

Geospatial World Forum, 09.05.2014

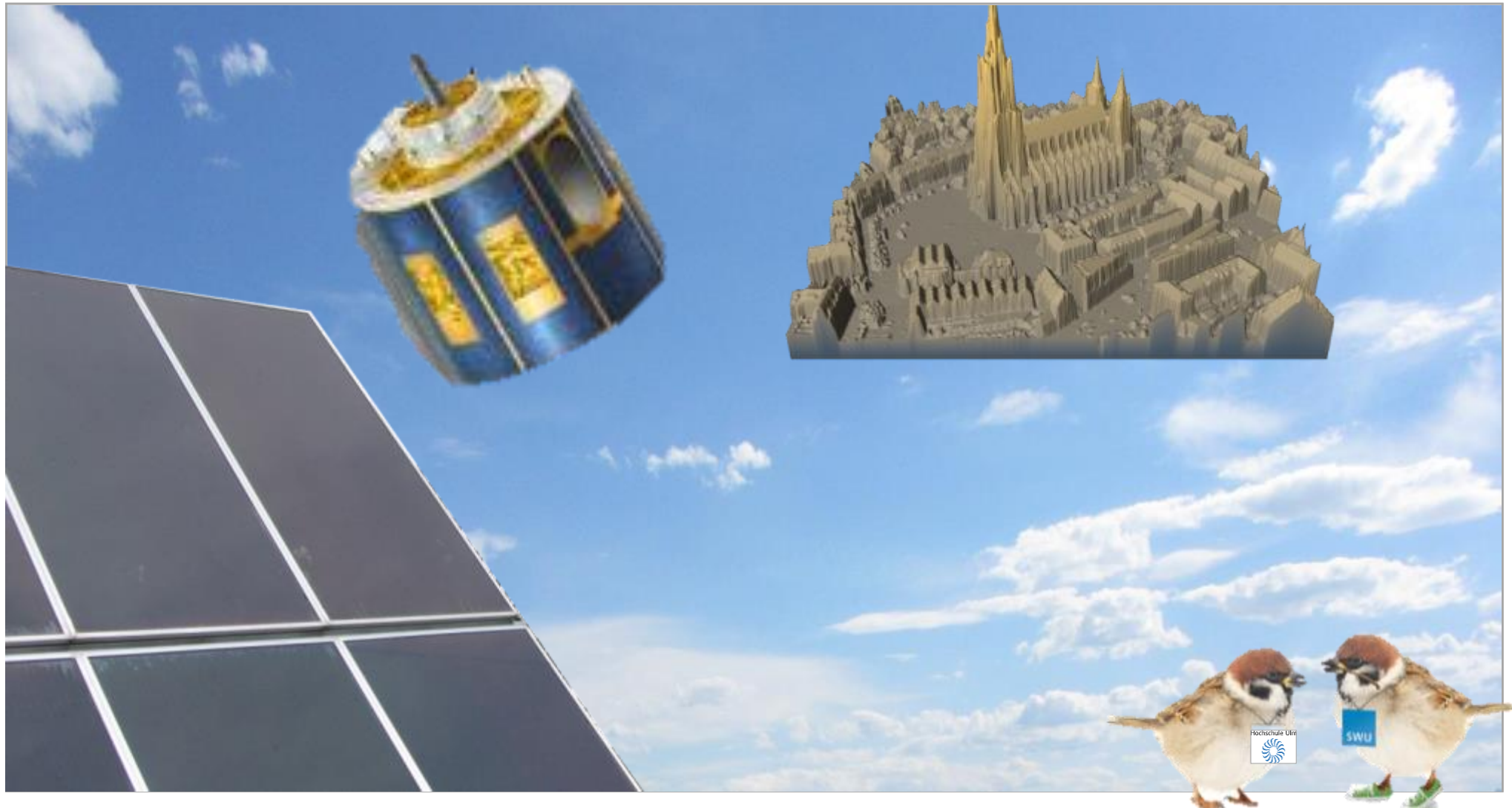
Holger Ruf

Satellite-based Nowcasting for Distribution Grids

Hochschule Ulm



Stadtwerke Ulm/Neu-Ulm
Netze GmbH





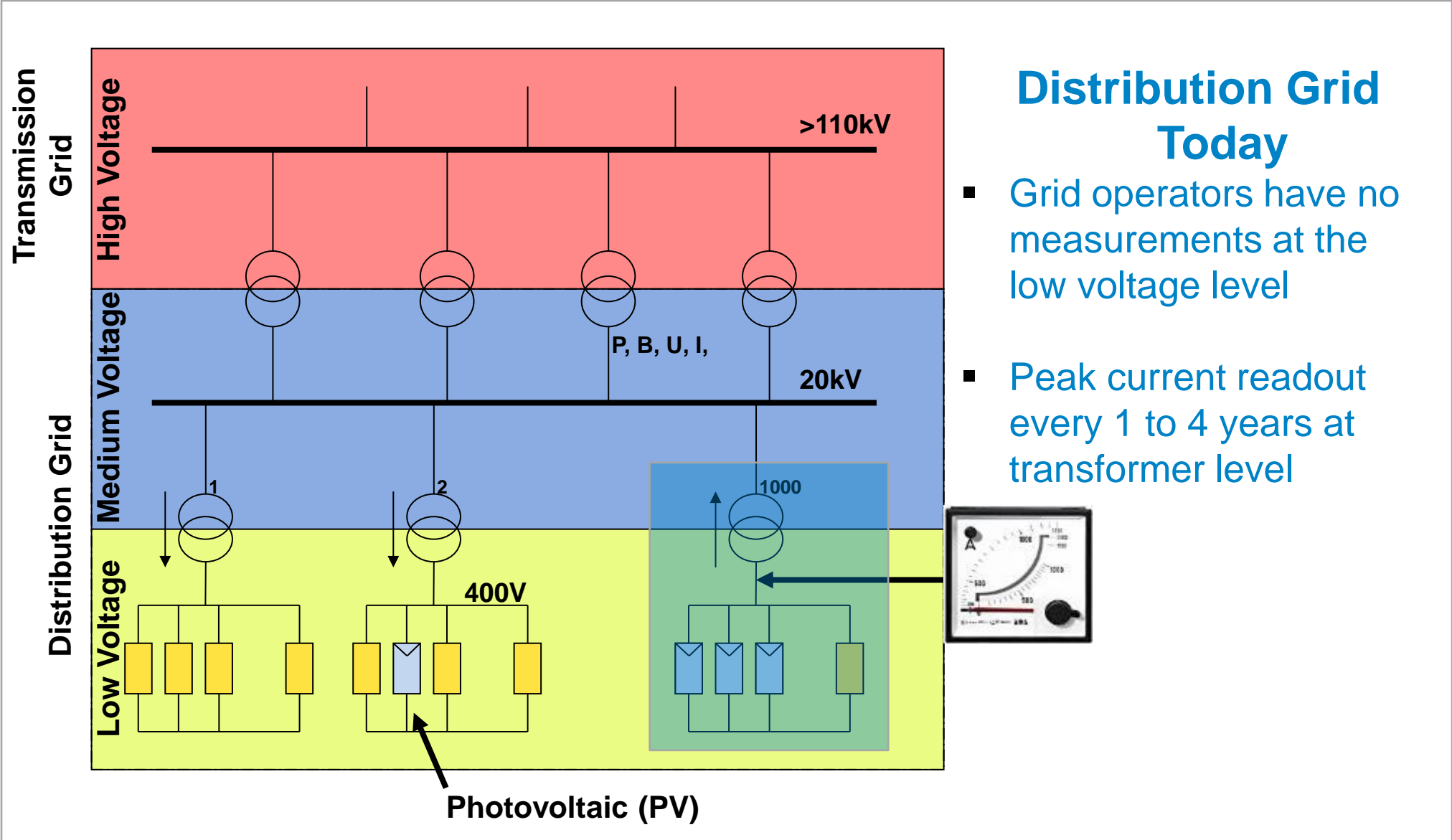
Outline

- Introduction to the electric grid
- Situation in Ulm
- Approach – Remote sensing for grid planning and operation
- GIS data for smart grids
- Results from Smart Grid Ulm
- Conclusion



The electric grid

A very short introduction



Distribution Grid Today

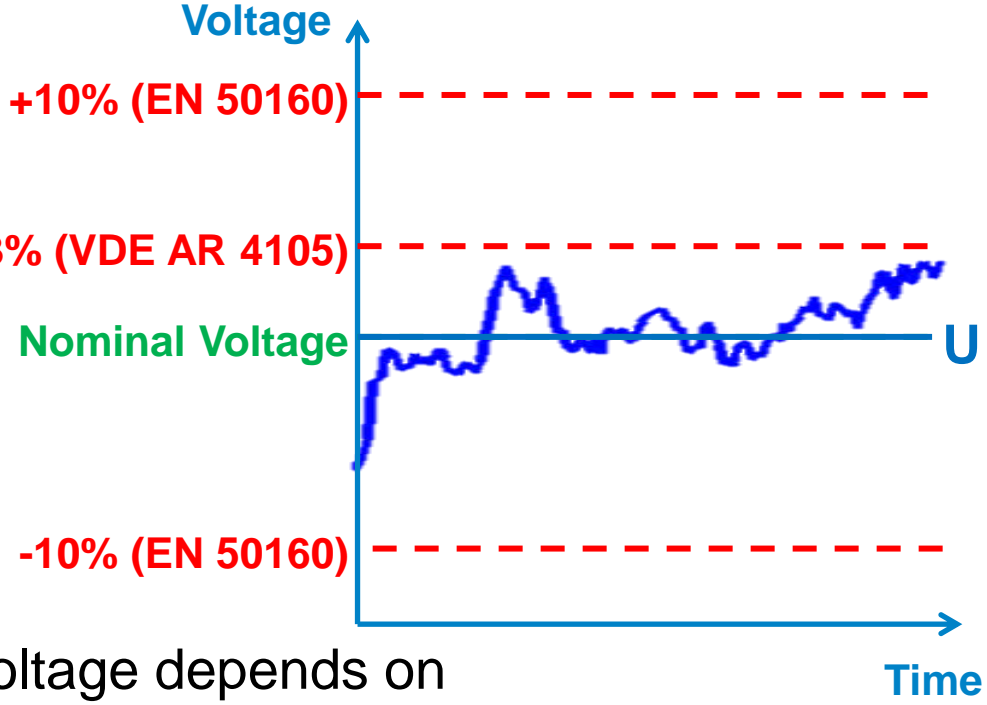
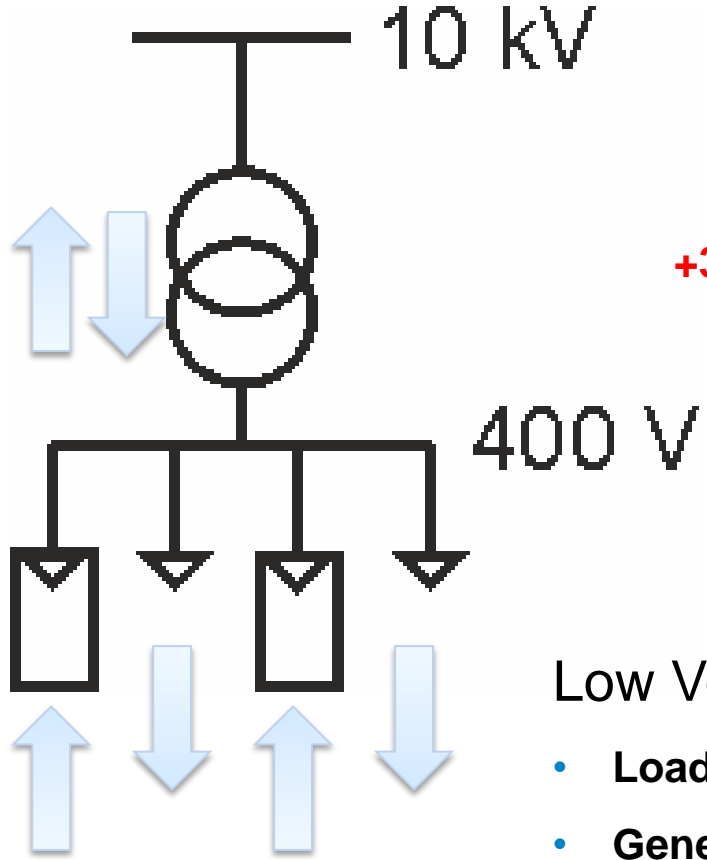
- Grid operators have no measurements at the low voltage level
- Peak current readout every 1 to 4 years at transformer level





