DISTRIBUTION GRID OPERATIONS MANAGEMENT

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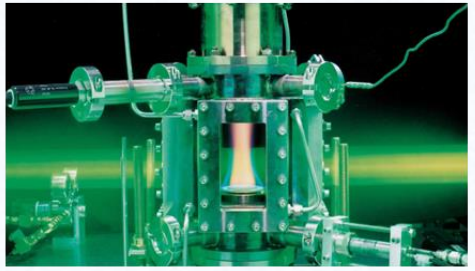
DLR Energy Research - a national network of institutes and facilities

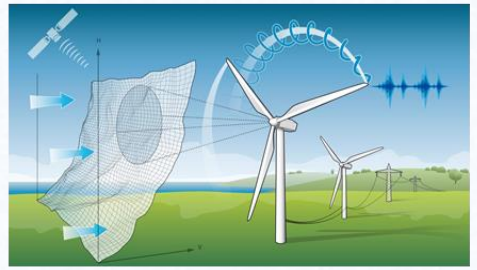
6 Research Areas:

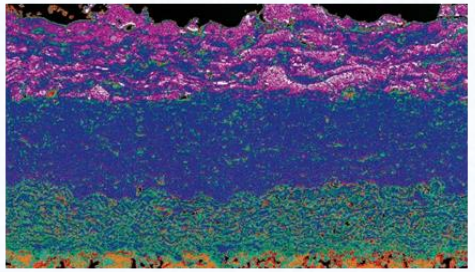
- Aeronautics
- Space Research
- **Energy**
- Transport
- Defence and Security
- Digitalization


