

14th EMS & 10th ECAC

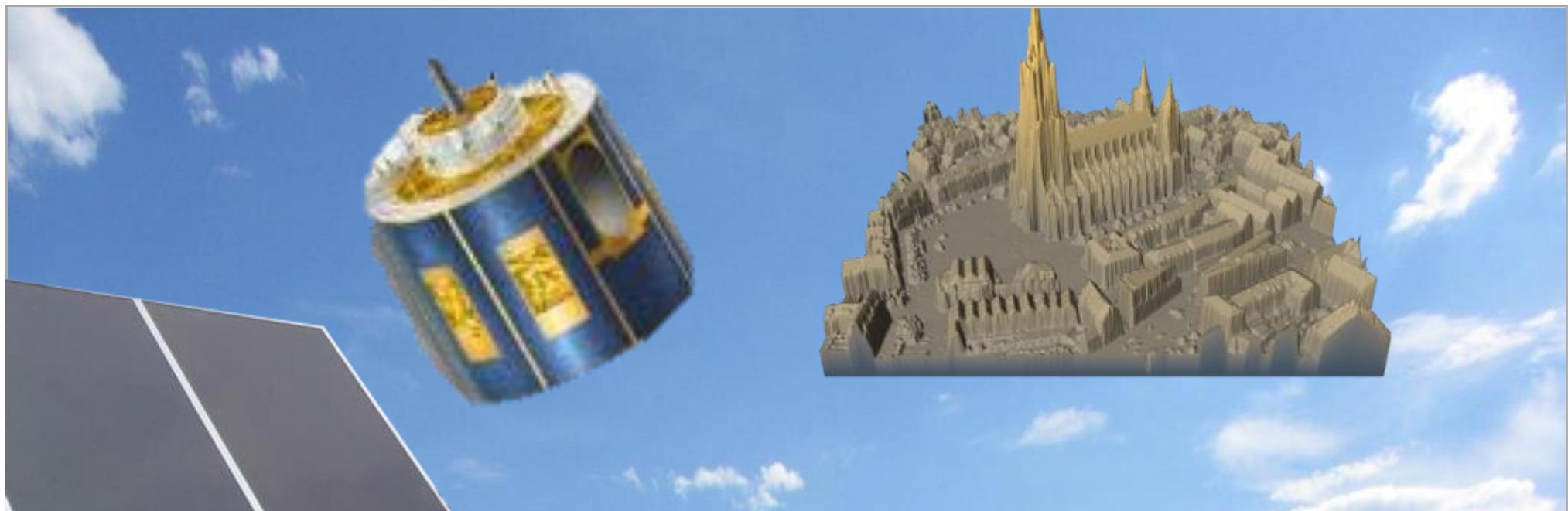
07 October 2014 | Prague

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Hochschule Ulm



**Stadtwerke Ulm/Neu-Ulm
Netze GmbH**



**Application of meteorological data for
state estimation of an electrical low
voltage grid with a high amount of
photovoltaic systems**





