Specificity of solar micro grids in island areas

Government of Tonga / PCREEE / ISA / INES PFE

SESSION 5
Commissioning

Micro-grid in Corsica named « Myrte »

Specificity of solar micro grids in island areas

SESSION 5: Commissioning on the ground

(Olivier VERDEIL)

- **Static and dynamic reception** of products (delivery inspection & quality control)
- **Commissioning check-list** (inspects, testing protocol, performance / standard criterias)
- **Relevance of remote supervision** systems
- **Different levels of monitoring**
- **Different types of instrumentation**
- **Operation** (analysis of production losses or other failures)
- **Case-studies** : presentation on the commissioning of the Tuvalu mini-grids
- **Operational and policy barrier** in mini grid implementation
- How to manage the various **constraints related to Covid-19 restrictions** (telework, late delivery, …)

PCREEE Pacific Centre for Renewable Energy and Energy Efficiency
SE4ALL Centre of Excellence to Promote Sustainable Energy Markets, Industries and Innovation

isa INTERNATIONAL SOLAR ALLIANCE

ines INSTITUT NATIONAL DE L'ENERGIE SOLAIRE

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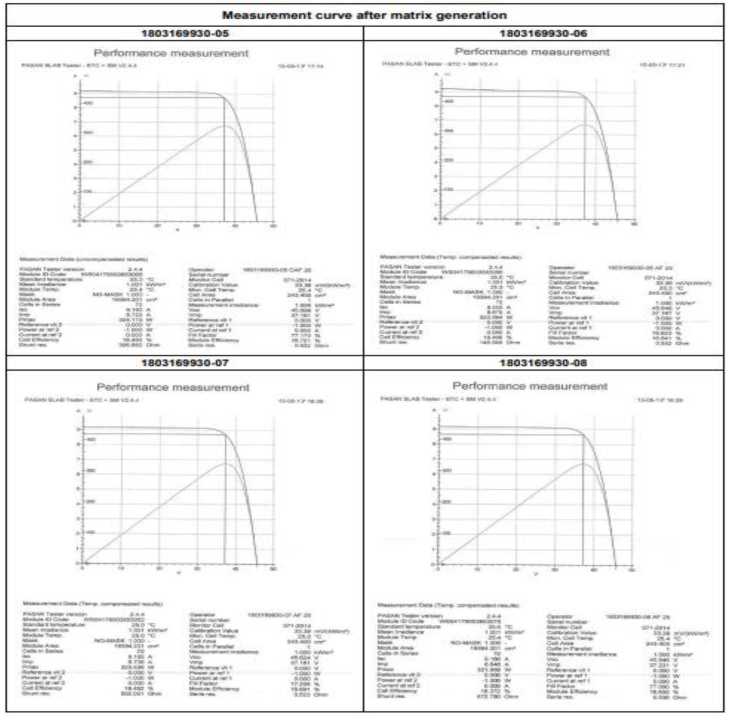
Static reception of products (quality and performance control)

QUALITY CHECKS OF PV MODULES BEFORE LEAVING THE FACTORY:

=> **Check that the product corresponds to international standards** (IEC 61215, IEC 61646, IEC 61701, IEC 61730, …)
=> **Request the "Flash test" report** (showing the **serial number** and the **main electrical characteristics** of each tested module)



Test date [DD/MM/YYYY]:	13-05-2017 to 15-05-2017									
Module temperature [°C]:	Corrected to 25									
Irradiance [W/m²]:	1000									
Sample no.	P_{max} [W]	V_{max} [V]	I_{max}[A]	V_{oc} [V]	I_{sc} [A]	FF [%]	M.efficy in [%]	C.efficy in [%]	Rsh in ohms	Rs in ohms
1803169930-05	324.11	37.16	8.722	45.70	9.190	77.17	16.72	18.49	306.88	0.532
1803169930-06	322.56	37.17	8.679	45.65	9.223	76.62	16.64	18.41	145.57	0.532
1803169930-07	323.54	37.16	8.706	45.62	9.185	77.21	16.69	18.46	502.05	0.523
1803169930-08	321.96	37.23	8.648	45.65	9.160	77.00	16.61	18.37	572.79	0.536
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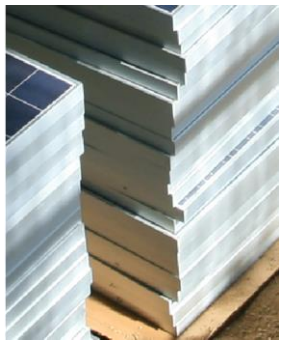
Dynamic reception of products (delivery inspection)

QUALITY CHECKS UPON RECEIPT OF PRODUCTS ON SITE:

⇒ **Check carefully upon receipt of the products that there has been no damage during transport** (pallet detached, material broken)
⇒ Be very **careful during the checking phase** and also **afterwards during installation not to stack the modules without aligning the frames with each other** (glass breeze and micro-cracking of cells possible)