Solar Energy


Energy Systems Analysis


Energy Converters


Wind Energy


Energy Storage


Energy System Technologies

Institutes and facilities across Germany

Motivation
Managing the Complexity of Energy Systems

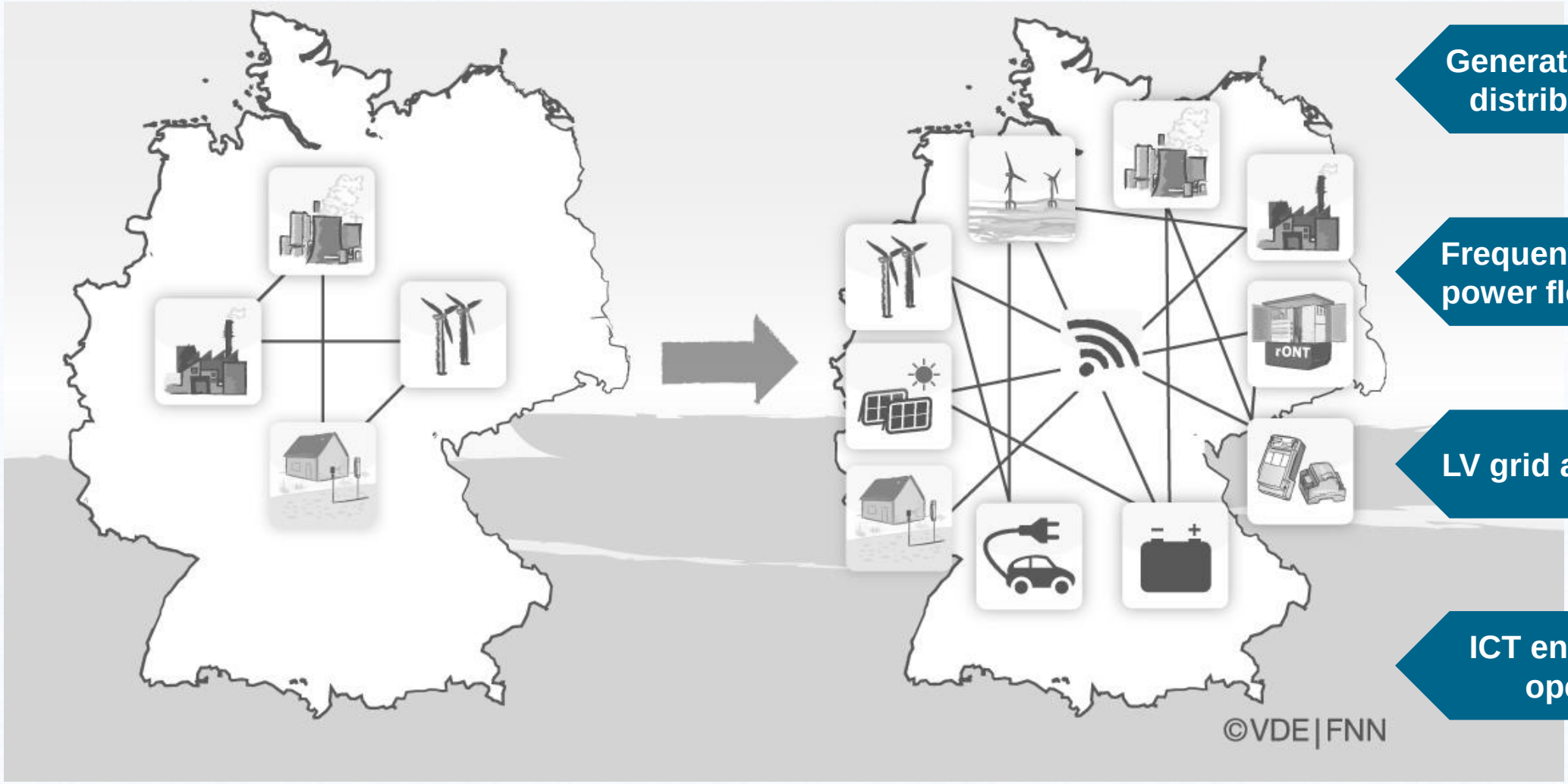


Image source: VDE-FNN

Framework

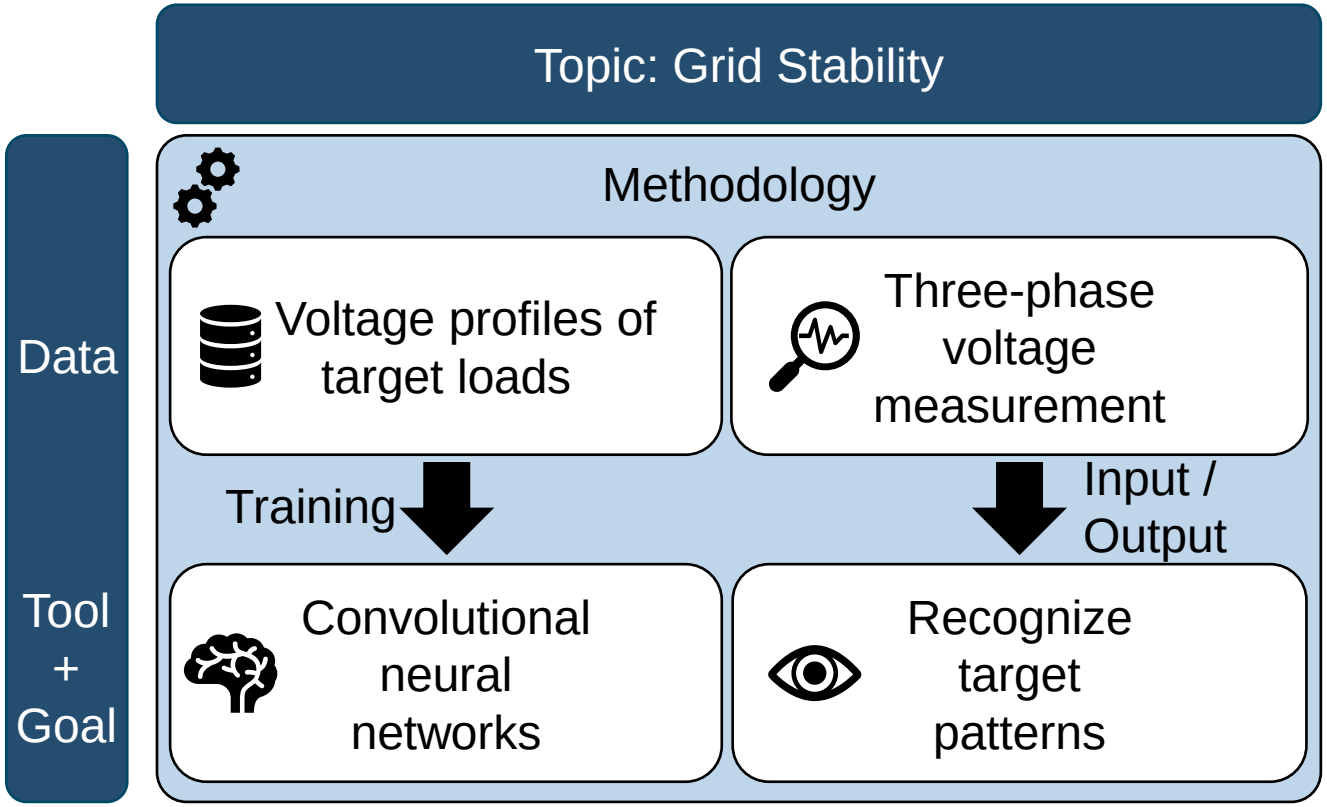
Recognition of grid participants in distribution grid

