ENERGY

O&M au service de la performance des centrales PV

Atelier d'échange sur les meilleures pratiques en exploitation et maintenance (O&M) pour les centrales PV en Tunisie

Vidipt Countcham

Tunis
mardi 25 février 2020

DNV GL: a independent quality assurance and risk management company

MARITIME

OIL & GAS

ENERGY

BUSINESS ASSURANCE

DIGITAL SOLUTIONS

150+ years

100+ countries

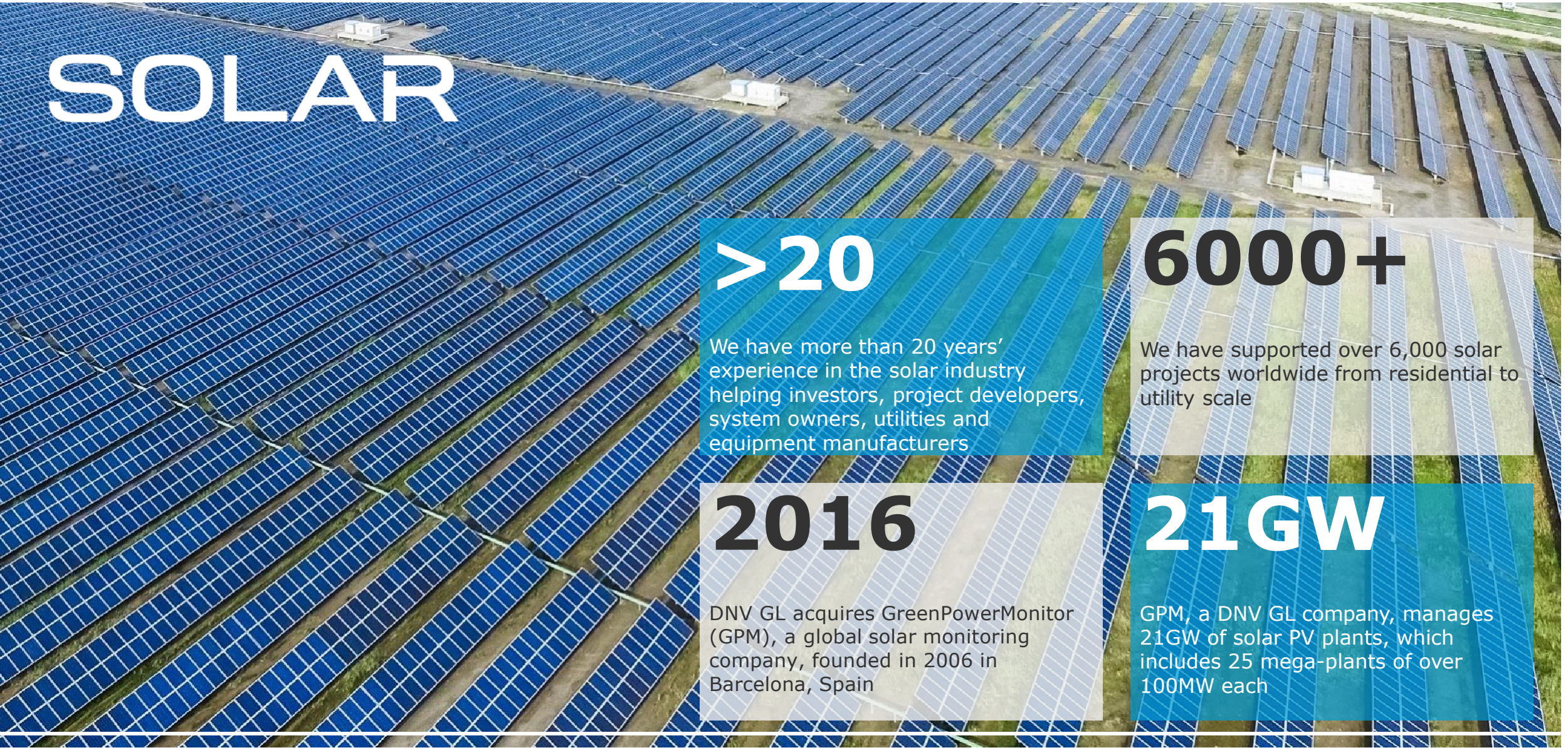
100,000 customers

12,500 employees

5% of revenue spent on R&D

DNV·GL

SOLAR



>20

We have more than 20 years' experience in the solar industry helping investors, project developers, system owners, utilities and equipment manufacturers

6000+

We have supported over 6,000 solar projects worldwide from residential to utility scale

2016

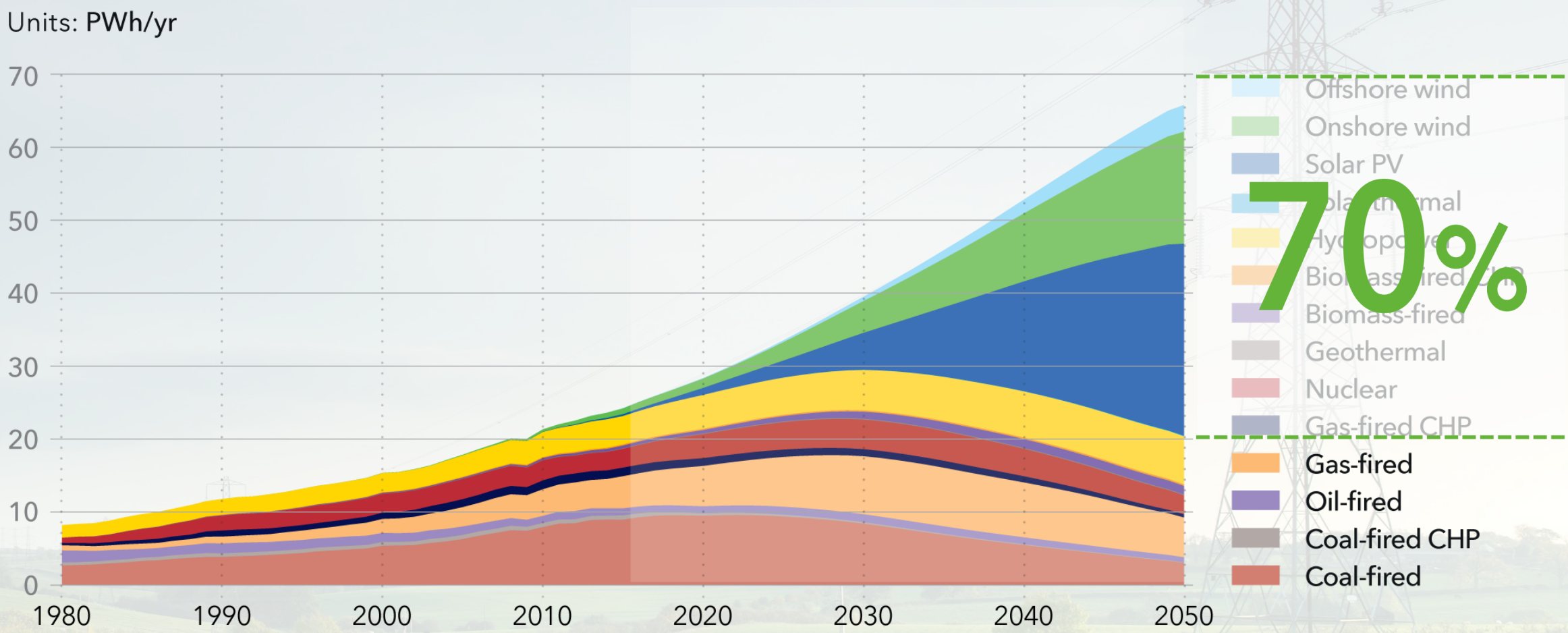
DNV GL acquires GreenPowerMonitor (GPM), a global solar monitoring company, founded in 2006 in Barcelona, Spain

21GW

GPM, a DNV GL company, manages 21GW of solar PV plants, which includes 25 mega-plants of over 100MW each

*Our testing, certification and advisory services are independent from each other

