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pv magazine Webinar: How much effort is wasted on troubleshooting, and how to do better?

powered by SunSniffer

With

- **Götz Fischbeck**, Smart Solar Consulting
- **John Davies**, Operations Director – Solar & Energy Storage, Cobalt Energy Ltd
- **Ingmar Kruse**, CEO SunSniffer
- **Moderation:** Ian Clover, Michael Fuhs, pv magazine

Content:

1. Discussion of troubleshooting cases and
2. Effect of faults on voltage, current and performance
3. SunSniffer setup
4. The analyst's view on advanced monitoring and O&M

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Case 1: What happens when… bypass diodes fail?

- Plant: about 5 MW, comissioned in 2011, central inverters with string monitoring
- In many of the strings there are negative deviations, **performance ratio reduced by 4%**
- Hypothesis: failed bypass diodes
- spot checks (with a thermographic camera and other equipment) -> failed bypass diodes
- **thermographic examination** of the entire plant (waiting for adequate weather)

-> 10% of the modules have one or more failed cell strings

case developed by Enovos Renewables O & M GmbH

Photo: Enovos

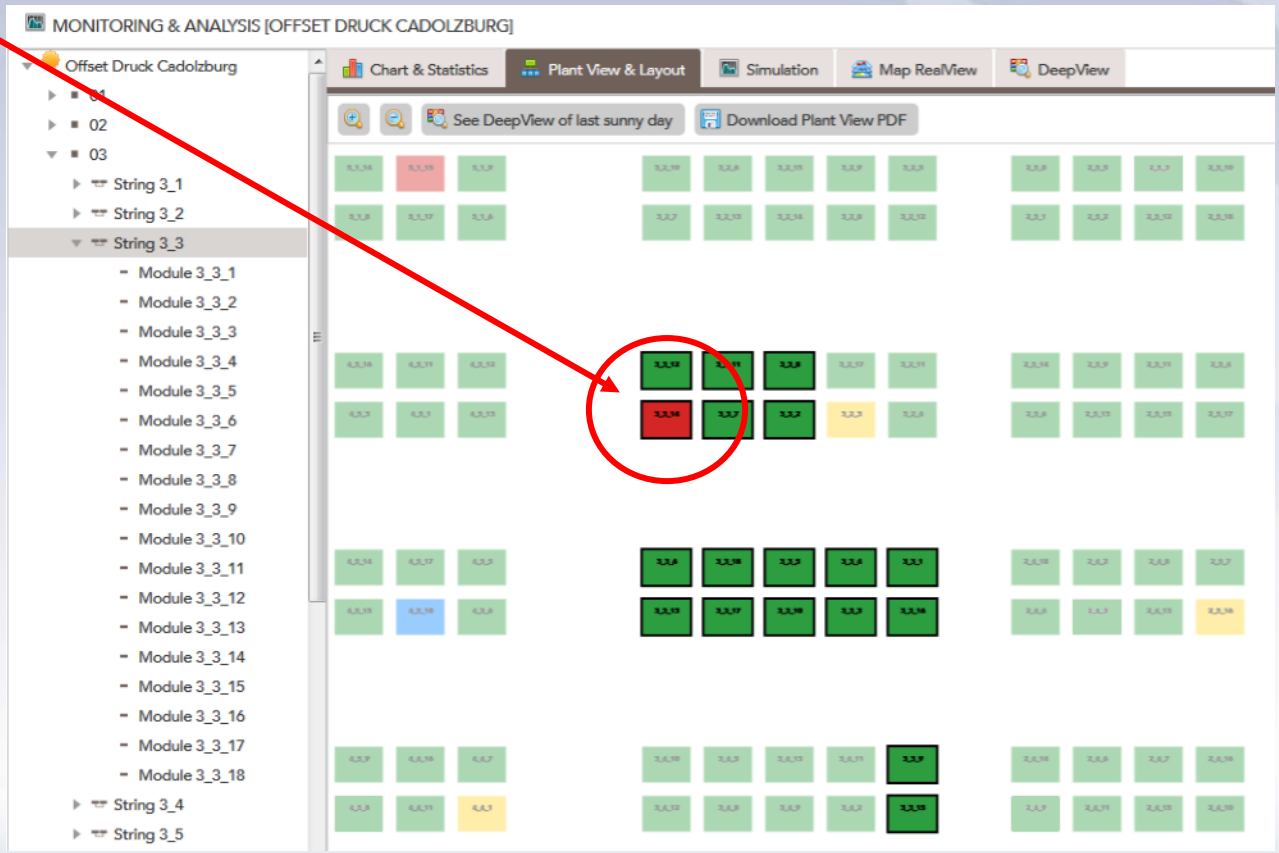
Effort of troublesooting in this case
around €5,000 for the thermographic survey + one workday.