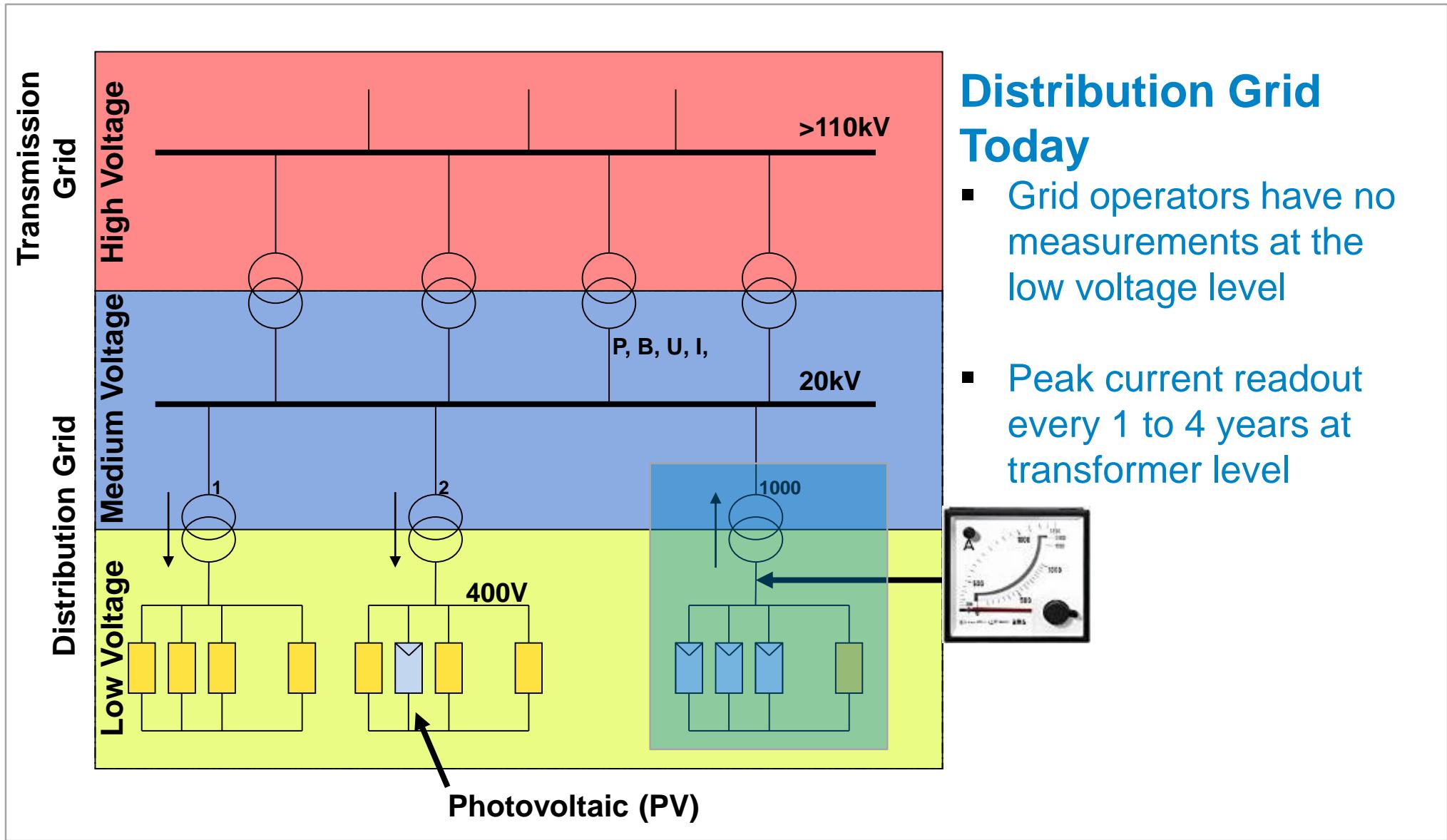
Outline

- Introduction to the electric distribution grid
- Smart Grid and Energy Meteorology
- Approach – Remote sensing for grid planning and operation
- Results and Conclusion



The electric grid

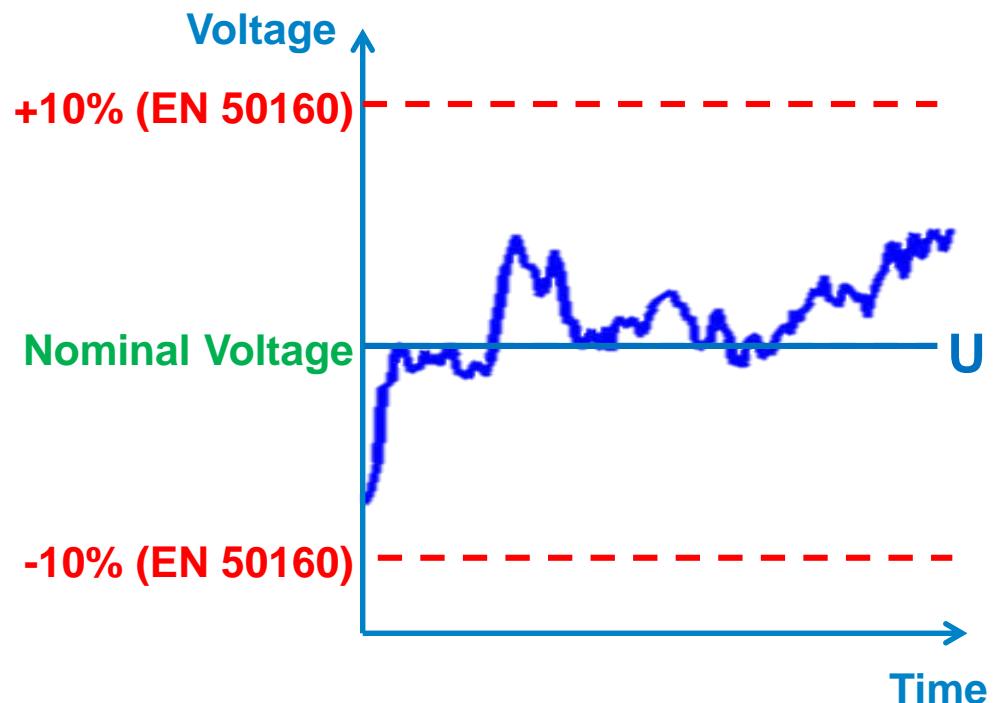
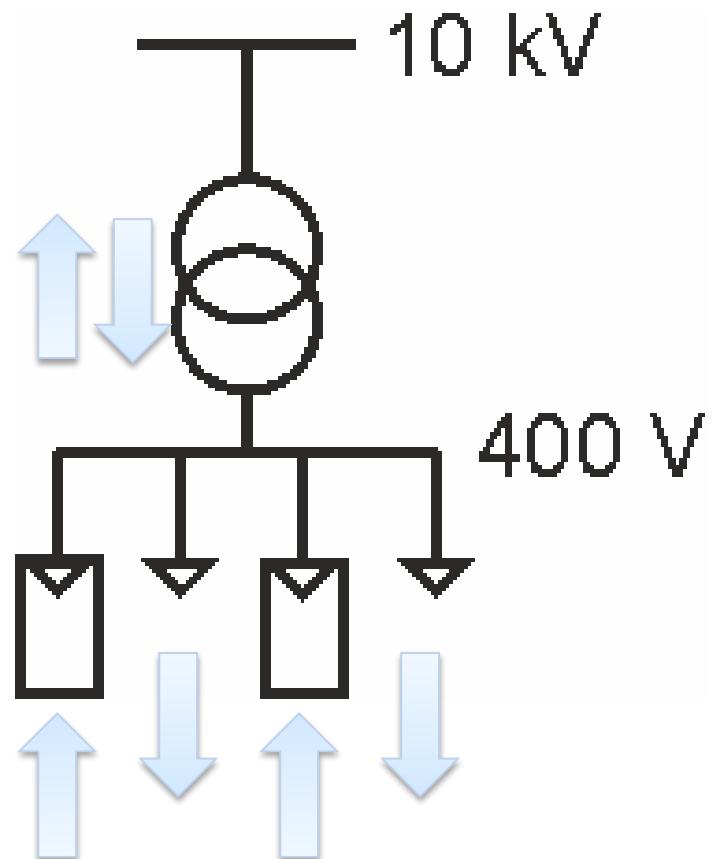
A very short introduction





Voltage drop

Influence of load and photovoltaic to voltage



Low Voltage depends on

- **Load** depends on load profile
- **Generation** depends on irradiance
- **Medium Voltage Level** is a superposition of both

Main questions

Smart Grid research in Ulm

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- 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?