Voltage drop

Influence of Load and Photovoltaic to voltage



Low Voltage depends on

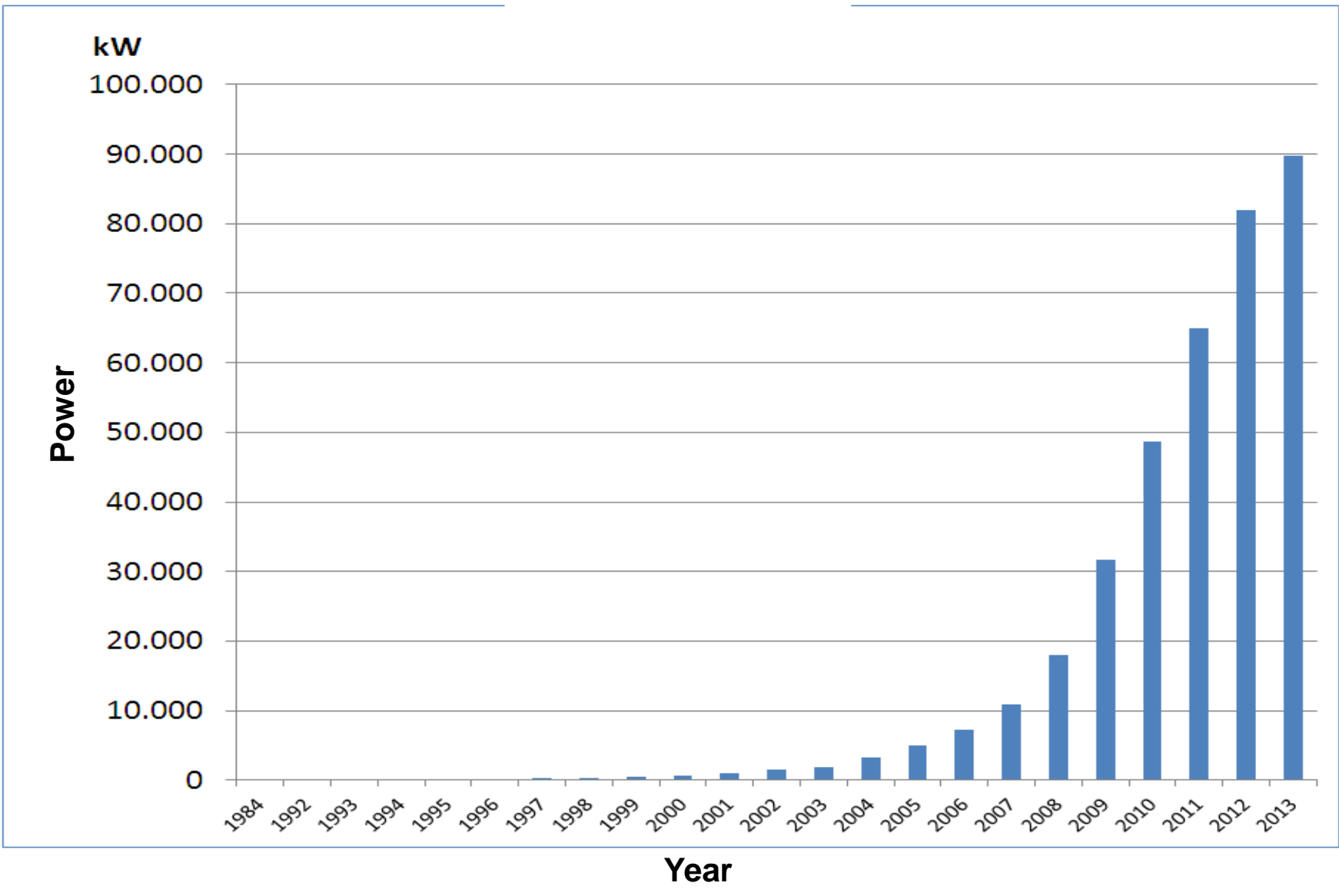
- Load
- Generation
- Medium Voltage Level

Load depends on load profile
Generation depends on irradiance
Medium voltage is a superposition of both



PV Power at Ulm

Installation mainly in low voltage grid





Motivation

Challenges for grid planning and grid operation

- Situation today
 - Over 90 MWp in Ulm
 - Over 4500 PV systems mainly in low voltage grids
 - No online-monitoring in the low voltage grid, just annual energy values per household
 - No grid status on low voltage level
 - Increasing error in load balancing (demand and production)
 - Unknown situation of voltage and load flow
 - Need measures to know about the risk of voltage band violation and component overload in low voltage grid in advance





Main Questions

Smart Grid Research at Ulm

- **How much PV the grid can take?**
- **What happens if 25% / 50%100% of the houses have PV systems**
- **How the grid has to be enforced?**
- **Which technical solutions are available?**
- **What are the costs?**
- **Which are the cost effective solutions?**

What are the costs for a Smart Grid?