waiting time
a few weeks (annual revenue shortfall > €42,000)

Case 1 – SunSniffer detects defective diodes

SunSniffer®

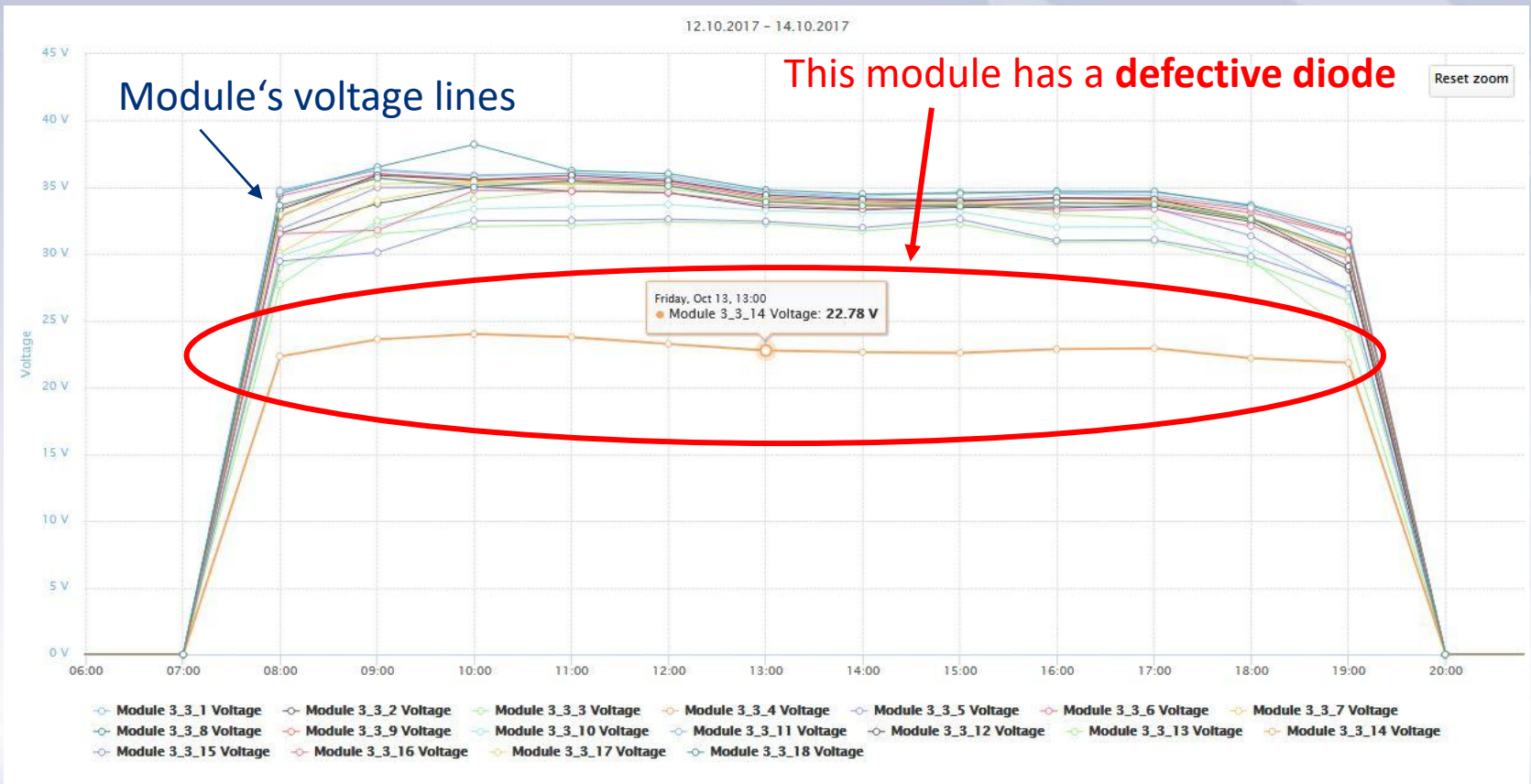
Where is it located?



Case 1 – SunSniffer detects defective diodes

SunSniffer®

How does it expose itself?



