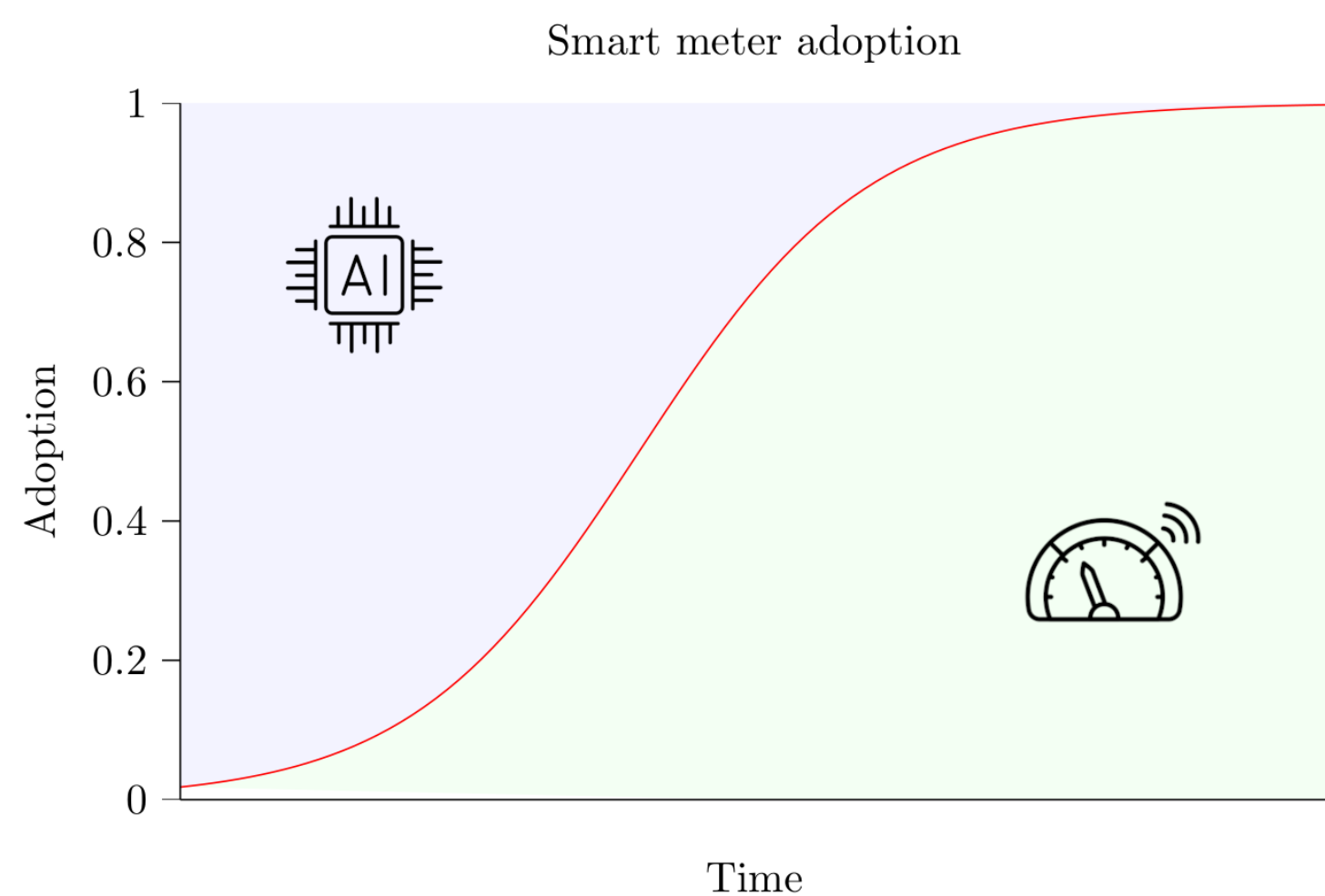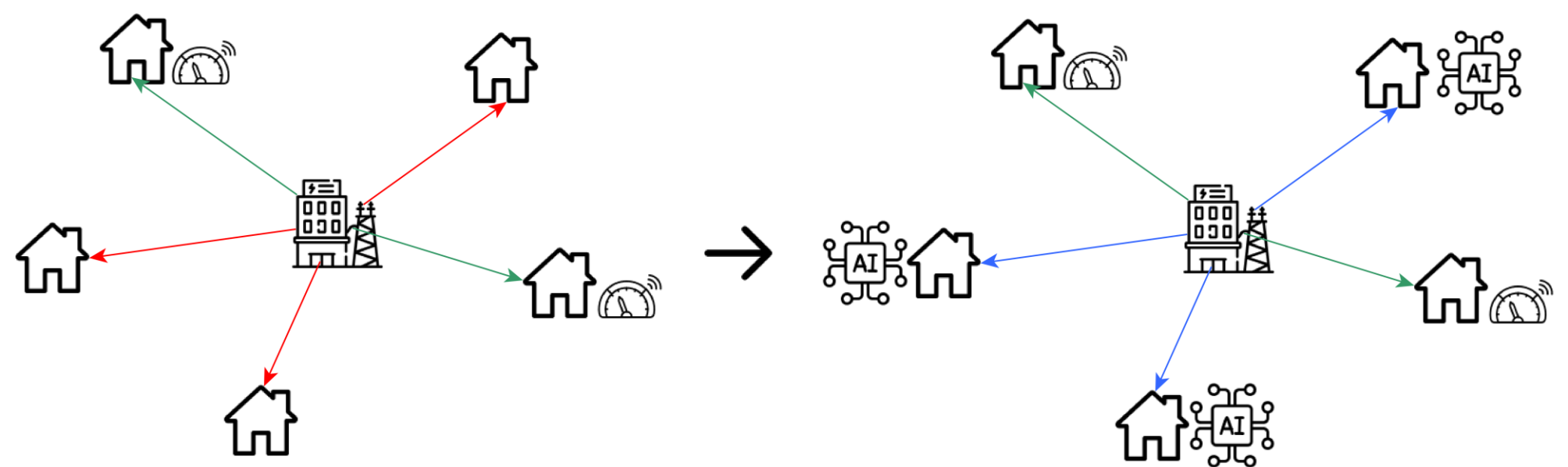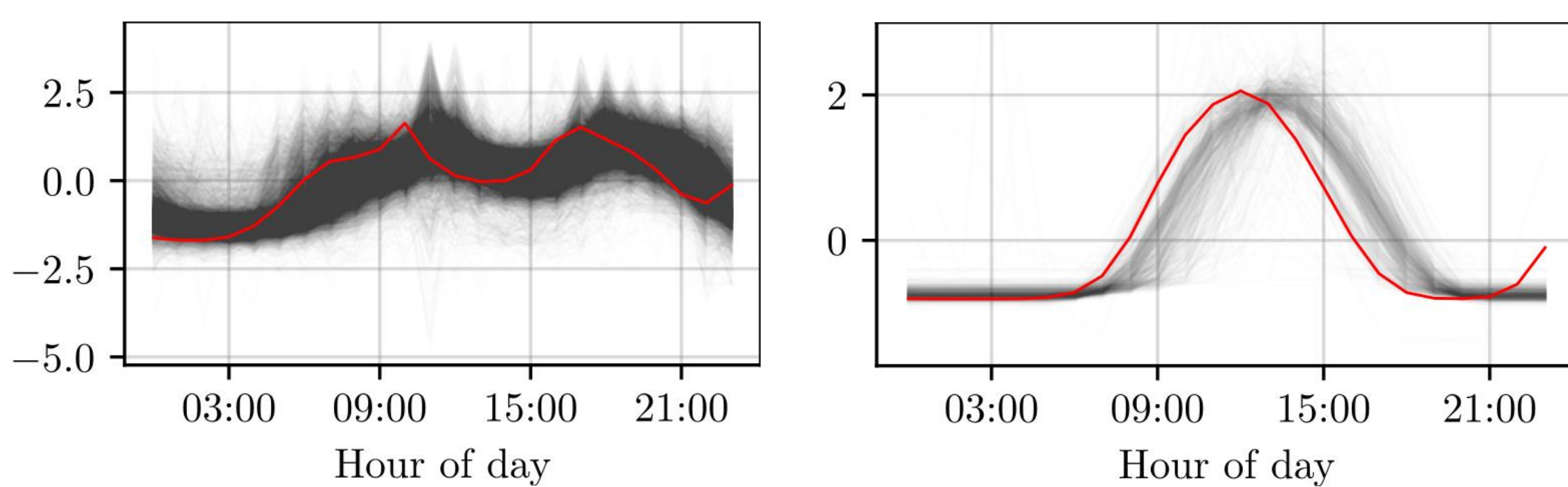**Energy & Environment**