PV system simulation

Required data and available data

- Accurate PV simulation requires various parameter per PV system
- Different Parameters have different impact to the result
- However, DSO do not know necessary parameters:

Peak capacity

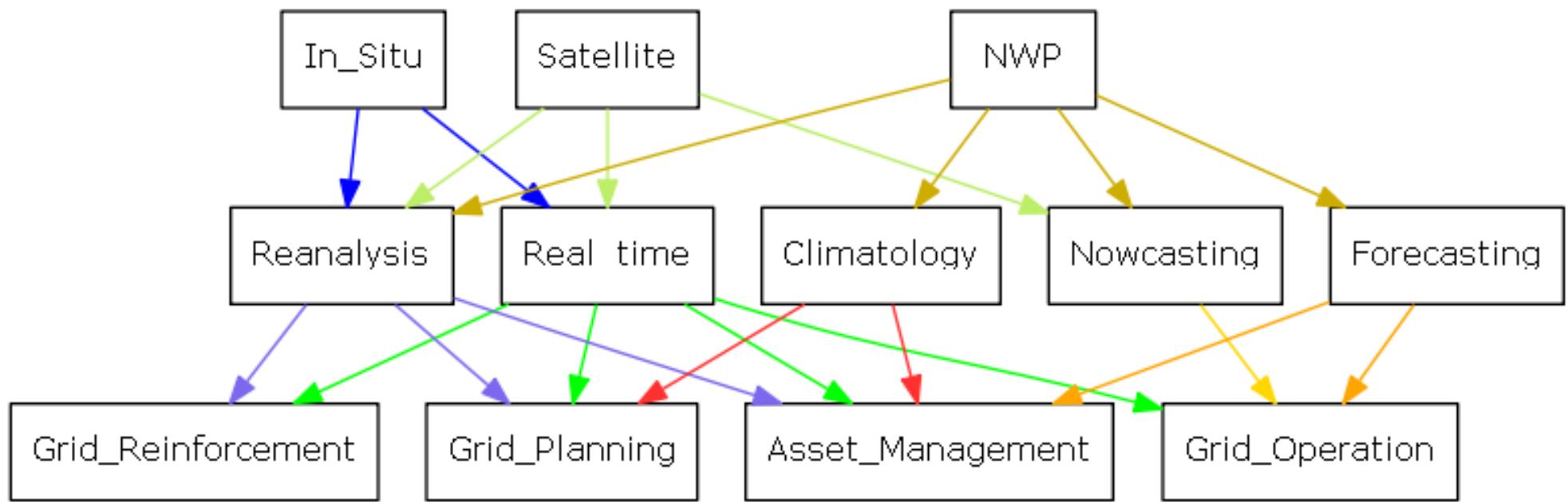
Global horizontal irradiation



Meteorology and Electric Grid

Mapping from DSOs point of view

- DSOs are interested in:
 - Grid reinforcement
 - Grid planning
 - Grid operation
 - Asset management
- Meteorology could provide:
 - Reanalysis and long term history
 - Real time values
 - Nowcasting and Forecasting
 - Climatological prediction

