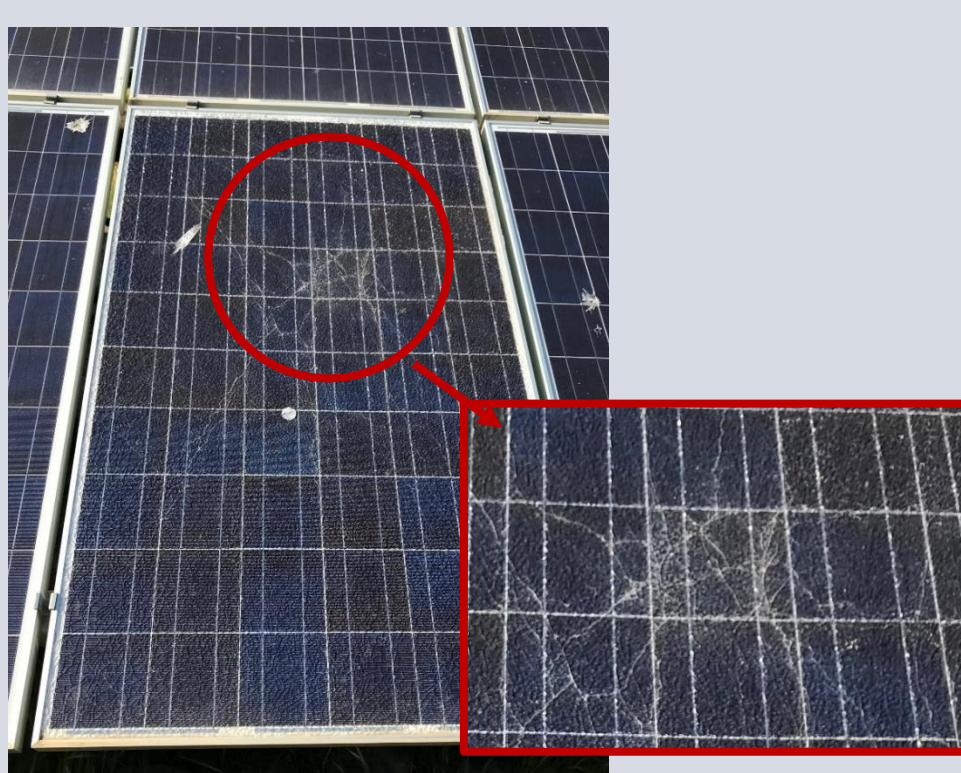
Connection of different PV mod.