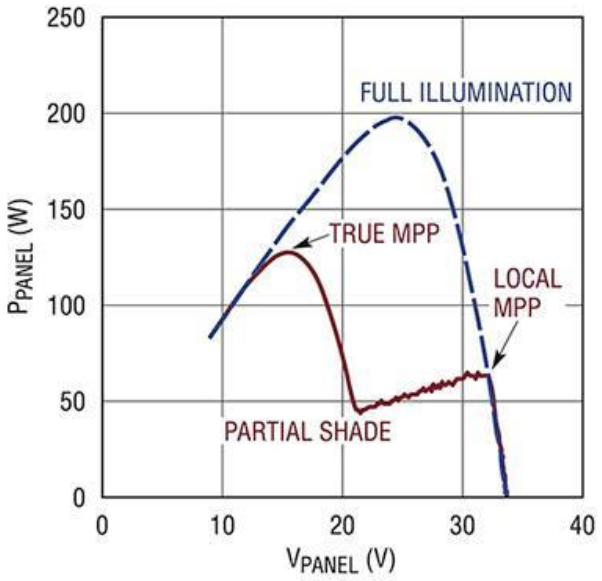


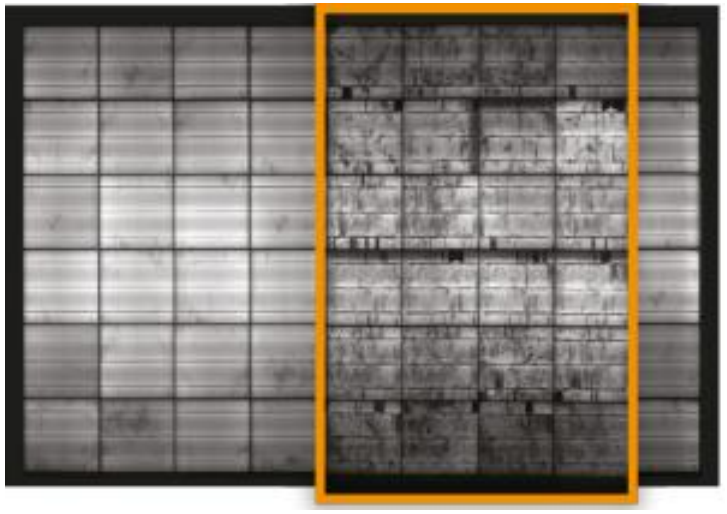
Specificity of solar micro grids in island areas

Dynamic reception of products (quality and performance control)

QUALITY CHECKS UPON RECEIPT OF PRODUCTS ON SITE:

⇒ **Regarding large projects with high financial investment, it is strongly recommended to request a mobile laboratory to check the performance directly on site during delivery** (Flash test, Electroluminescence test, LID test, PID test, Insulation fault test, ...)





Specificity of solar micro grids in island areas

Commissioning check-list

PV FIELD CHECK-LIST:

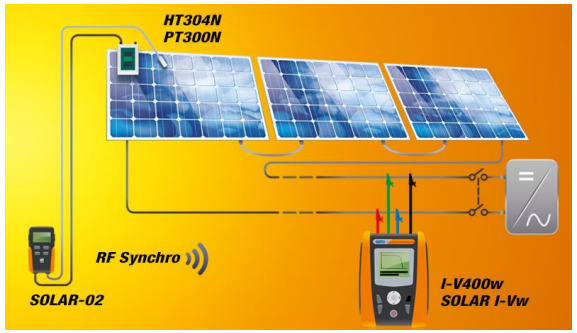
⇒ **Inspection of good general appearance** (visual inspection)

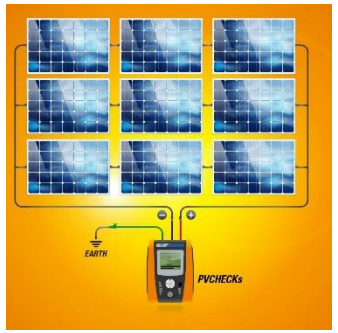
⇒ **Check that open circuit voltage of PV modules from each string corresponds to the sum of voltage from each module** (with a voltmeter)

⇒ **Check that non polarity inversion of each string of PV modules before connecting them to the inverters or regulator** (with a voltmeter)

⇒ **Check that the operating current of each PV string corresponds to the current irradiance condition** (with clamp current amp meter)

⇒ **Ideally, measure the performance of each PV string** (with an I/V tracer) **and measure the insulation fault** (with a megohmmeter)





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Commissioning check-list

BATTERY PARC CHECK-LIST:

⇒ **Inspection of good general appearance** (visual inspection)

⇒ **Check that non polarity inversion in the series and parallel connection of the batteries to each other** (visual control)

