Data & AI in Energy Networks

22.05.2025

The new world of electricity – decentral, distributed and volatile

The age of the dumb grid

- Centralized production
- One-way electricity flow
- High share of non-renewable energies

Moving towards smart grids

- Growing share of volatile renewable generation
- New electricity consumers (e.g. e-mobility, heat pumps)
- More flexibility through new appliances (battery storage, heat pumps etc.)
- Two-way electricity flow

Our Mission: Making the Energy Transition happen and boost efficiency using Data & AI.

Data & AI for Energy Networks

Use Case Deep-Dive Load Forecasting in the E.ON Lab

“Flexumer” – Driving the energy transition

§14EnWG

Emergency dimming of flexible households could lead to uncontrolled and **overdimensioned grid expansion**

Could we **proactively prevent** emergency dimming?

Until 2030, up to six million assets will be connected to E.ONs distribution grids

+3 Mio.

+2 Mio.

+1 Mio.

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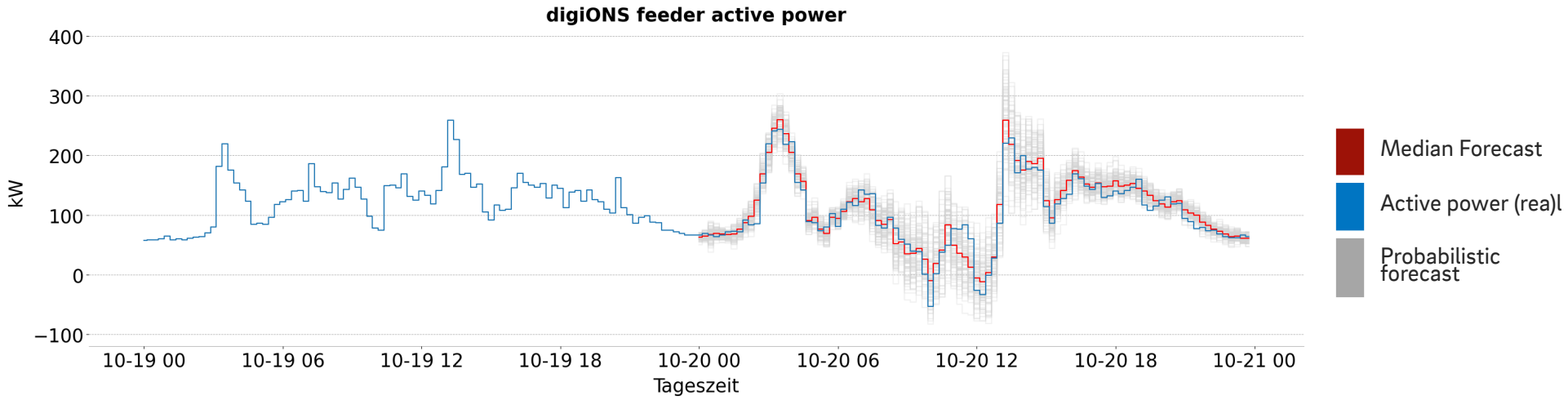
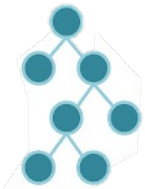
Data-Driven load forecast of substations



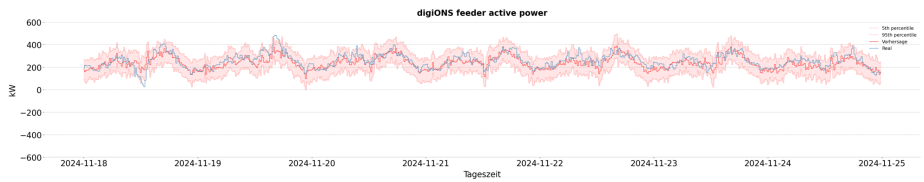
→ **Goal:** (Probabilistic) Forecast of 15 minute load intervalls of the next day (00:00 - 24:00) based on sensor and weather data