DRAMATIC RISE IN SOLAR PV AND WIND

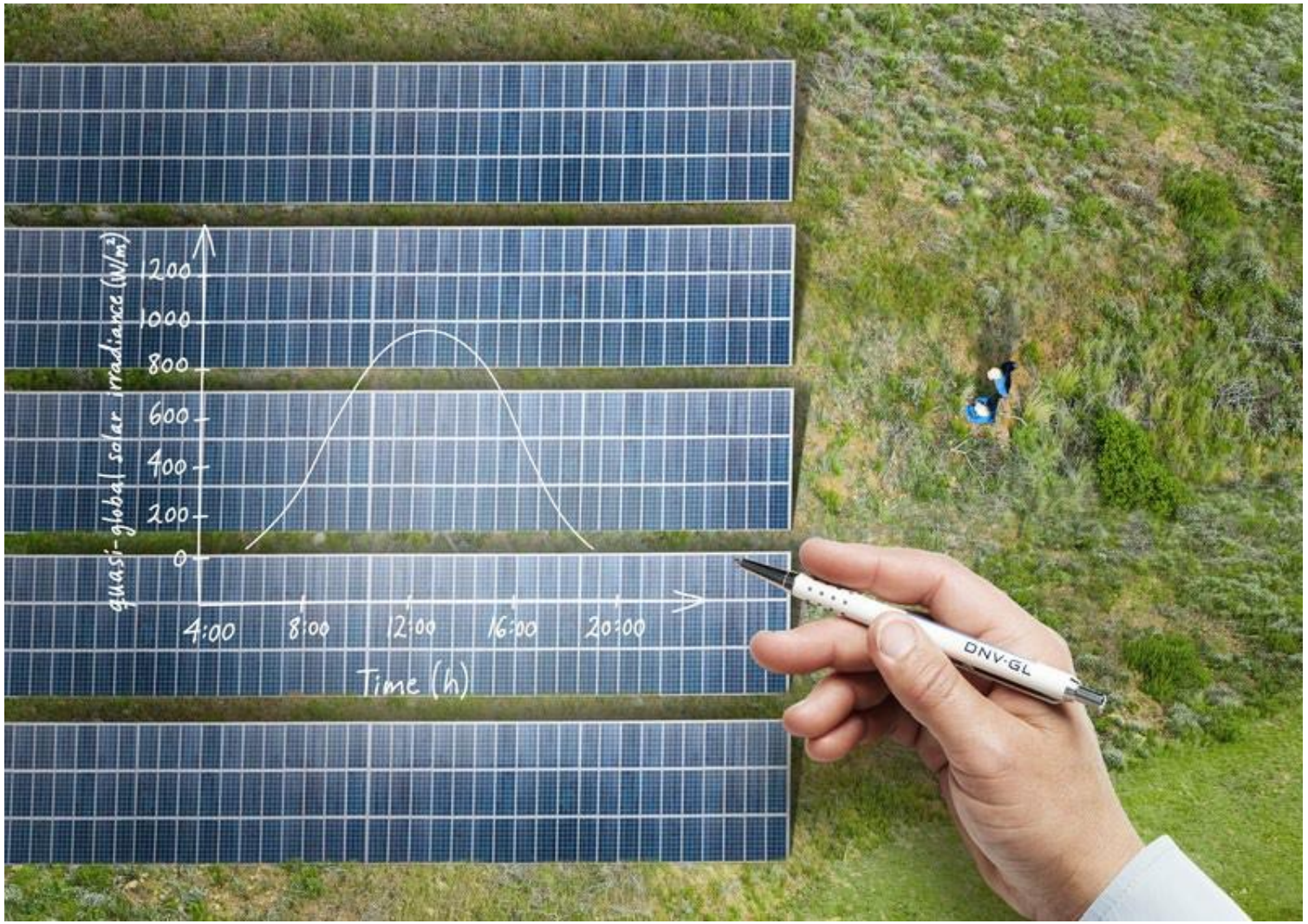


eto.dnvgl.com/2019

Failure Techniques based on monitoring performance data analysis

Maximising Energy Production and Minimising LCoE

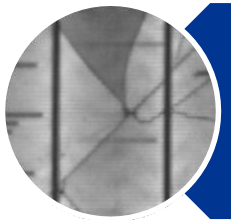
- Identifying and accurately quantifying performance loss and failures
- Ensuring reliability and optimal performance
- Reducing cost of O&M and downtime periods
- Increasing useful lifetime



Digitalisation of methods – Relationships among source of information

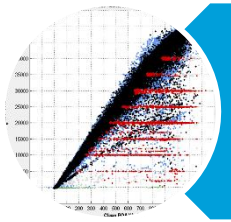
Visual Inspections

- PV array and components
- Ground conditions
- Infrastructure



Imaging Processes

- IR, EL, PL, UV
- Manually or drone supported

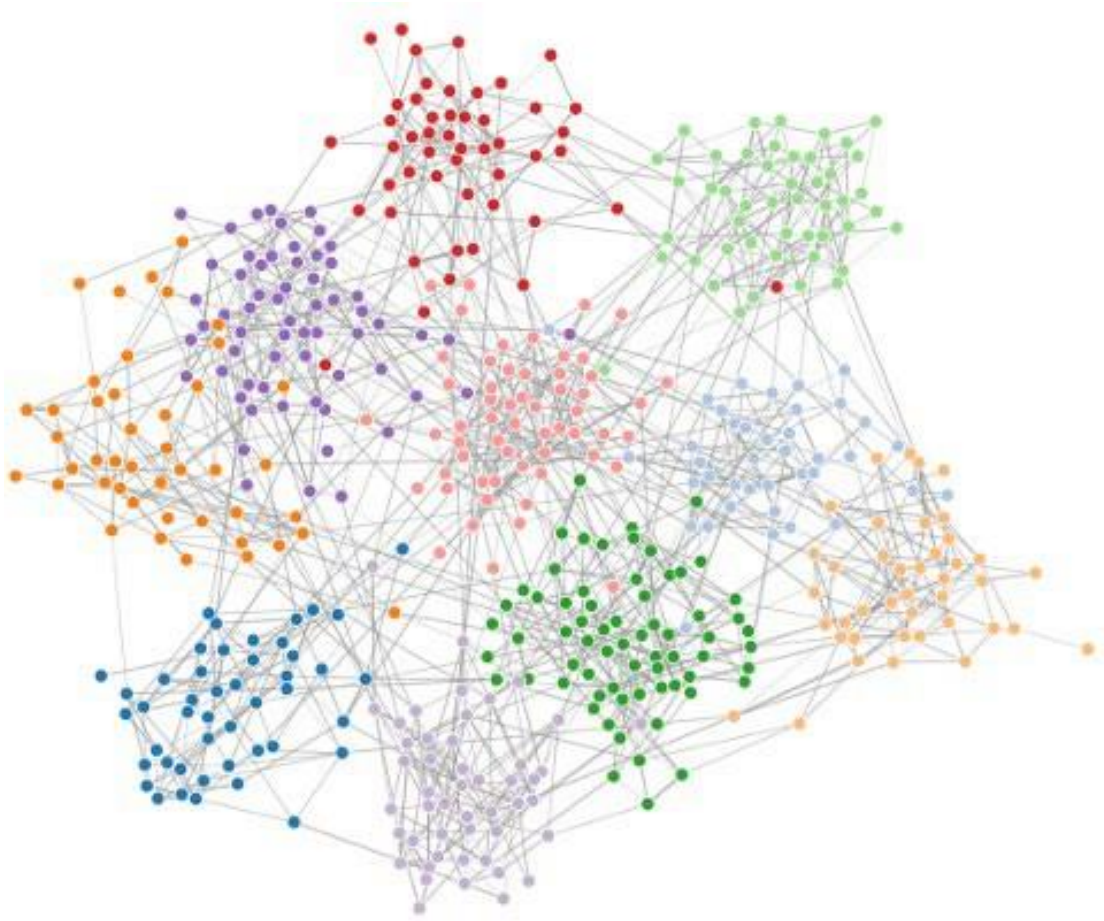


Data Analysis and O&M

- Failures and system performance
- O&M: corrective and preventive activities

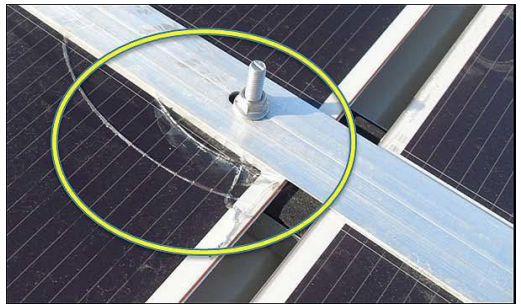
Measurements and Testing

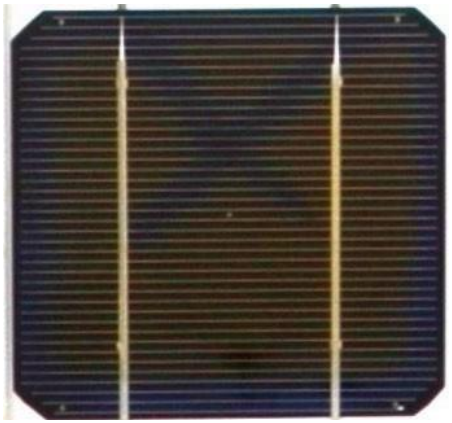
- Characterisation of components: PV module (flash test, IV, IR, EL), inverters settings, structures, solar resource.



