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Team Zero

A wide-angle photograph of a solar farm. In the foreground and middle ground, several rows of dark blue photovoltaic solar panels are mounted on metal frames, tilted at an angle towards the sun. The panels are arranged in a perspective that leads the eye into the distance. The ground between the panels is dry and covered with sparse, low-lying vegetation. The background is a vast, clear blue sky filled with soft, white, wispy clouds that stretch across the entire frame. The overall scene conveys a sense of clean, renewable energy.

iCEM

integrated Climate Energy Module

120 houses located in Zoetermeer



Research Question

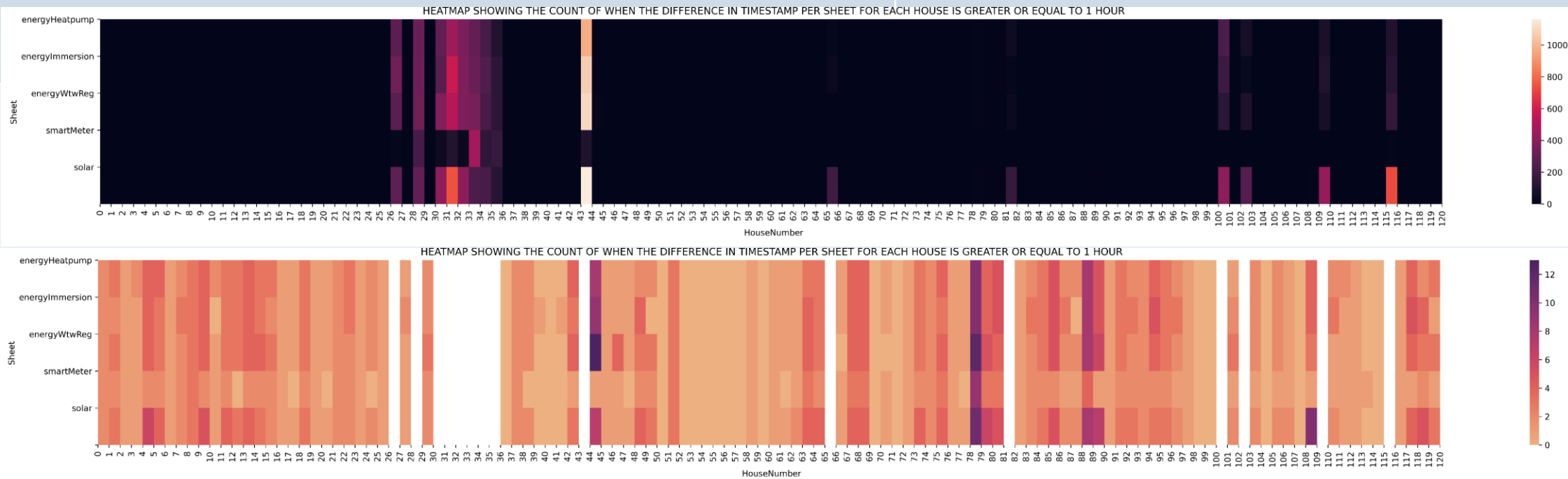
What is a suitable machine learning model to predict energy use & production of a “zero at the meter” residential house, one day in advance with (if possible) an hourly resolution?

Consumption

- Energy Consumption = $\text{Smart}_{\text{in}} + \text{Solar}_{\text{out}} - \text{Smart}_{\text{out}}$
- Week mean, day mean
- Hour of measurement one hot encoded (0 or 1)
- 15 weeks training
- 16th week validation
- 17th week test

Production

- Energy Production = $\text{Solar}_{\text{out}}$
- Hourly resolution
- 10 months training, 10 days validating, 10 days test
- Weather data from Voorschoten (within 15km radius from Zoetermeer)
 - Global irradiance (24,48,72 hours ago)
 - Outside temperature (24,48,72 hours ago)
 - Temperature (24,48,72 hours ago)



Short-term energy use prediction of solar-assisted water heating system: Application case of combined attention-based LSTM and time-series decomposition

Deep learning for estimating building energy consumption*

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Forecasting residential gas consumption with machine learning algorithms on weather data

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Development of prediction models for next-day building energy consumption and peak power demand using data mining techniques