⇒ **Check that open circuit voltage of each battery string corresponds to the sum of voltage from each battery** (with a voltmeter)

⇒ **Check the open circuit voltage from each battery** (with a voltmeter)

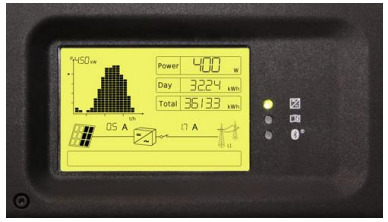
⇒**Check filling level (if liquid electrolyte) from each battery** (visual inspection)

INVERTER & REGULATOR CHECK-LIST:

⇒ **Inspection of good general appearance** (visual inspection)

⇒ **Check that it is in good working order** (stable green or blue LED, no error message)

⇒ **Check that the displayed values are consistent with the system sizing values**



⇒ **Check that the displayed values are consistent with the production and consumption conditions at the time**

Specificity of solar micro grids in island areas

Relevance of remote monitoring systems

OBJECTIF AND CHOICE OF MONITORING:

⇒ **the main objective of the monitoring system is to:**

- **monitor** the PV **energy produced**
- **assess the performance** of the PV system
- **detect drifts** or **malfunctions**
- **warn immediately** in the event **of a fault**.

⇒ **the choise of the monitoring system depend of:**

- **technical constraints** (access to internet / data / telephone network?, interoperability of different equipment (MTM)?, …)
- **security constraints** (installation to provide comfort or to guarantee the survival of a person, which desired sampling level?)
- **financial constraints** (budget limits?)

Specificity of solar micro grids in island areas

Different level of monitoring systems

MONITORING SOLUTION FROM THE SIMPLEST TO THE MOST COMPLEX:

LEVEL 1: only possible to read indicator lights (no access to a com portal)

+ very resistant and **economical monitoring**
- Provided very little information (working status, level of production or charge)

Specificity of solar micro grids in island areas

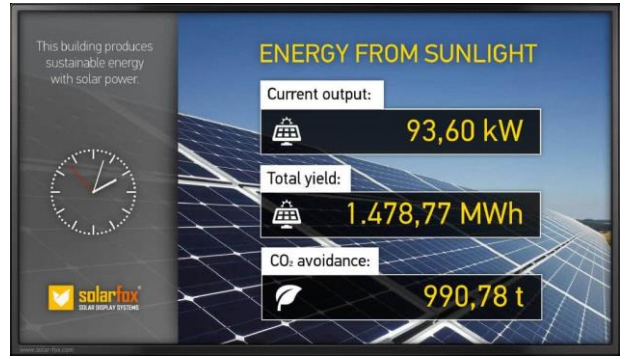
Different level of monitoring systems

MONITORING SOLUTION FROM THE SIMPLEST TO THE MOST COMPLEX:

LEVEL 2: access to a remote display (no access to a com portal)

+ good solution to communicate with a large audience

- Provided very little information (working status, visualization of the energy produced and the CO_2 saved)



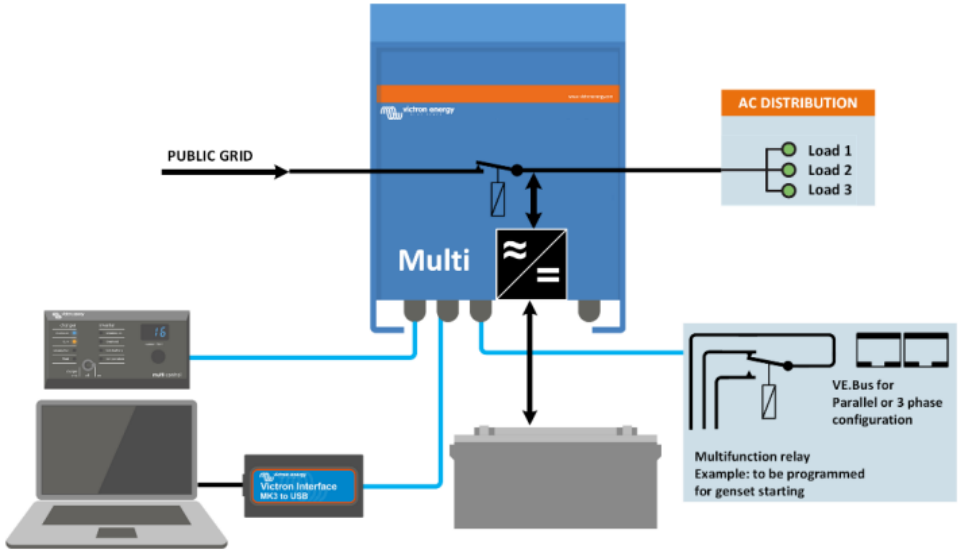
Specificity of solar micro grids in island areas