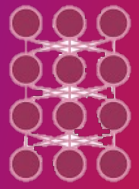
Tested AI models

XGBoost with Bootstrap of the Residuals



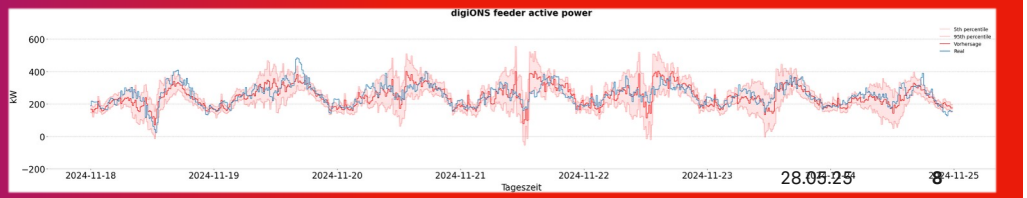
- Training of a regular XGBoost model
- Calculation of the residuals for each training example
- Bootstrapping of the residuals to obtain a distribution function
  - Random sampling of a model error (“disturbance factor”)
  - Generation of a “disturbed” prediction
  - Result: Emprical distribution of the prediction





Neural network with Monte-Carlo dropout

- Classical NNs provide deterministic predictions
- Modeling uncertainty using Monte Carlo dropout
- Through multiple runs in the inference phase (with active dropout layer) we obtain a distribution of predictions



