

ATAMOSTEC Project: Atacama Desert PV Platform



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TECNOLOGÍAS FOTOVOLTAICAS DE ATACAMA



The Atacama Desert

105.000 km² Area

2.500^(GHI)/3500^(DNI) kWh/m² year Average irradiance

4.000 HOURS Average annual hours of sunlight

Average annual hours of sunlight

65% UV-B IRRADIATION Above European average

Above European average

T < 30° CELSIUS Average temperature in summer

Average temperature in summer

2 mm Average annual rainfall in some desert areas

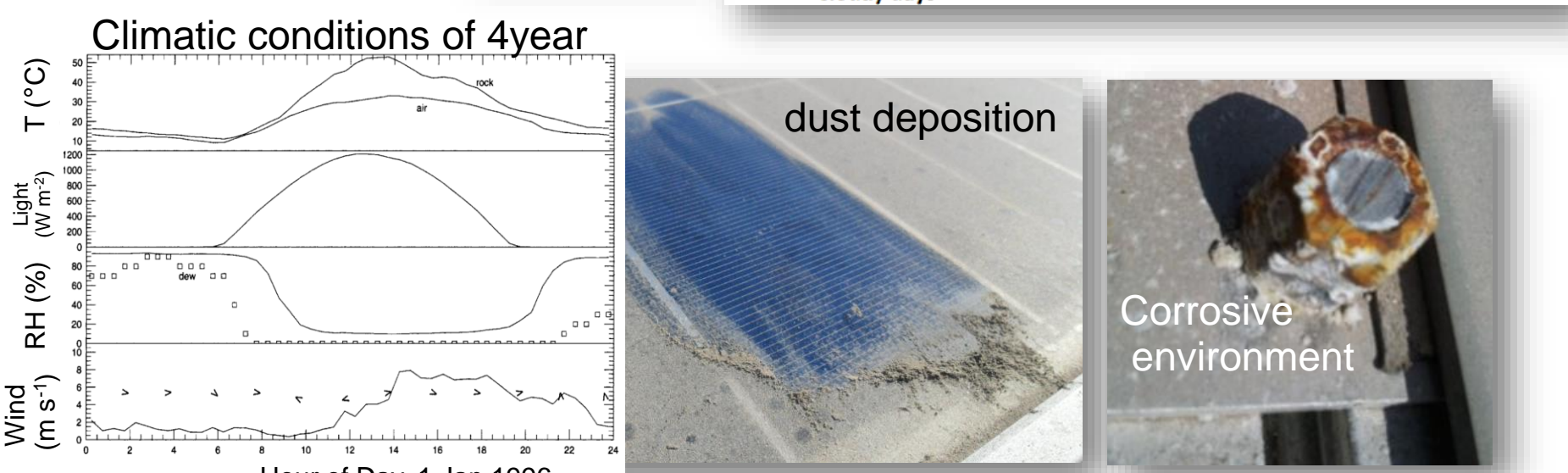
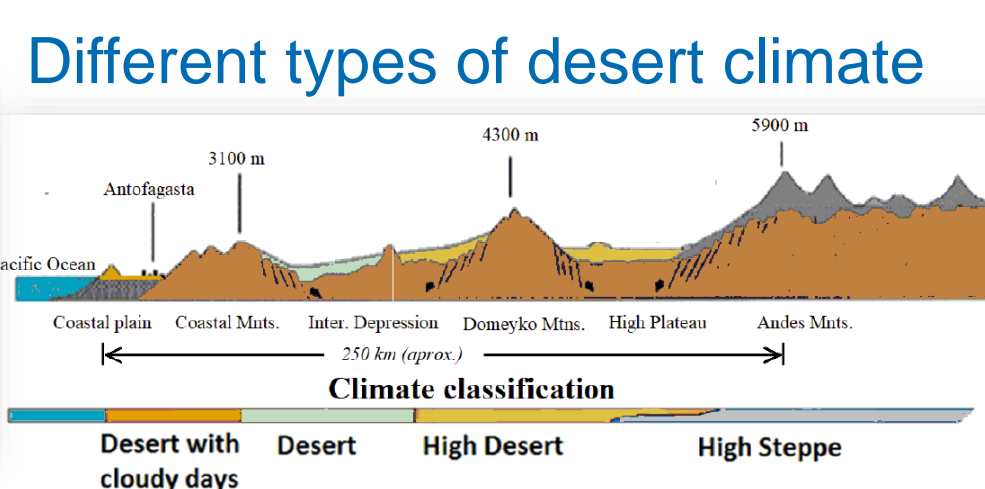
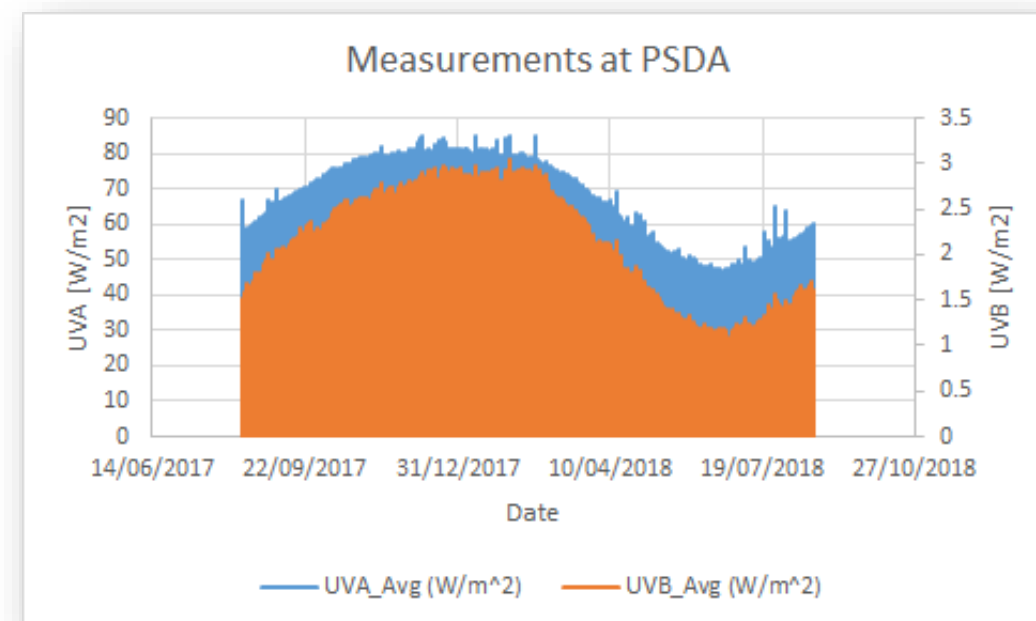
Average annual rainfall in some desert areas