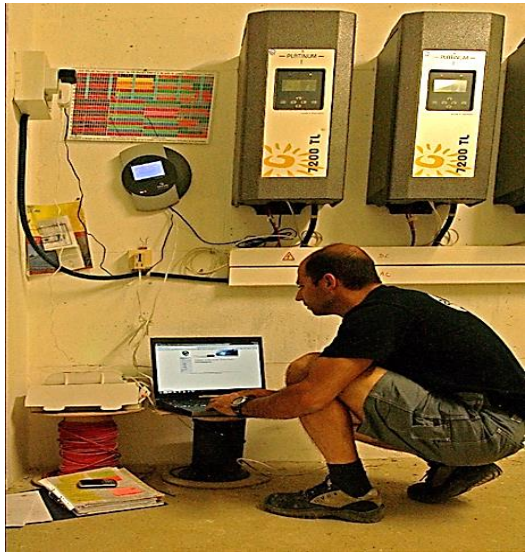
Different level of monitoring systems

MONITORING SOLUTION FROM THE SIMPLEST TO THE MOST COMPLEX:

LEVEL 3: inverter data access via a PC interface (no access to a com portal)

+ allows **access to data not visible on the inverter display** and also **to modify the parameters** of the inverter
- **needs to be in direct proximity** to the installation





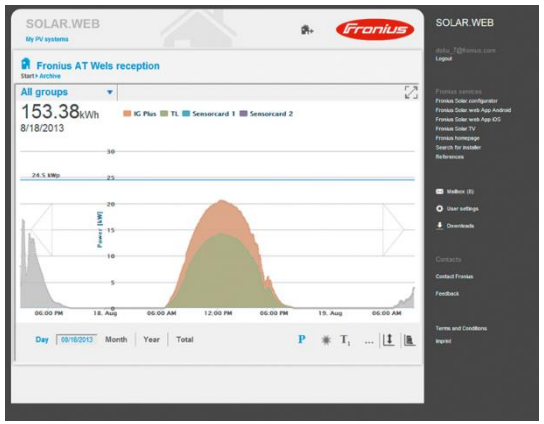
Specificity of solar micro grids in island areas

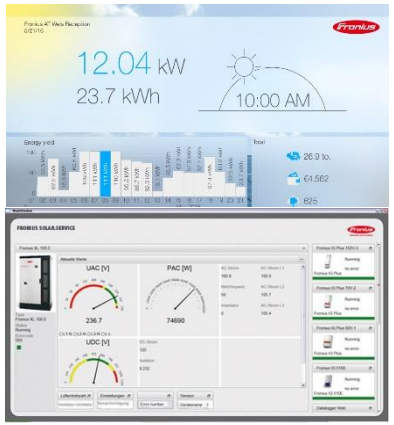
Different level of monitoring systems

MONITORING SOLUTION FROM THE SIMPLEST TO THE MOST COMPLEX:

LEVEL 4: inverter/charger manufacturer service via a Website Portal or/and App (emission of a local Wifi signal)

+ **remote access to numerous inverter / charger data** (status, error message, power, energy, voltage, current, ...)
+ on some systems, it is **possibility to remotely update**
- solution **not possible if the inverter cannot be connected to an internet or telephone network**
- supervision solution **only available for manufacturer brand inverters**





Specificity of solar micro grids in island areas

Different level of monitoring systems

MONITORING SOLUTION FROM THE SIMPLEST TO THE MOST COMPLEX:

LEVEL 5: Universal solution

+ **remote access to numerous inverter / charger data** (status, error message, power, energy, voltage, current, ...)
+ **compatible with most brands of inverter/charger manufacturer**
+ on some systems, it is **possibility to remotely update**
- solution **not possible if the inverter cannot be connected to an internet or telephone network**

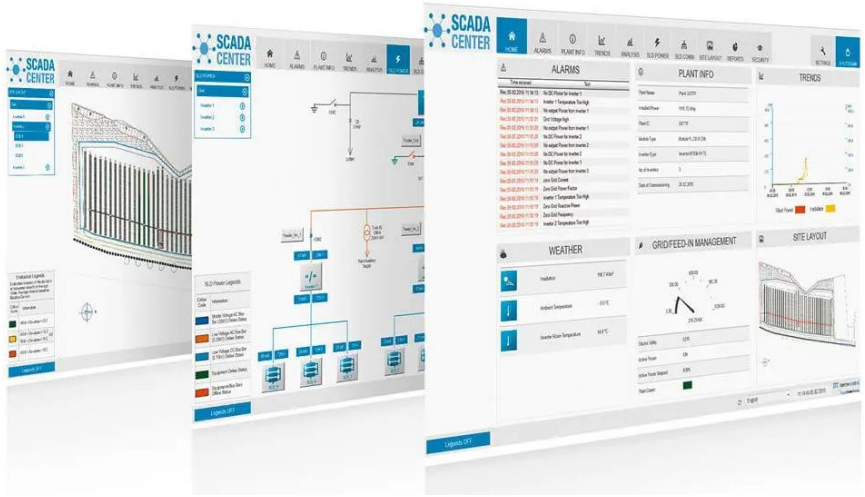
Specificity of solar micro grids in island areas

