THE ENERGY OF TOMORROW:

Forecasting building energy demand

The Green City Solutions Group

09.08.2022

Our team

Leon Pichotka

M.Sc. Sustainable Energy Technology

Erick Cantu

M.Sc. Organic Agriculture and Food Systems

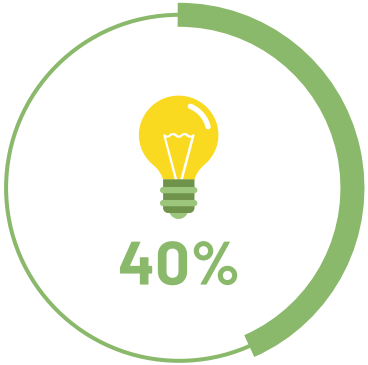
Su Leen Wong

Ph.D. Mechanical Engineering

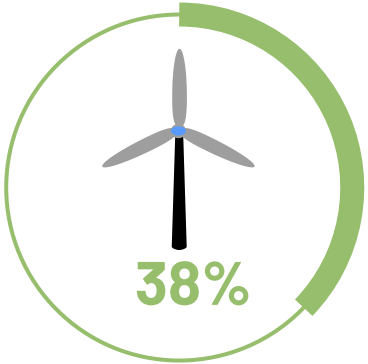
Rafael Arndt

Ph.D. Applied Mathematics

Energy Facts in EU



Total energy demand by buildings



Renewable share of electricity production

https://www.agora-energiewende.de

Current situation

- Increasing share of renewable energy in electricity production
- Decentralized renewable energy sources and energy storages

} Fluctuating energy production

Growing challenge for grid stability and power supply

Building sector has strong influence on overall energy consumption

Adapting/developing energy management strategies is required

Goal

- Modelling the net energy demand of different buildings (individually and combined)
- Predict energy demand to enable better energy management

Who is interested in that?

Energy demand forecasting is fundamental for an energy utility's decision making on:

- Grid stability
- Planning power supply activities
- Reducing energy wastage

Photo: https://www.pexels.com/photo/power-lines-3632866/

Dataset

- Synthetic data of 4 years, 9 buildings from the CityLearn Challenge* (southern US suburb)
- Hourly data of energy demand and solar generation
- Hourly weather data (temperature, humidity, solar radiation)

Building types:

Building 1: Office building

Building 2: Fast food restaurant

Building 3: Standalone retail

Building 4: Strip mall retail

Buildings 5-9: Multi-family buildings

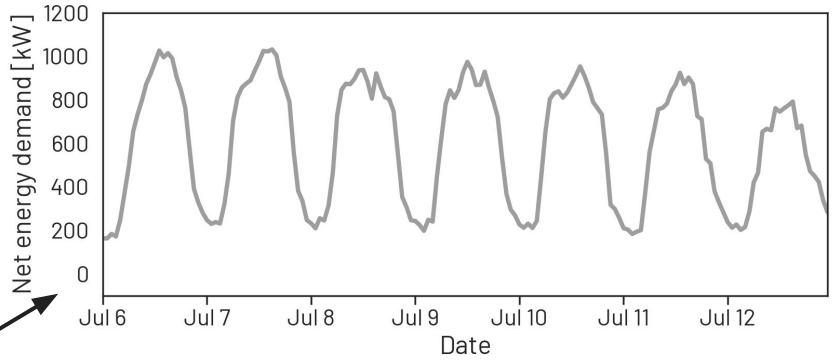
* www.citylearn.net

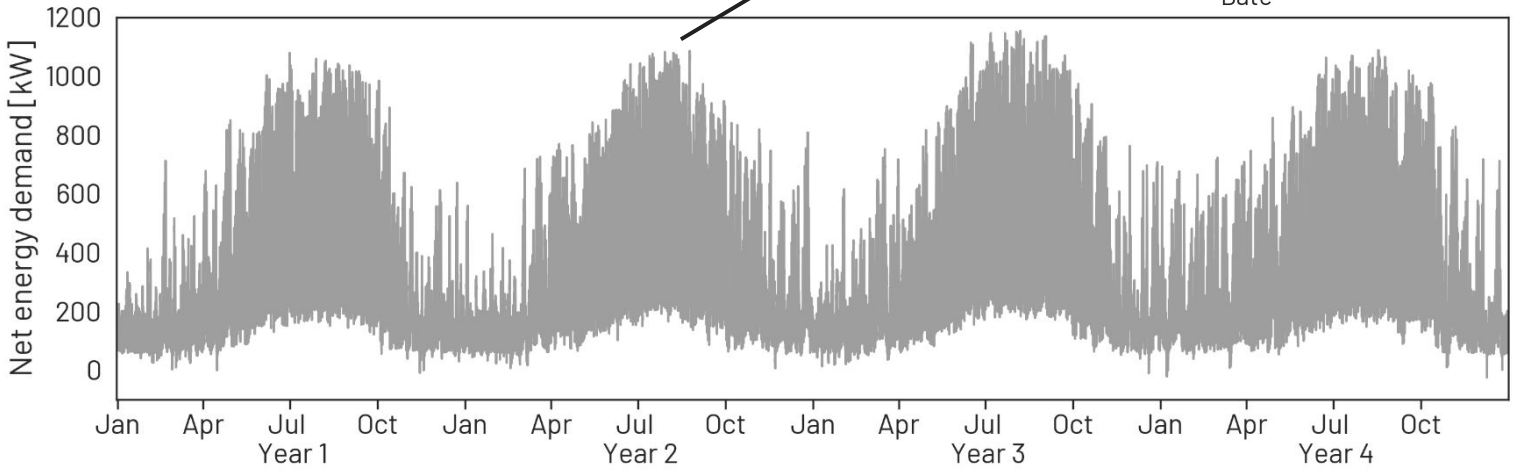
https://www.pexels.com/photo/low-angle-view-of-office-building-against-sky-323705/

Data exploration

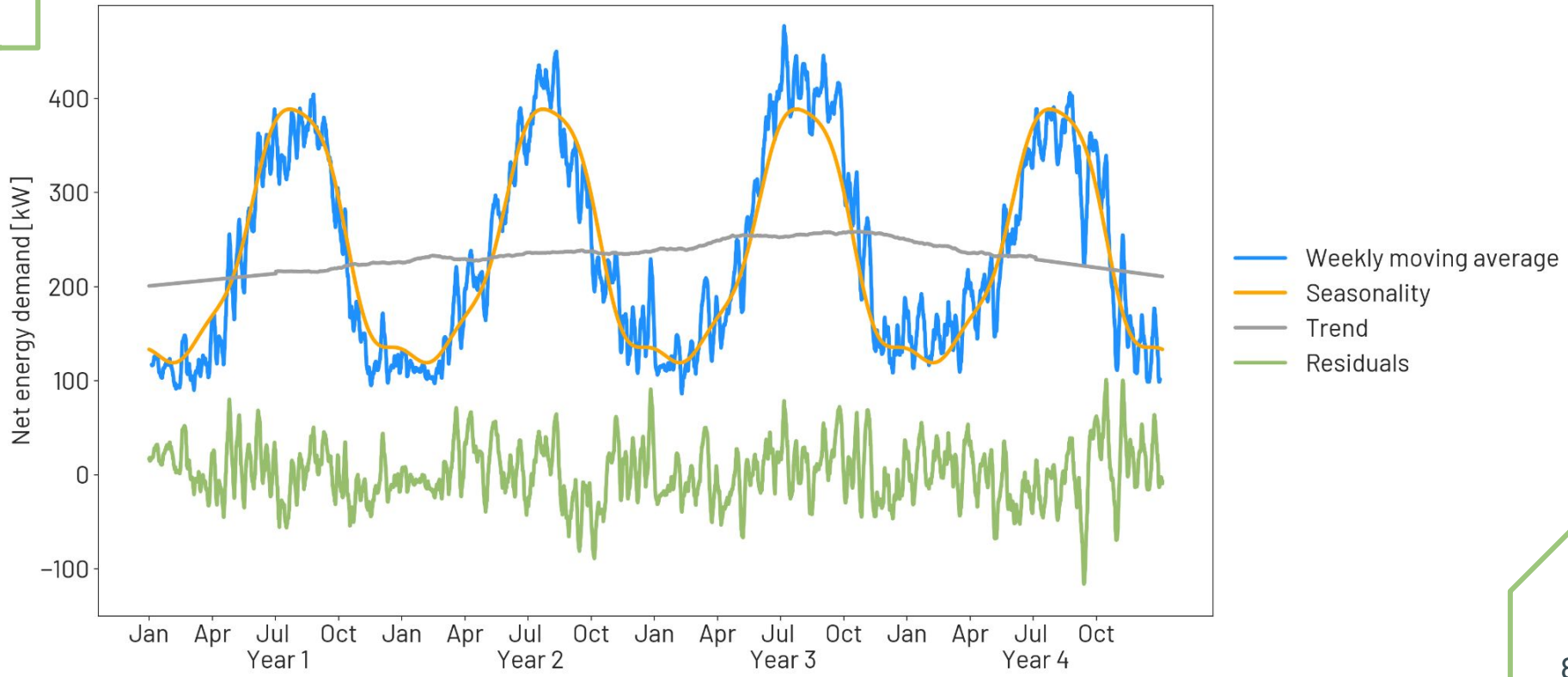
The time series is composed of:

- Trend
- Yearly seasonality
- Weekly seasonality
- Daily seasonality

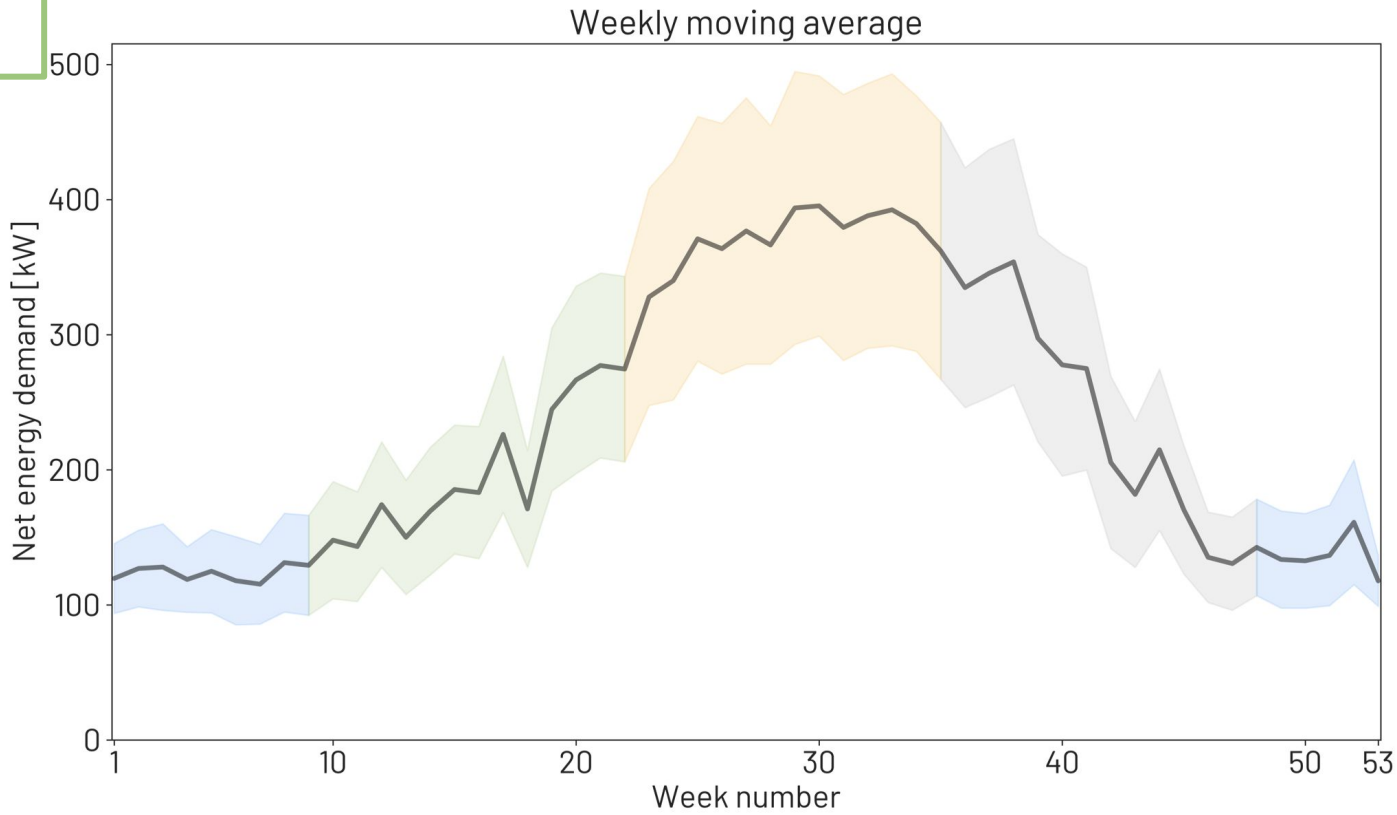




Seasonality and trend decomposition

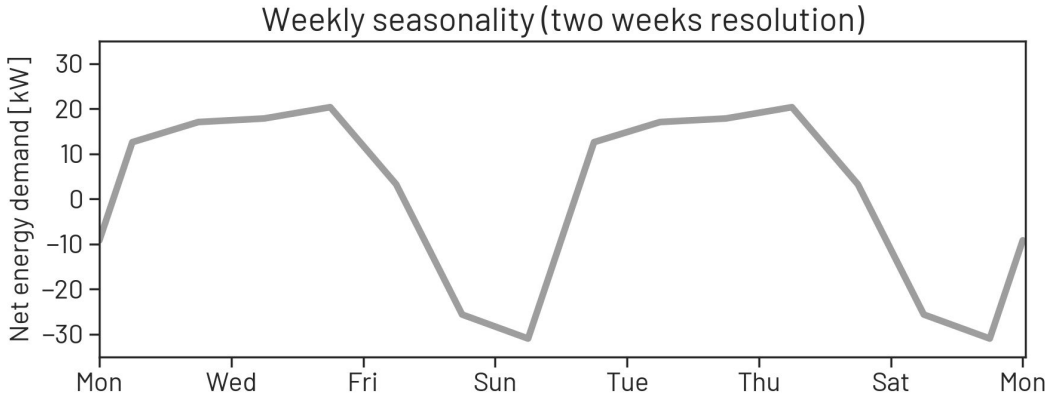