Case 1 – Failed bypass diode

SunSniffer®

Without SunSniffer:

Yield losses within 6 years:	- 252,000 €
Inspection costs:	- 5,000 €
Total costs/losses:	**- 257,000 €**

Those losses would have been saved with SunSniffer.

CAPEX costs for SunSniffer: 75,000€. SunSniffer ROI: 1.79 years.

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SunSniffer calculates the amount of defective diodes which is profitable to trigger exchange service.

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Case 2: What happens when… insulation fails?

- Plant: about 1 MW rooftop, comissioned in 2010, 40 multi-string inverters. In monitoring, five strings are combined for each inverter
- The inverters do not measure insulation values and the **monitoring first indicates reduced performance** when strings are compared
- In the yield curves of some strings, isolated failures of entire inverters, infrequently in summer, more often in fall
- **A technician has to measure** the individual strings and modules at the times when problems were detected (wet and humid)

→ **some connectors had insulation defects**

case developed by Enovos Renewables O & M GmbH

Photo: Cornelia Lichner

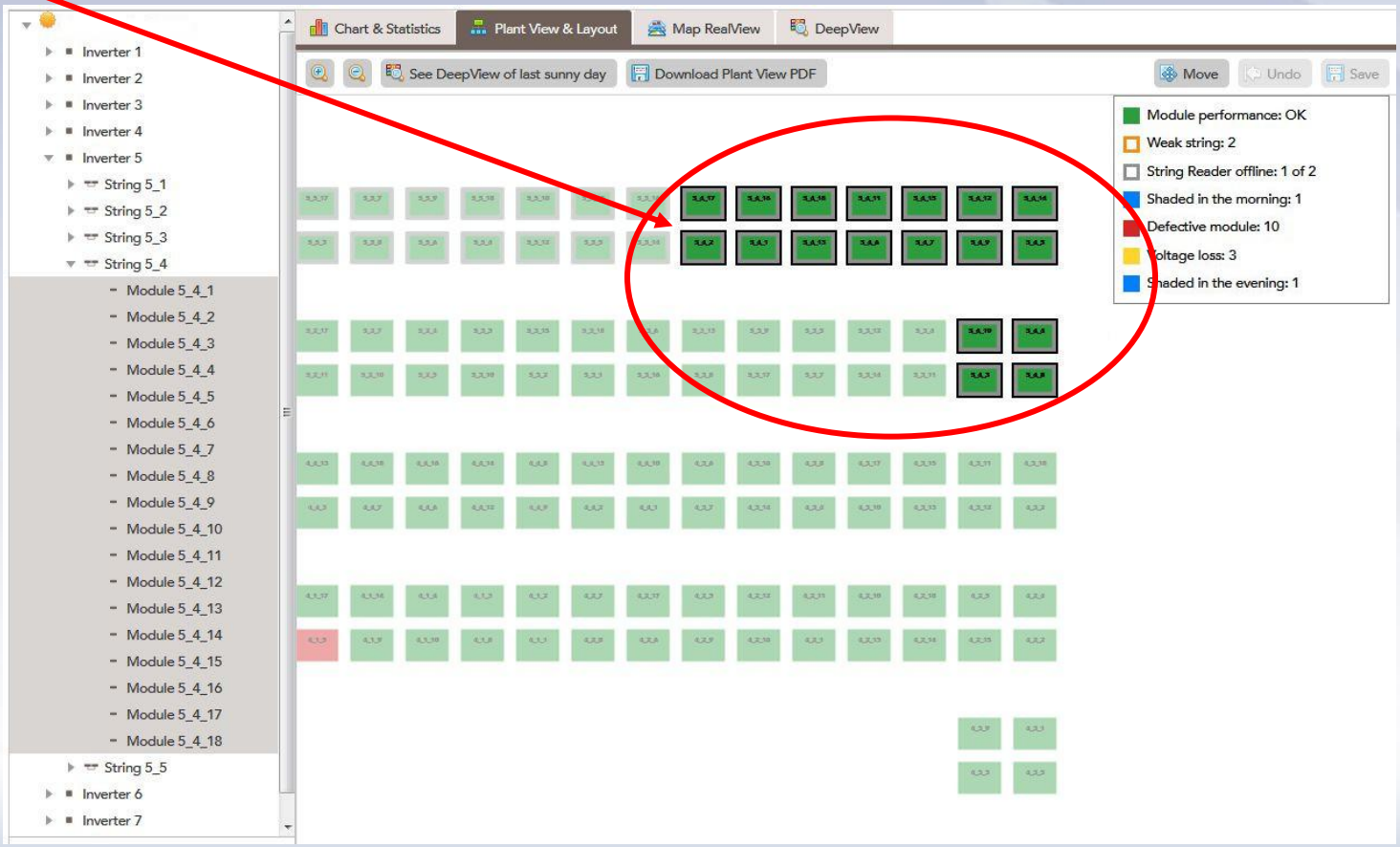
Effort of troublesooting in this case
one workday.