Cheng Fan, Fu Xiao^{*}, Shengwei Wang

Department of Building Services Engineering, The Hong Kong Polytechnic University, Kowloon, Hong Kong

Building electrical energy consumption forecasting analysis using
conventional and artificial intelligence methods: A review

Mohammad Azhar Mat Daut^{a,b}, Mohammad Yusri Hassan^{a,b,*}, Hayati Abdullah^{a,c},
Hasimah Abdul Rahman^{a,b}, Md Pauzi Abdullah^{a,b}, Faridah Hussin^{a,b}

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Accuracy analyses and model comparison of machine learning adopted in building energy consumption prediction

Zhijian Liu¹ , Di Wu¹, Yuanwei Liu¹,
Zhonghe Han¹, Liyong Lun², Jun Gao³,
Guangya Jin¹ and Guoqing Cao⁴

- ✓ SVR
- ✓ MVLR
- ✓ MLP
- ✓ LSTM

R²: R-squared error

The value of this error represents the linearity between the predicted value (typically called yhat) and the actual value (y).
[0-1]

RMSE: Root Mean Squared Error

Is more sensitive to peaks or outliers in the data.
[0-∞]

MAPE: Mean Absolute Percentage Error

Represents the percentage error between yhat and y.
[0%-100%]

MAE: Mean Absolute Error

Represents the absolute error between yhat and the average value of y.
[0-∞]

$$R^2(y, \hat{y}) = 1 - \frac{\sum_{i=0}^{n_{\text{samples}}-1} (y_i - \hat{y}_i)^2}{\sum_{i=0}^{n_{\text{samples}}-1} (y_i - \bar{y})^2}$$