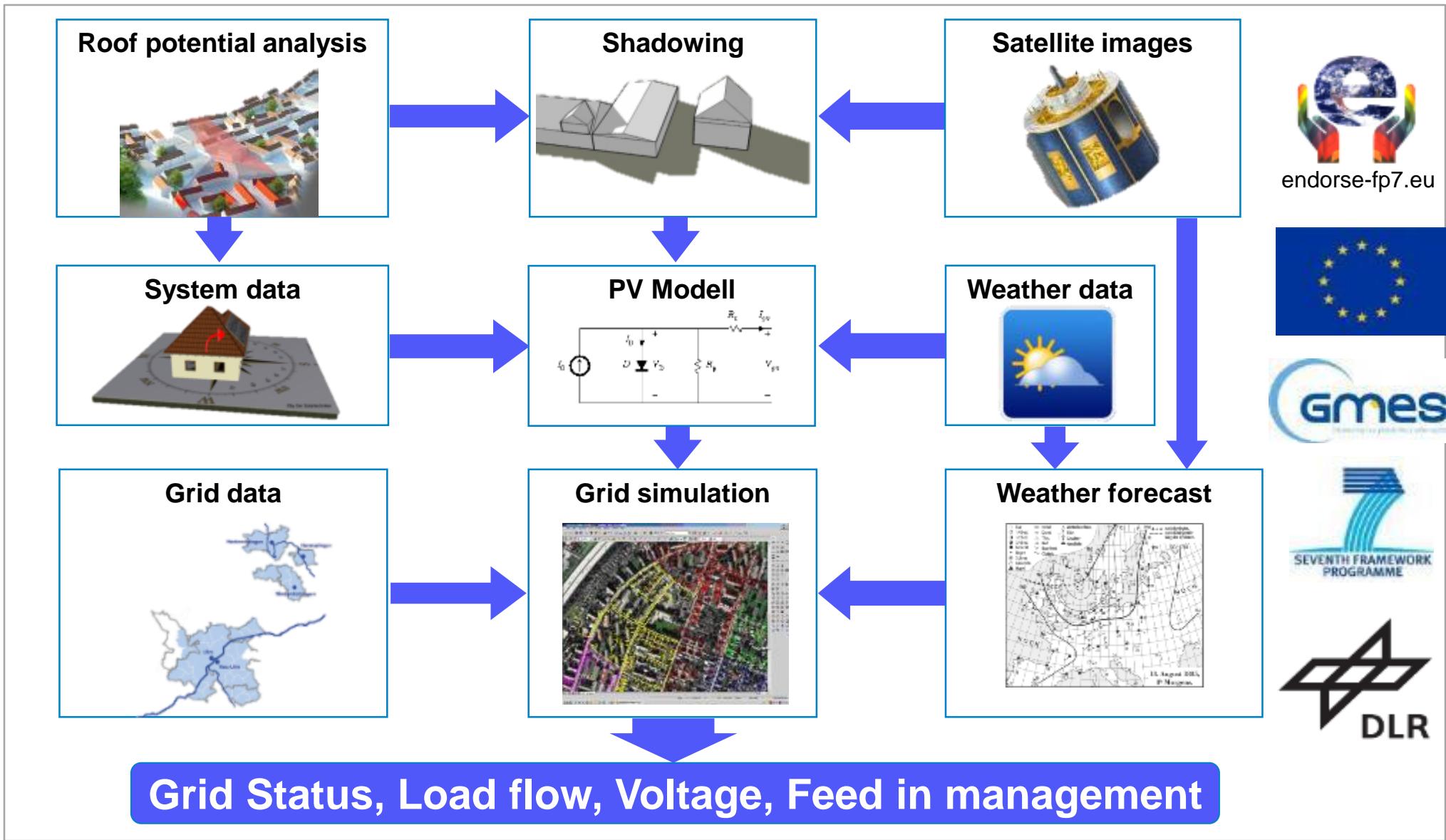




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General approach

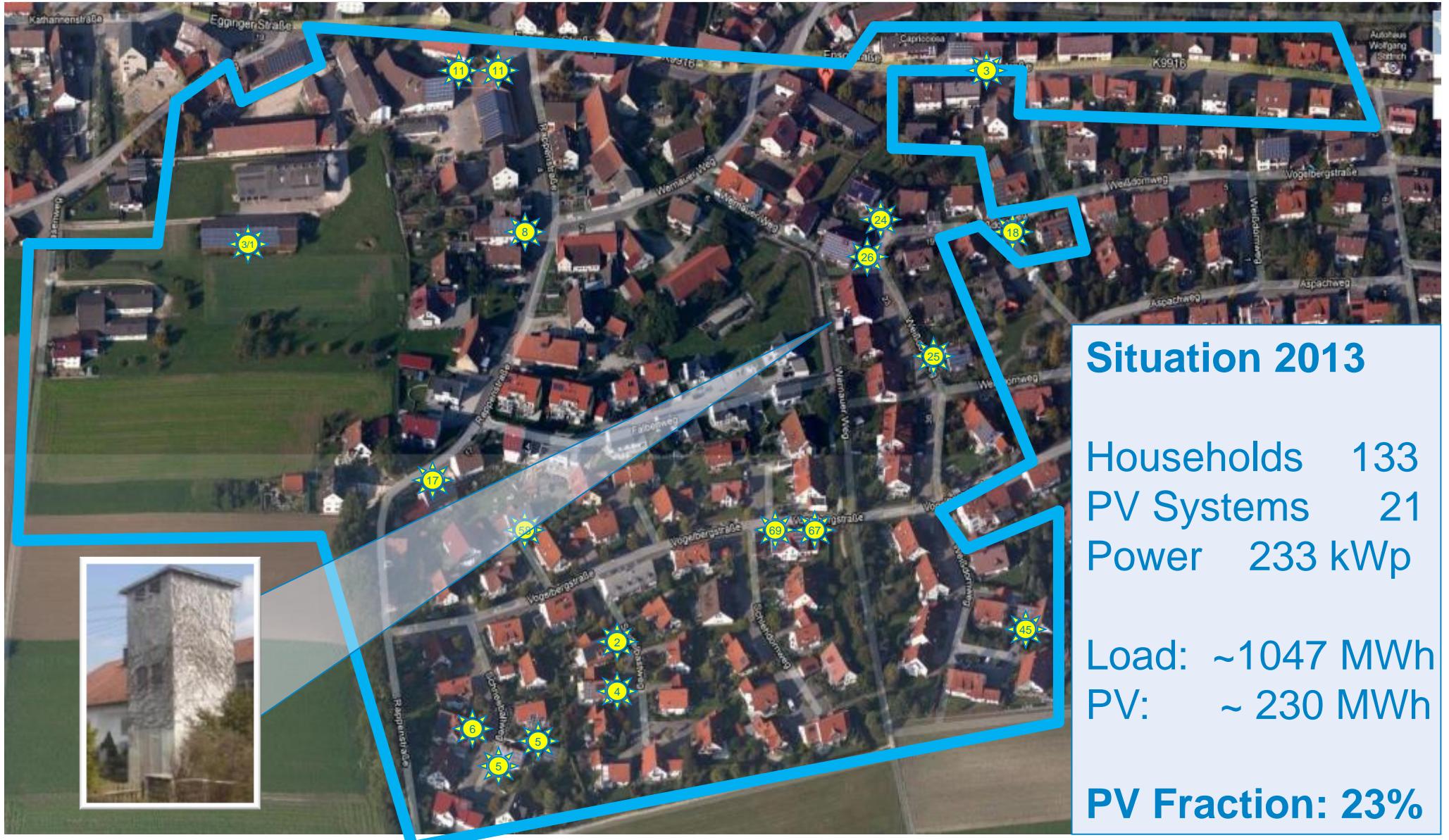
Grid status with high shares of PV