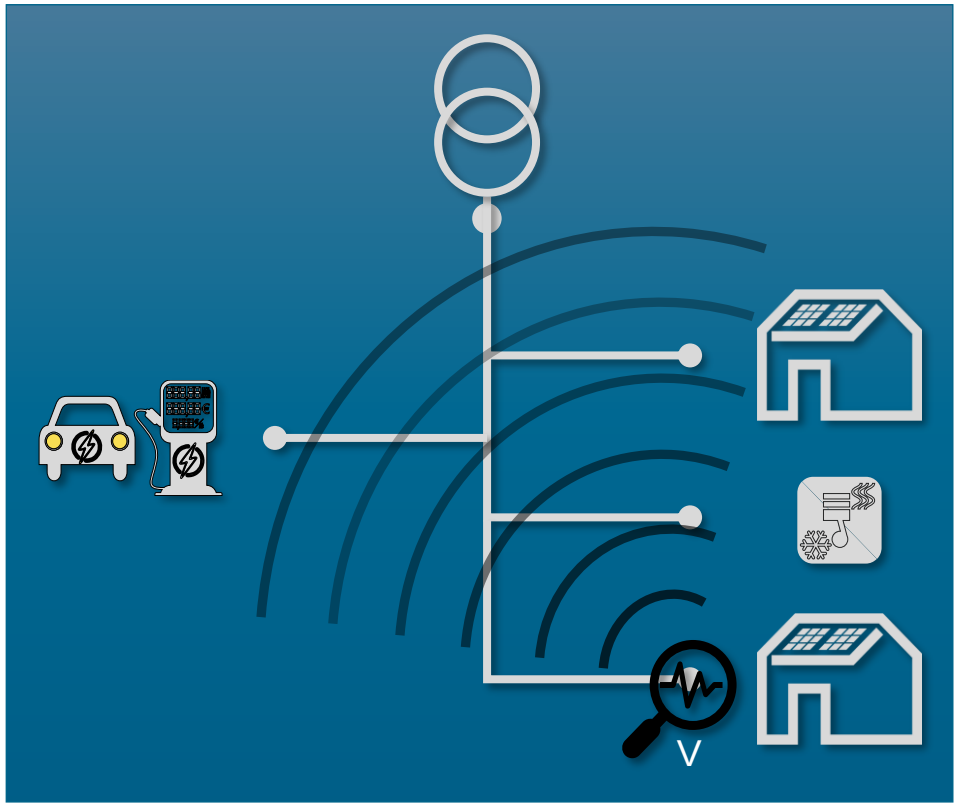
Short-term power prediction for PV systems

In-house smart grid control center

- Gain more insights into local distribution grids
- Importance of short-term prediction of solar output for grid operations
- Overarching ICT-platform enabling data-exchange to optimally utilize network capacities