Failure diagnose methods – Visual Inspections

Visual Inspections

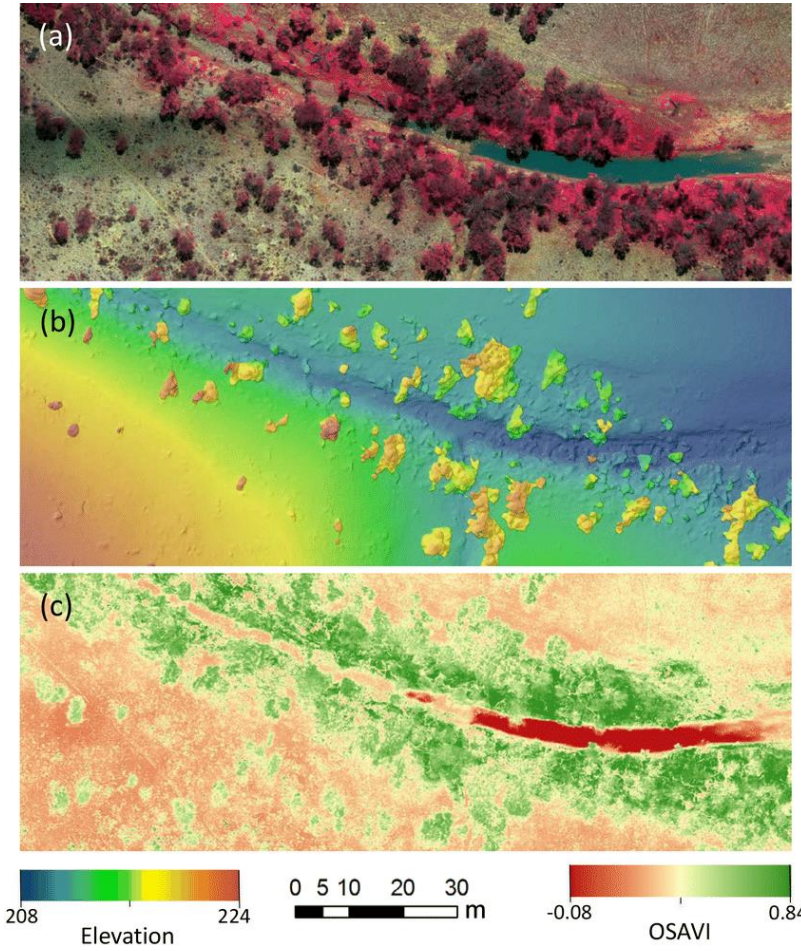


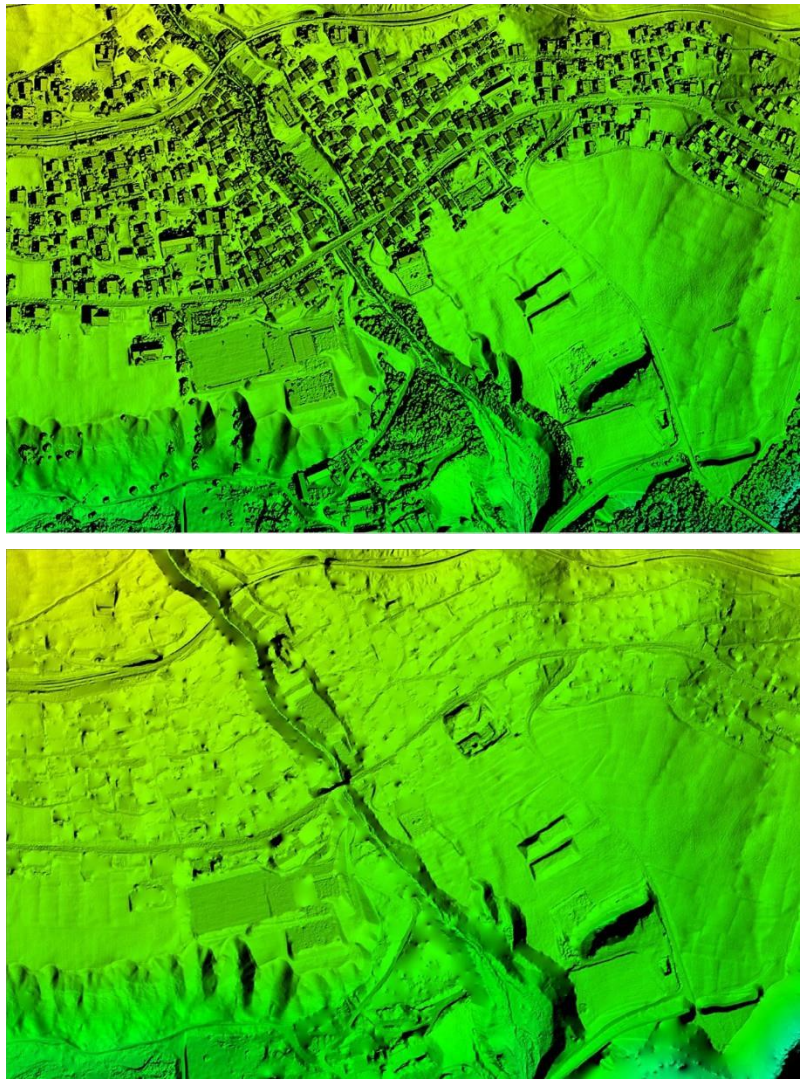


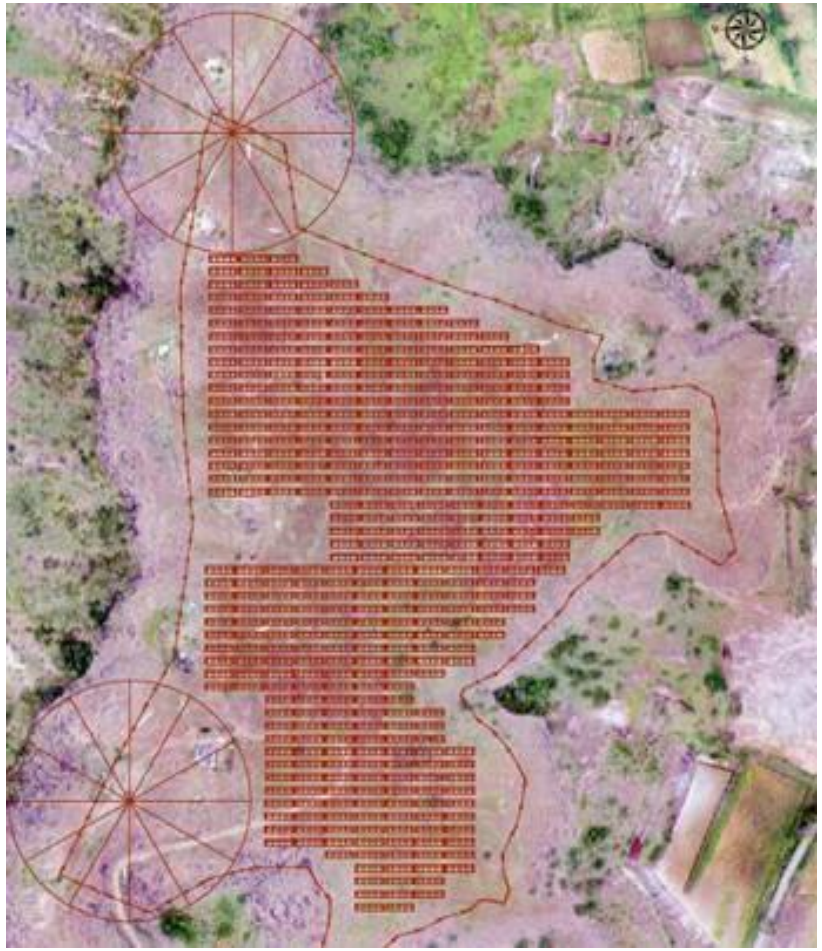
Integration of UAV digital applications

- **Pre-construction**: land surveying, cartography, topographic, elevation models (DTM, DSM, DEM, TIN), 3D mapping.
- **Construction**: progress monitoring, reception and delivery, quality inspections, stock levels.
- **Operation**: IR inspections, shadows, vegetation control, security perimeter, internal roads, drainage system.

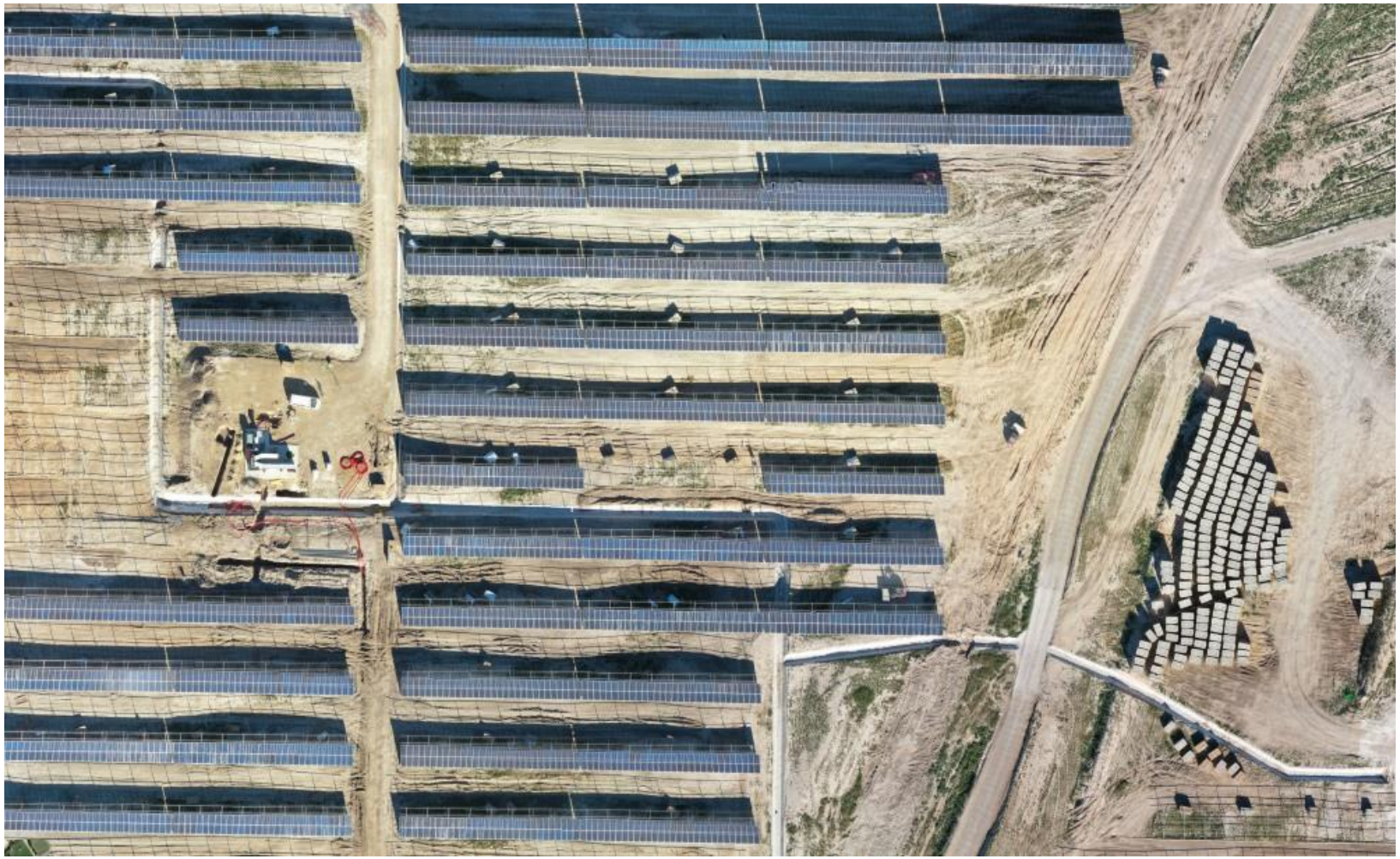
Integration of UAV digital applications – pre construction



