

# A New Generation of PV Monitoring System with High-Grade Remote Diagnostics Based on Module Level Monitoring and Integrated Yield Simulation

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30<sup>th</sup> EUPVSEC Hamburg

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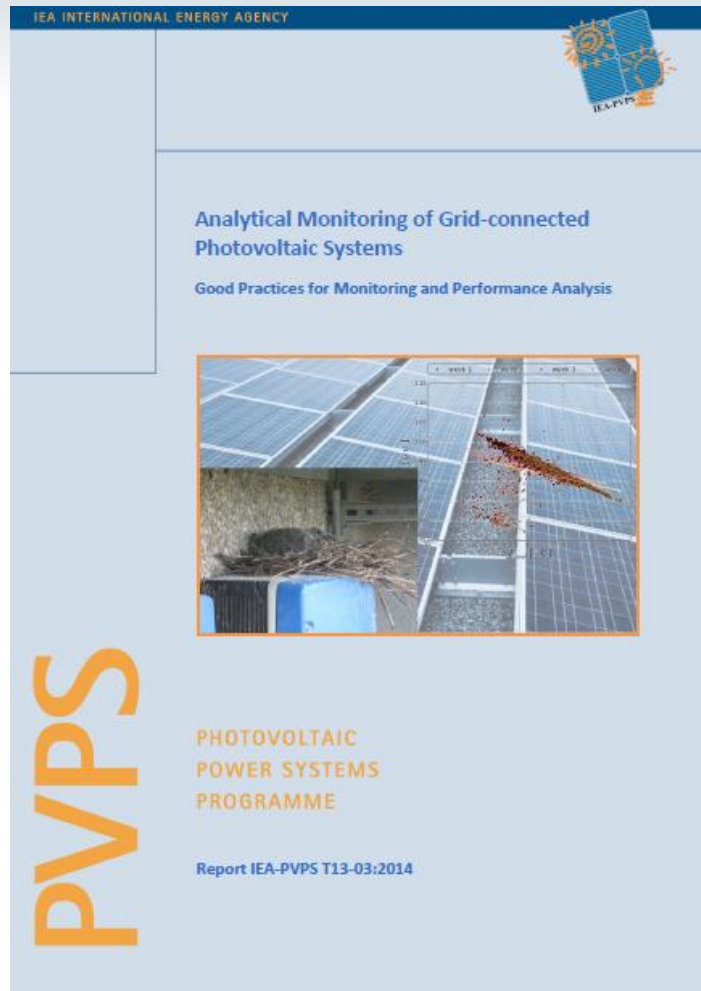
EWE-Forschungszentrum für  
Energietechnologie e.V.

supported by:



- | **Motivation of our PV Monitoring Approach**
- | **Experimental Setup**
- | **Current Status of Research Project InSeMo**
  - » **Automated error detection via nominal-actual value comparison**
  - » **Automated fault analysis**
- | **Conclusion and Outlook**

# 1. Motivation of our PV Monitoring Approach



## Report IEA-PVPS T13-03:2014

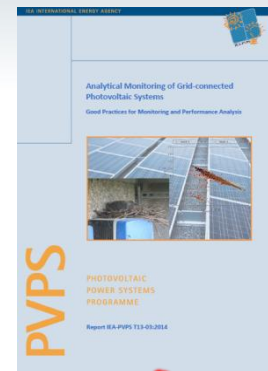
- » By now PV plants are performing at a satisfactory level **but could achieve higher levels of output**
- » **Essential recommendation**
  - **(a) Fault finding and trouble-shooting must be carried out in greater depth**

# 1. Motivation

## Report IEA-PVPS T13-03:2014

- » By now PV plants are performing at a satisfactory level but could achieve higher levels of output
- » **Essential recommendation**
  - (a) Fault finding and troubleshooting must be carried out in greater depth
  - **(b) Monitoring at least on the junction box level is strongly recommended**