Voltage-Based Recognition of Active Grid Participants in Distribution Grid



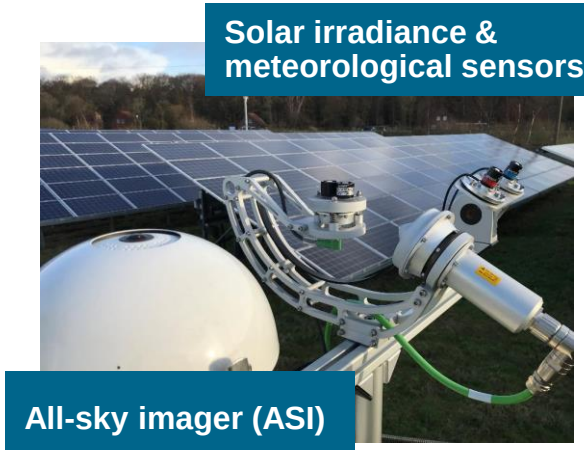


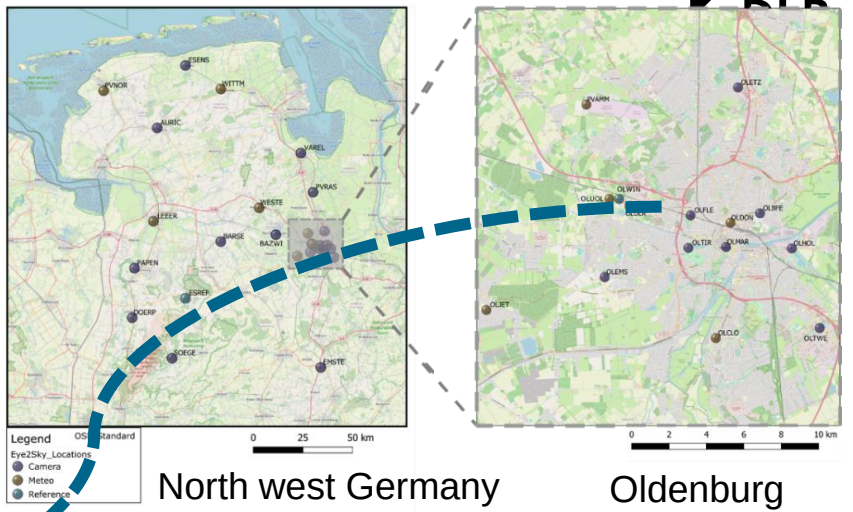
- Machine learning application to gain knowledge about the local grid for stabilizaton of LV grids
- Use new information to adapt decentralized control strategies at the individual point of coupling

[2] Schlachter et al., 2022 [3] Bokker et al., 2023 [4] Schlachter et al., 2022

Eye2Sky – Probabilistic Solar Nowcasting

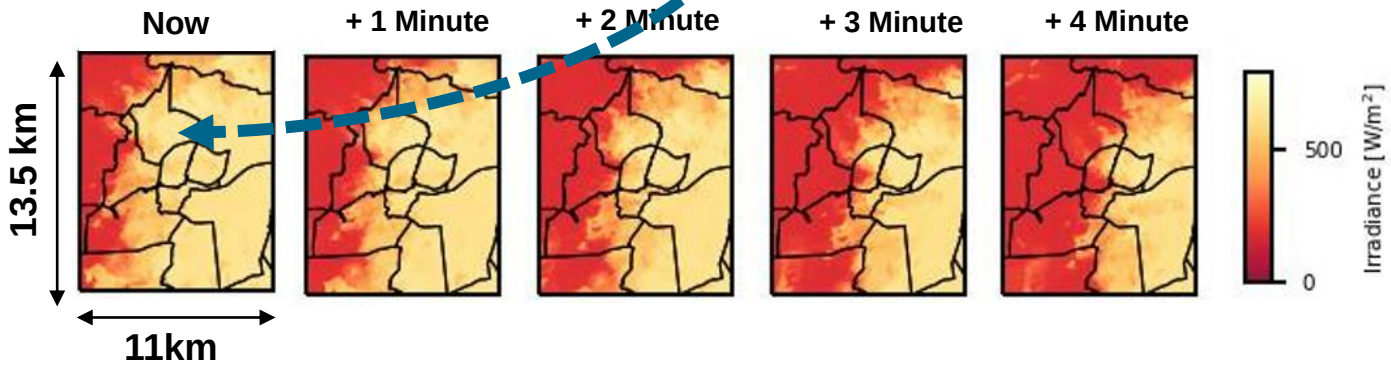
- Total 30 measurement stations
- Covering ~110km x 100km area in north-western Germany
- High-density network Oldenburg