Test Site 1

Suburban Ulm-Einsingen



Situation 2013

Households 133
 PV Systems 21
 Power 233 kWp

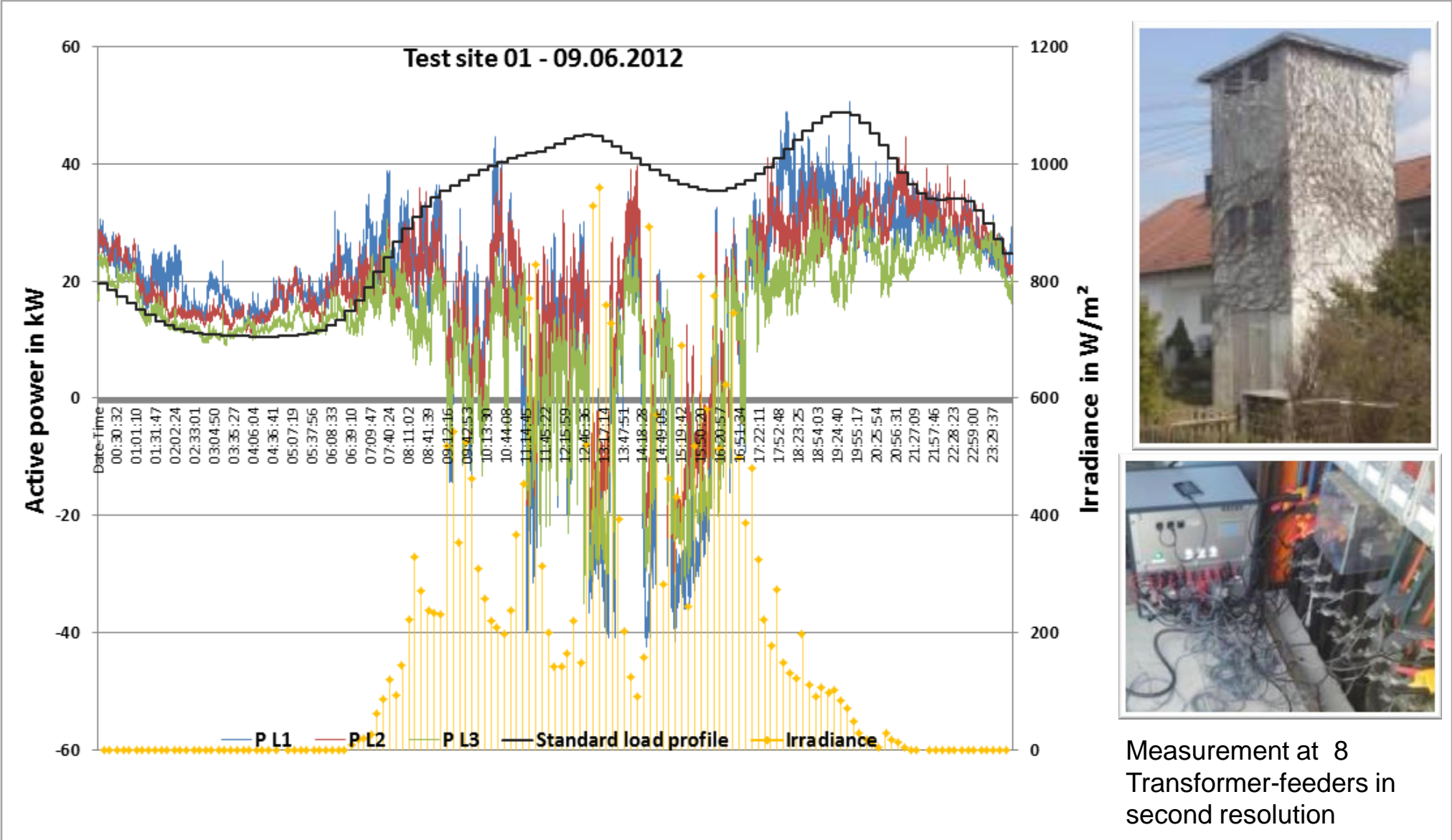
Load: ~1047 MWh
 PV: ~230 MWh

PV Fraction: 23%



Test Site 1

Measurements at the Transformer

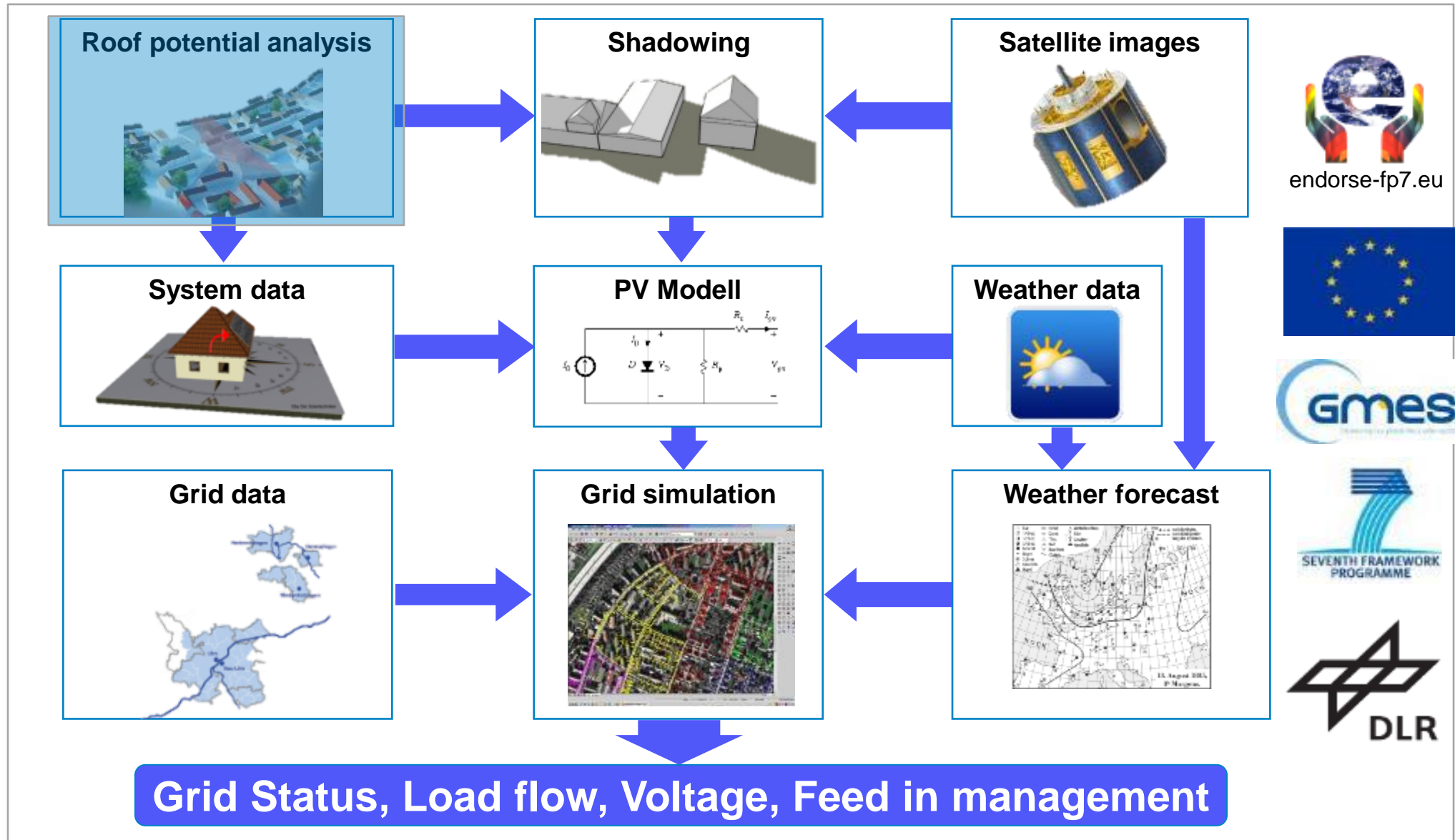


Measurement at 8
Transformer-feeders in
second resolution



Approach

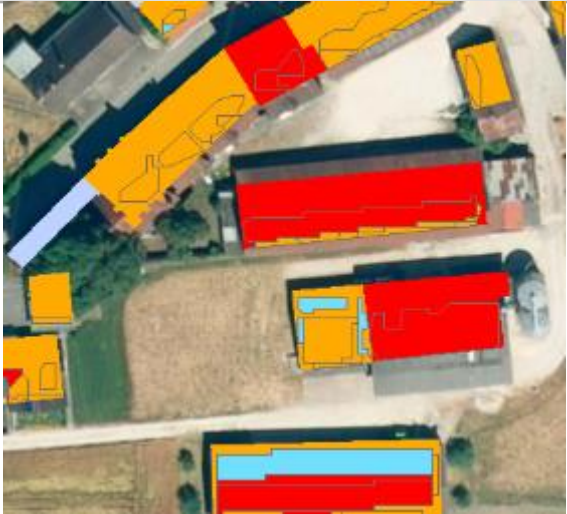
Grid status with high shares of PV