For more advanced monitoring the power or current on the junction box level or the string currents should be measured. The additional cost for advanced monitoring depends on the PV plant layout and capacity. The economic benefit of advanced monitoring compared to the simple inverter monitoring depends very much on the individual project. The economic benefit is higher when more energy is produced per installed power plant and results in a higher price per kWh. In case the PV plant produces less energy than expected, junction box or string based monitoring reduces the time and cost significantly for detecting the failure. If the PV plant is sold to a new owner, advanced monitoring gives more security about the quality of the plant. **For these reasons, monitoring that registers the DC production at least on the junction box level is strongly recommended.**



## 2. Experimental Setup

### I SunSniffer® PV Monitoring System

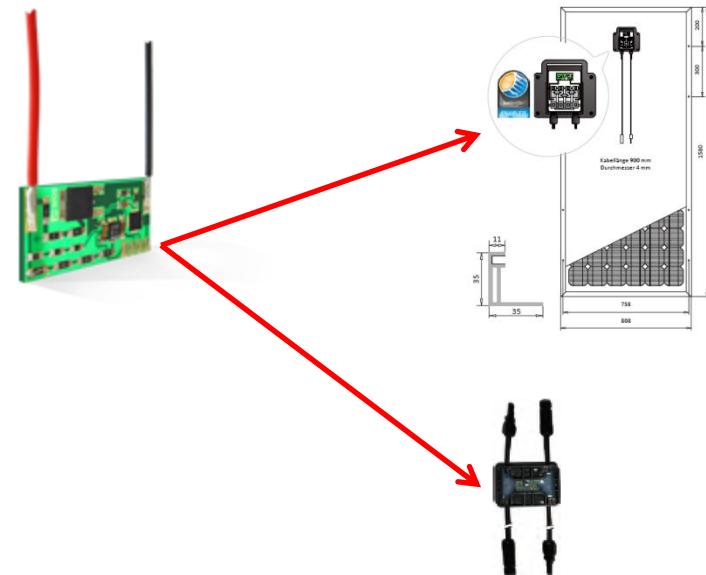


» Company **STORM Energy**, Nuremberg (Germany)

