AGGREGATION OF ENERGY CONSUMPTION FORECASTS ACROSS SPATIAL LEVELS

Using CNN-LSTM energy consumption forecasts of lower spatial levels to forecast on higher spatial levels.

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1 Introduction

With a total energy consumption of 118 TWh, households in the Netherlands accounted for 23% of total national energy consumption in 2021 [1]. Being able to accurately forecast both the location and the time of 23% of the total national energy demand is an important part in managing and reducing the strain on an already congested electricity grid.

Forecasting the energy consumption of a single household by aggregating appliance energy consumption forecasts, results in more accurate forecast compared to directly forecasting household energy consumption [2].

2 Research Question

Can the forecast accuracy of community and city energy consumption be improved by aggregating the energy consumption forecasts made on lower levels compared to directly forecasting energy consumption on the levels themselves? (Figure 1)

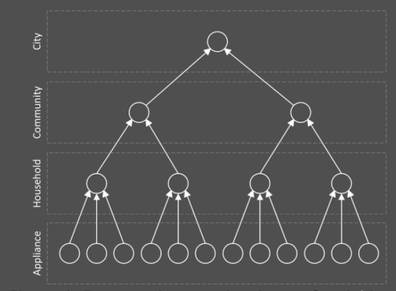


Figure 1: Forecast Aggregation Across Spatial Levels

2 CITIES
9 COMMUNITIES
45 HOUSEHOLDS
619 APPLIANCES

779 TRAINED MODELS
3 MONTHS OF DATA

3 Methodology

CLEAN DATA

- Assign Communities
- Remove outliers
- Generate missing data
- Create aggregated data for the 3 highest levels
- Extract Timestamp features

CREATE MODELS

- Create CNN-LSTM model without hyperparameters
- Create CNN-LSTM model with hyperparameters
- Create forecast aggregation network

TRAIN MODELS

Train models for:

- Every appliance
- Every households
- Every community
- Every city

TEST MODELS

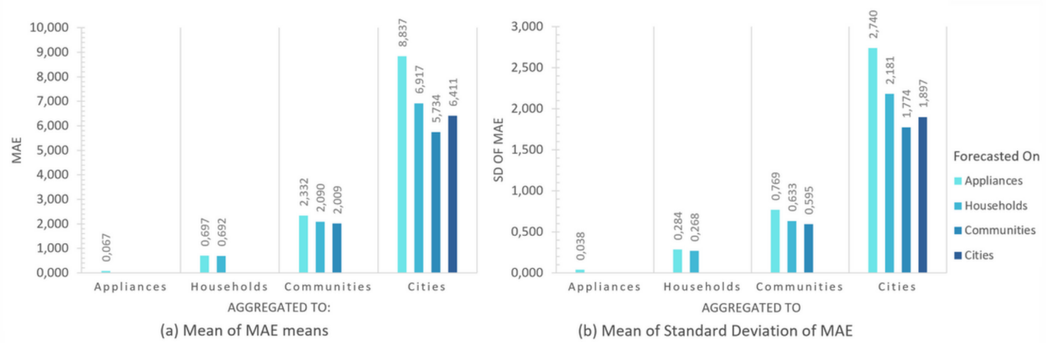
- Test the accuracy of every model individually
- Test the accuracy of aggregating forecasts using the forecast aggregation network

ANALYZE RESULTS

Compare the difference in accuracy between:

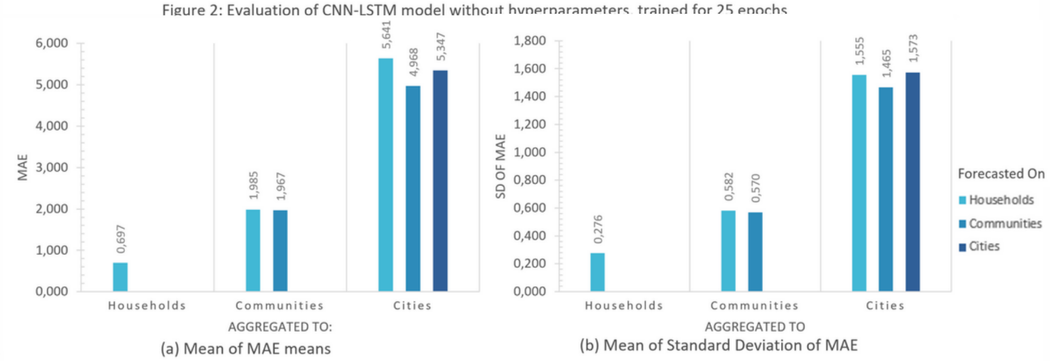
- Forecasting on aggregated data
- Aggregating forecasts made on lower levels

4 Results



(a) Mean of MAE means (b) Mean of Standard Deviation of MAE

Figure 2: Evaluation of CNN-LSTM model without hyperparameters, trained for 25 epochs



(a) Mean of MAE means (b) Mean of Standard Deviation of MAE

Figure 3: Evaluation of CNN-LSTM model without hyperparameters, trained for 100 epochs

5 Conclusion

Aggregating appliance and household forecasts led to a worse forecast accuracy compared to directly forecasting.

Aggregating community level forecasts to a city level resulted in more accurate forecasts compared to directly forecasting

Whether more accurate forecasts can be made by aggregating forecasts of lower levels, depends on the data volatility of the lower levels and the difficulty of directly forecasting higher levels.

6 Further Research

What is the impact of data volatility of lower spacial levels on the forecast aggregating performance?

What is the impact of a models ability to forecast volatile data on the forecast aggregating performance?

[1] Eurostat. Final energy consumption by sector. https://ec.europa.eu/eurostat/databrowser/view/TEN00124/default/table?lang=en, 4 2023. Accessed: 2023-05-11.

[2] Zhuang Zheng, Hainan Chen, and Xiaowei Luo. A kalman filter-based bottom-up approach for household short-term load forecast. Applied Energy, 250:882–894, 9 2019.