Burned PV cell



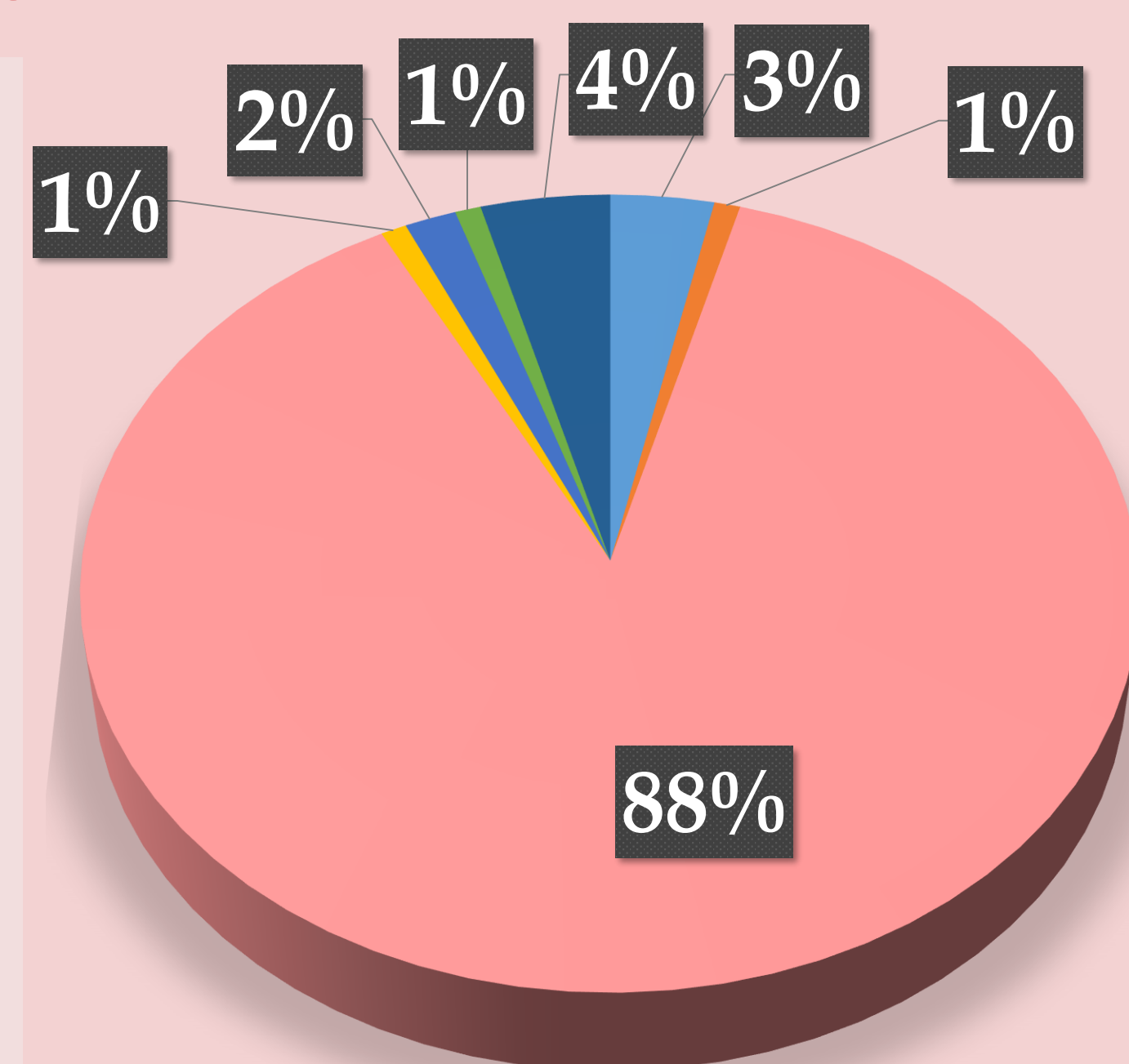
Discoloration



Broken front-glass

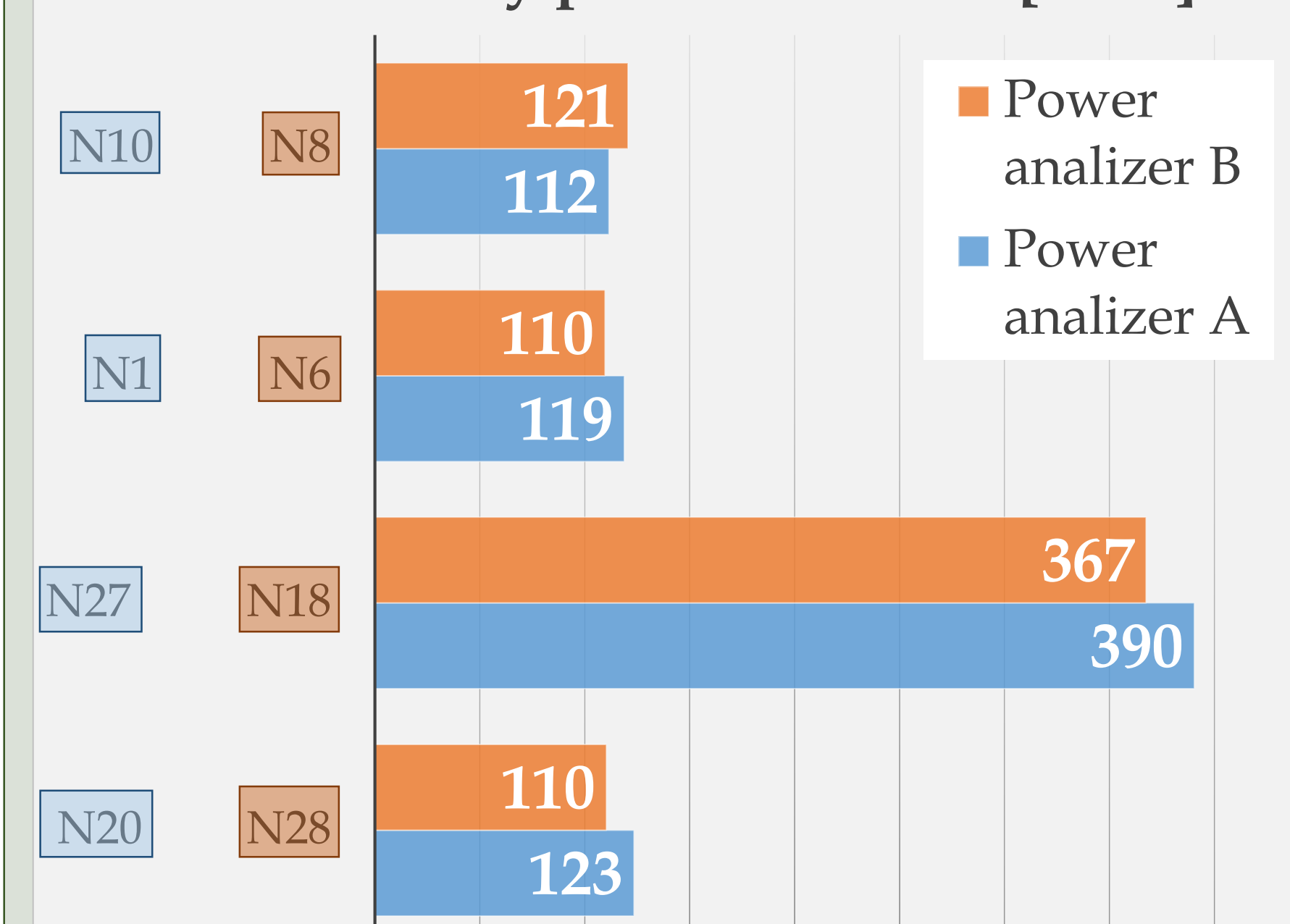
3. Infrared (IR) thermography

- PV String disconnected
- Junction box burned
- Hot spots
- PV module disconnected
- PV module short-circuited
- PV module shaded
- PV module substring disconnected