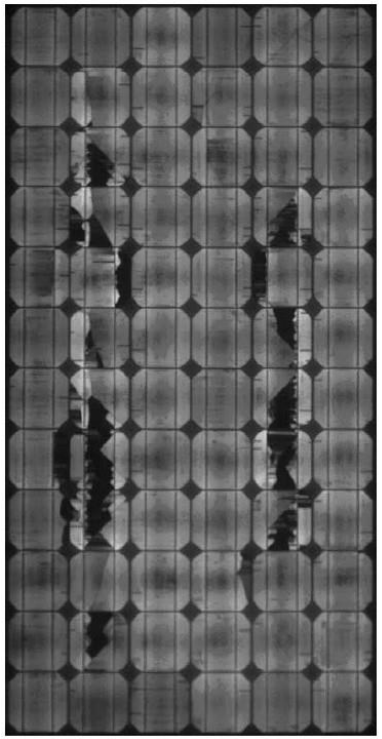


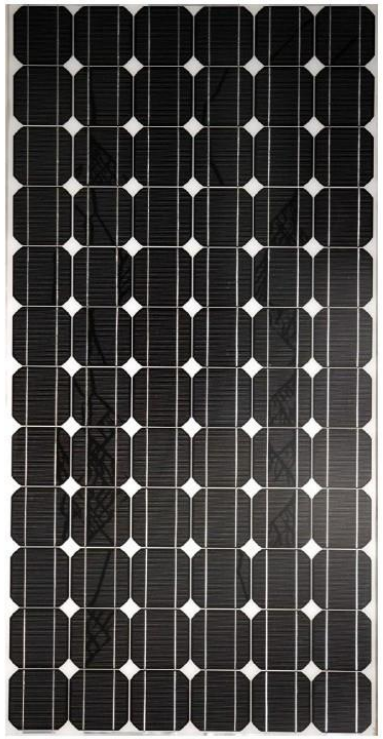


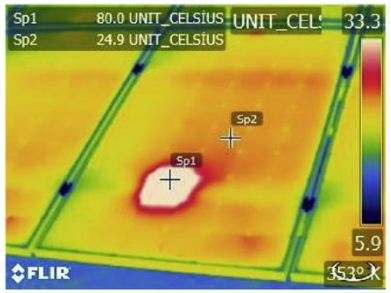
Integration of UAV digital applications - construction



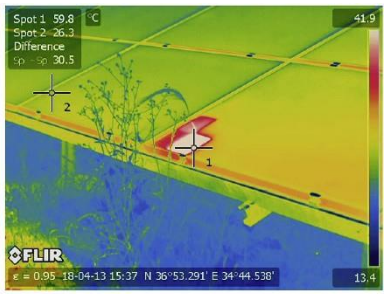
Failure diagnose methods – Imaging Processes



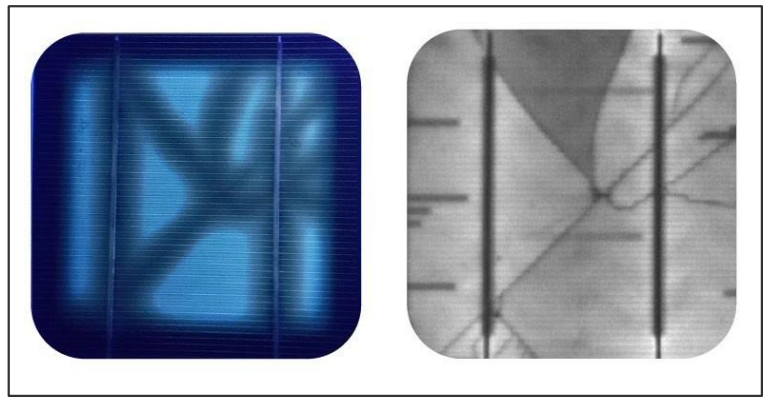




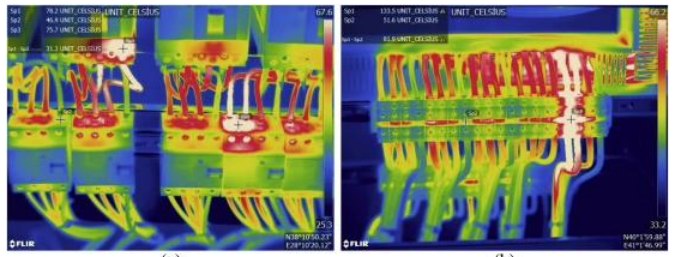
(a)



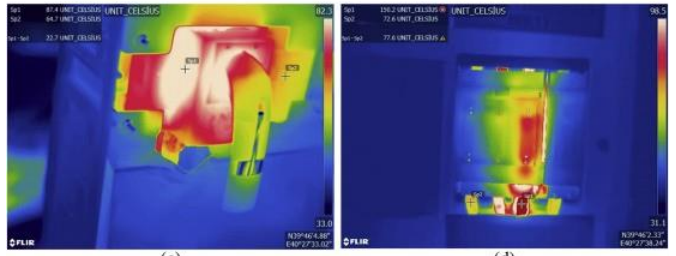
(b)



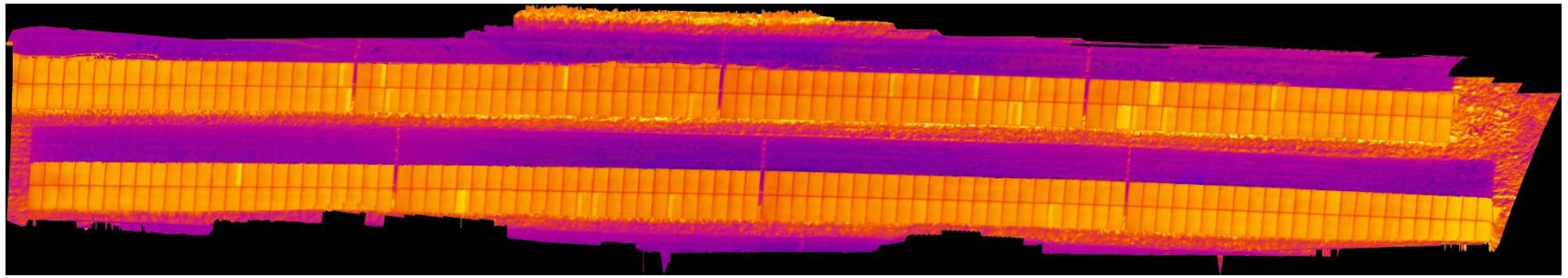
Imaging Processes



(a) (b)



(c) (d)