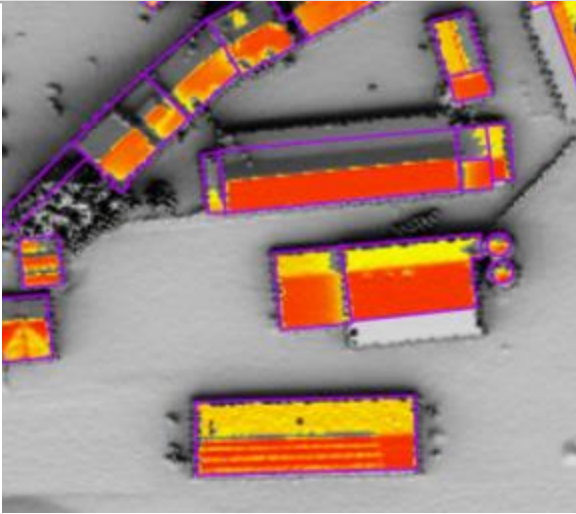


Solar Potential Analysis

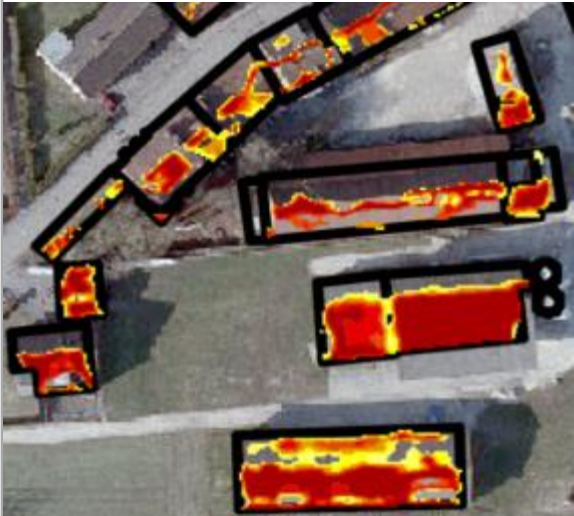
Source for necessary data for today and tomorrow



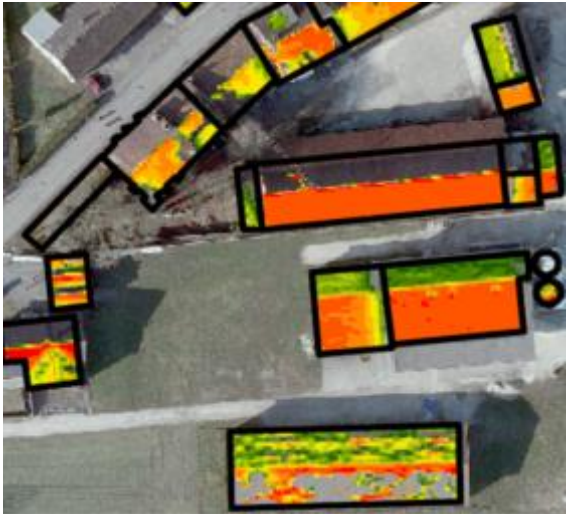
LUBW Potentialatlas EE



SunArea with Lidar 2013



SunArea + GridIt



SunArea + Blom

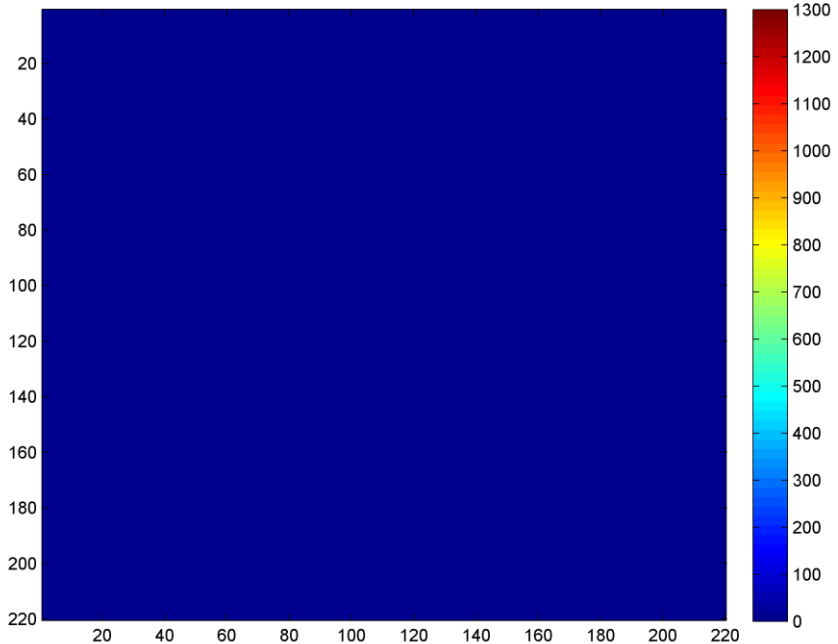
- New flight data
- Excellent results
- Correct analysis of existing PV-systems