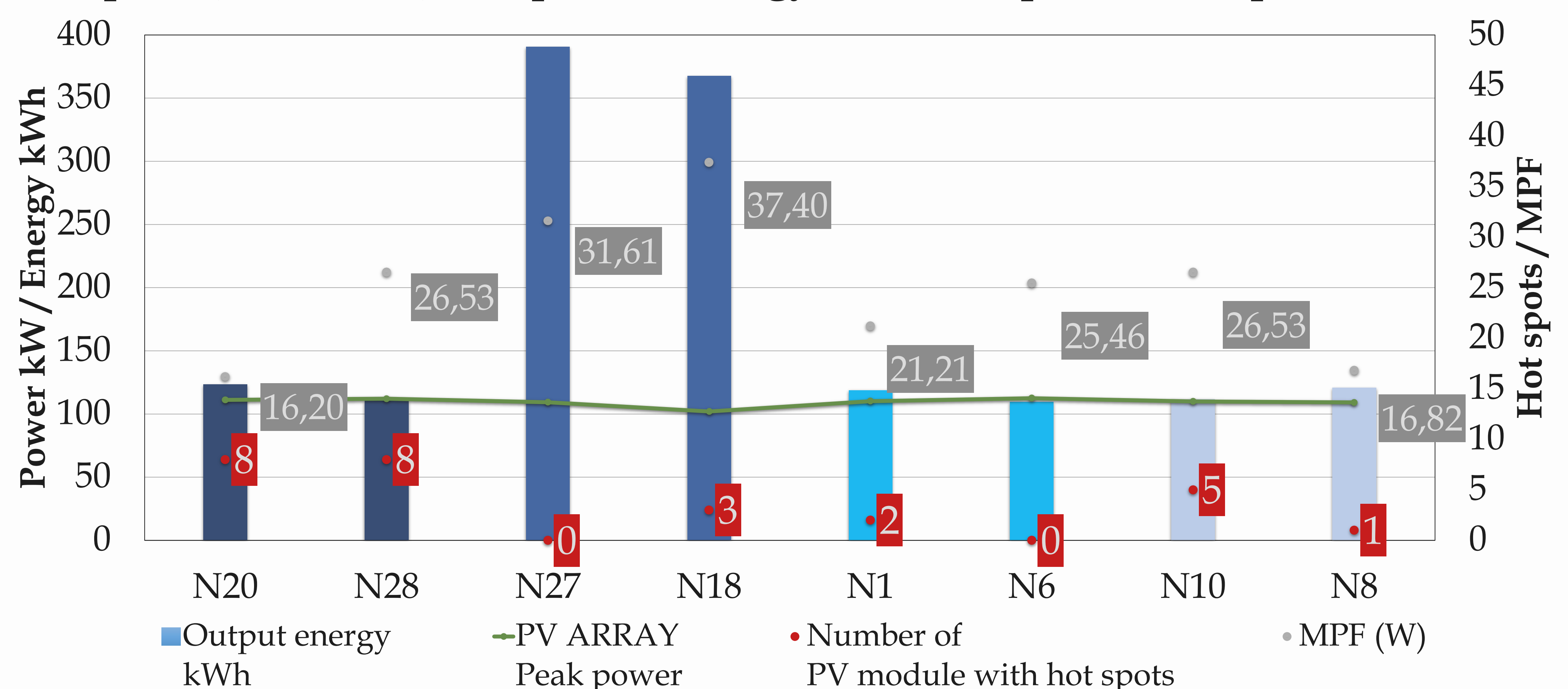


4. Electrical monitorization

Comparison of output energy measured by power analyzers [kWh]



Peak power, mismatch, hot spot and energy relationship in the compared inverters.



Conclusions

- ✓ Several front front-side defects were found in the visual inspection; discoloration, browning, yellowing, burned PV cells, snail tracks, milky and broken front-glass, and the connection of different PV modules classes
- ✓ IR thermographic inspection results have shown that less than 1% (0.76%) of the whole PV plant has been affected by thermal anomalies, of which 88% was categorized as hot spots.
- ✓ The electrical monitoring results shown a homogeneous injection of electrical energy between inverters compared, but with a certain difference, since, inverters with higher values of MPF in their PV arrays injected less energy.