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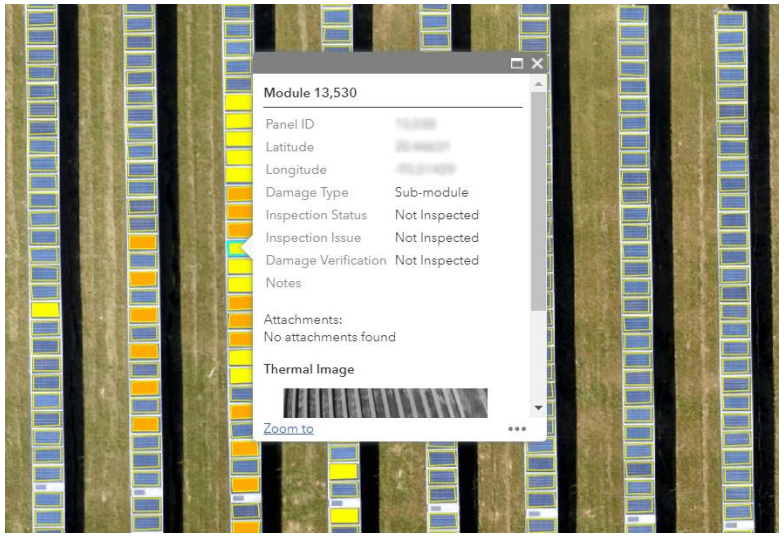
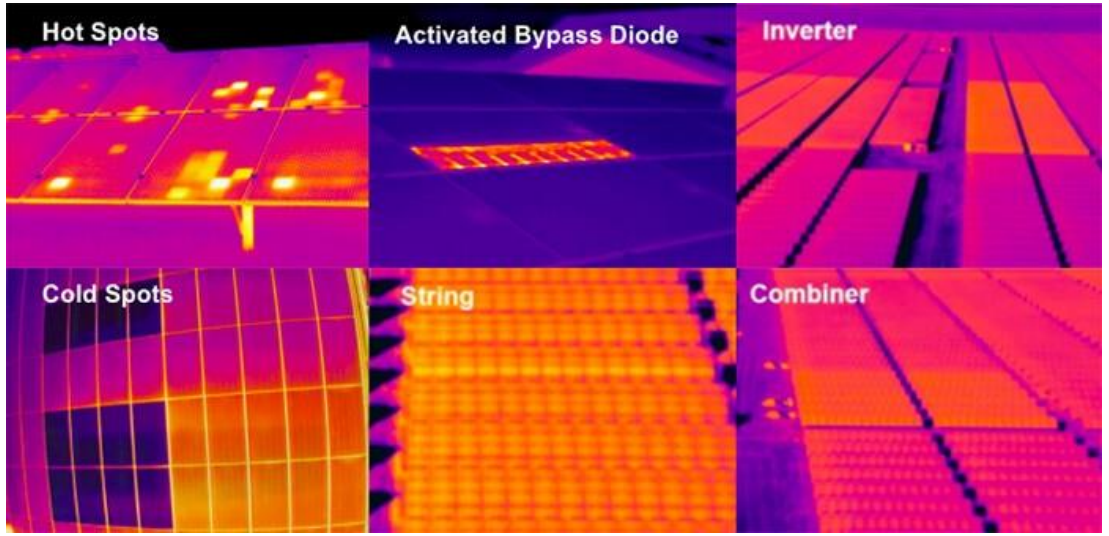
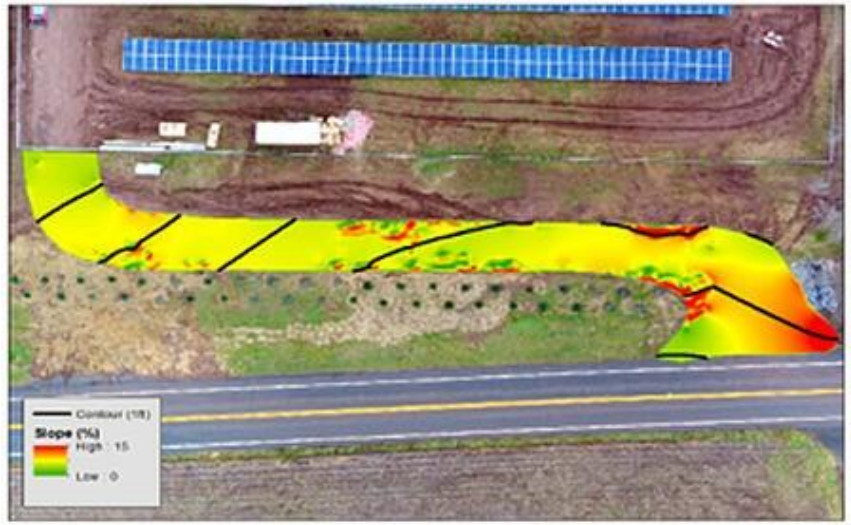
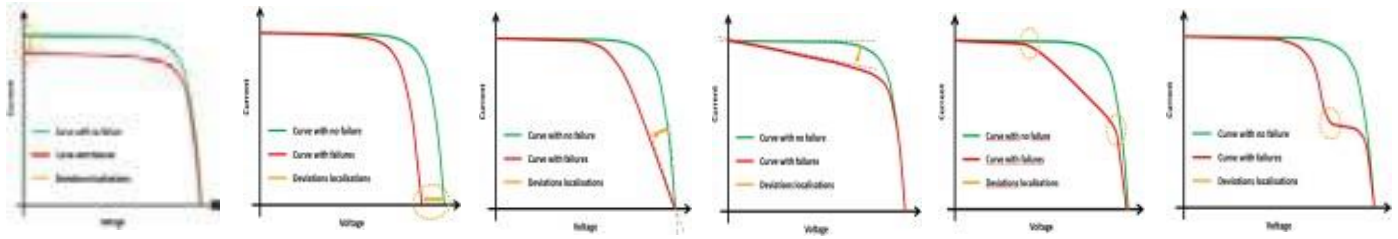
Integration of UAV digital applications - operation

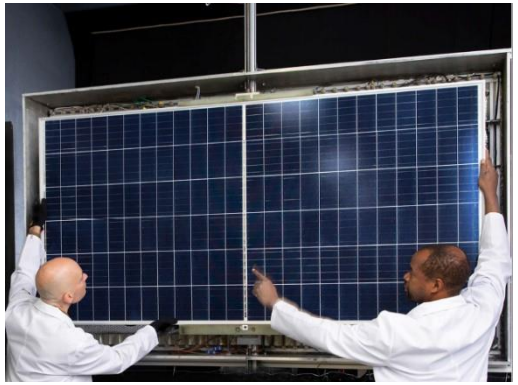


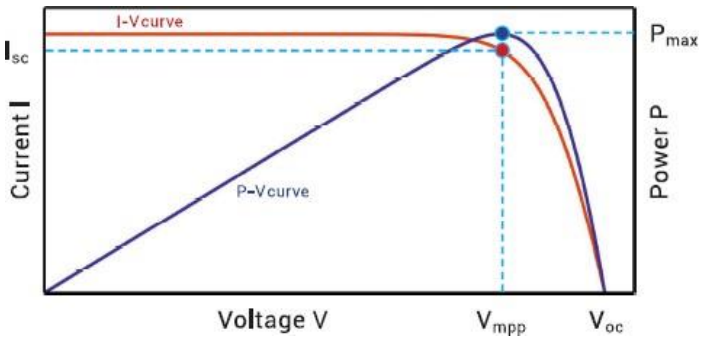




Failure diagnose methods –Measurements and Testing







Measurements and Testing

Failure diagnose methods – Data Analysis and Documentation

Quality of Data

- Data Availability: communication issues, maintenance, data storage system and format.
  - Correlation with Satellite or LT reference source and O&M Reports (log issues).
  - Selection of parameters (IEC 61724): Irradiance – Environmental – DC – AC – Tracker – Metering data

- Data Quality:
  - sensor quality and uncertainty, outliers, redundant, spurious and stuck data.
  - What do we do with those "blind" periods → they have to be considered in some way.

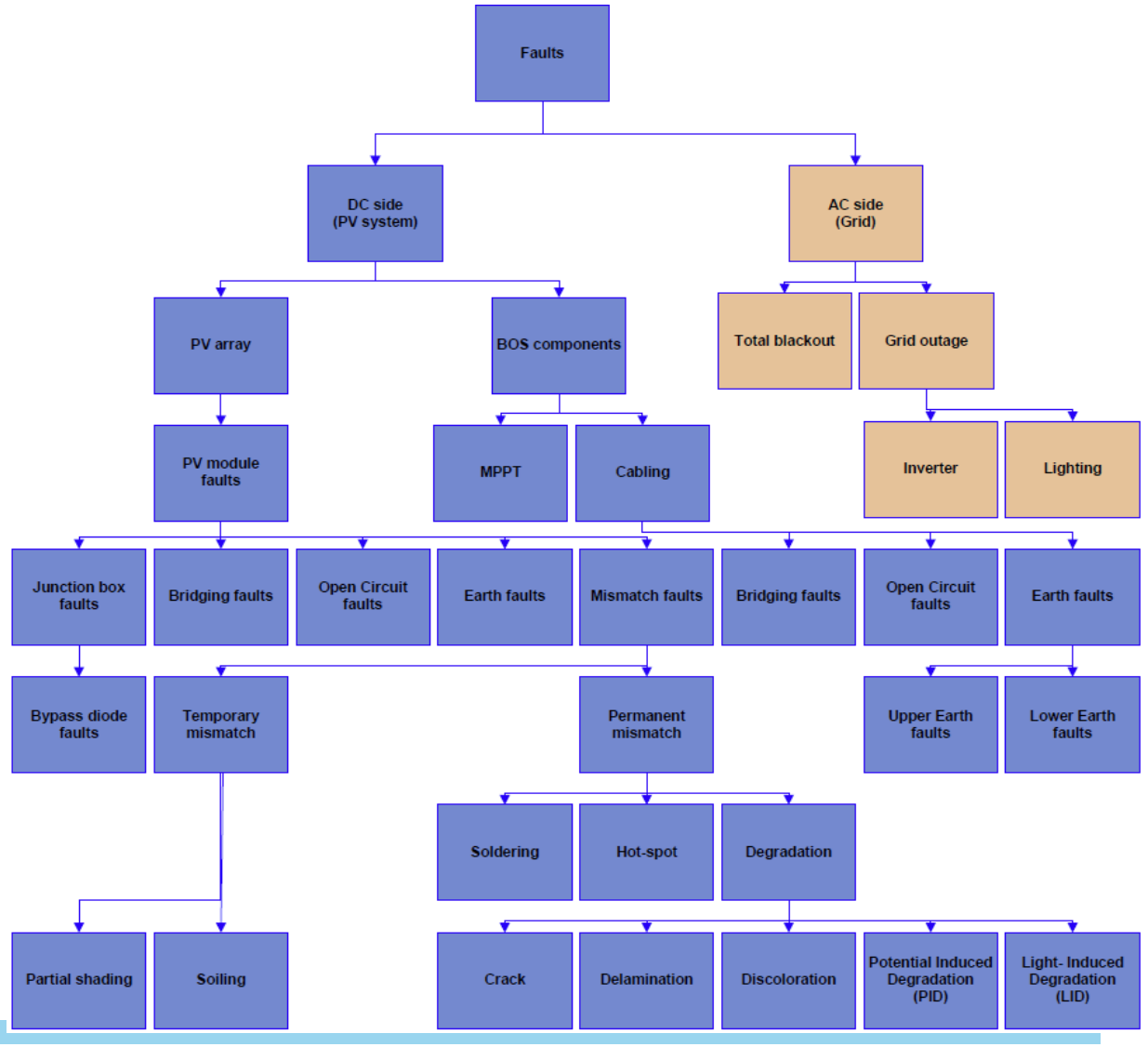
Data Analysis and Documentation

- Representativeness: which is de minimum data availability to be representative? Sampling, averaged interval and period.
  - Degradation and uncertainty: hourly, 3-5 years.
  - Performance Assessment: 15 min/hourly, >2 years.