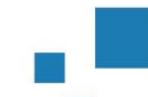




Test site 1

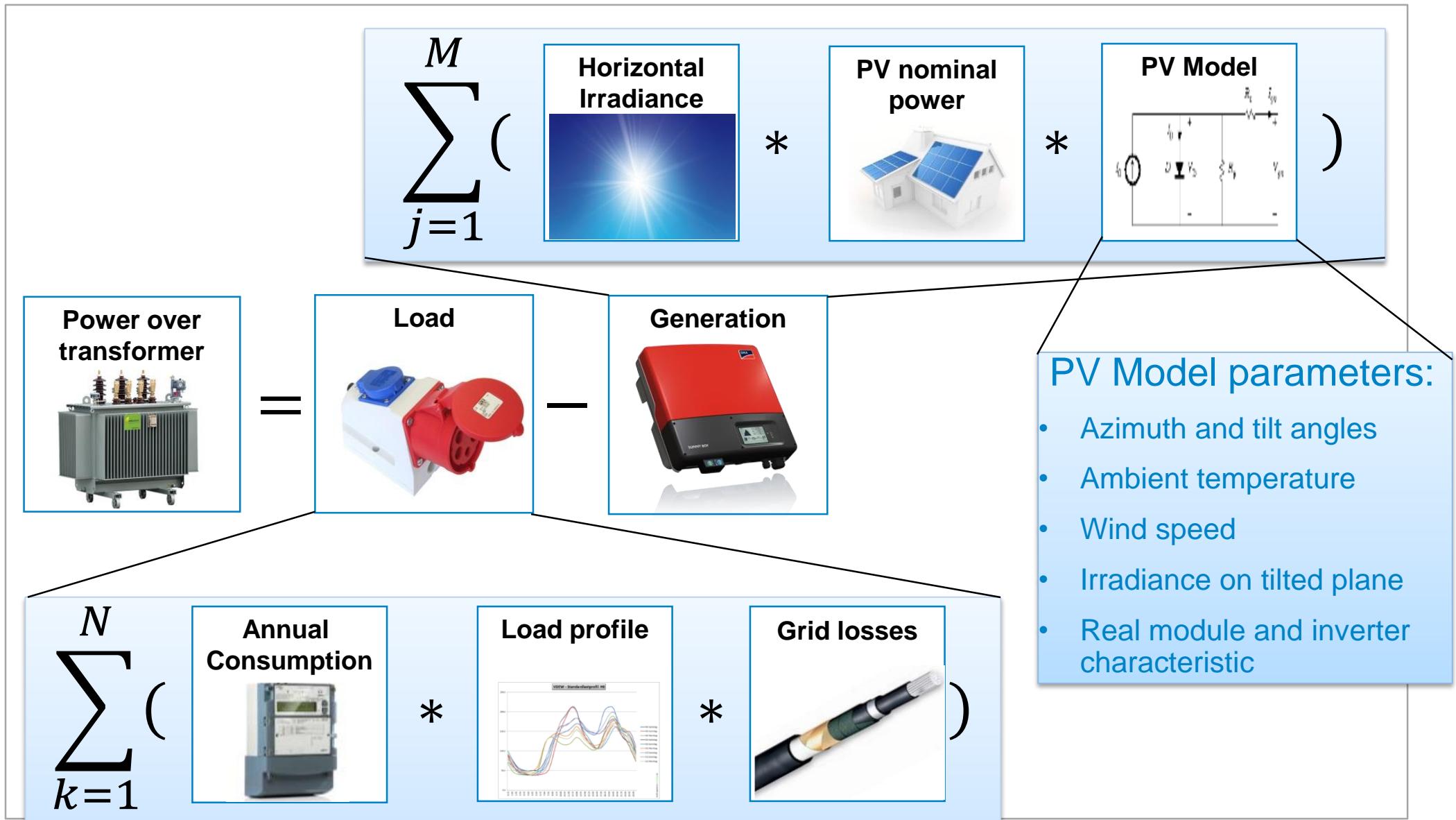
Suburban Ulm-Einsingen





Load flow calculation

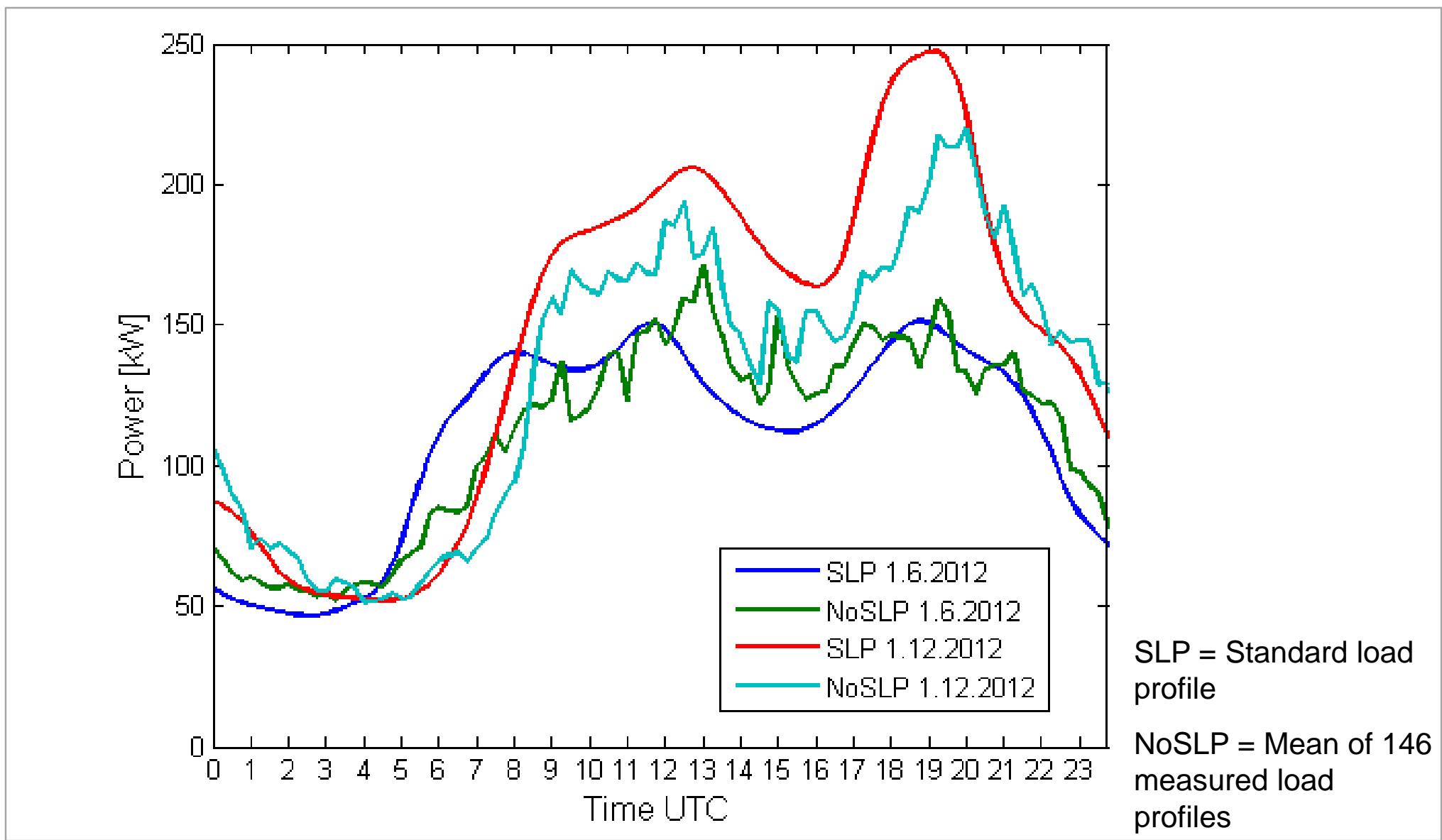
Approach





Residential Load Profiles