Estimation of the cost of repair:
One workday and small parts

Case 2 – Insulation error: SunSniffer helpful?

SunSniffer®

Where is it located?



Case 2 – Insulation error: SunSniffer helpful?

String helps **validating** an offline string **in remote**.

➡ Analysis of data:

- Check of **JB temperature** before going offline
- Check of any other potential **problem before**
- Cross-check of **inverter** data

➡ Insulation resistance measurement is under evaluation; update to be released **06/2018**

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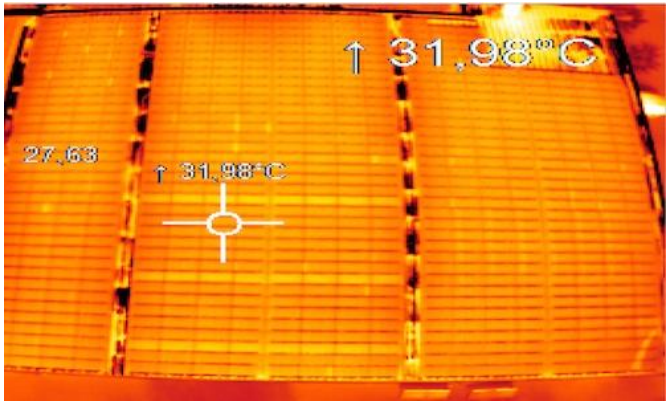
Case 3: What happens when… several module strings fail?

- Plant: about 4 MW rooftop, thin film, comissioned in 2009, six module strings with eight modules each are interconnected for monitoring
- Monitoring reveals that, for its size and location, the total plant produces a **yield that is 6% too low in two of the three subsystems**
- no visible signs of any unusual features on the front side, back side not visible, the operator suspects that entire module strings may have failed
- Difficult to perform an on-site string measurement -> thermography shows that 20 module sub-strings have failed
- **Technician discovers a large number of module connectors are disconnected**
- Reconnected -> plant output +1% (€3,700 per year)

case developed by Ensibo

Photo: Ensibo



Estimated cost:
€2,200.

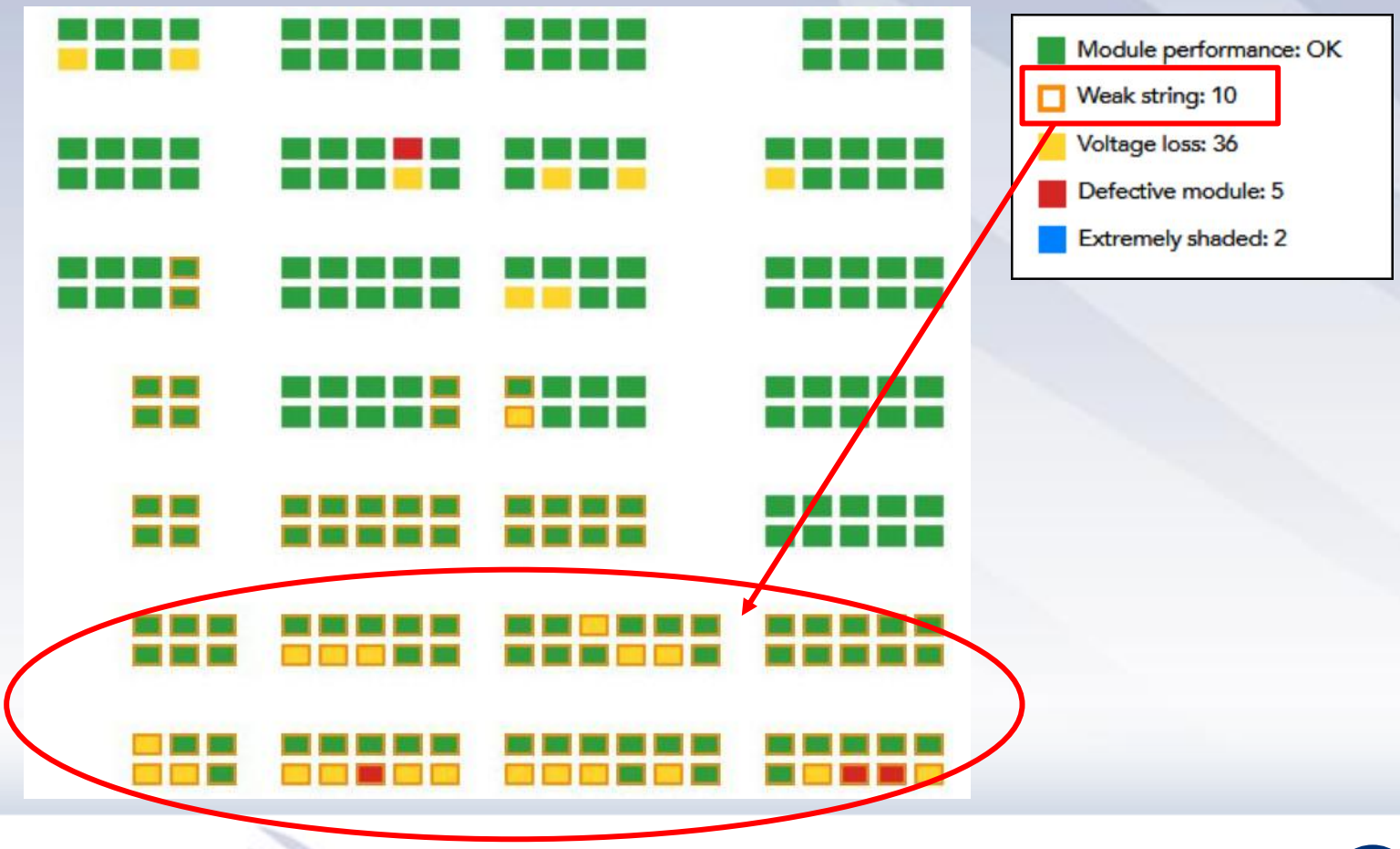
Estimated waiting time:
three months.