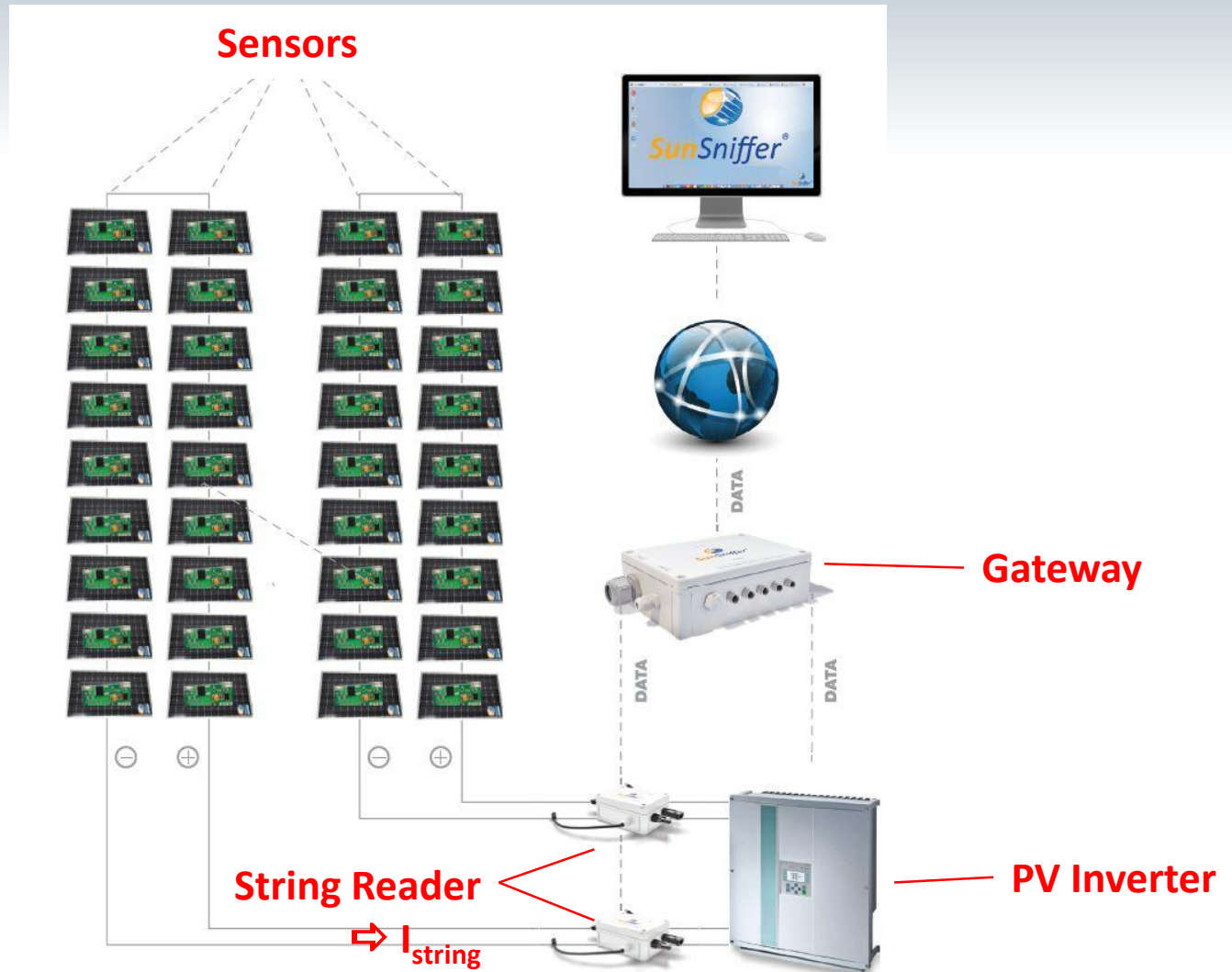


» **SunSniffer® Sensor**

- Core of the system
- Continuous measurement of
  - **Module voltage**
  - **Junction box temperature**



# SunSniffer® PV Monitoring System



### 3. Research Project InSeMo

#### I Consortium

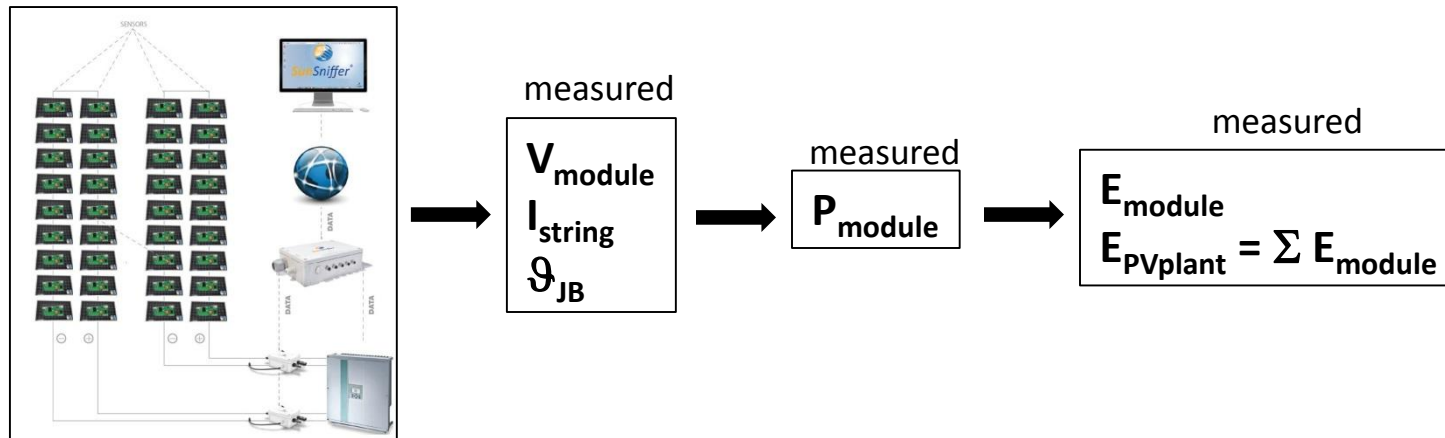
- » STORM Energy 
- » NEXT ENERGY 
- » University of Applied Sciences Bielefeld