Periodic power flow studies on a low-voltage network using real and machine learning based synthetic load profiles
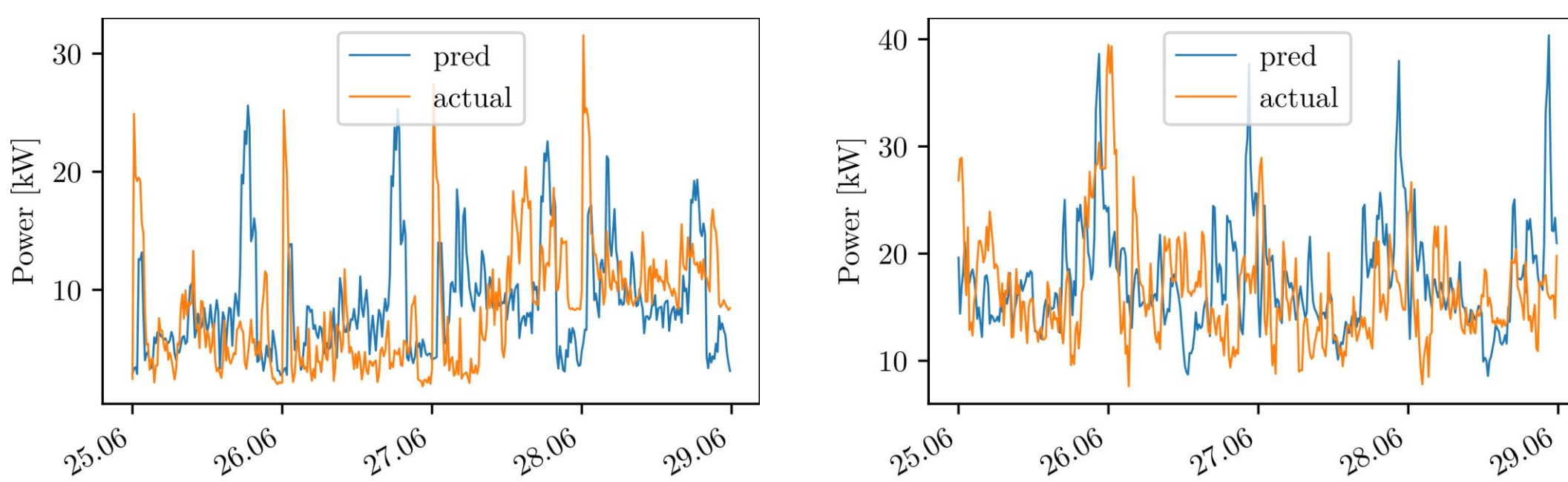