Estimate of how long the diminished yield probably already existed:
five years

Case 3 – SunSniffer detection in operation

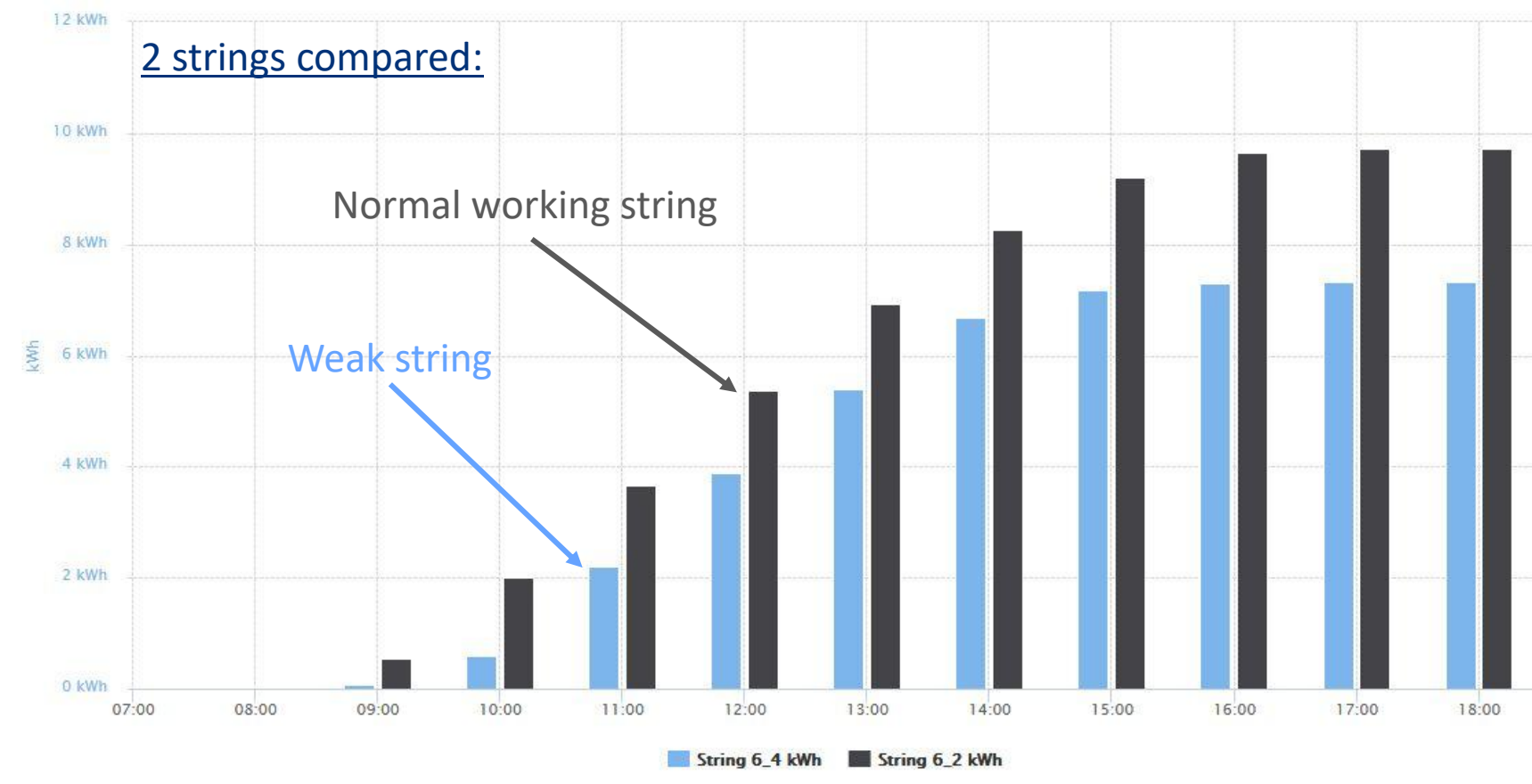
SunSniffer®

Where is it located?



Case 3 – SunSniffer detection in operation

How does it expose itself?



Case 3 – String failure

SunSniffer®

Without SunSniffer:

Yield losses within 5 years:	- 188,700 €
Inspection costs:	- 2,200 €
Total costs/losses:	**- 190,900 €**

Those losses would have been saved with SunSniffer.

CAPEX costs for SunSniffer: 40,000€. SunSniffer ROI: 1.06 years.

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Location is very complicated if modules are in parallel.

SunSniffer displays exactly the right modules to be changed.

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Case 4: What happens when… modules get dirty?

- Plant: about 1 MW rooftop, comissioned in 2011, takeover by operator in summer 2016
- **PR ratio drops in Sept. to 75% from 80 to 83% in summer**
- Operator followed some wrong tracks
- local technician tests the module array -> classifies soiling as light to medium. But: system was never cleaned prior to 2016.
- on-site inspection with own personnel. Spot I-V curve measurements, thermal imaging -> soiling only cause left
- Cleaning increases PR to 82%
- **Conclusion:** the modules are exposed to deposits of tire dust, anthracite and lignite dust. All three emissions are very opaque. Presumably there was **a fault in the operation of one of the plants in the neighbourhood**

case developed by Ensibo

Photo: Ensibo

Estimated cost:
service technician: 0.5 work days
field service Ensibo: 1.5 engineer work days