$$\text{RMSE} = \sqrt{\sum \frac{(y_{\text{pred}} - y_{\text{ref}})^2}{N}}$$

$$\text{MAPE} = \frac{1}{n} \sum_{i=1}^n \frac{|Y_i - \hat{Y}_i|}{Y_i}$$

$$\text{MAE} = \frac{1}{n} \sum_{j=1}^n |y_j - \hat{y}_j|$$

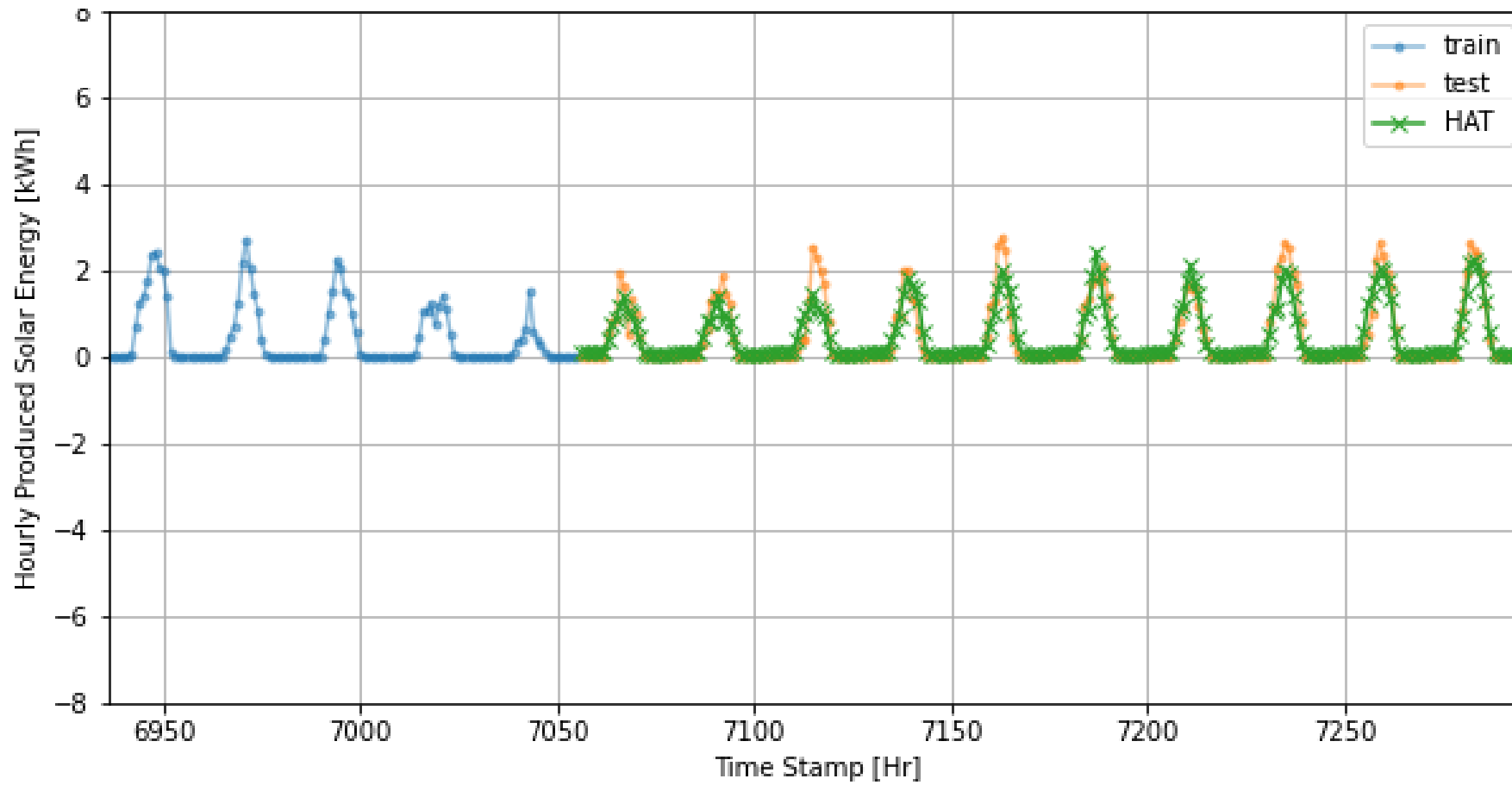
Evaluation Metrics

Problems:

- MAPE error has trouble with really small values
- RSME has difficulty with energy consumption data