Solar potential time series

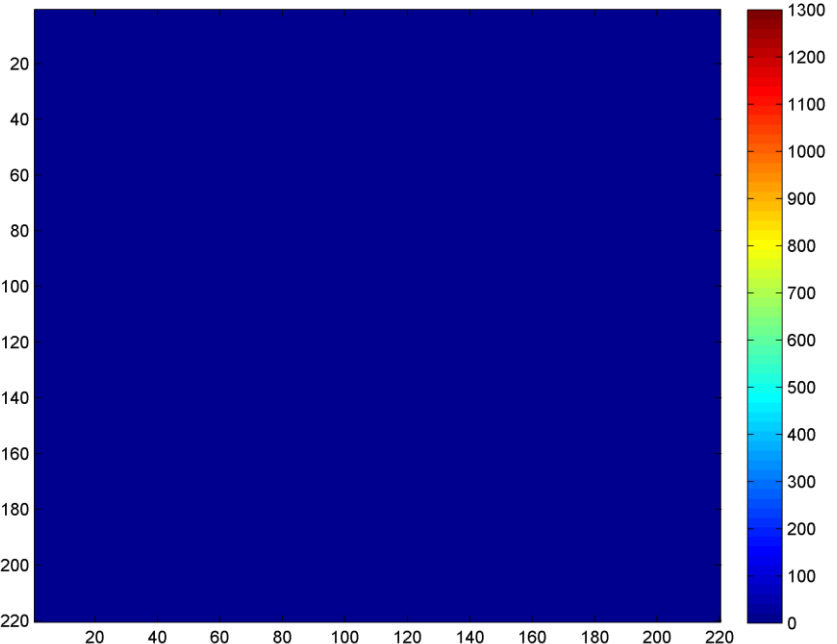
Ideal and real irradiation during one day