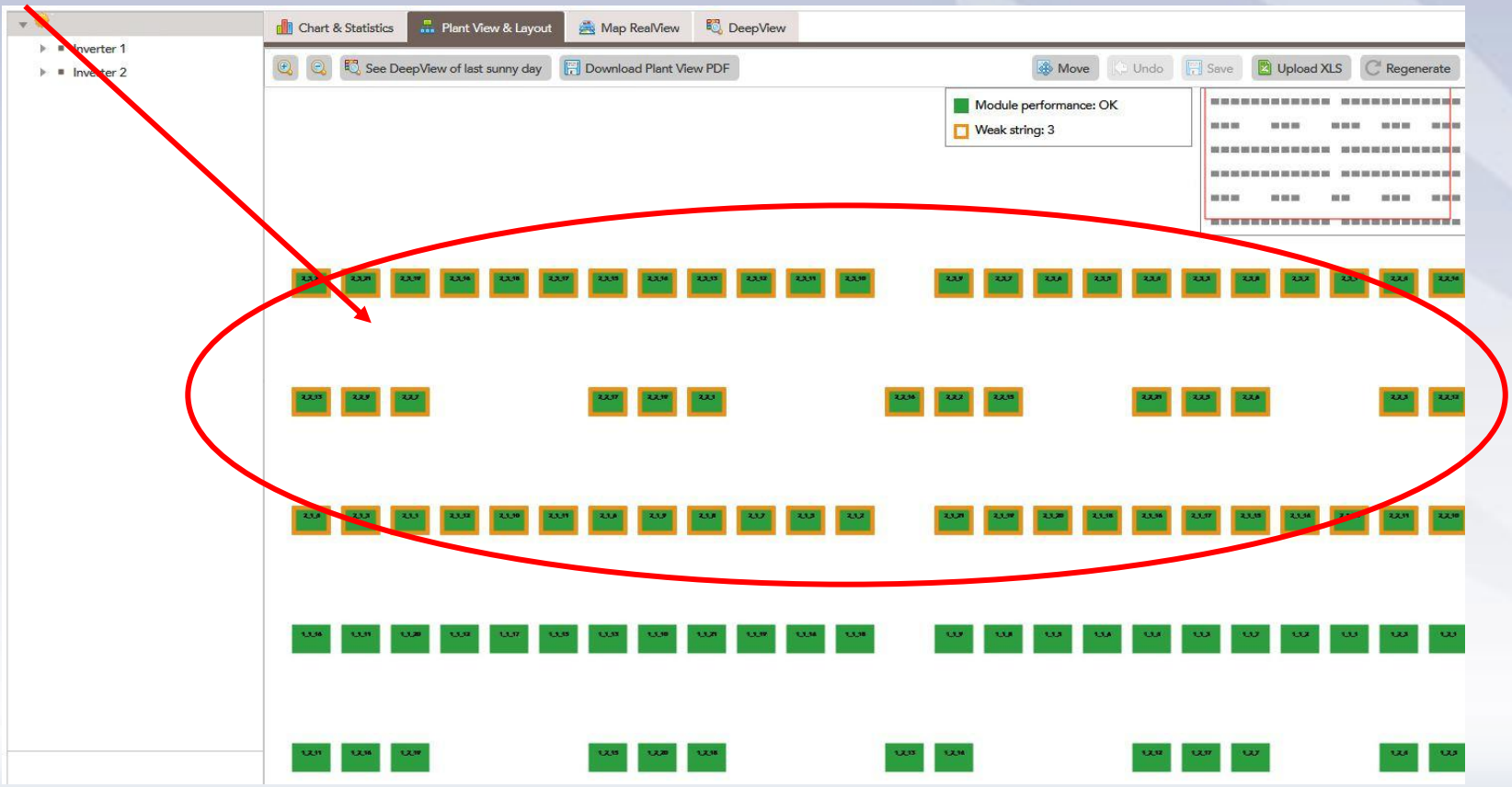
Waiting time:
5 weeks (Euro 10,000/a loss)

Cleaning costs:
6,000 Euro