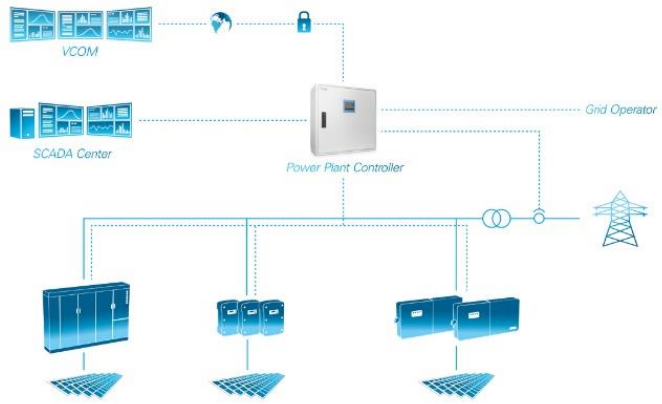
Different level of monitoring systems

MONITORING SOLUTION FROM THE SIMPLEST TO THE MOST COMPLEX:

LEVEL 5+: SCADA (Supervisory Control And Data Acquisition)

+ **Very suitable for large-scale remote management, allowing a large number of telemetry**
+ Solution allowing **software update** and **control actions directly** on the remote hardware
- Solution **not possible if the inverter cannot be connected to an internet or telephone network**
- Requires **specific development** for each project
- Very **expensive solution**





Specificity of solar micro grids in island areas

Different type of instrumentation

THE MAIN TYPES OF INSTRUMENTATION:

⇒ **INVERTER / REGULATOR / INDEPENDENT METERS:** Inverter electricity meters (useful data but **cannot be considered official**)



Data accessible on site but also remotely, **thanks to a telephone connection** (GSM) **or internet** (via powerline, Wifi, DSL, optical fiber)

⇒ **ELECTRICITY METERS OFFICIAL NETWORK COMPAGNY:** (good level of accuracy +/- 0.5% because needs a fair invoice)




Specificity of solar micro grids in island areas

Different type of instrumentation

THE MAIN TYPES OF INSTRUMENTATION:

⇒ **DIFFRENTS OFFICIAL ELECTRICITY METERS TECHNOLOGIES**

METER	ANALOGUE	DIGITAL	INTELLIGENT (SMARTMETER)
Type	**Electromecanical**	**Electrical**	**Connected Electronic**
Data transmission	No transmission	Flash, Pulse output or TIC output	Powerline (CPL)
Advantage	Stable technologie	Transmission possible (simple)	Access to real-time consumption profile and bidirectional metering
Disadvantage	Only in direct reading !	Only one direction of counting	Privacy spy !?

Specificity of solar micro grids in island areas

Different type of instrumentation

THE MAIN TYPES OF INSTRUMENTATION:

⇒ **EXTERNAL SENSORS:**

- Weather data sensors:
  - Illumination (pyranometer, photodiode, reference cell)
  - Air temperature
  - Anemometer



- Electrical data sensors:
  - Tension
  - Current


- Temperature data sensors:
  - Modules rear face temperature
  - Inverter / Regulator temperature
  - Battery temperature