Clear Sky



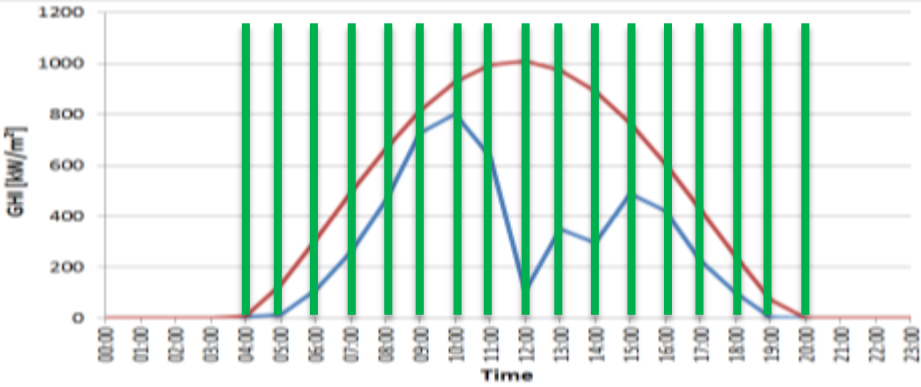
07.06.2012--20:00

Real irradiance



07.06.2012--20:00

Time series of **Clear Sky irradiance** useful for **planning** electric grids

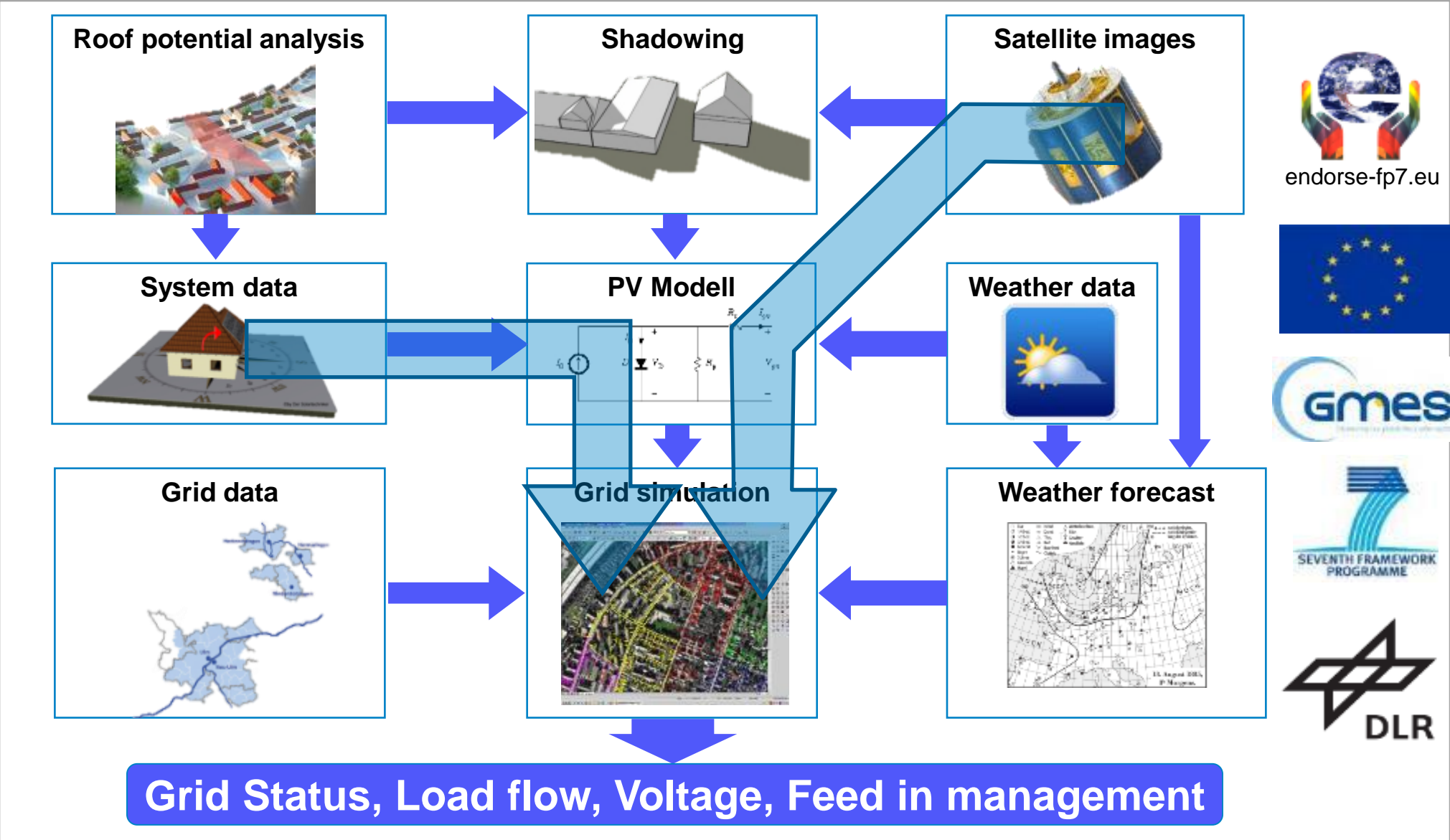


Time series of **real irradiance** useful for **operate** of electric grids