Case 4 – SunSniffer detection in operation

SunSniffer®

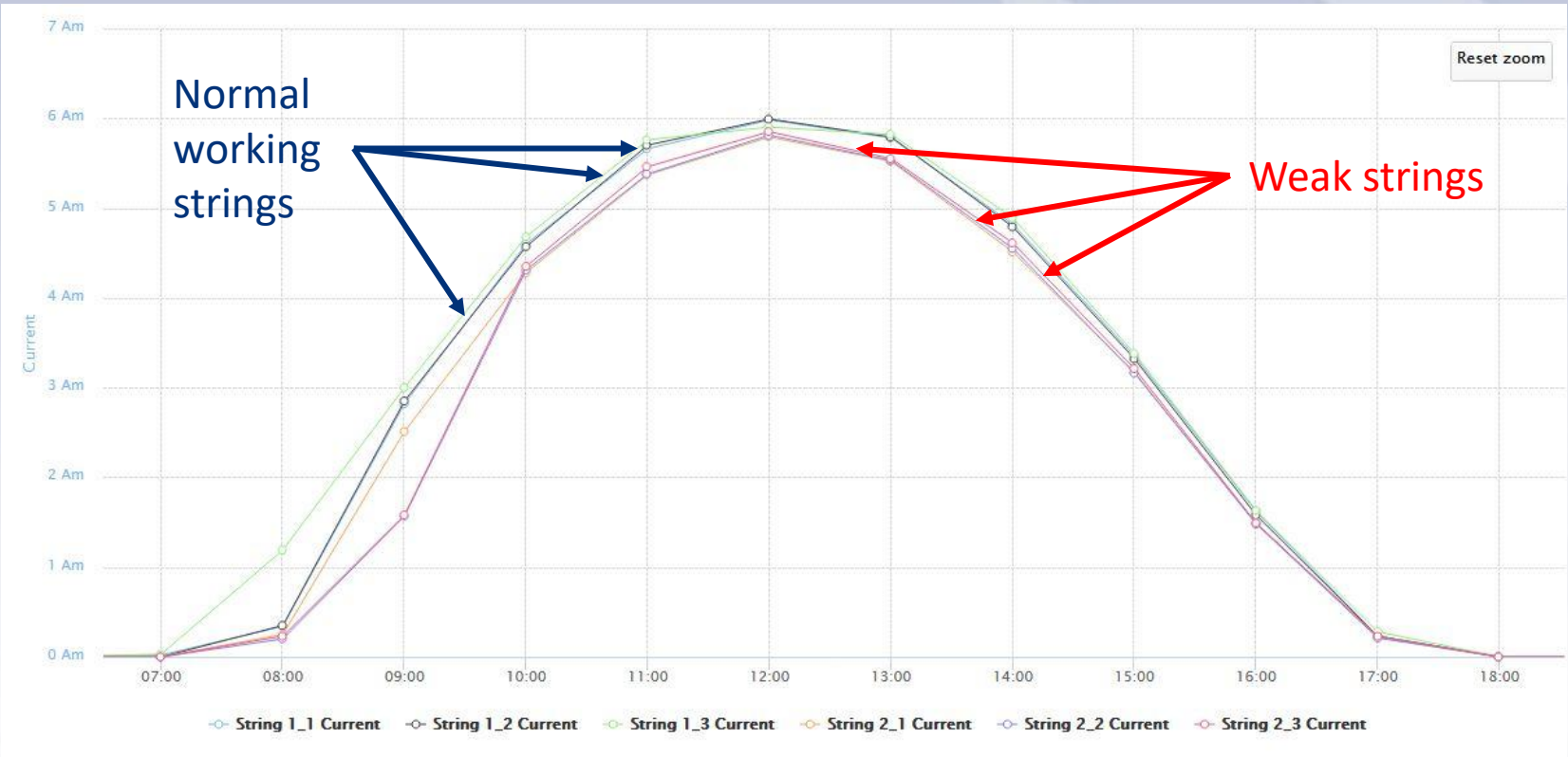
Where is it located?