Standard load profiles and measured profiles

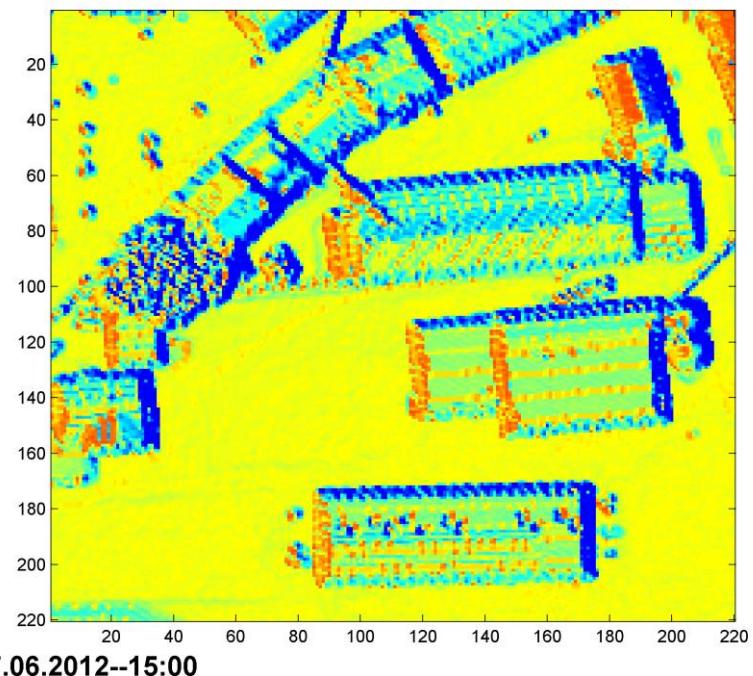




Solar potential time series

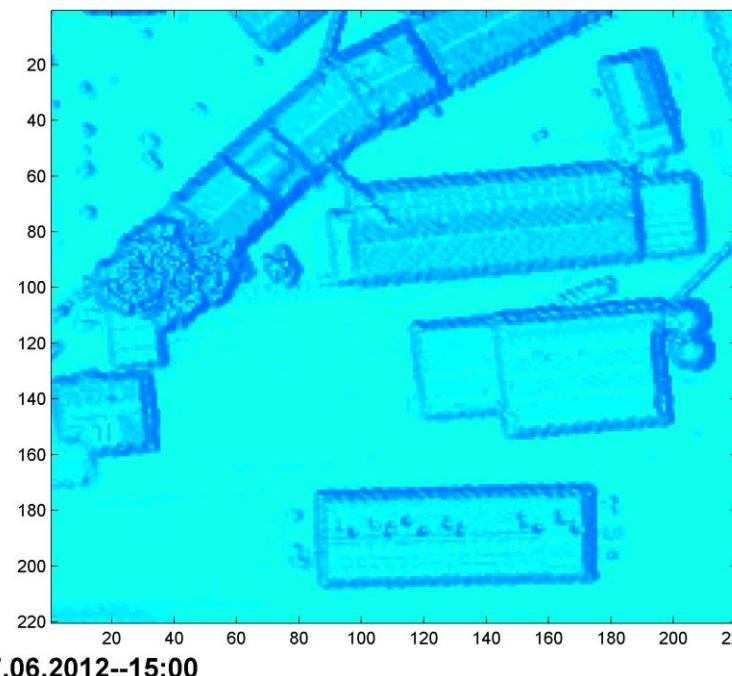
Ideal and real irradiation during one day