- I **Project aim:** Distinct extension of functionalities of SunSniffer® PV Monitoring System

### 3. BMWi-E Joint Research Project InSeMo

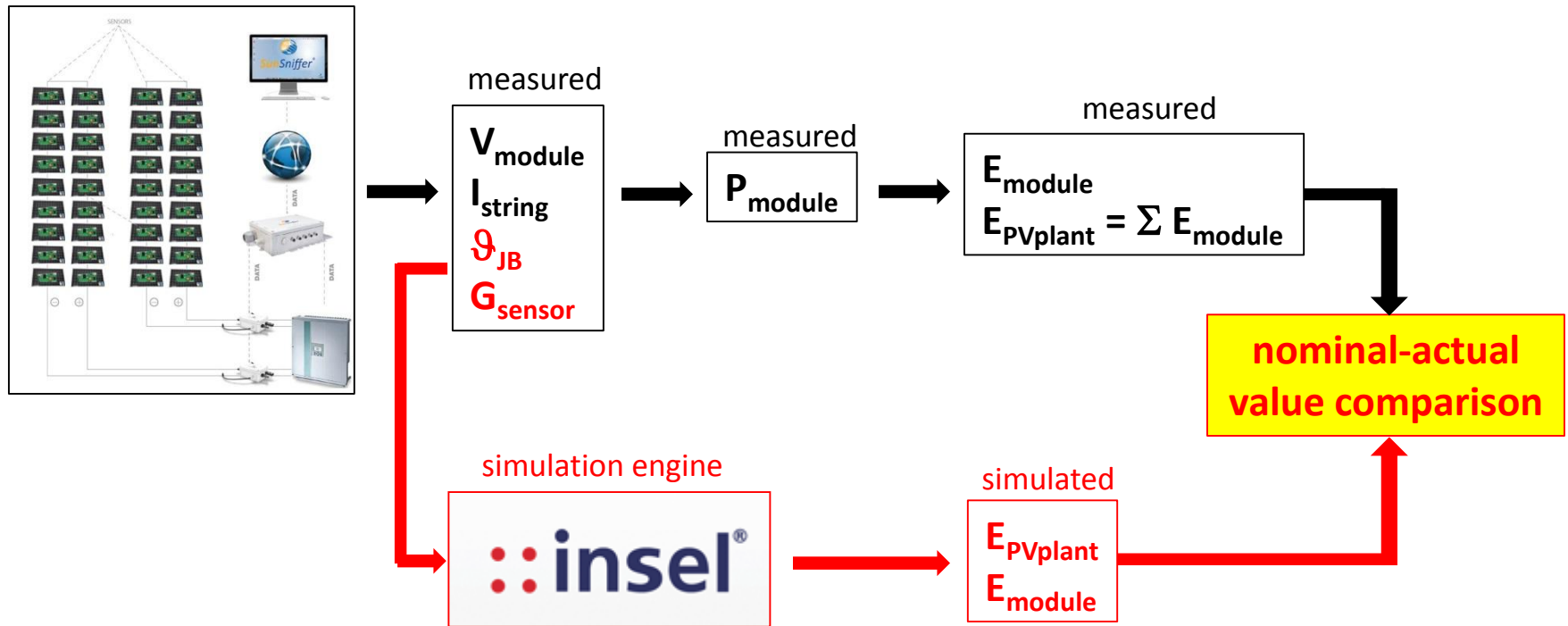
Project aim: Distinct extension of functionalities of SunSniffer® PV Monitoring System



