Smart Energy Forecasting

An In-Depth Study on Forecasting Methods for Electric-thermal Storage Systems

Abstract

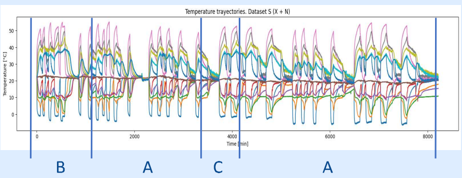
Smart grid developments have recently gained significant attention due to their potential to optimise energy consumption and reduce environmental impacts. For this reason, it is crucial to forecast future state conditions such as power, temperatures, heat, or SOC (state-of-charge) to make the most accurate and suitable control decision depending on the context and need. Since many processes are hard to model, the forecasting task can be executed by exploiting the advantages of machine learning algorithms such as LSTM, transformer, Autoformer, or CNN.

Methodology

In the context of the RESONANCE Horizon Europe project, in Fortiss EnergyLabs in Munich, a smart electric-thermal storage (SETS) was investigated, which consists of a device that converts excess electricity into thermal energy offering charge and discharge operation modes. Given an operation schedule and a value lookback of at most 30 minutes, the system can predict the following temperatures and power values for the next hour using fine-tuned models based on ML approaches.

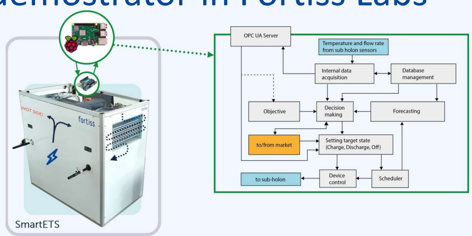
The dataset consists of a series of transitions between states, each between 45 and 75 minutes, continuously for almost 6 days.

Dataset:



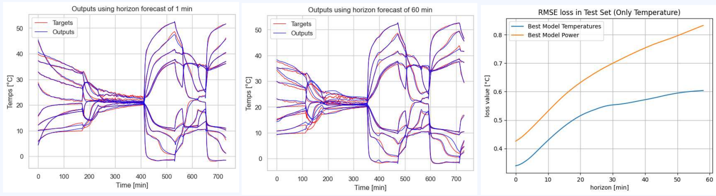
A. Training: 75 %
B. Validation: 15%
C. Test: 10 %

SETS demostrator in Fortiss Labs

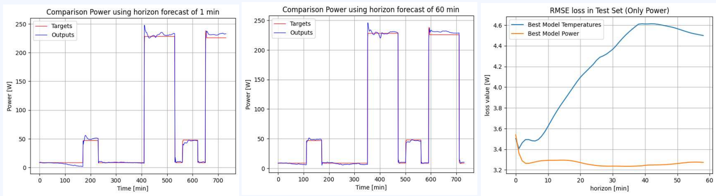


Results

Temperature Forecast:



Power Forecast:



The best-performing model was determined to be LSTM, utilizing a lookback of only 5 minutes and a batch size of 16. This finding suggests that lengthy lookback support is not essential for generating a long-range forecast. The model was able to produce an impressive RMSE error of just **0.6°C** for a one-hour forecast. On the other hand, the optimal model for power forecast was LSTM with a 20-minute look back and batch size of 8. This model produced an RMSE error of approximately **3.4 W**, which was relatively independent of the forecast horizon.

Conclusion

Very accurate forecasters can be created using ML approaches like LSTM, which enables energy consumption planning and enhances the potential of smart grids. One of the further steps to be improved is an automatic optimal control module only based on a user-defined state-of-charge curve.

Contact

Cristian S. Cubides-Herrera

T: +49 15753887482

cubides@fortiss.org