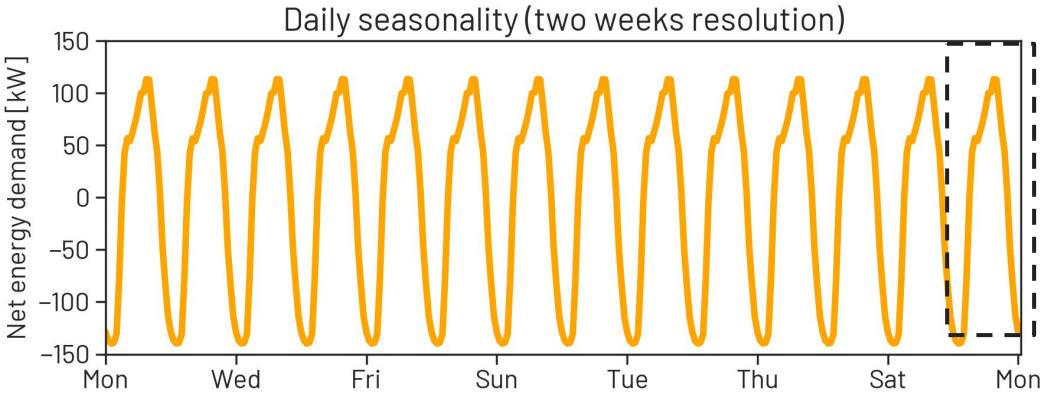
Yearly seasonality

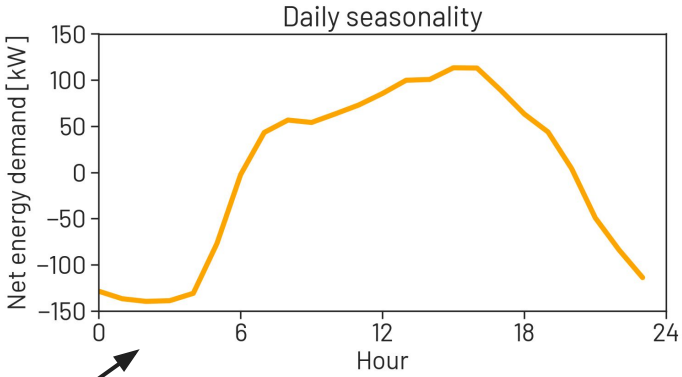


Spring: Mar 1 to May 31
Summer: Jun 1 to Aug 31
Autumn: Sep 1 to Nov 31
Winter: Dec 1 to Feb 28