Clear Sky

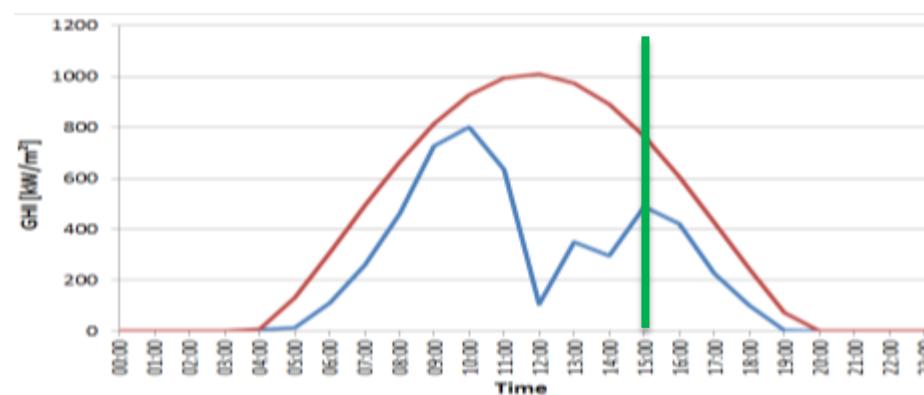


Time series of
Clear Sky
irradiance useful
for **planning**
electric grids

Real irradiance



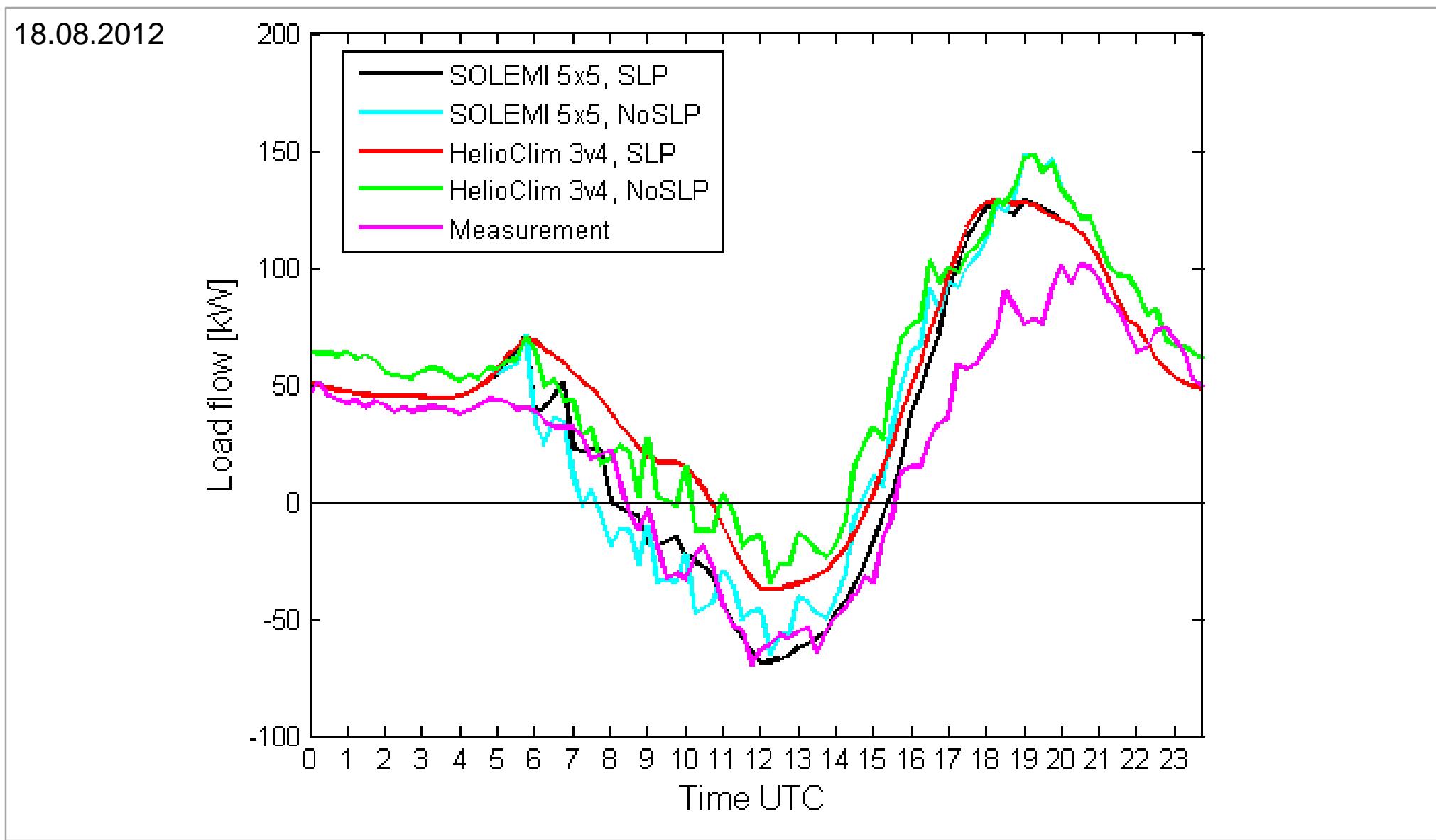
Time series of **real**
irradiance useful
for **operation** of
electric grids





Load flow at transformer (1)