Failure modes of grid-connected PV systems

Understanding the influence of each individual failure on system performance

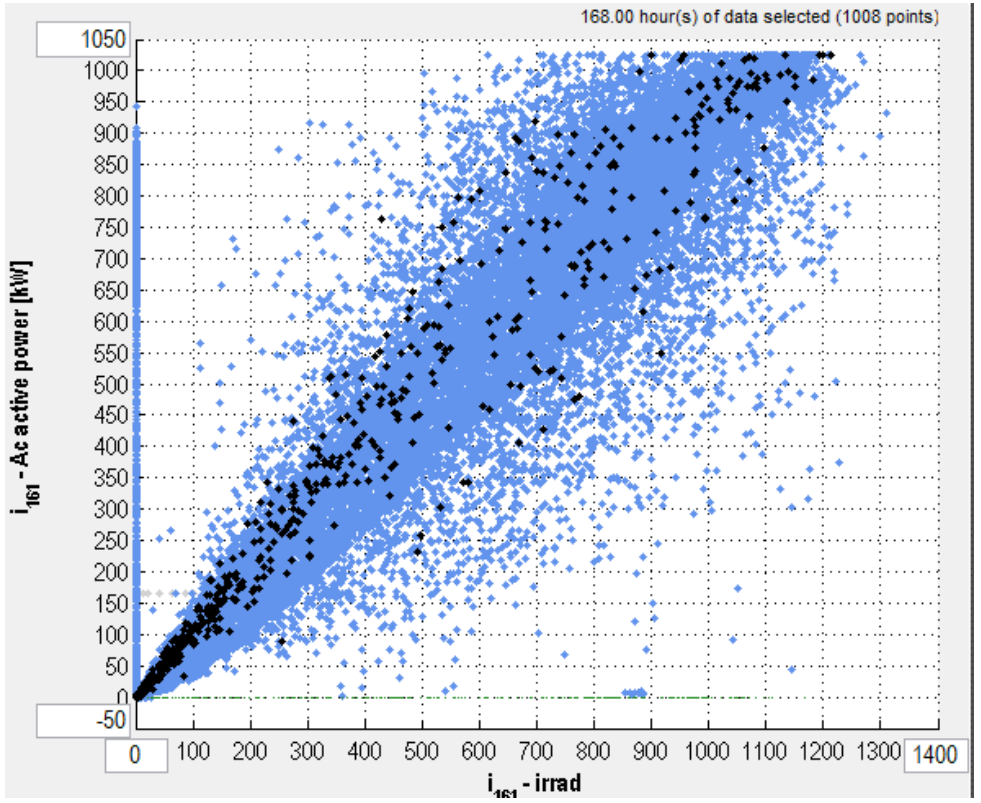
TYPE OF FAILURE	P_{MPP}	V_{MPP}	I_{MPP}	T_M
Partial shading (shading obstacle)	-	-	-	+
Cracks	-	-	-	+
Hot-spot	-	-		+
Shorted bypass diode	-	-		
Bridged fault	-	-		
Earth fault	-	-		
LID	-	-		
PID	-	-		
Short-circuited PV modules in a string	-	-		
Inverter shutdown	-	+	-	
Soldering	-		-	+
Open-circuit fault	-		-	
Soiling	-		-	
Delamination	-			
LeTID	-			
Module mismatch	-			
MPPT fault	-			
Discoloration	-			

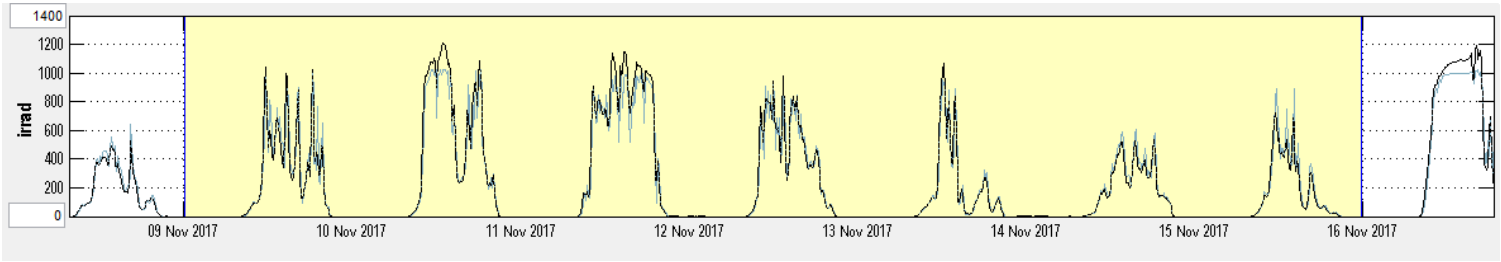


Case Study – Understanding the data

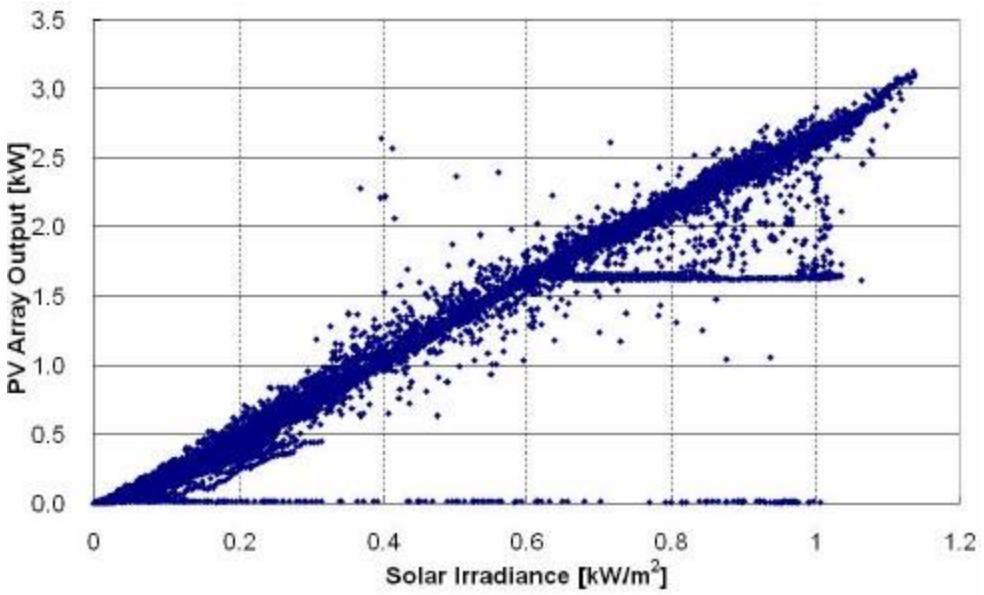
AC Power (Y) vs Irradiation (X)

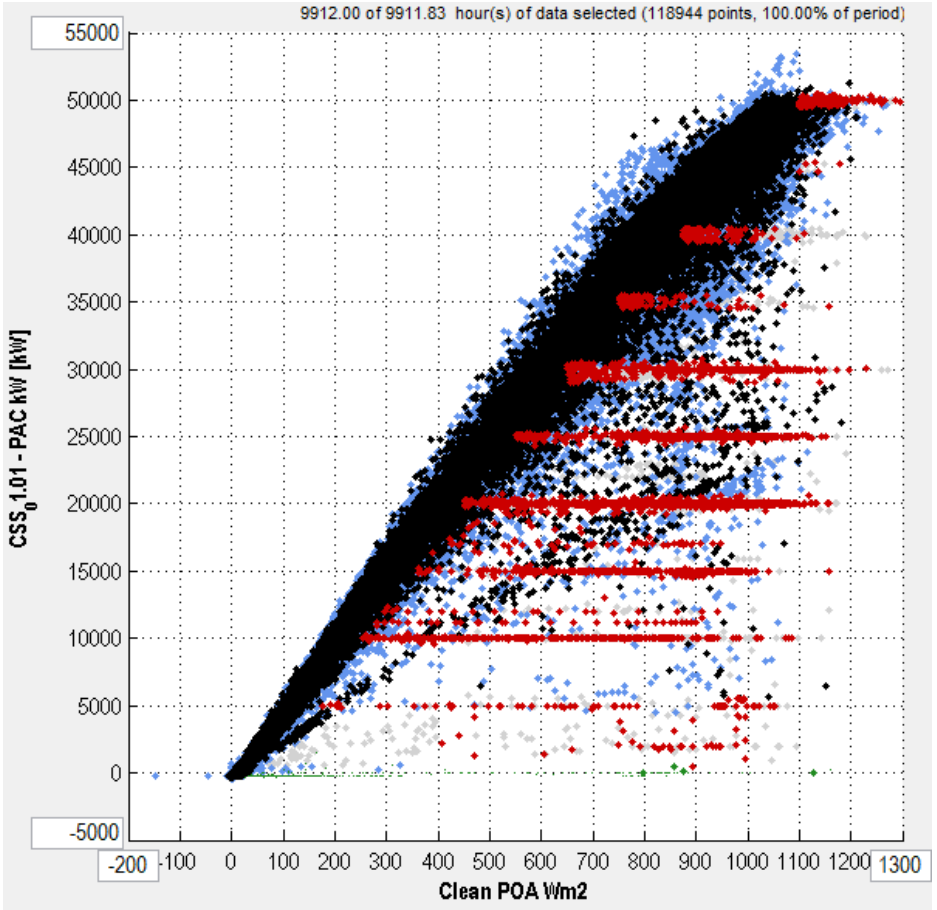
- X-axis: unavailability
- Y-axis: Communication faults
- Black dots: unstable weather → inverter underperformance
- Clipping
- Temperature influence
- Curtailments
- Tracker misalignments