Systematic winds In speed and direction (east-west)

High energy consumption Mining activities

Challenges

- Extremely high UV-B levels
- Specific solar spectrum
- High albedo of desert sand
- Corrosive environment
- Partial high humidity
- Various geographic areas
- Sticking fine dust
- Water scarcity
- High seismicity

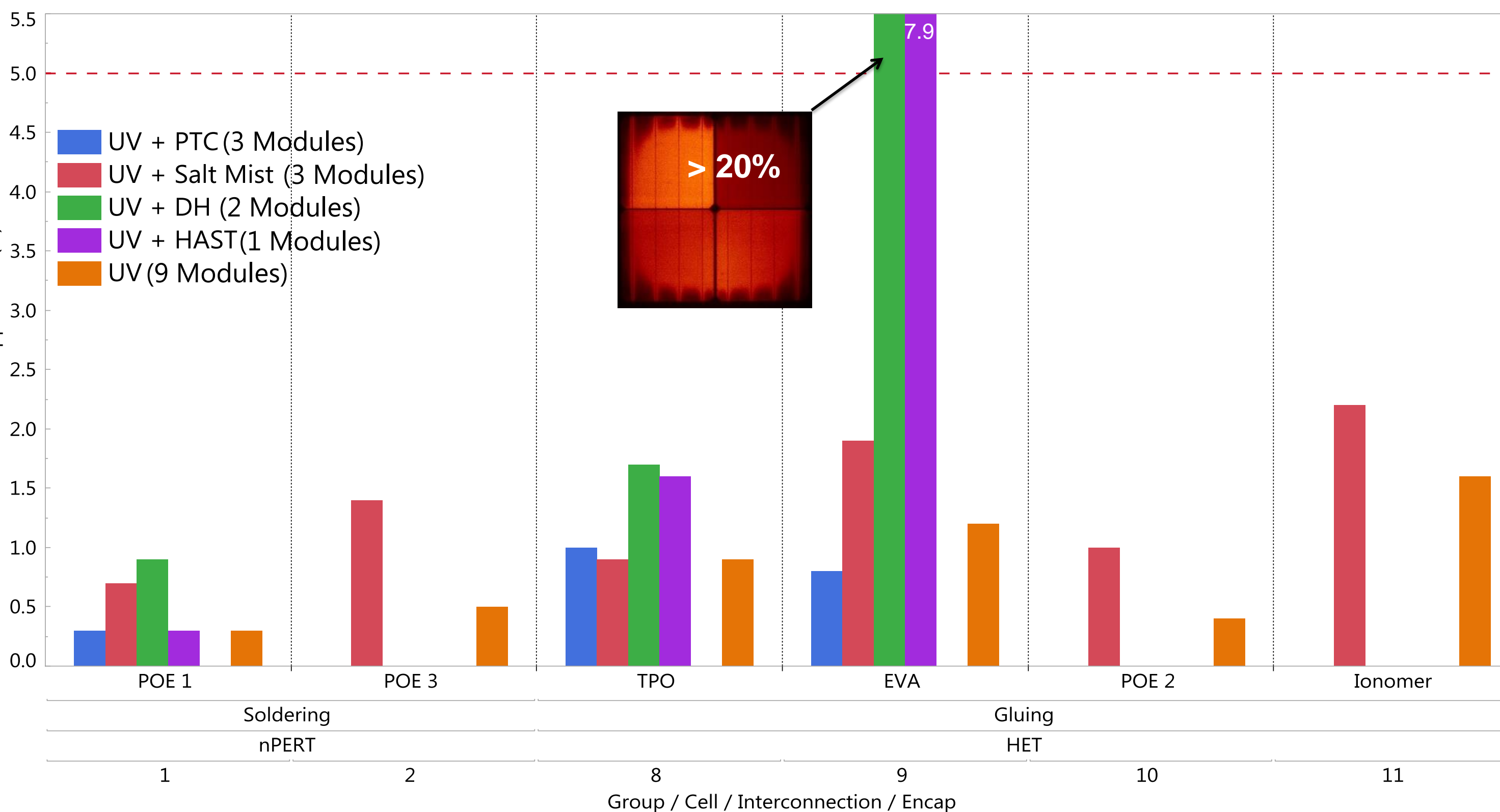
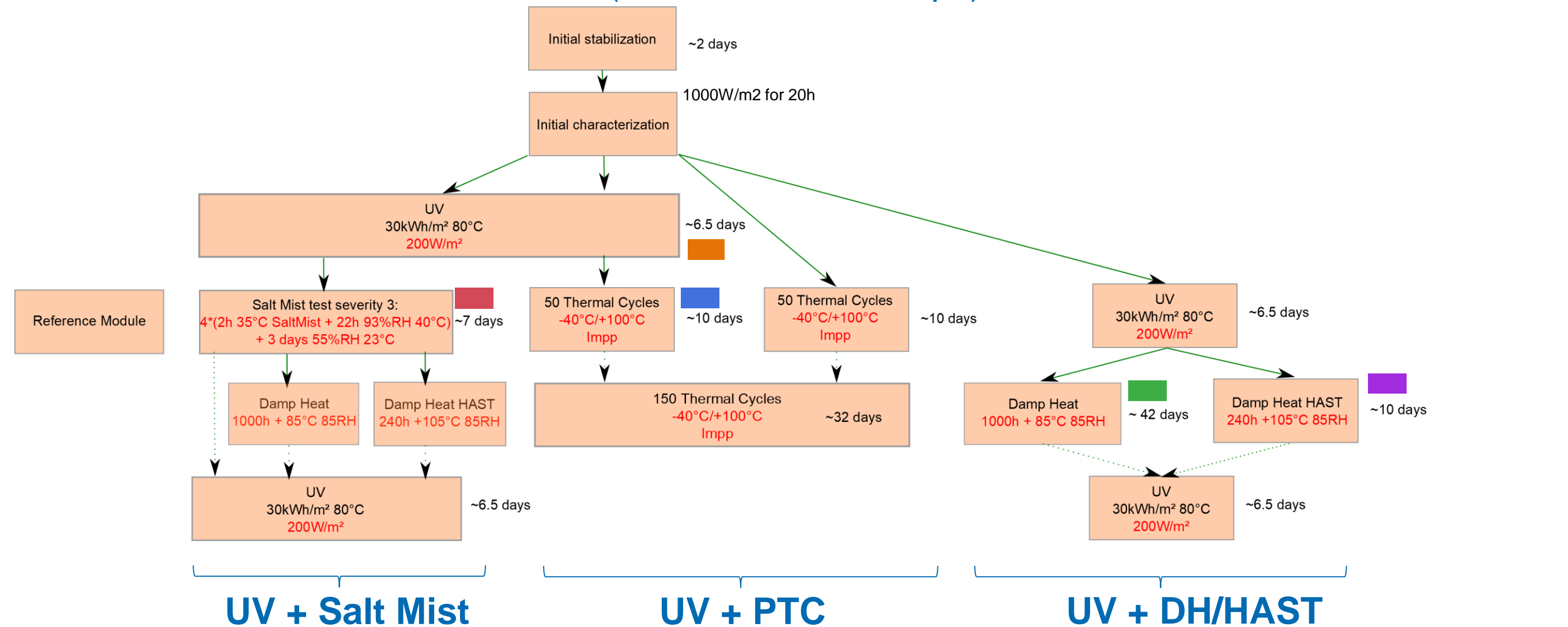