Specificity of solar micro grids in island areas

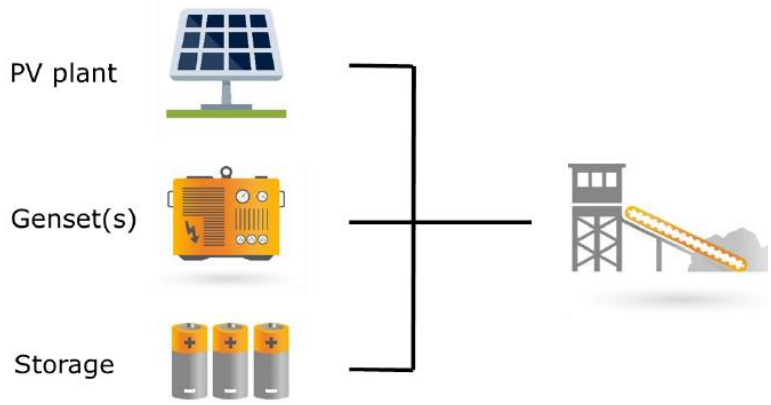
Different type of instrumentation

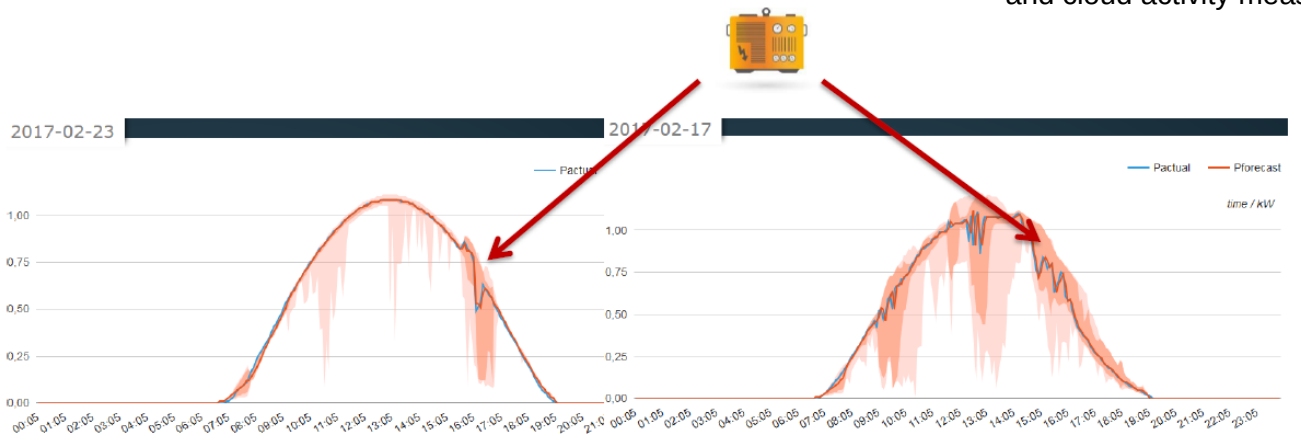
THE MAIN TYPES OF INSTRUMENTATION:

⇒ **WEATHER FORECASTING AND ENERGY MANAGEMENT SERVICE TO REDUCE OPERATING COSTS**

- Provide solar production forecasts
- Provide meteorological data forecasts
- Provide advices to companies impacted by the increase of renewable energies in the energy mix.

Start-up **STEADYSUN** has developed a sensor combining solar irradiance and cloud activity measurement





Difference of less than 2% between forecast and reality !!!

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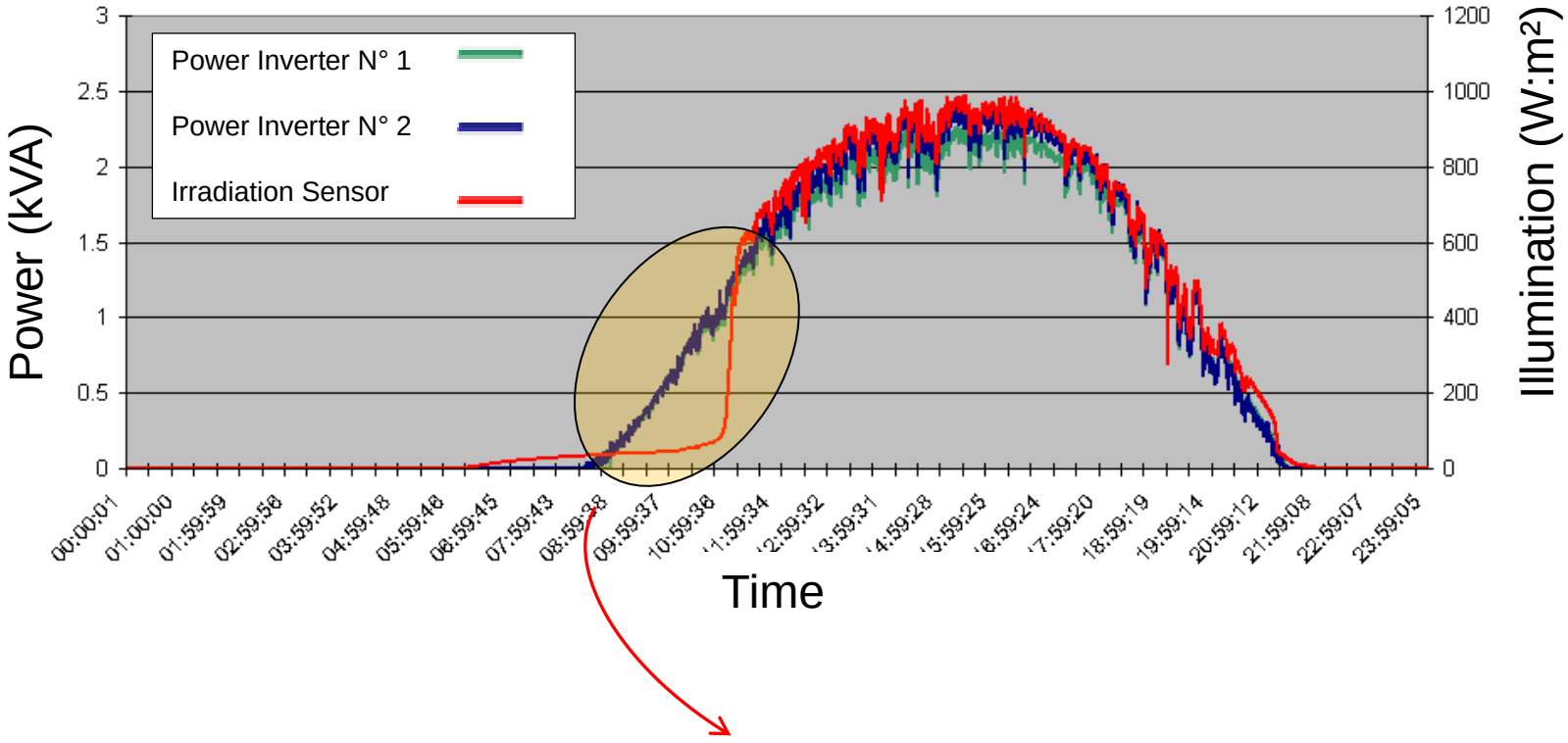
Operation : analysis of production losses or other failures