Weekly and daily seasonality

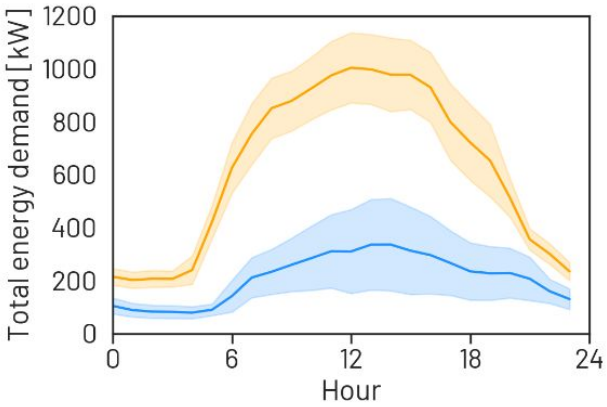


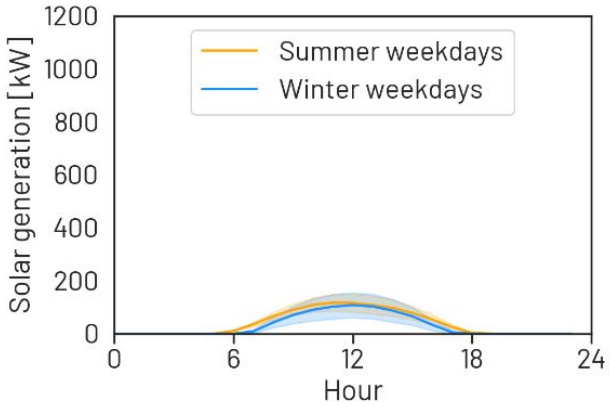


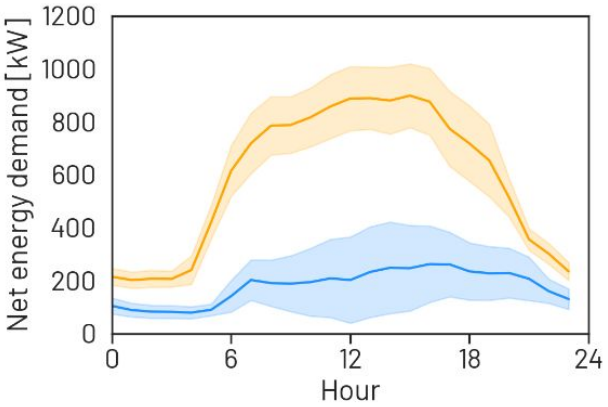


Daily net energy demand

Total energy demand - Solar generation = **Net energy demand**



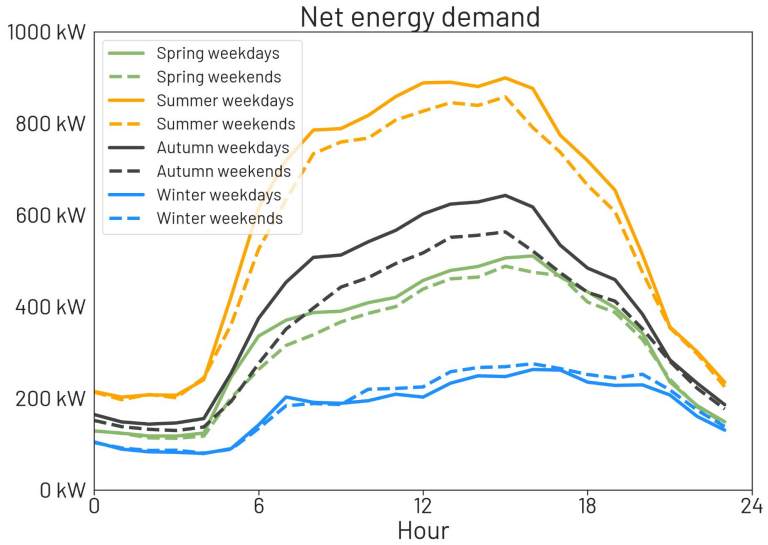


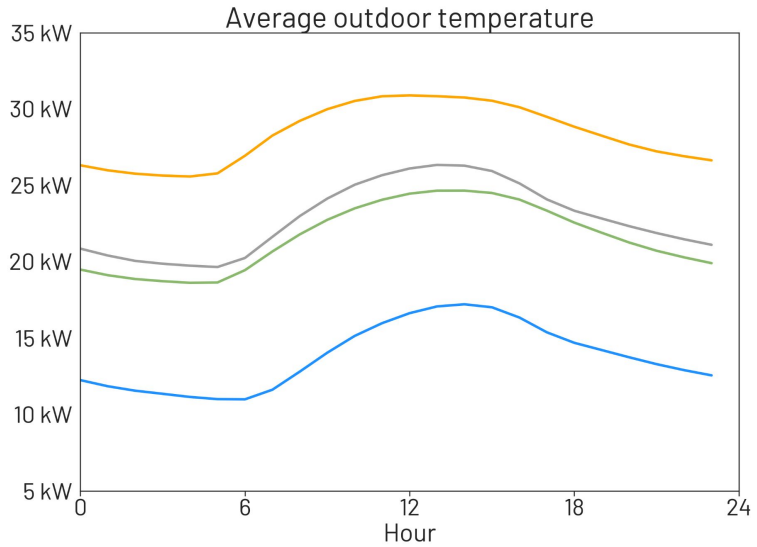


Total energy demand:

- Electrical equipment load
- Hot water heating
- Cooling load

Daily seasonality





Spring: Mar 1 to May 31
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Net energy demand:

- higher on weekdays vs weekends
- higher in summer due to air conditioning

Time series forecasting

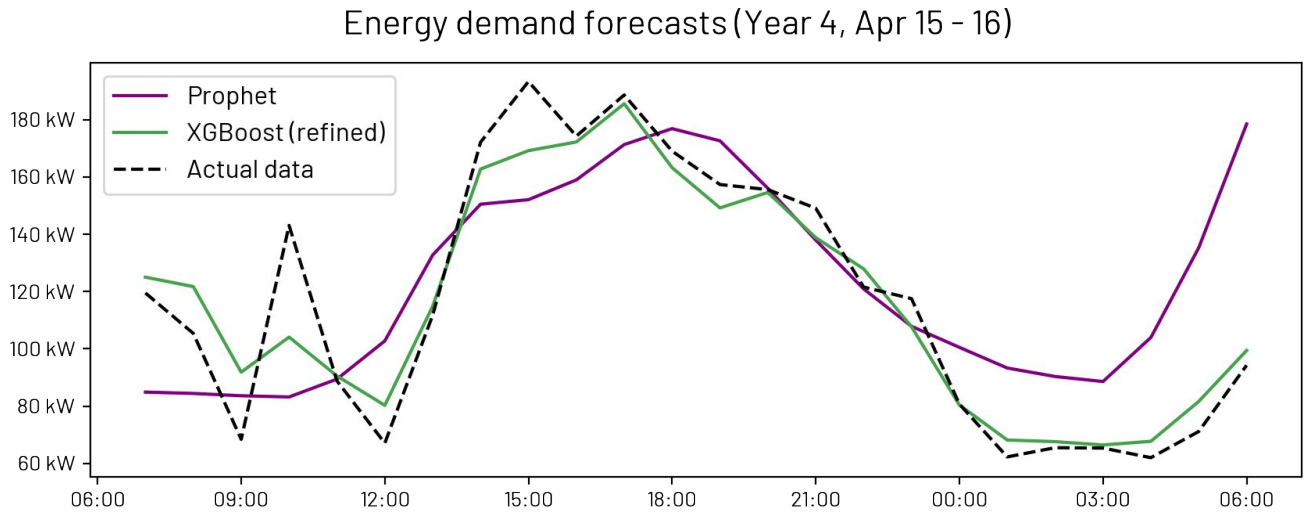
Time Series Models:

- SARIMAX
- Prophet
- TBATS

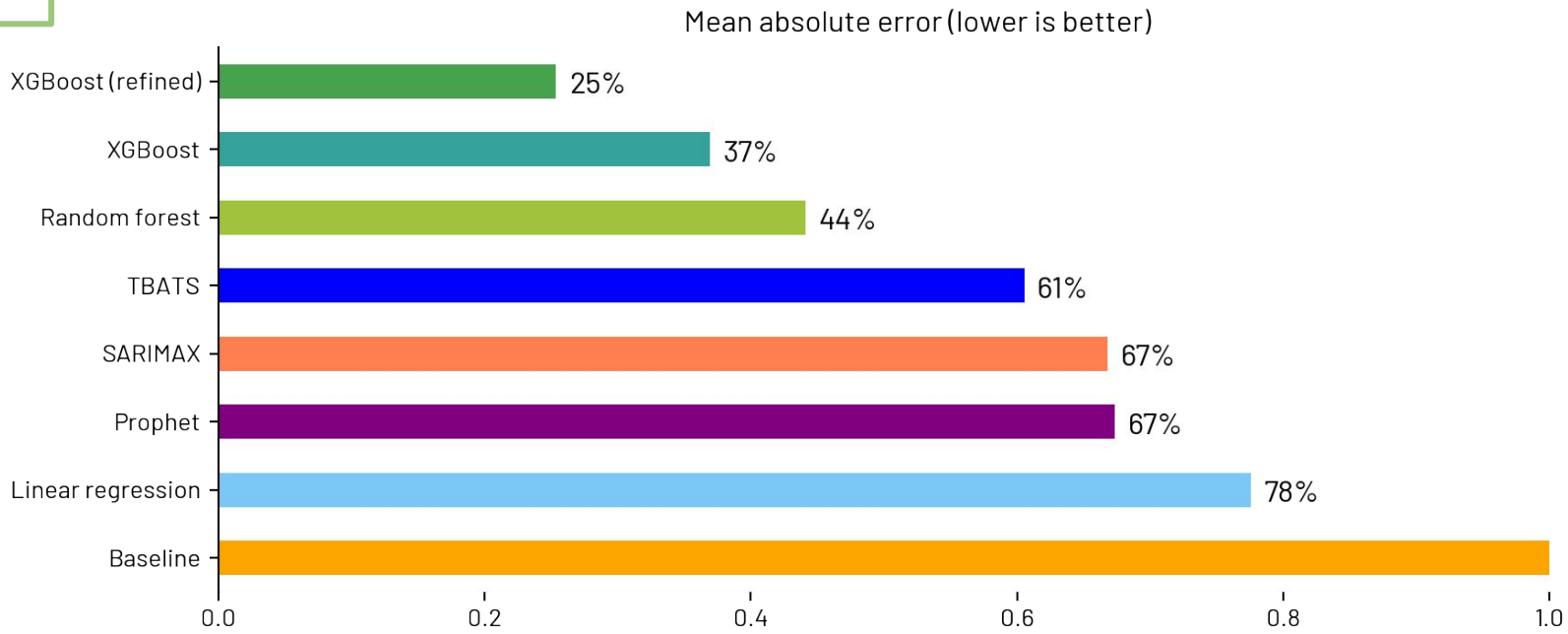
Machine Learning Models:

- Random forest
- XGBoost

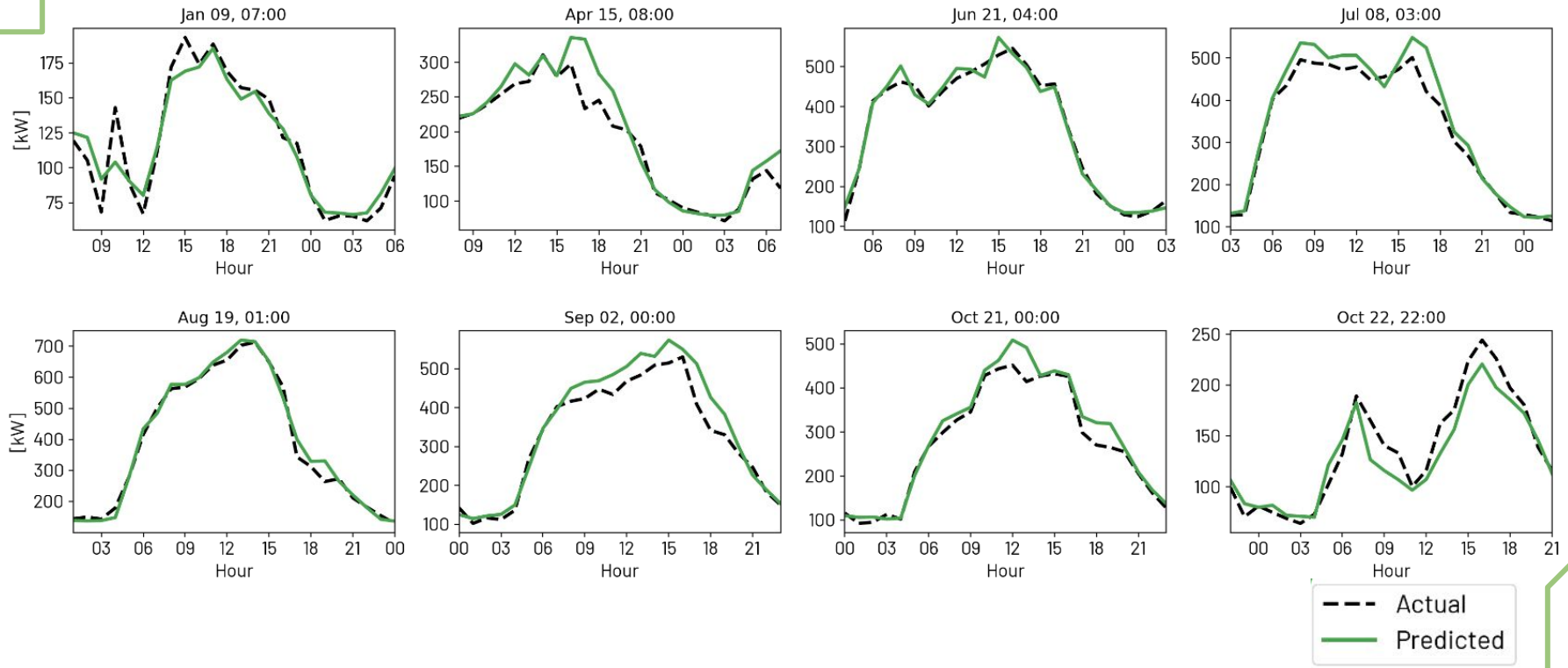
Baseline:
Last year's values



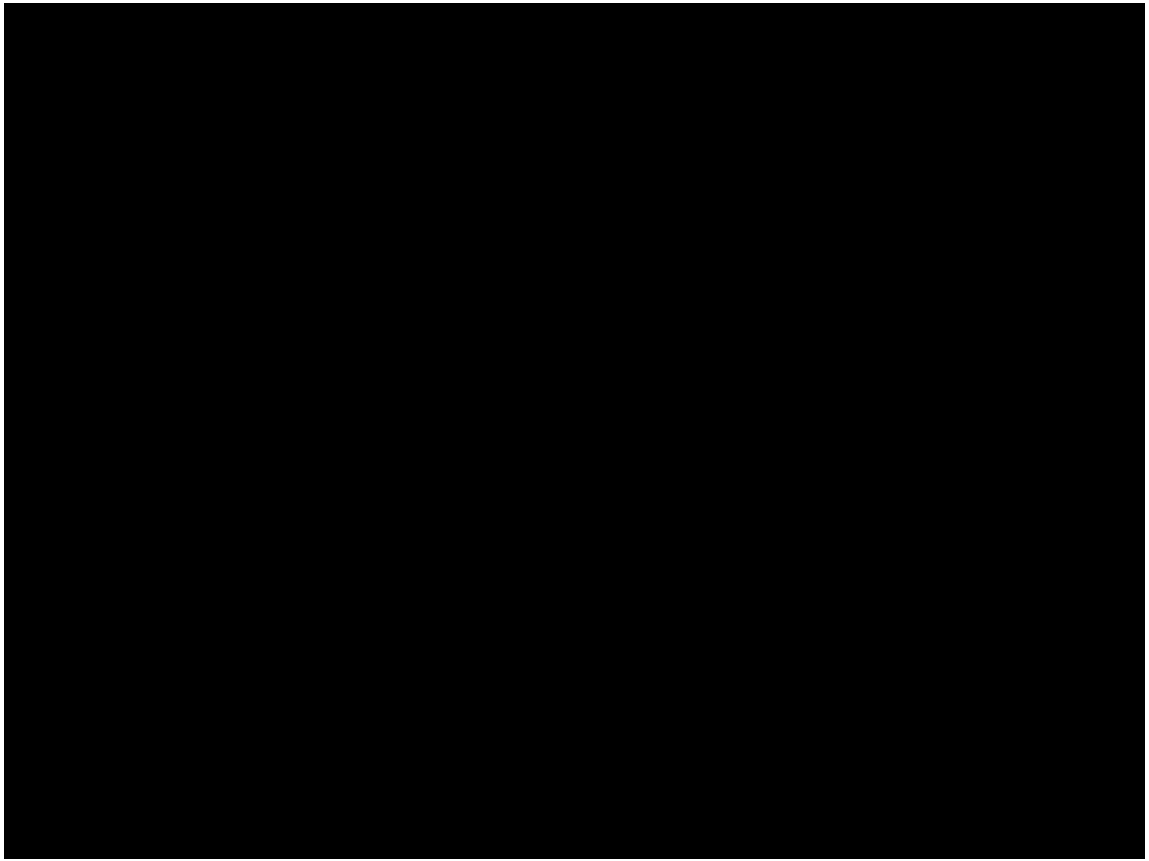
Benchmarking



XGBoost forecasts



Dashboard demonstration



Come see it live @ our breakout room

Conclusions

Takeaways

- Analysis of seasonalities of energy consumption and production data
- 1 day ahead energy demand forecasts
- Machine learning models performed better than time series models for forecasting short-term energy demand

Outlook

- Implement real-time predictions of energy demand into dashboard
- Generalize our model to different climate zones and countries
- Develop energy management strategies, optimizing battery utilization towards cost reduction and grid stability

Thank you for your attention

Project Repository:
github.com/eaunaicr97/TheGreenCitySolutionsGroup

Rafael Arndt

github.com/**r4f**

Erick Cantu

github.com/**eaunaicr97**

Leon Pichotka

github.com/**Leee-P**

Su Leen Wong

github.com/**suleenwong**