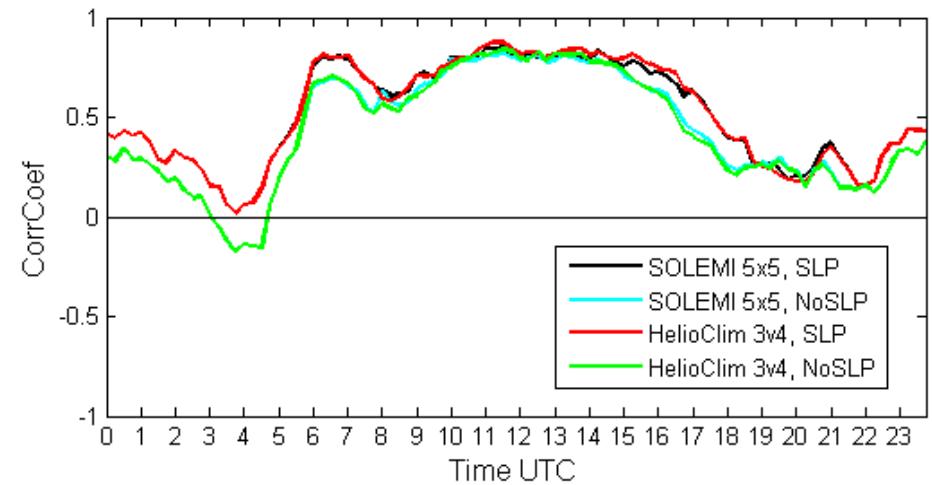
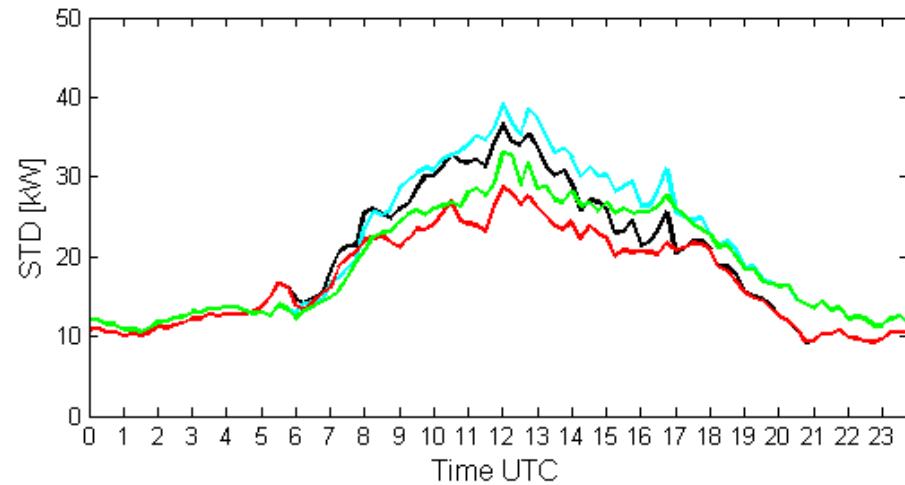
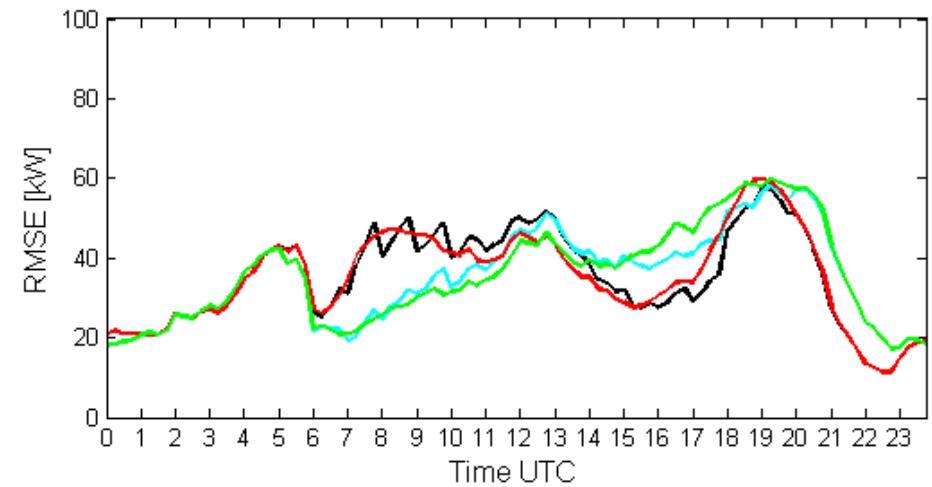
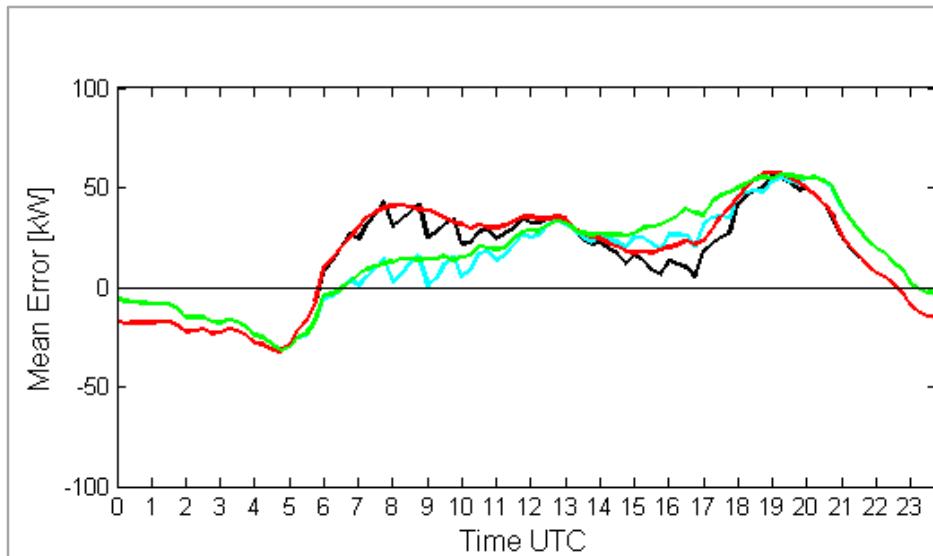
Calculated load flow by remote sensing





Load flow at transformer (2)

Statistics of Simulation minus Measurement





Conclusion and Outlook

Increasing Requirements for DSOs

- Distribution System Operators are important users of meteorological data
- Both have to understand the needs and possibilities of each other: DSOs and meteorologists
- The different time scale suits together
- Meteorological data are also useful for low voltage grids
- Next steps
 - Development of load models necessary
 - Implementation of nowcast approaches
 - Development of voltage estimation

New Service for Grid Operators



Thank you.

Any questions ?

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