Approach

Grid status with high shares of PV

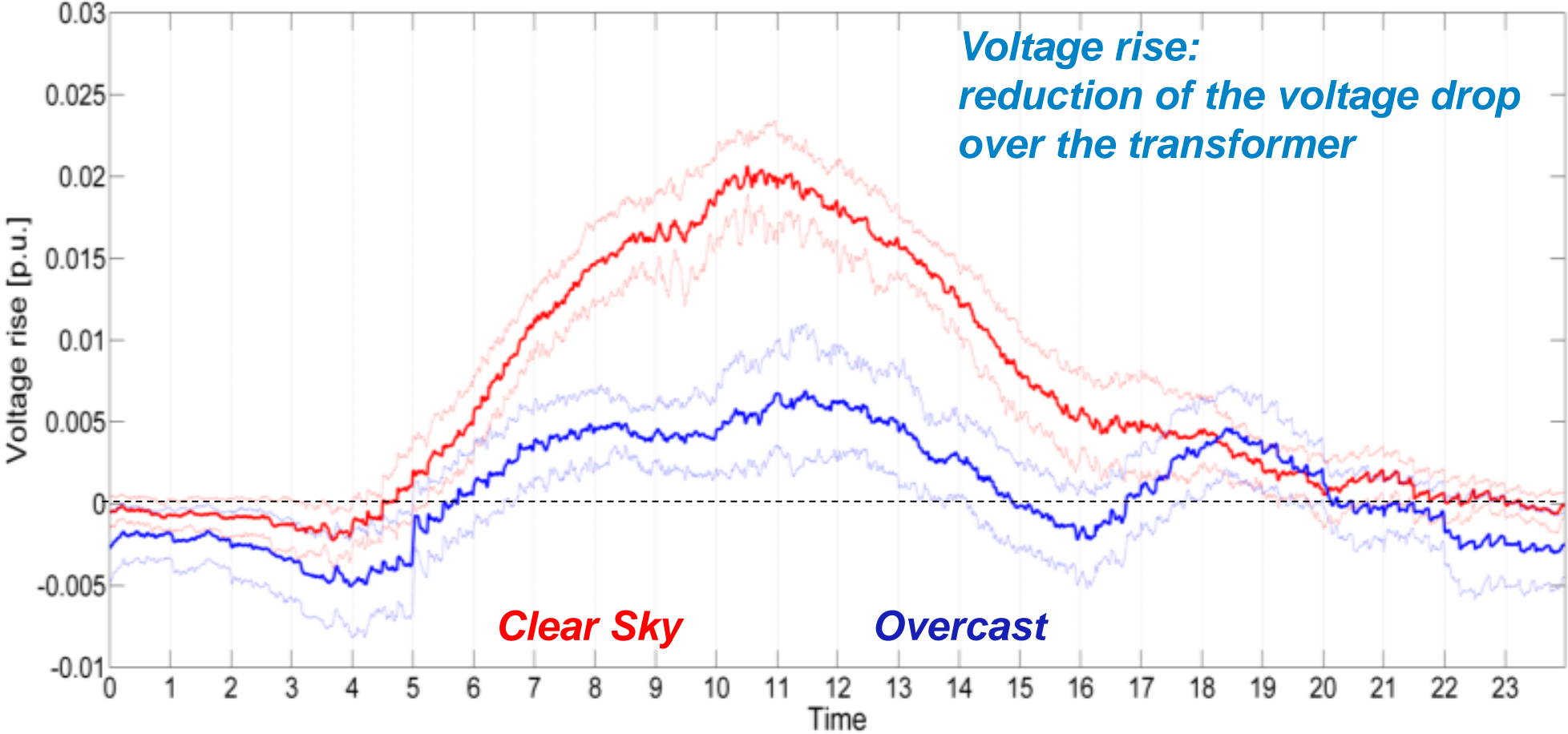




Voltage drop at Transformer

Correlation between clouds site and measured voltage

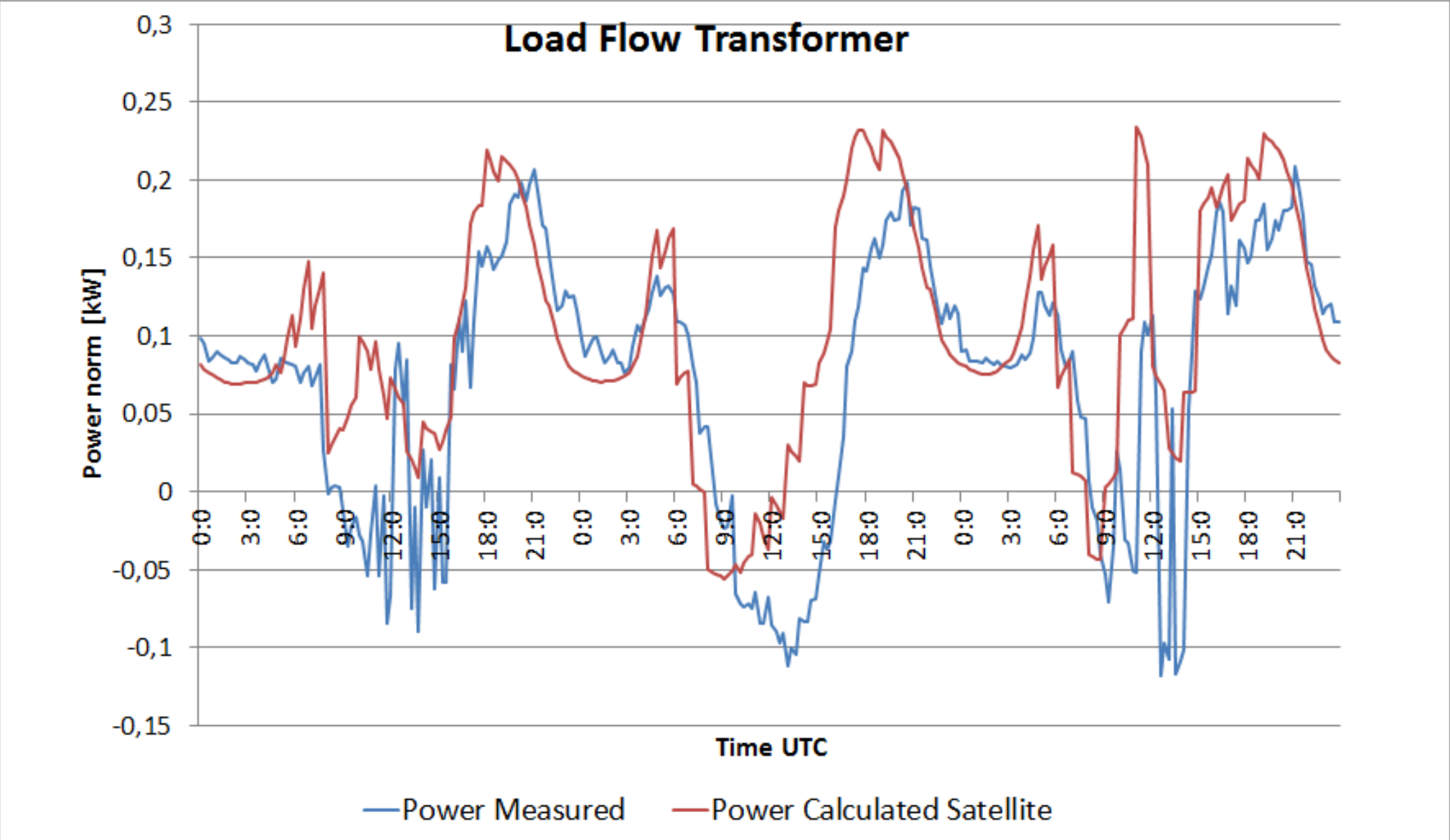
Mean voltage rises - Clear Sky and Overcast all days