Case 4 – SunSniffer detection in operation

SunSniffer®

How does it expose itself?



Case 4 – Soiling

SunSniffer®

Without SunSniffer:

Yield losses within 5 years:	- 50,000 €
Inspection costs:	- 2,000 €
Total costs/losses:	**- 52,000 €**

Those losses would have been saved with SunSniffer.

CAPEX costs for SunSniffer: 15,000€. SunSniffer ROI: 1.5 years.

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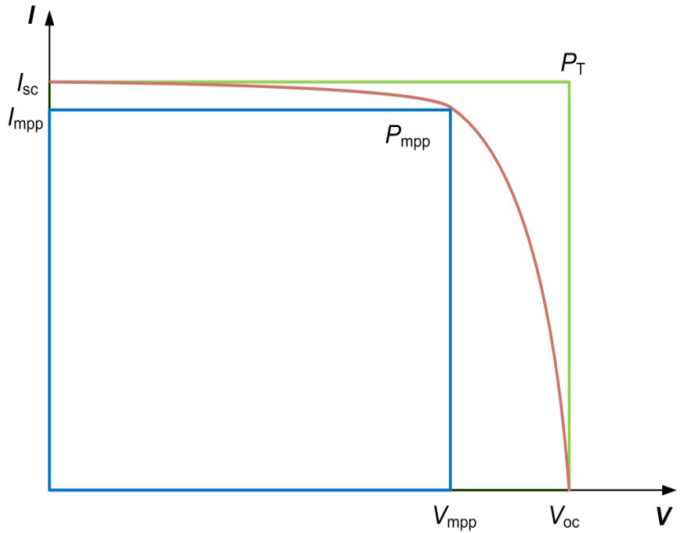
SunSniffer knows instantaneous when which modules are soiled. Action can be taken immediately.

Cobalt Energy Ltd

IV-Curve Example

- O&M Scope – Typically10% IV-Curve inspection per annum
  - 5MWp site ≈ 831 strings x 10% ≈ 84 strings
  - Standard test once on site and connected ≈ 1-2 minutes / string (no fault finding, just testing)
  - Interpretation & Module Fault Identification can be up to an 1 hour / string
  - Worst case ≈ 83 hours of IV-Curve testing
  - Limited irradiation window of 3-4 hours per day in UK summer time (>400W/m^2) – IEC-61829/2015
  - Equates to 20 working days of a technicians time (≈ £7,500 cost)
  - Reporting & Client Education = More costs to be absorbed by O&M service provider
  - 10% is typical, but some scopes are 100% (30MWp site ≈ 2 technicians with two IV-curve testers for 2-3 months of the summer period, just IV-curve testing…



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