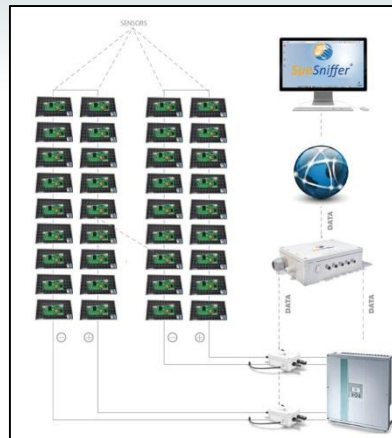


### 3. BMWi-E Joint Research Project InSeMo

Project aim: Distinct extension of functionalities of SunSniffer® PV Monitoring System



# Extension of SunSniffer® Functionalities



integrated  
simulation  
engine

$$\Delta = E_{PV,meas} - E_{PV,sim}$$

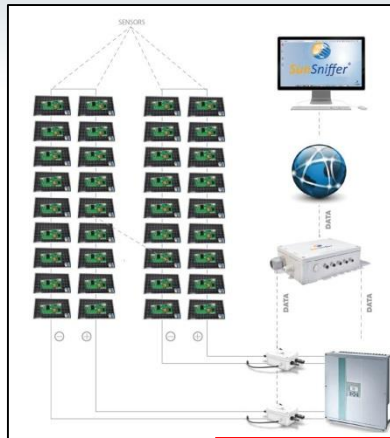
PV performance  
problem?

(1) automated  
error  
detection

yes

no

# Extension of SunSniffer® Functionalities



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$$\Delta = E_{PV,meas} - E_{PV,sim}$$

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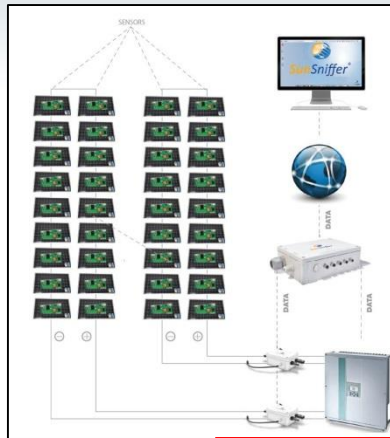
(1) automated  
error  
detection

yes

no

(2) automated  
fault  
analysis

# Extension of SunSniffer® Functionalities



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$$\Delta = E_{PV,meas} - E_{PV,sim}$$