- PV system performance and longevity strongly affected
- International Standards only partly applicable for the evaluation of the module reliability and durability
- Bifacial glass-glass modules are a very promising option

Indoor characterization (preliminary results)

[1] J.-P. Lelievre et al., 4AV.1.37, presented on the 36th EUPVSEC, 2019

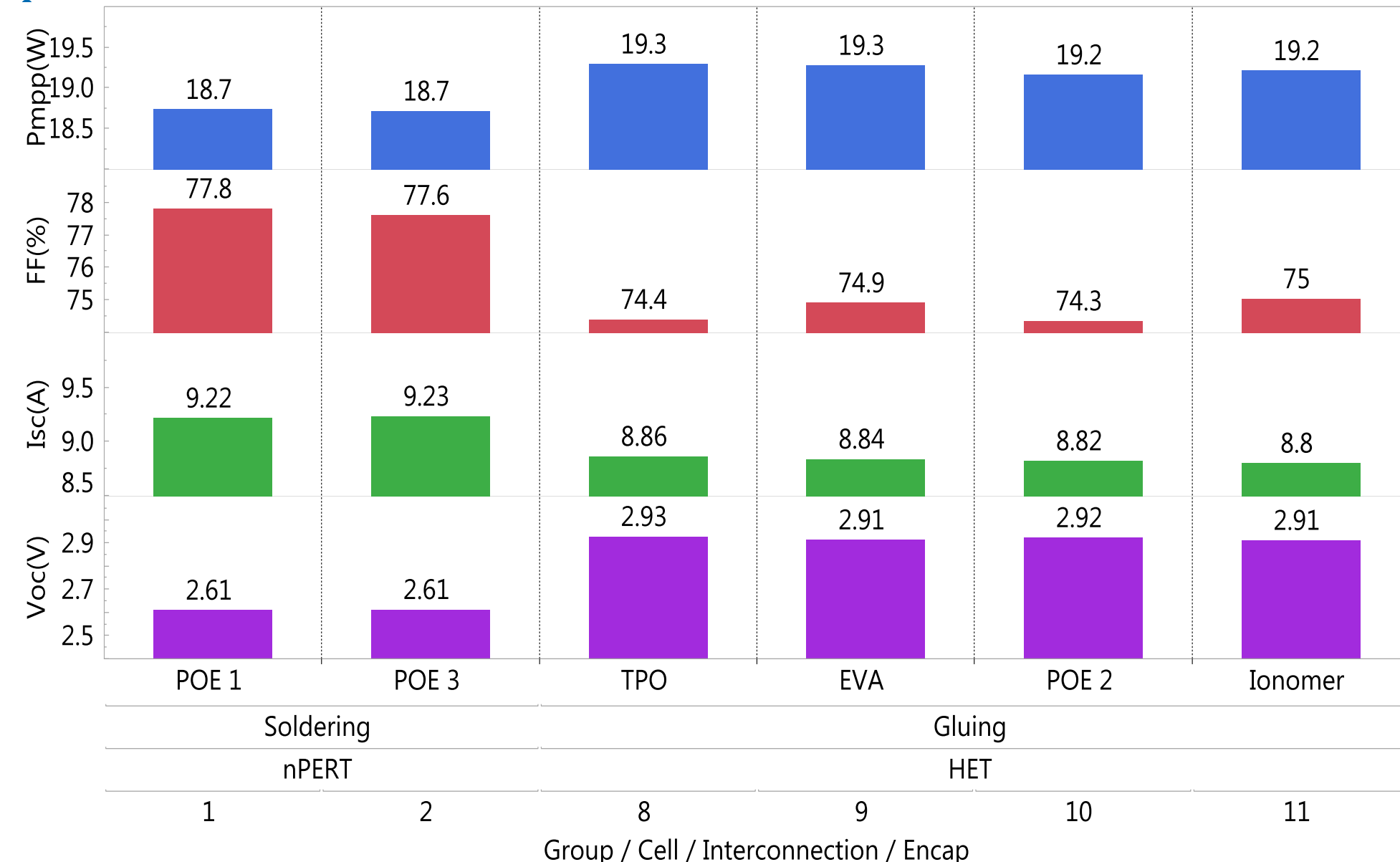
- Reliability and durability Investigations through the development of new ultra-accelerated ageing test protocols adapted for desert conditions. Objectives:
 - Reduction of time and increase of aggressiveness for accelerated ageing tests
 - Investigation of impact of higher UV doses (+ intensity) at higher temperature
 - Evaluation of impact of:
 - UV and PTC (TC+Current injection+higher temperature range),
 - UV and DH (correlation with more aggressive HAST chamber)
 - Salt mist corrosion test procedure and UV
 - Manufacture of 4-cell modules (nPERT and HET) with different material and configurations for ultra accelerated indoor tests (in total ca. 30 Groups)



- Groups pass all tests (Pmp losses < 5%) except Group 9 based on EVA encapsulant (deliberately chosen to evaluate the sensitivity of each tests). Ageing tests ongoing.
- All Groups based on 4-cells ready for implementation in the PSDA. Outdoor data needed for testing technology and indoor ageing methodology.
- Group 1 (nPERT+POE1) and Group 8 (HET+TPO) were manufactured in 72-cell glass-glass sizes and installed in the PSDA for energy yield studies. Both developments correspond to the first module version of the ATAMOSTEC project.