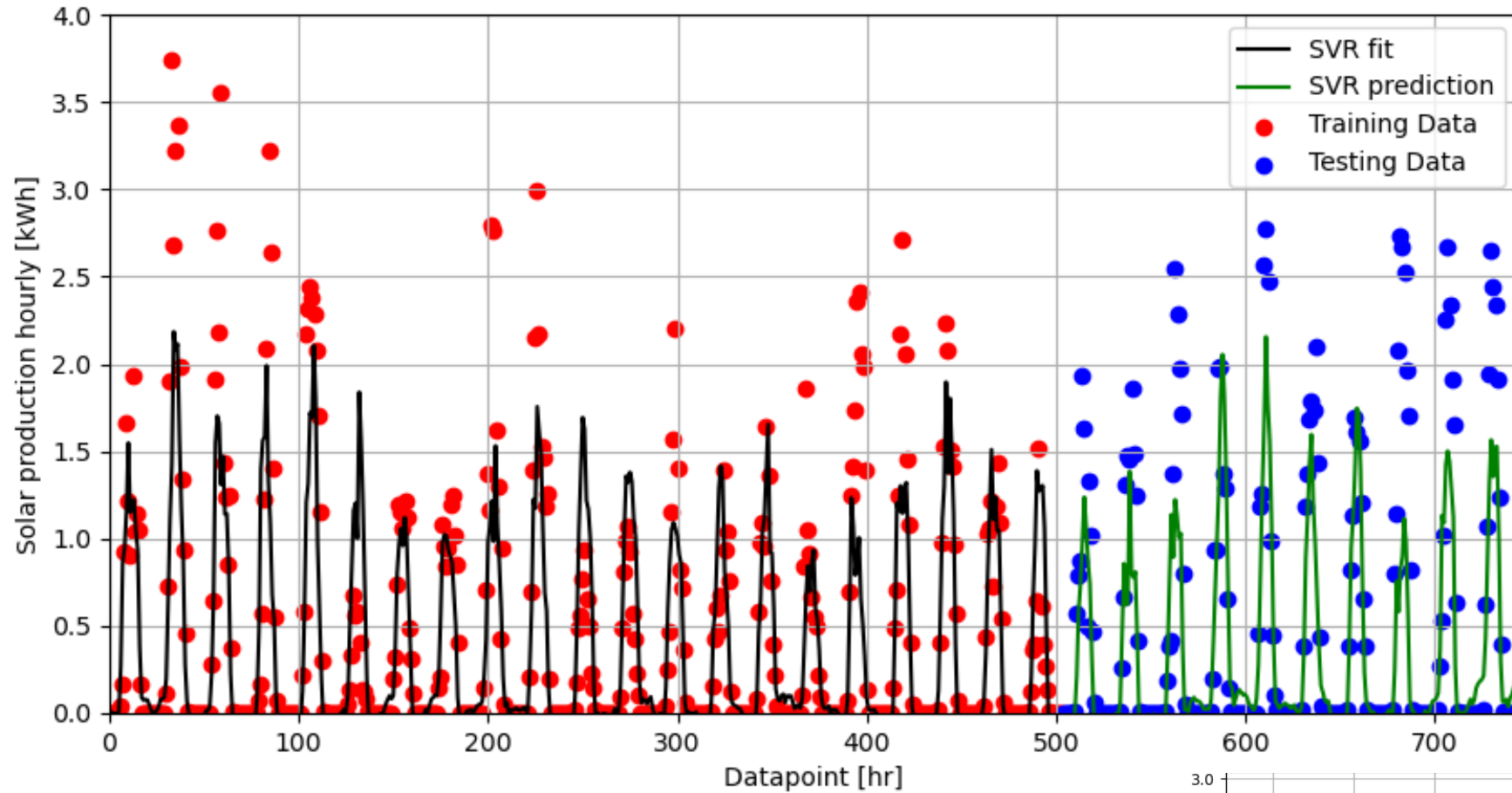
Production

Regular patterns



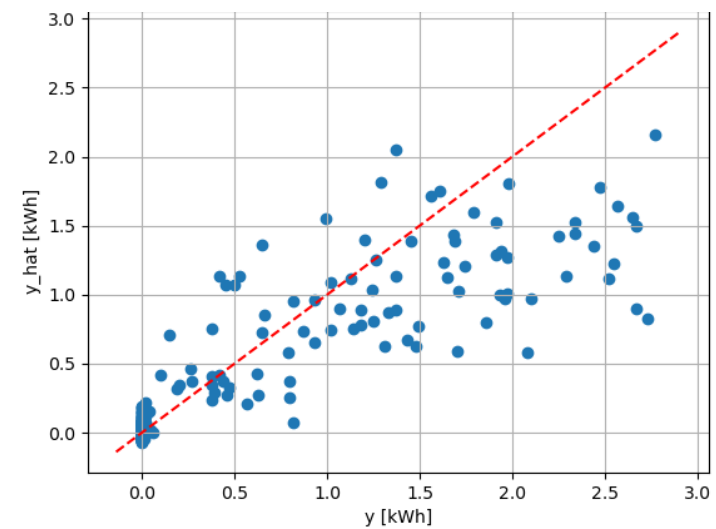
MVLR

Multi Variate Linear Regression – Machine Learning



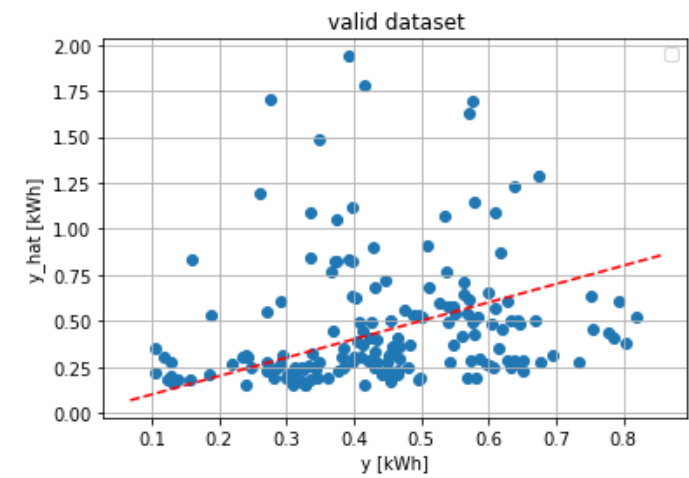
SVR
(Support Vector Regression)