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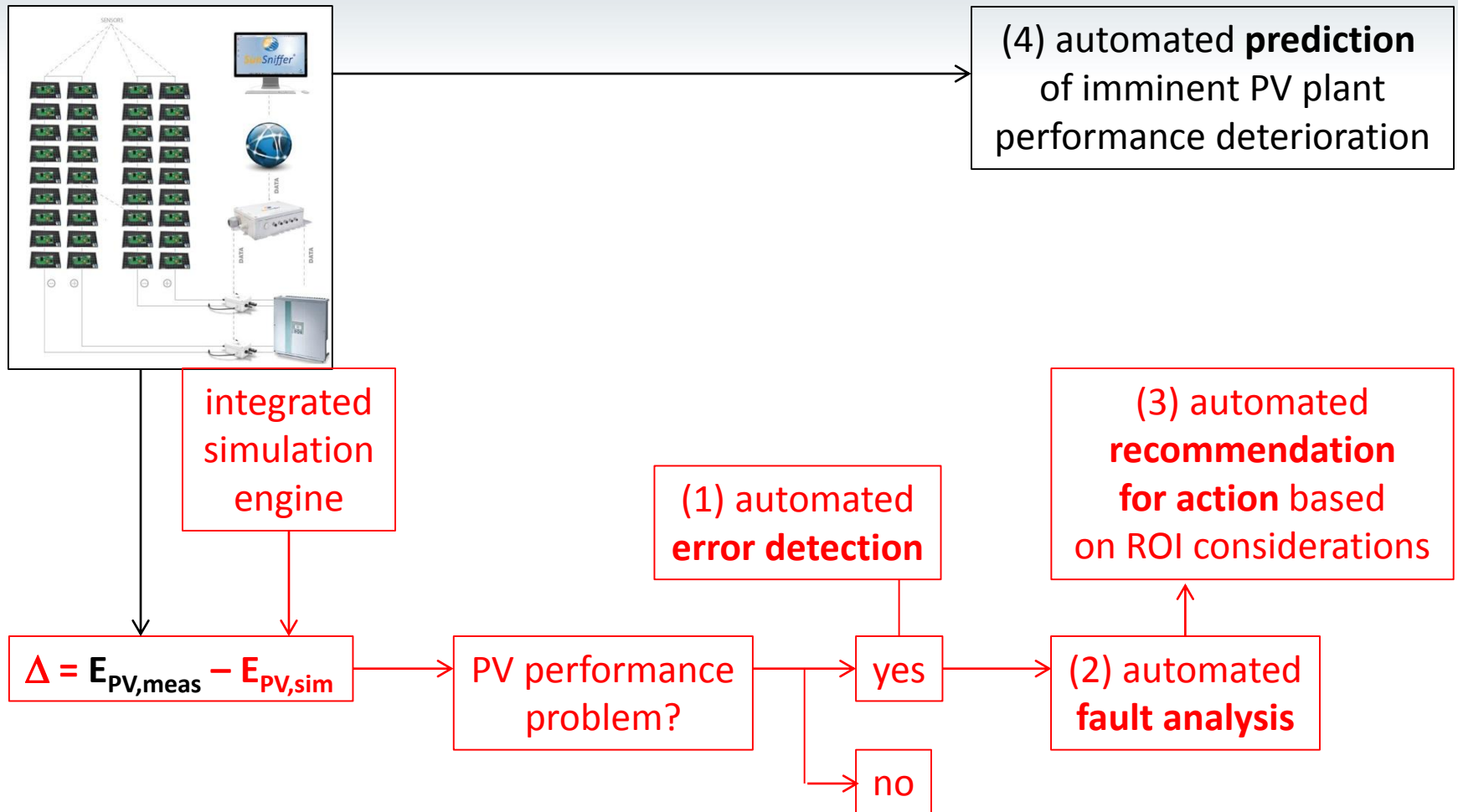
yes

no

(3) automated  
recommendation  
for action based  
on ROI considerations

(2) automated  
fault  
analysis

# Extension of SunSniffer® Functionalities



# Current Status of Research Project InSeMo

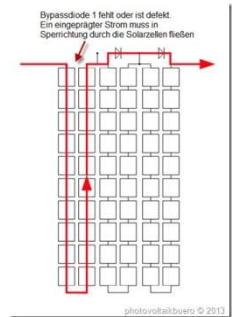
## I Already implemented

- » **Simulation engine integrated into SunSniffer® Internet Platform** 
  - prio to this simulation accuracy was evaluated
  - comparison between measured and simulated annual PV energy yield  
⇒ simulation accuracy **down to 0.4 %** achieved
  
- » **Automated error detection via nominal-actual value comparison**
  
- » **Automated fault analysis** (started but not just yet completed)

# Automated Fault Analysis

## Distinction between

- » Soiling
- » Shadowing
- » PID
- » Wire insulation issues
- » Defect bypass diodes
- » Cell cracks
- » ...