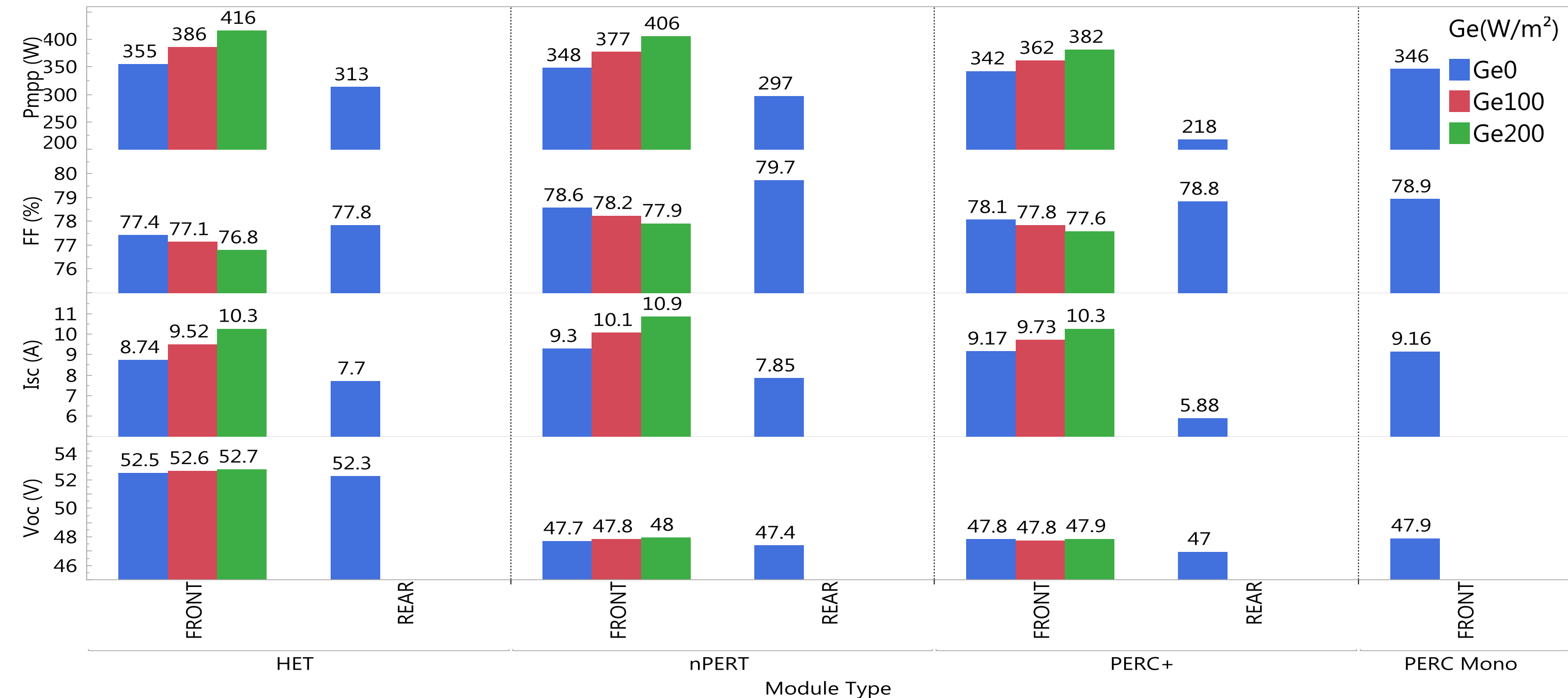
Module Development: Bifacial & double glass

- 4-cell modules on nPERT and HET technologies with different types of configurations: Soldering vs gluing, Half vs Full cell design, different encapsulants and glasses (with and without coatings), installed in the PSDA (Atacama Desert Solar Platform) and for ultra accelerated indoor tests.
- Mini-modules were fabricated for the PSDA with 26 lines of outdoor IV monitoring.