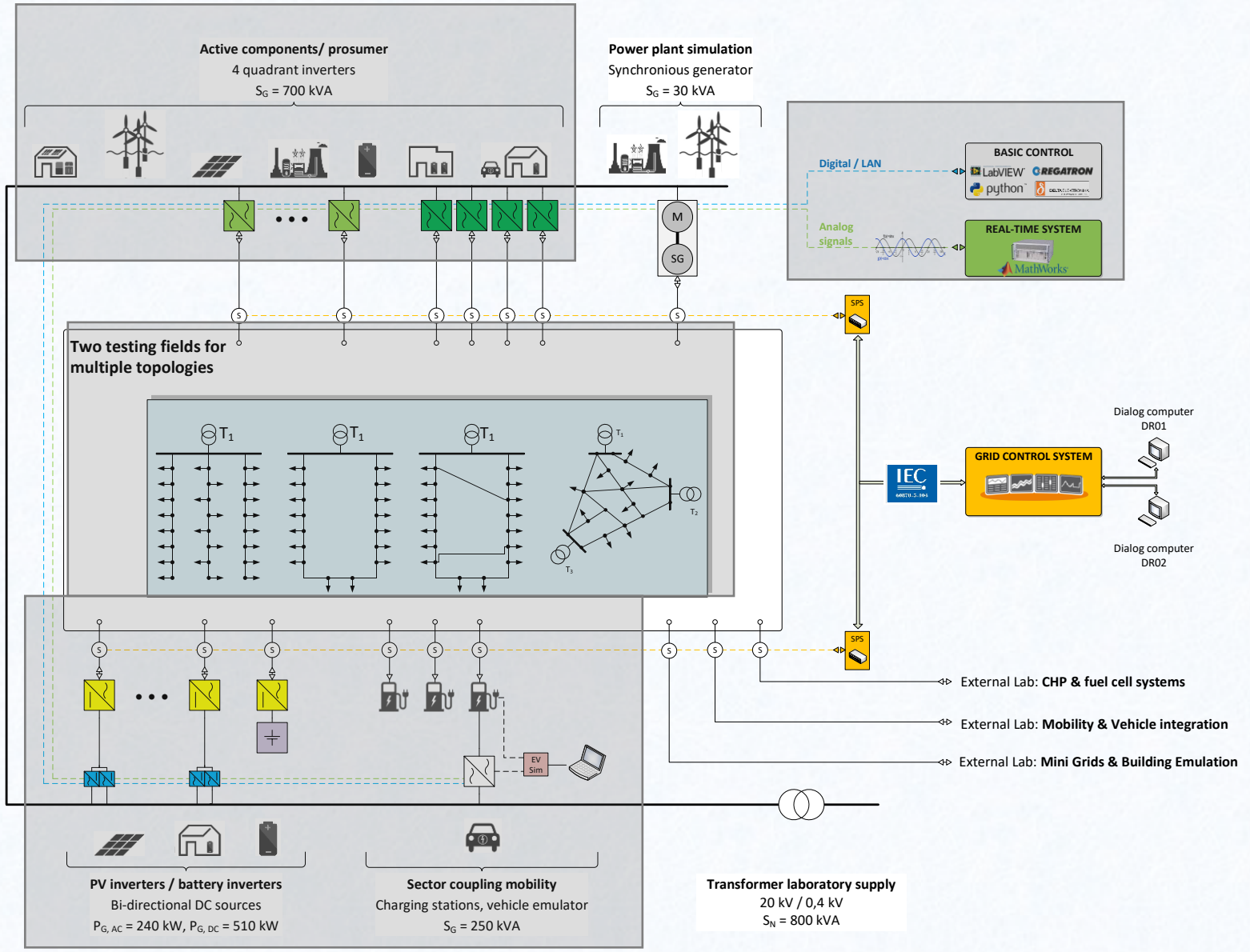
Solar irradiance nowcast example based on network of 13 cameras in Oldenburg

- 4 minute ahead forecast (up to 30 minutes possible)
- **Spatial:** 50 meters
- **Temporal:** 1 minute



- Eye2Sky: Regional and urban all-sky imager and solar irradiance measurement network
- Developed for very accurate high-resolution and very short-term solar irradiance forecasts

Networked Energy Systems Emulation Center (NESTEC)



Real-Time Simulation, Communication and Analysis

[5] von Maydell et al., 2022

Smart grid operator as an innovative control center for intelligent distribution networks

* This slide has been removed due to confidential material. If there is interest in the topic, pleas contact.

References

[1] DLR – VE, Institute of Networked Energy Systems: https://www.dlr.de/ve/en

[2] Schlachter, H.; Geißendörfer, S.; von Maydell, K.; Agert, C. Voltage-Based Heat Pump Recognition in Low Voltage Distribution Grids with Convolutional Neural Networks," *2022 IEEE PES Innovative Smart Grid Technologies Conference Europe (ISGT-Europe)*, Novi Sad, Serbia, 2022, pp. 1-6, https://doi.org/10.1109/ISGT-Europe54678.2022.9960641

[3] Bokker, O.; Schlachter, H.; Beutel, V.; Geißendörfer, S.; von Maydell, K. Reactive Power Control of a Converter in a Hardware-Based Environment Using Deep Reinforcement Learning. *Energies* **2023**, *16*, 78. https://doi.org/10.3390/en16010078

[4] Schlachter, H.; Geißendörfer, S.; von Maydell, K.; Agert, C. Voltage-Based Load Recognition in Low Voltage Distribution Grids with Deep Learning. *Energies* **2022**, *15*, 104. https://doi.org/10.3390/en15010104

[5] von Maydell et al., 2022. The Networked Energy Systems Emulation Center at the German Aerospace Center DLR – bridging the gap between digital simulation and real operation of energy grids. at - Automatisierungstechnik, 70(12), 1072-1083. https://doi.org/10.1515/auto-2022-0019

Thankyou

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Image source: DLR