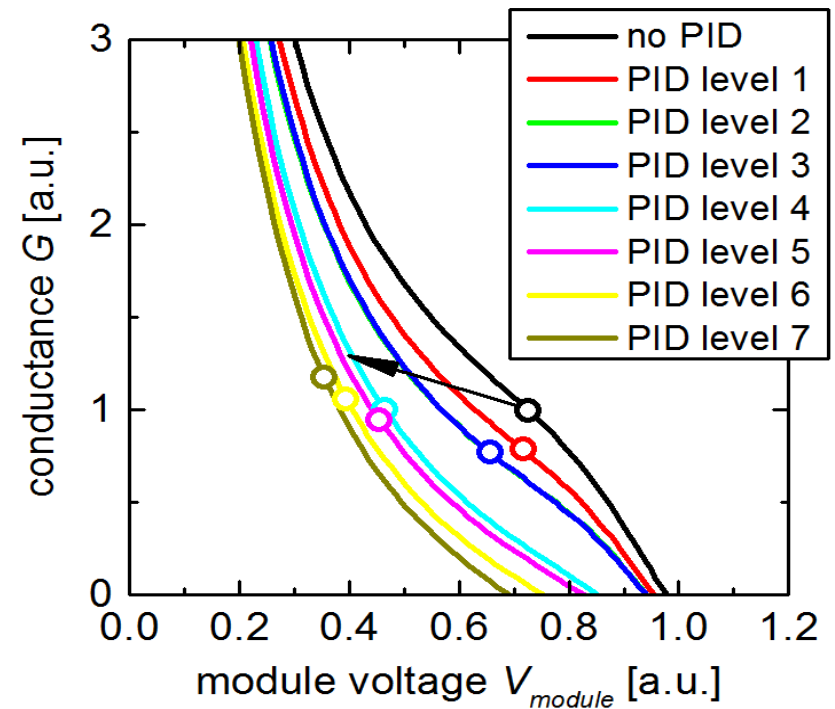
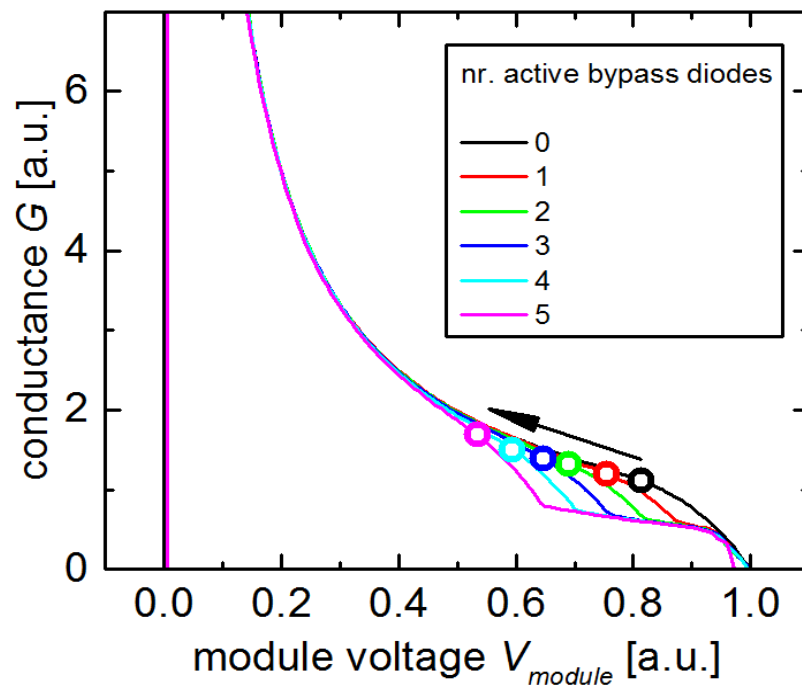
M. Diehl, photovoltaikbuero GbR, [www.pvbuerode](http://www.pvbuerode)

## Pattern matching as approach

# Pattern matching

Distinction between partial shadowing and PID

$$G = \frac{I_{string}}{V_{module}}$$





## Conclusion and Outlook

- I Research Project aims to distinctly extend functionalities of SunSniffer<sup>®</sup> PV monitoring system
  - » Integration of **PV yield simulation engine** after evaluating simulation accuracy
  - » Automated error detection developed based on **nominal-actual value comparison**
  - » Automated fault analysis development started based on **pattern matching**
  
- I Further work
  - » Automated recommendations for action based of ROI considerations
  - » Automated prediction of imminent PV plant performance deterioration
  - » **Long-term field test** ⇨ evaluate reliability of all new SunSniffer<sup>®</sup> functionalities

# Acknowledgement

## I Thanks to

- » Colleagues at NEXT ENERGY
- » Partners at

- STORM Energy



- University of Applied Sciences Bielefeld



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