Incorrect installation of instrumentation:



Irradiation sensor is in the shade until 11 a.m

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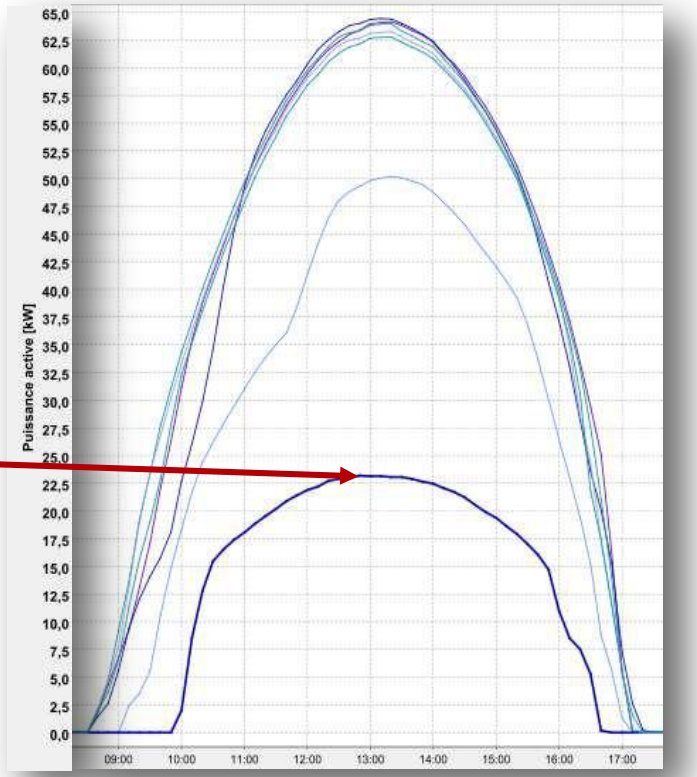
Operation (analysis of production losses or other failures)

Bad sizing of spacing between PV module lines:



75% production loss during 2 winter months on 80 kWp => 8338 kWh lost !

Specificity of solar micro grids in island areas

Operation (analysis of production losses or other failures)

Very durty of the PV modules:

2% to 4% production loss during 1 month on 80 MWp => 5.47 to 11 MWh lost !