C-parameter: 1.0



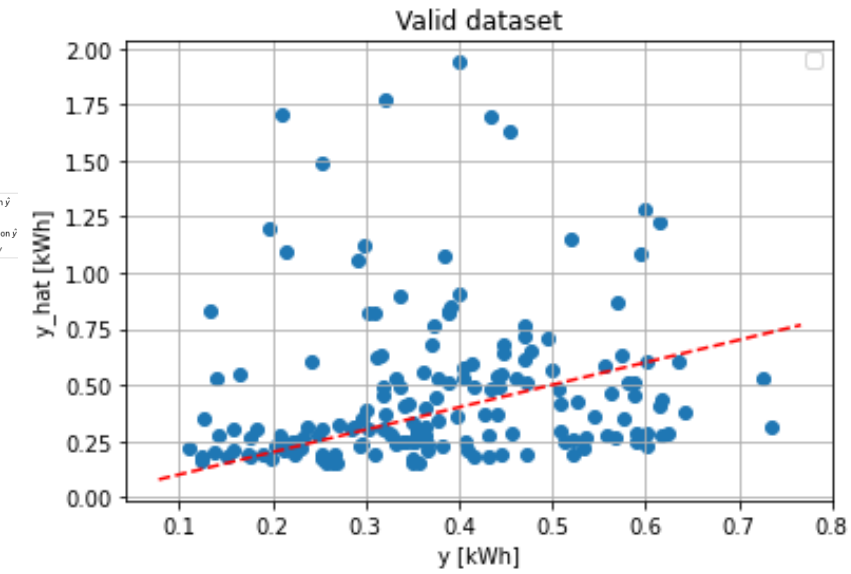
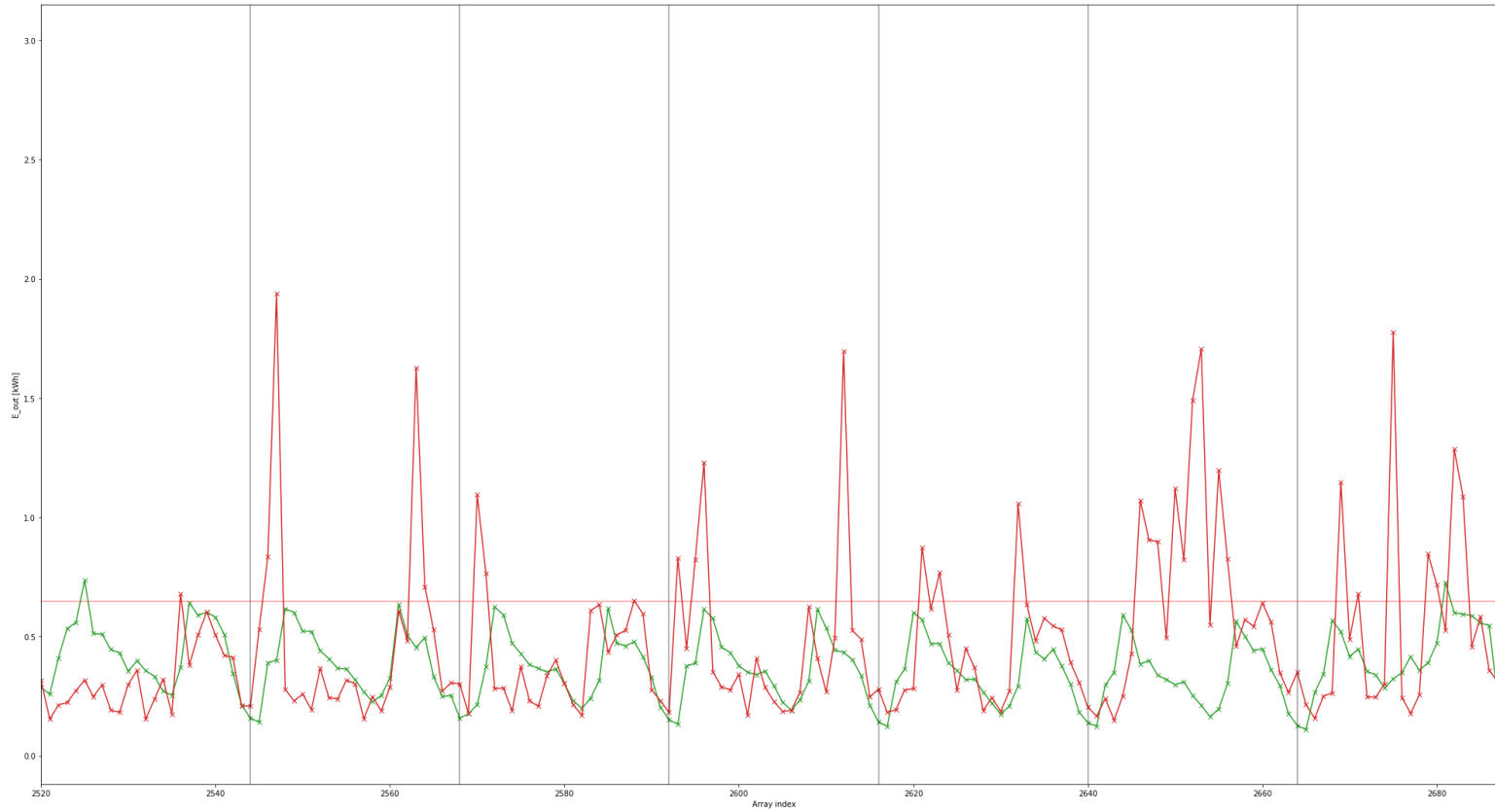
Consumption