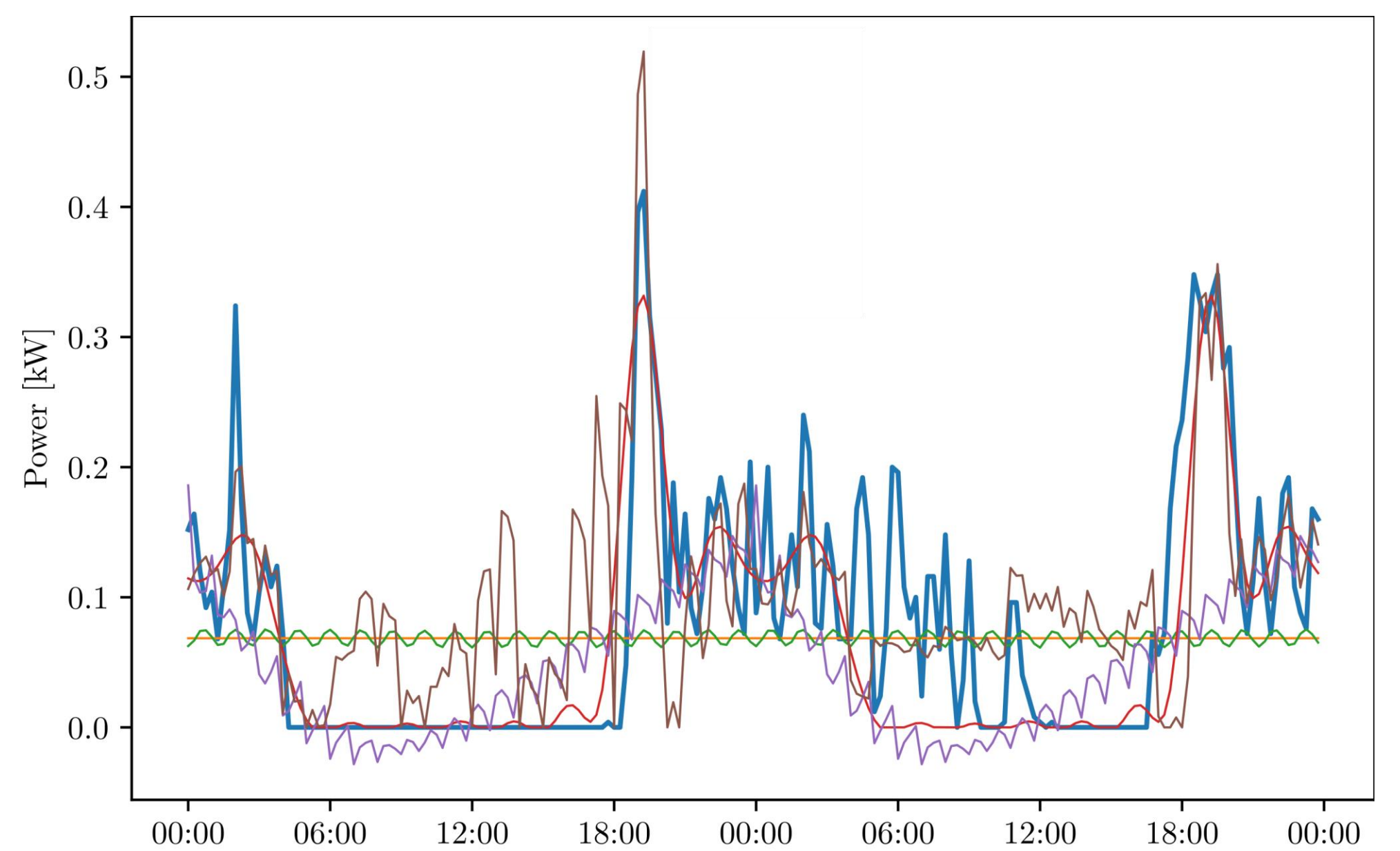© Figure 1: Smart meter adoption over time