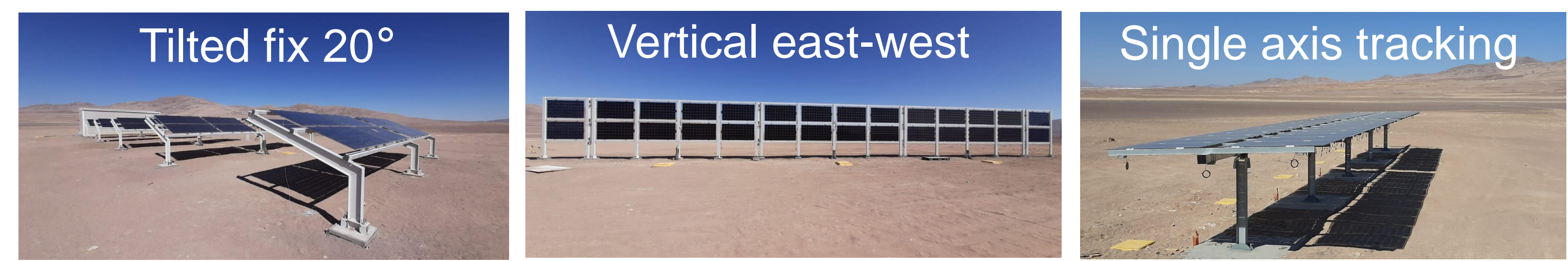
- Front IV data of 6 Groups (of 30 mini-modules):
 - HET modules exhibit higher Pmp and Voc than nPERT modules while nPERT modules achieve better FF and Isc.
 - Group 1 (nPERT+POE1):
 - Glass with anti-reflective coating increase Pmp (1.3%) due to Isc increase.
 - HALF cell design increase Pmp (2.6%) due to the better FF (less resistive losses).

- 72-cell modules based on nPERT (ATAMOS1), HET (ATAMOS1), PERC+ (as bifacial reference) and PERC mono (as mono reference) technologies are installed in the PSDA.
- FRONT and REAR IV data including equivalent method for bifacial modules according IEC TS 60904-1-2:2019 were performed. This method considers that bifacial cells operate at a higher total irradiance (rear side illuminated) and takes into account the related increased in resistive losses.
- The graph below compares the bifacial architectures with the monofacial reference at a given rear side illumination (Ge=STC, Ge100=100W/m² & Ge200=200W/m²).



Energy yield measurements

- Monitoring of 3 different bifacial technologies (nPERT, HET, PERC+) installed in 3 types of different structures: vertical, tilted and horizontal single axis tracker



- 1 MW PV Plant with HSAT. 25% of possible change in the plant for R&D investigation
- Outdoor Laboratory network, equipment and infrastructure in Chile



Conclusions

- The Atacama Desert offers unique conditions for solar energy, but at the same time important challenges to guarantee the reliability and durability of photovoltaic systems.
- Accelerated ageing standards applied in the photovoltaic industry (IEC61215-2016) largely underestimate PV module degradation due to ultraviolet (UV), which is of great concern for desert applications such as Atacama.
- Development of aggressive ultra-accelerated ageing test protocol combining UV (strong intensity / dose / temperature) and Thermal Cycles / Salt Mist / Damp Heat to characterize nPERT and HET modules with different encapsulants.
- All Groups (except "bad" reference EVA) showed less than 5% relative Pmp losses after UV+PTC, UV+Salt Mist, UV+DH and UV+HAST (tests ongoing)
- Different 4-cell module configurations ready for installation at the PSDA in order to evaluate outdoor performance and to adapt indoor ageing methodology
- Energy yield studies are planned to be carried out in the Atacama Desert Solar Platform (PSDA) for 3 bifacial technologies based on 72-cell modules installed in 3 types of structures: vertical, tilted and horizontal axis tracker

Acknowledgement

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