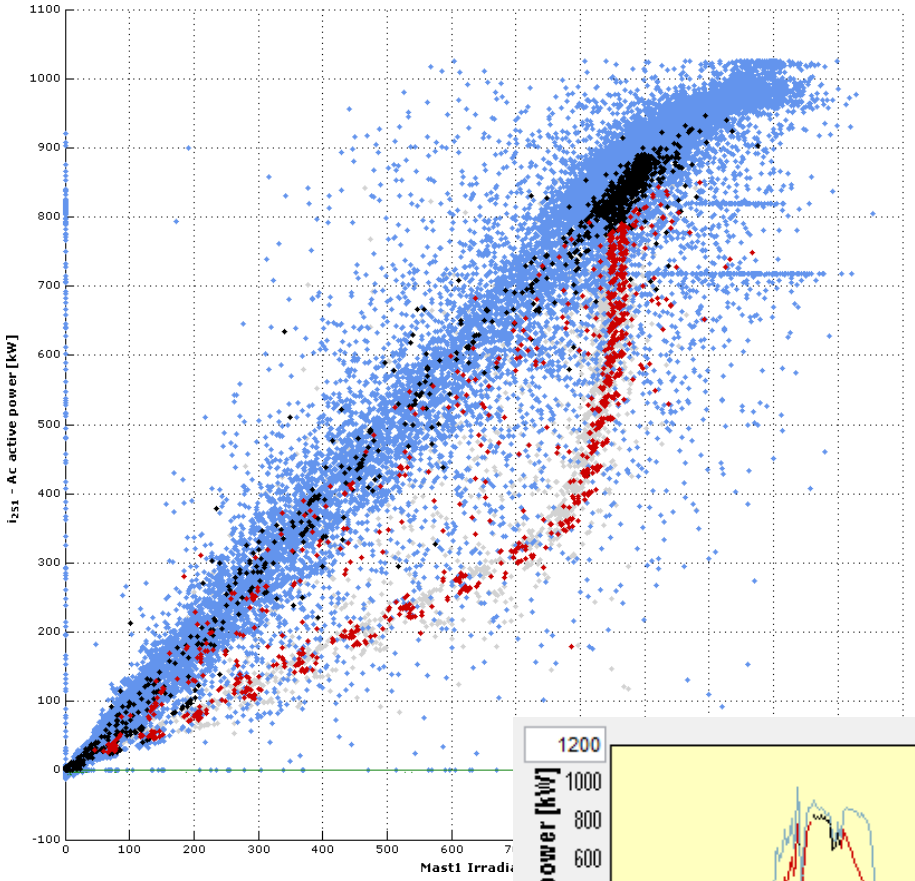


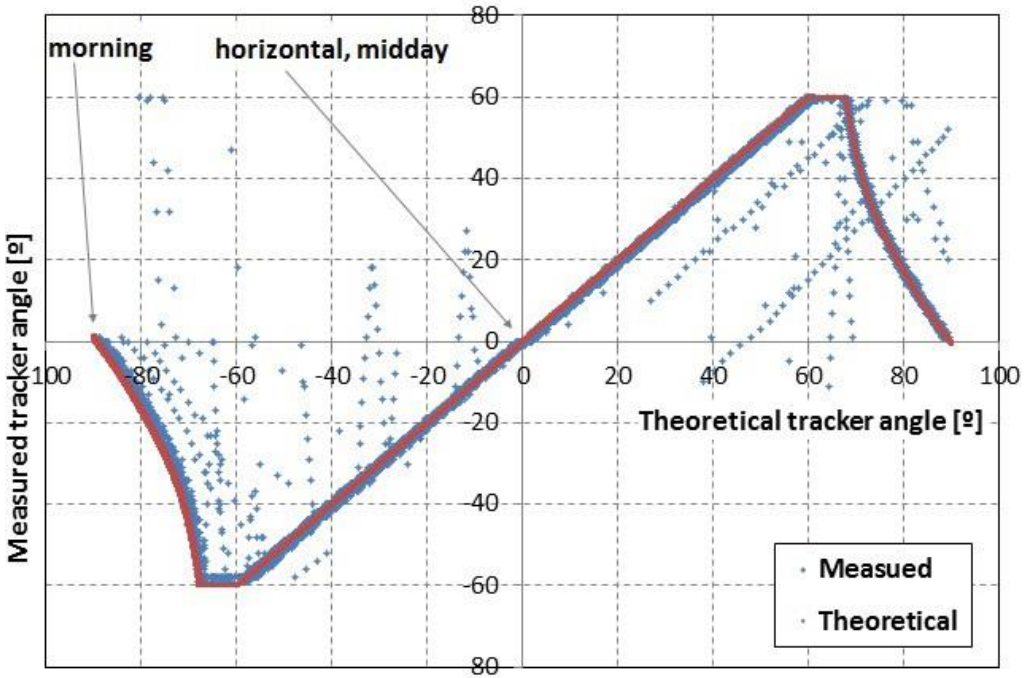
Case Study – Curtailments

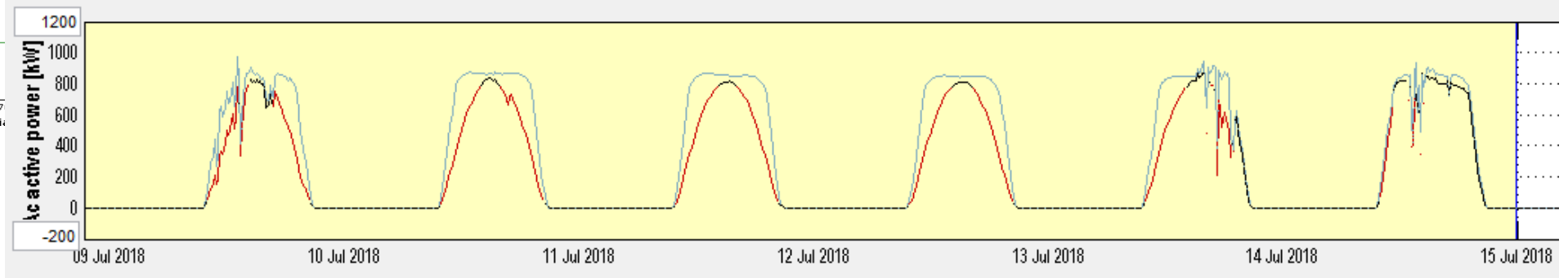




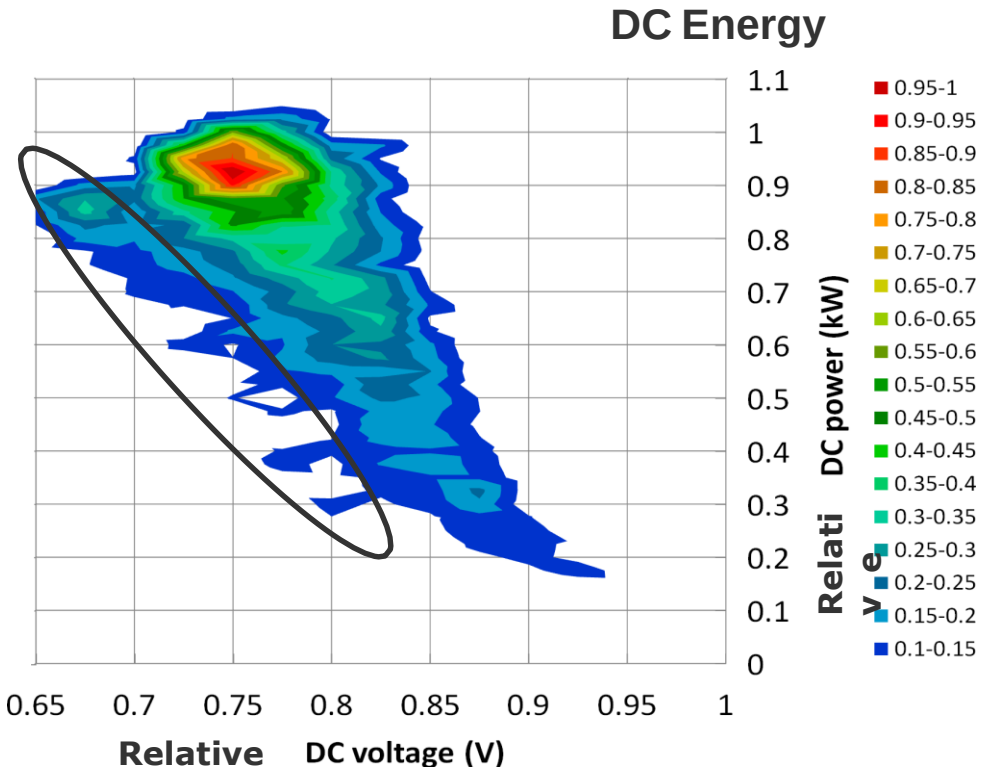
Data Analysis – Tracker misalignments

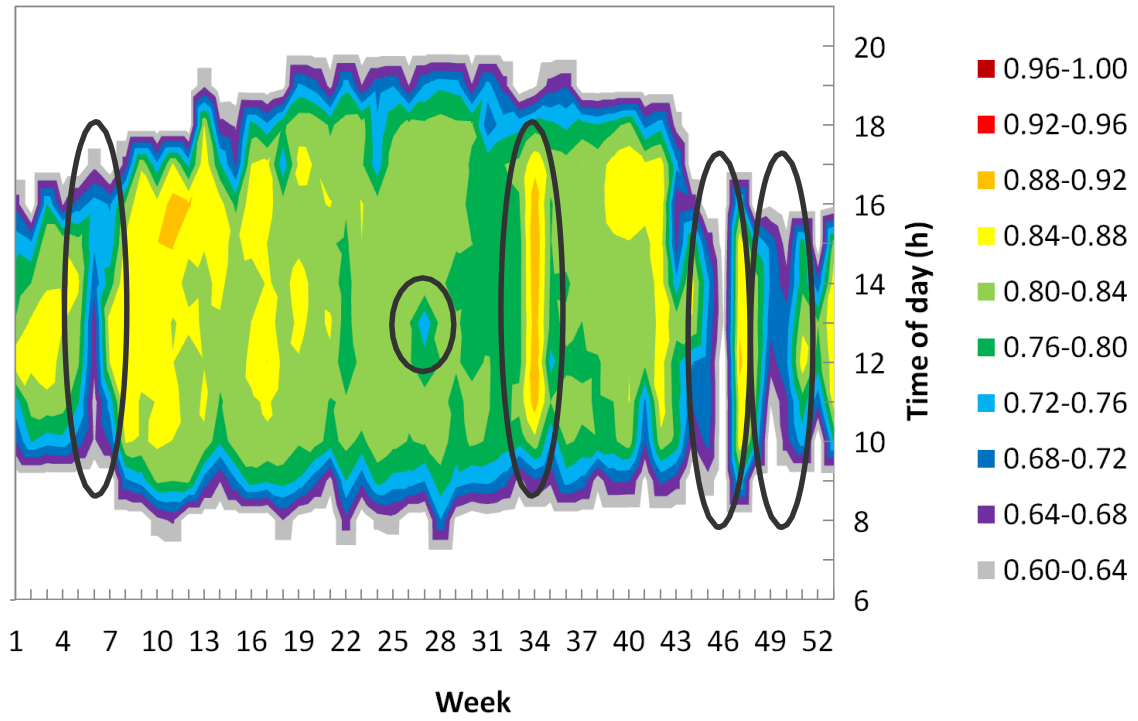




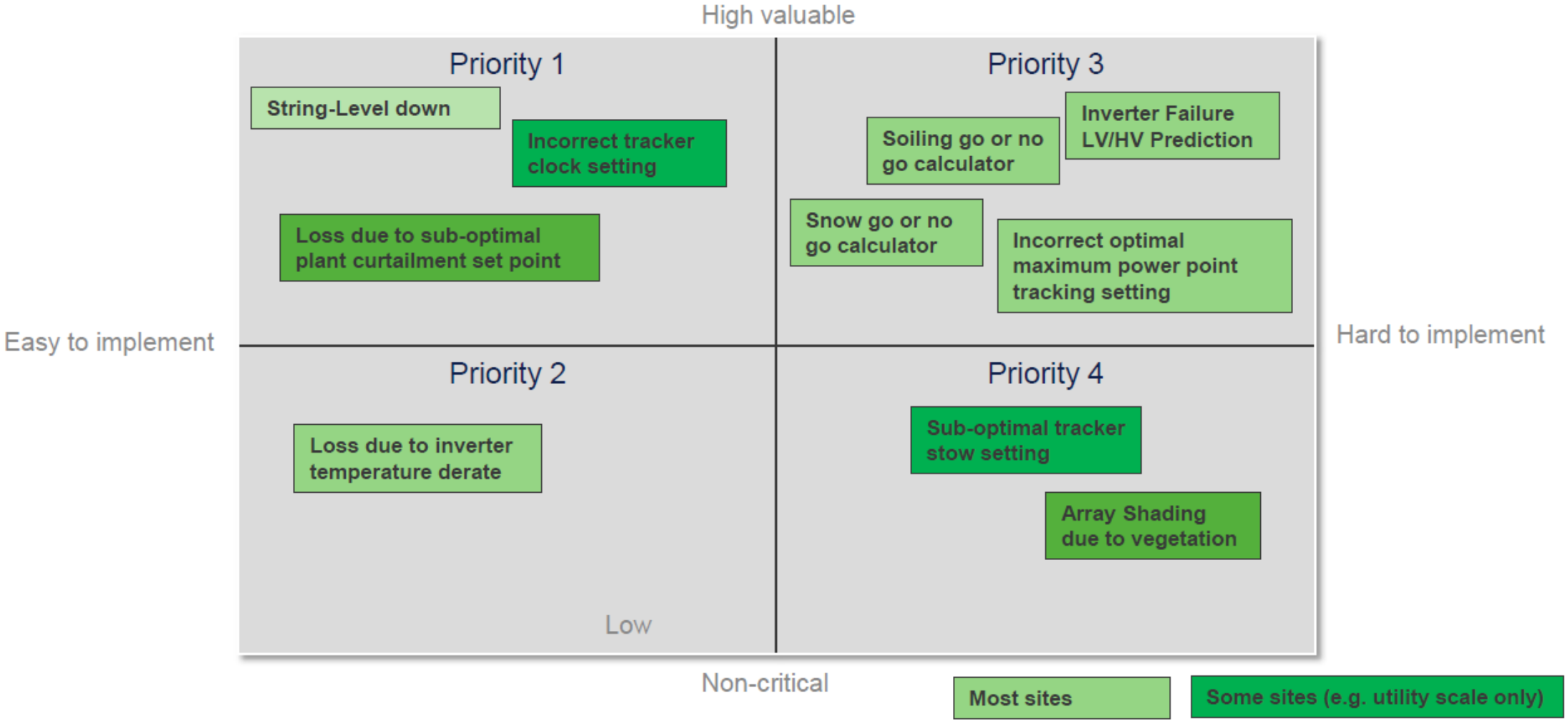


Data Analysis – Identifying issues

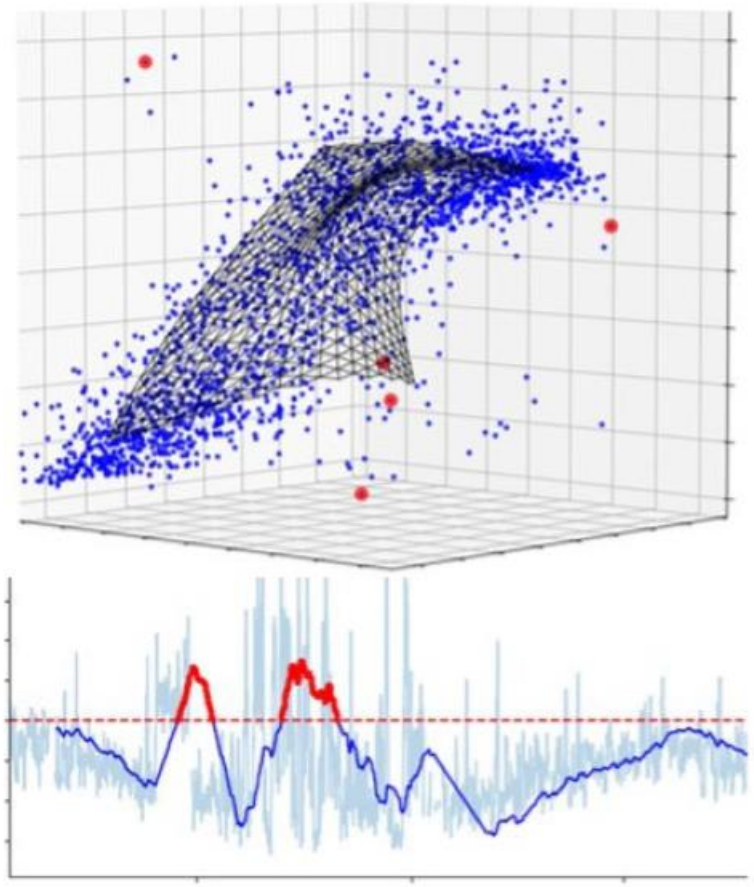




Combining the forces of advisory with data: DNV GL + GPM



AI applied to Inverters



Normal Behaviour Model

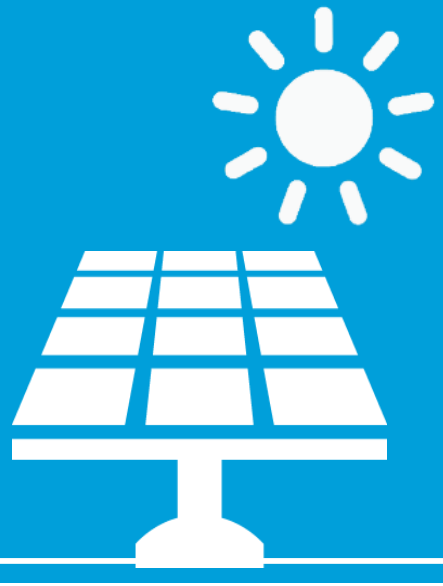
- Combination of Self-Organizing-Map and Autoencoder
- Based on historical data of the normally operating inverter:

Irradiance	Module Temperature	Ambient Temperature
AC Power	AC Current	Internal Temperature
DC Power	DC Current	DC Voltage

Anomaly Detection

- Degree of anomaly quantified by a single key performance indicator
- Increased rate of severe anomalies before failure

Any questions?



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