© Figure 2: Missing smart meter data being replaced with AI meter

© Figure 3: Cluster of consumer loads and PV generators

© Figure 4: Transformer load prediction with synthetic profiles (left) and real, forecasted (right)

© Figure 5: One day-ahead consumer load forecast (blue: real, other: synthetic)

Problem statement

One of the Energy Strategy 2050 requirements is the improvement of the low-voltage network's monitoring capabilities. This is most commonly done by deploying smart meter to end-consumer (Figure 1). The generated load profiles can be used to perform power flow studies and predict a possible congestion. However, since the smart meter rollout is not always carried out in groups, the accuracy of simulations with fragmented profiles is limited.

To counteract this challenge, machine learning can be used to generate synthetic load profiles to compensate for missing smart meter installations (Figure 2). The real and synthetic load profiles are then used to make load, voltage and current predictions using power flow studies.

Solution

This project uses state of the art frameworks and techniques to build an autonomous and scalable system which performs rolling simulations while always using the most recently trained models. A novel method is proposed for the synthetic load profile assignment based on clustering (Figure 3). This method ensures a high utilization rate of all available smart meter such that forecasts are as accurate as possible at any given time.

The prediction performances are measured on consumer-level (Figure 5) as well as aggregated on the low-voltage transformer level (Figure 4). The achieved accuracies on the individual household are promising and therefore the need for a full smart meter coverage for transformer level predictions is questioned.

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