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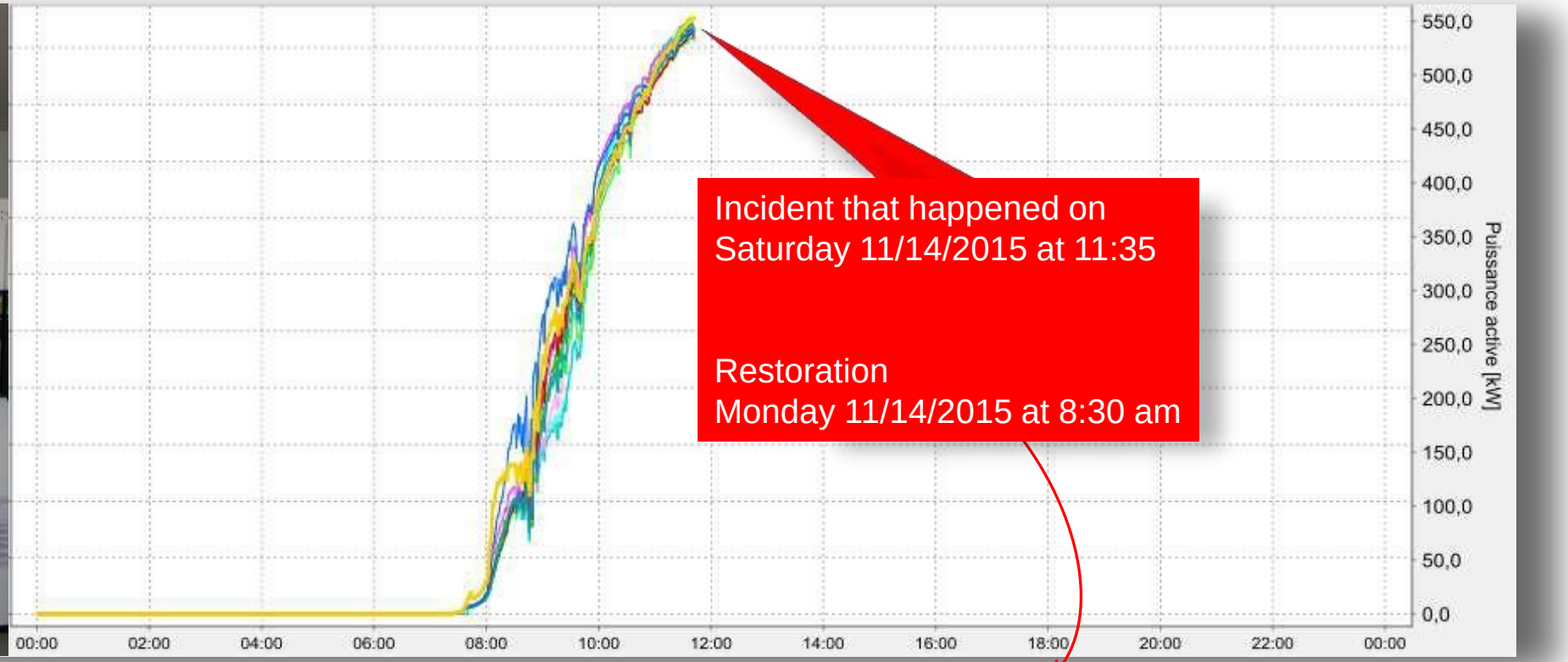
Operation (analysis of production losses or other failures)

General shutdown due to an electrical network fault:



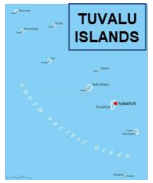
100% production loss during 2 days on 11 MWp => 43.68 MWh lost !

Specificity of solar micro grids in island areas

Case-studies : presentation on the commissioning of the Tuvalu mini-grids

How did that happen?

Location: FUNAFUTI (Tuvalu Island)
Commission: 2008 (13 years ago)
PV power: 40 kWp (60 MWh / year)
Project Leader: Kansai Electric Power



40kW solar PV grid-connected system at the football stadium in Funafuti

In 2008, we commissioned the **first grid-connected solar power system** on the island nation **of Tuvalu**, paving **the way for solar power development** on the island. Like many Small Island Developing States (SIDS), Tuvalu, an archipelago of nine coral islands in the South Pacific Ocean, **has been heavily reliant on imported fuel** for its diesel power generation systems. It is also one the places on earth that are most vulnerable to the effects of climate change. This pioneering project has helped Tuvalu's government in its quest to switch from full reliance on oil imports to an energy system with an increased share of renewable energy.

At commissioning, the 40 kW solar power system generated an annual 60 MWh of electricity with a stable monthly production average. **This accounted for about 5%** of Funafuti's (Tuvalu's capital) **peak demand**, and **3%** of TEC's **annual household consumption**. We monitored the system for a two-year period, during which we **collaborated with local stakeholders** to **ensure local and sustainable ownership of the project** and **completed various repairs**.

Specificity of solar micro grids in island areas

Operational and policy barrier in mini grid implementation

⇒ **Not enough trust in solar energy**

⇒ **High investment of mini hybrid grid**

⇒ **Difficulty to do remote payment and so, repaying the initial investment**

⇒ **Lack of qualified personnel in the study , installation and maintenance of mini grid PV hybrid system**

⇒ **Electricity grid remain fragile due to storms and cyclones, compare to genset system or simple off grid PV system**

⇒ **Off grid PV system investment took place at the <u>individual level</u> ≠ Micro-grid system investment took place at the <u>community level</u>**

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How to manage the various constraints related to Covid-19 restrictions (teleworking, late delivery, …).

⇒ **<u>More regular teleworking and travel restrictions</u>:**

- The fact of **no longer being able to see a work colleague** on a **daily basis** and the fact of **no longer being able to meet** the project **partners:**

  => **requires to organize remote meetings** (visio appointment via ZOOM / TEAMS / ...)

  => **requires delegating more missions to on-site partners**

⇒ **<u>Management of longer delivery times</u>**

- The fact of **undergoing delays much longer than normal**, or even **random delays**:

  => **requires having to anticipate** the stages of a project even better

  => **requires to show more flexibility** and even **creativity**.

Specificity of solar micro grids in island areas

THANK YOU FOR YOUR ATTENTION

Olivier VERDEIL - Solar Photovoltaic Expert and Trainer at INES
Online Training – November 2021

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