Load Flow at Transformer (1)

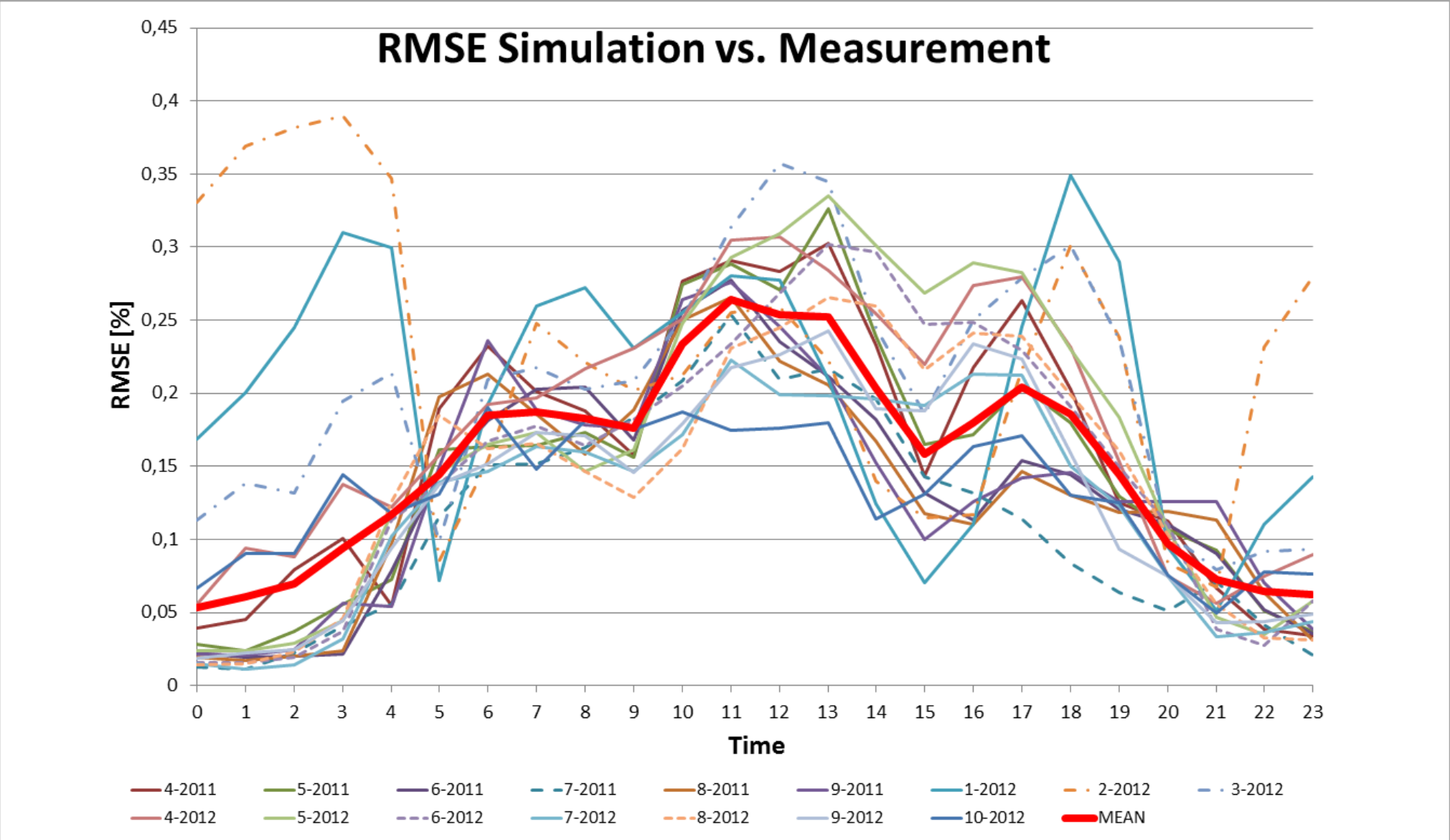
Estimate load flow by remote sensing





Load Flow at Transformer (2)

RMSE of Simulation minus Measurement





Conclusion

Increasing Requirements for DSOs

- Solar potential analysis
 - High accuracy necessary for local areas
 - LIDAR data recommended
 - Instantaneous results necessary
- Remote sensing of low voltage grids
 - Voltage and load flows are important
 - Higher estimation errors
 - Forecasting possible
- Next steps
 - Implementation forecast approaches
 - Development of voltage estimation

New Service for
Grid Operators



Thank you.

Any questions ?

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