Very irregular patterns



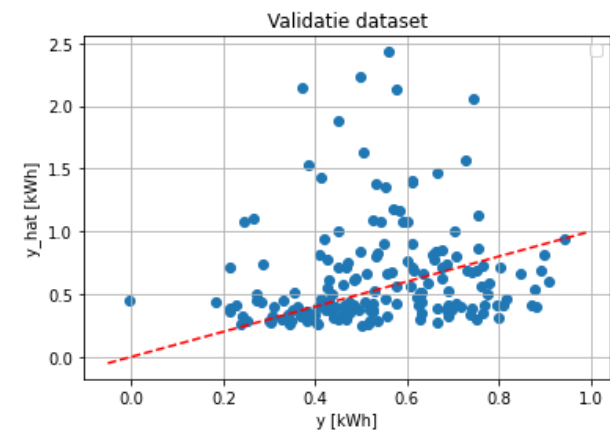
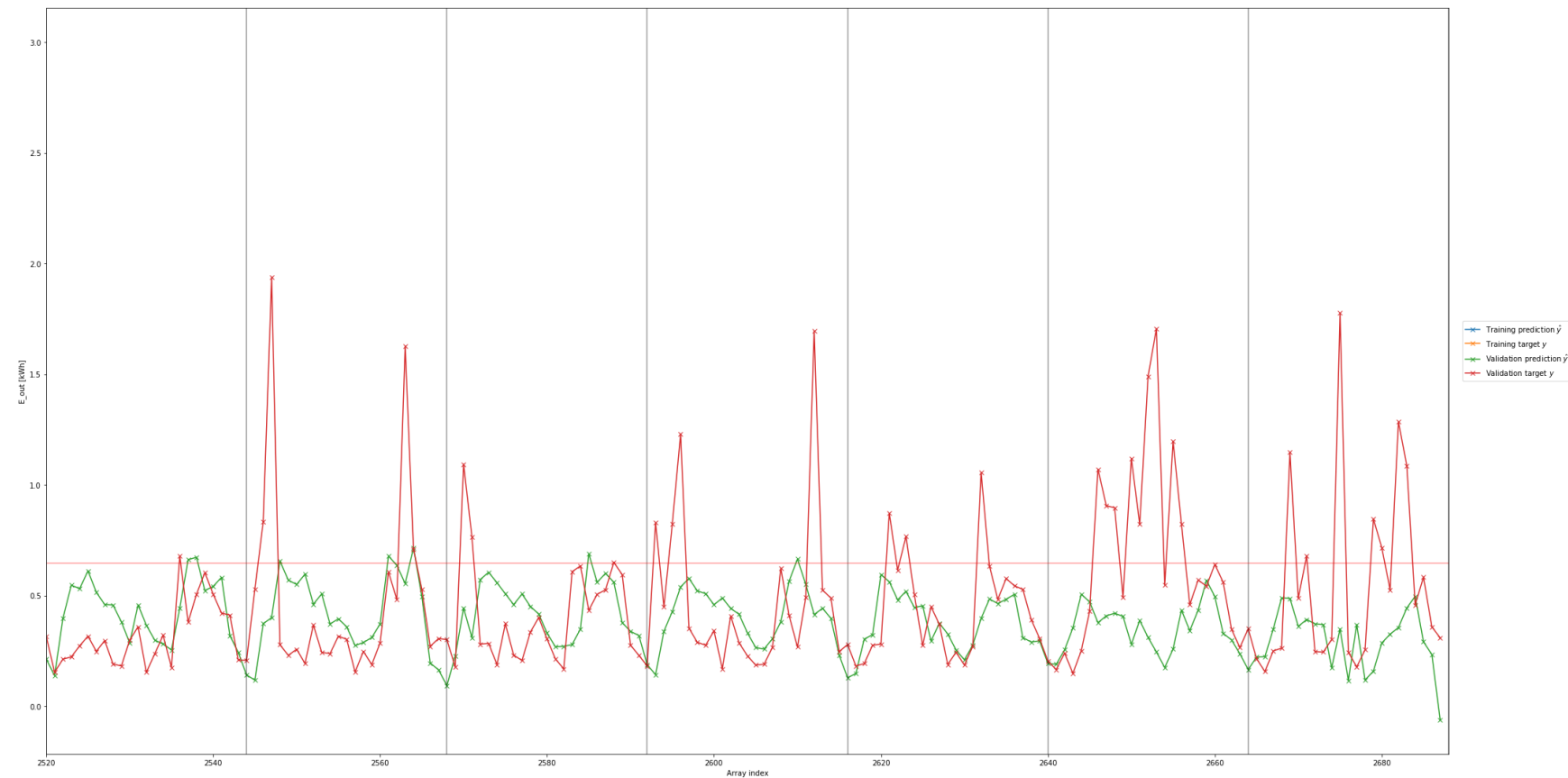
MVLR