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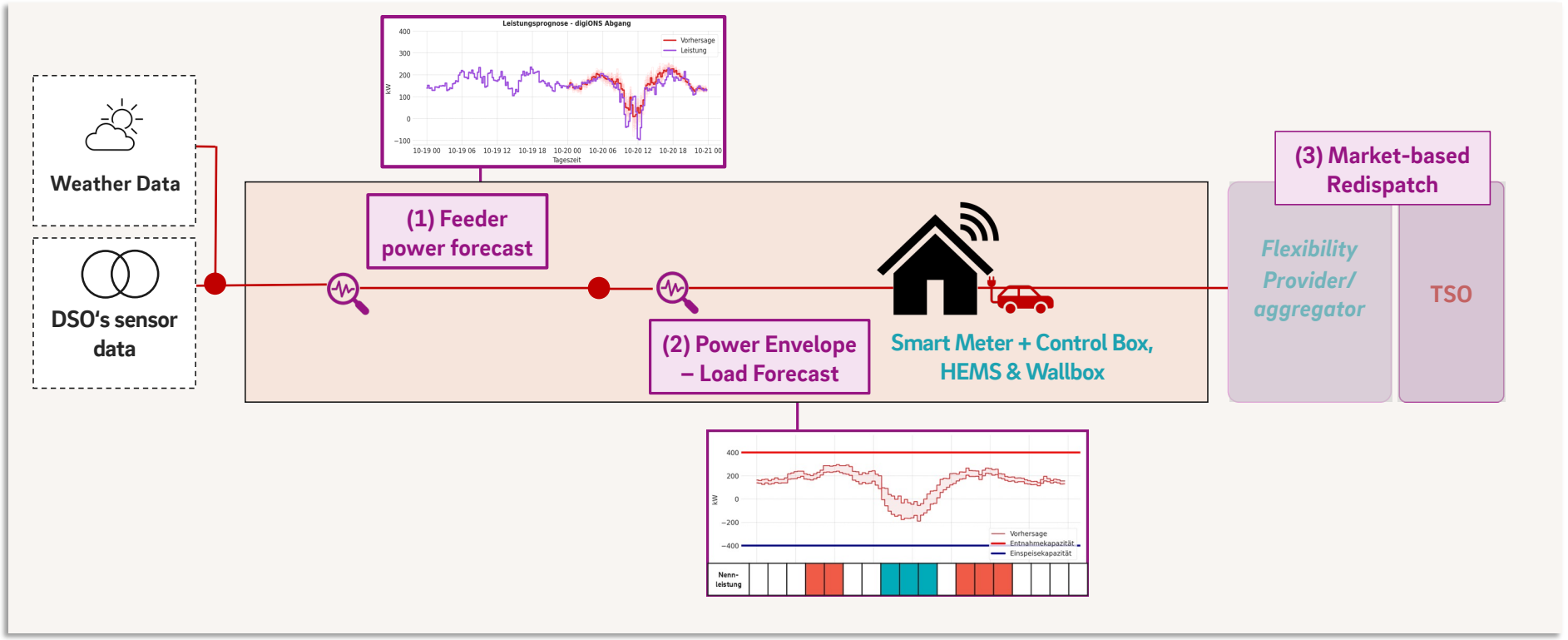
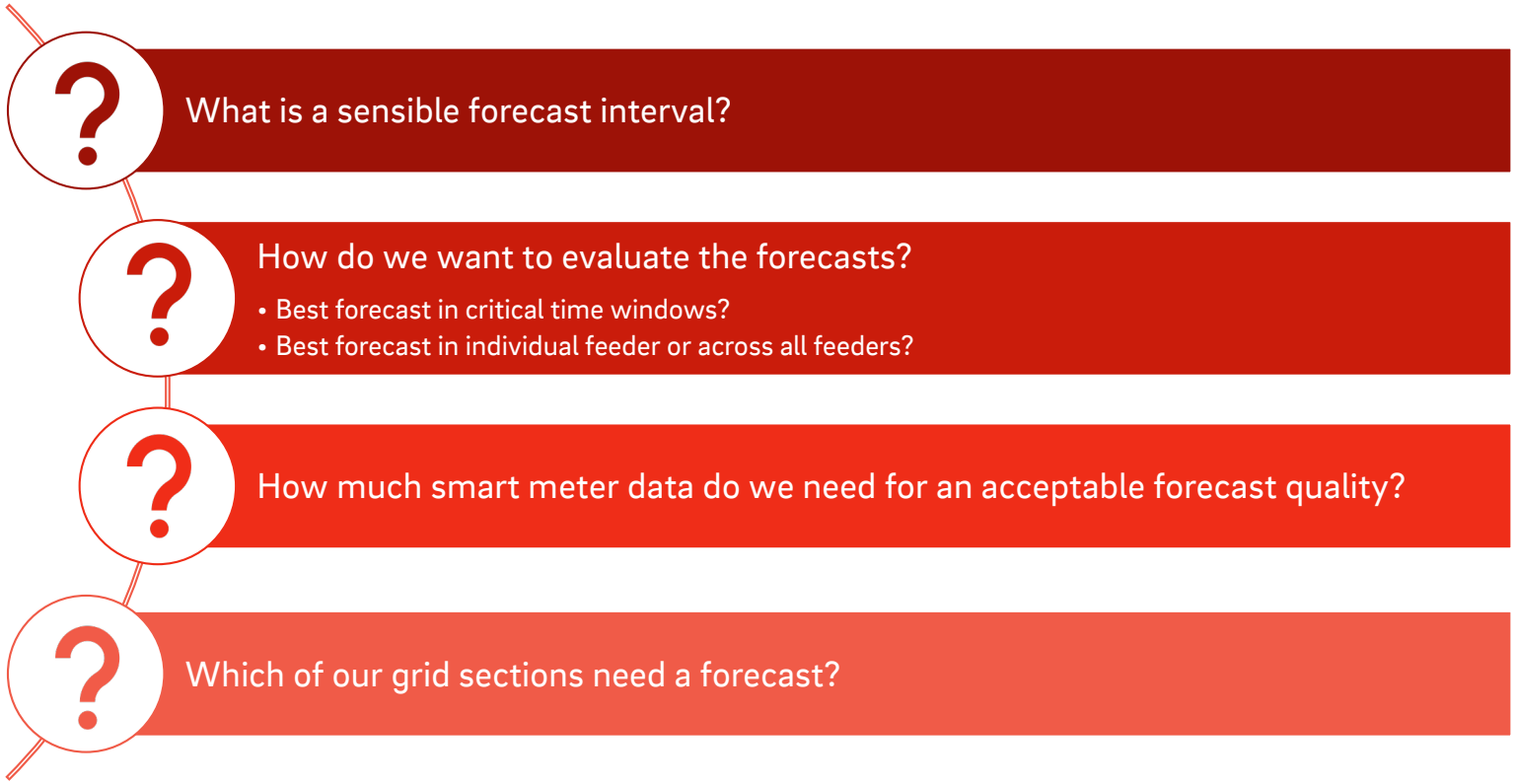
Power Envelope – The first step towards proactive congestion management



Open questions



From PoC to Smart Grid

Challenges


Thank you!
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