(Multi Variate Linear Regression – Machine Learning)



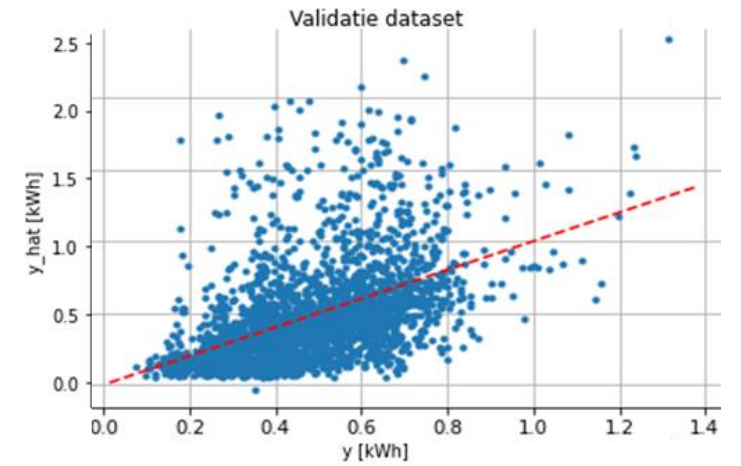
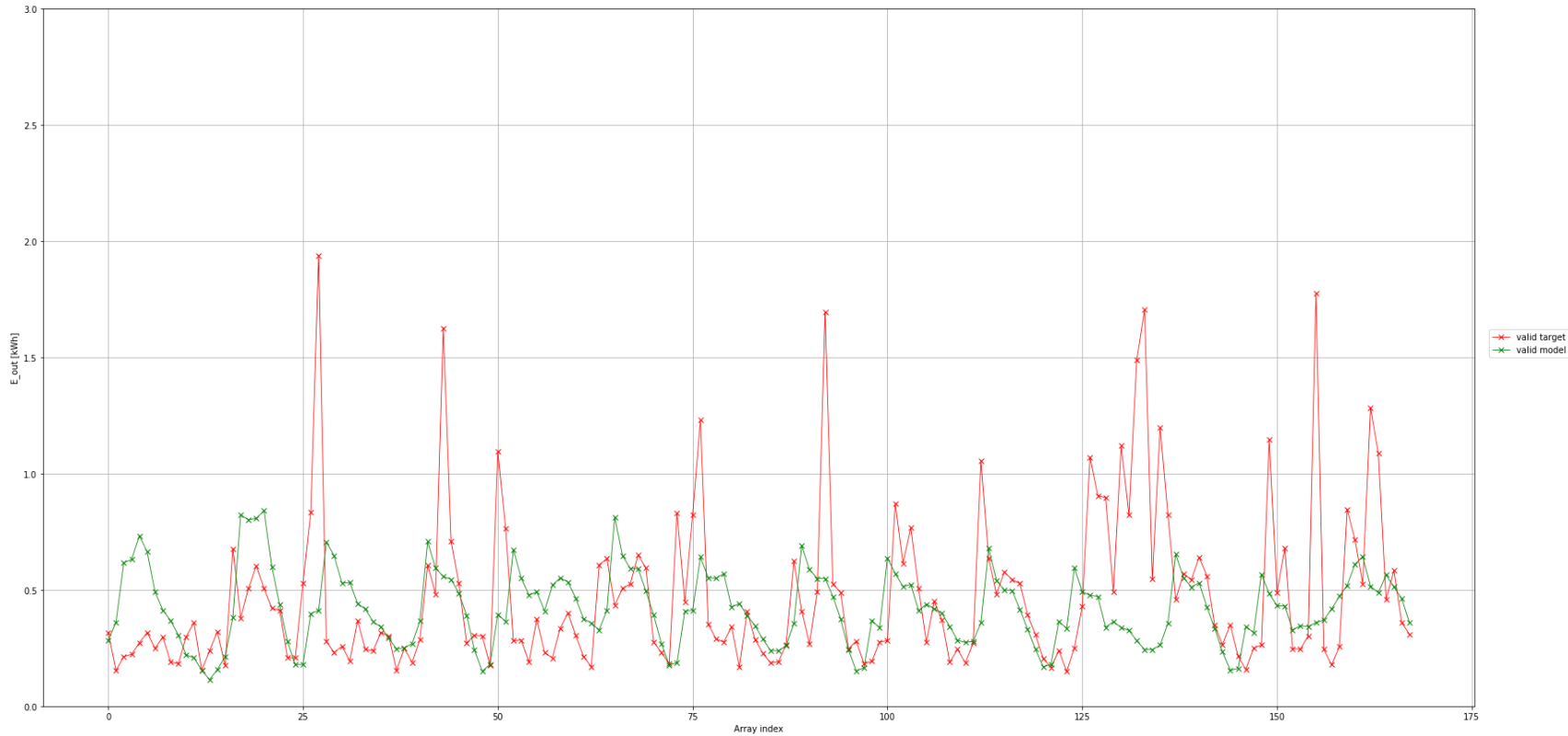
SVR
(Support Vector Regression - SVM)

C-parameter: 1.0



MLP
(Multilayer Perceptron - ANN)

2 Linear layers
loss function: MSE - loss



LSTM
(Long Short Term Memory - RNN)

2 LSTM cells that feeds
in 1 linear layer
loss function: MSE - loss

Summary

LSTM is the best method

Energy Production (over validation)

	MVLR	SVR	MLP	LSTM
R^2	0.77	0.42	NTB	NTB
MAE	0.20	0.23	NTB	NTB
RSME	0.30	0.41	NTB	NTB
MAPE	Inf	inf	NTB	NTB

Energy Consumption (over validation)

	MVLR	SVR	MLP	LSTM
R^2	-4.09	-5.87	-5.50	-1.77
MAE	0.24	0.23	0.29	0.20
RSME	0.36	0.37	0.45	0.30
MAPE	55.69	59.69	42.75	65.13

Green: The best score per score

Future

- Create 2 LSTM's for peak data and non-peak data for energy consumption
- Create a similar LSTM for production
- Continue to write our paper

Remarks,
Suggestions,
Questions



Open Questions:

- How much energy does a real zero at the meter house consume?
- Which appliance uses the most energy in the house?
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