Monthly Report of Peak Shaving project on Fort William TS Power Station

2021-April

Overview

This monthly report analyzes the Peak Shaving system of Fort William TS power station during 2018-April. This report contains four sections: First, the graphical results of peak shaving activities of power consumption. Second, the numerical results peak shaving activities of power consumption and expected bill saving. Third, the monthly performance of energy forecasting models. Four, detailed peak shaving activities of the highest five peak days during this month.

The graphical results of Peak Shaving

Figure (1) shows a monthly forecasting graph. The black line describes the actual power consumption curve; the red line describes the prediction curve and the yellow line describes the battery discharging period set by the predicted peak.

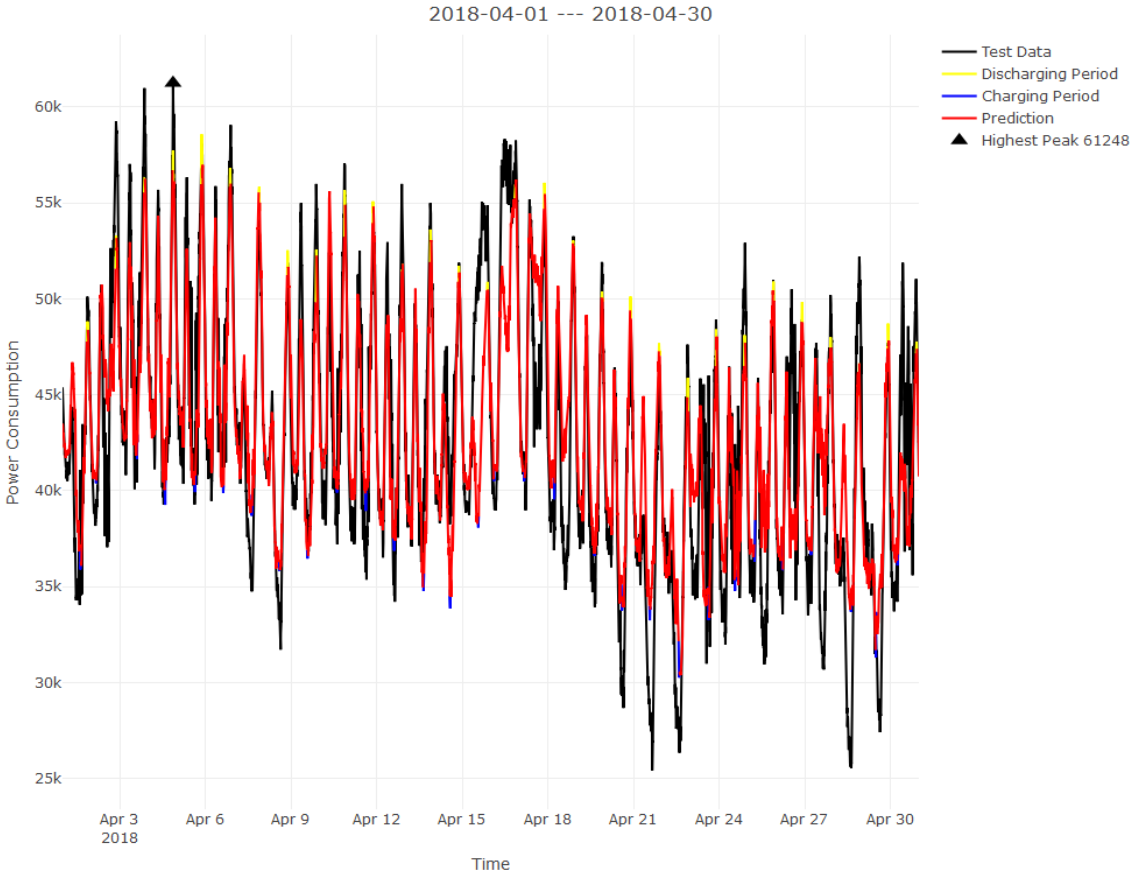

Figure 1: Monthly forecasting graph

Figure (2) shows a comparison of the expected power consumption curve(black) and after the peak-shaving curve(red). According to figure (2), The highest peak of power consumption of the month is reduced from 61248kW (2018-04-04 20:55:00) to 59635.2kW (2018-04-04 21:50:00). Figure (3) shows the detailed peak shaving result of the highest peak of the month which is in 2018-04-04.

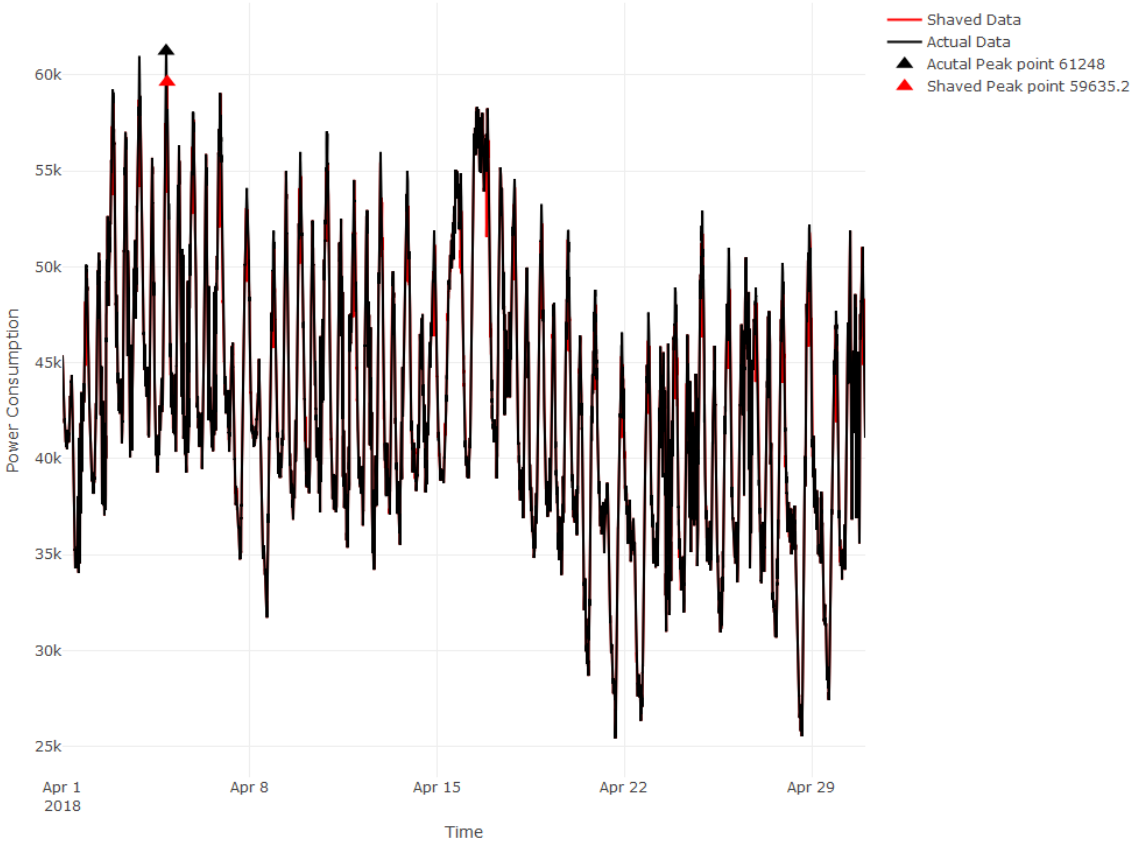

Figure 2: Monthly Peak Shaving Activies graph

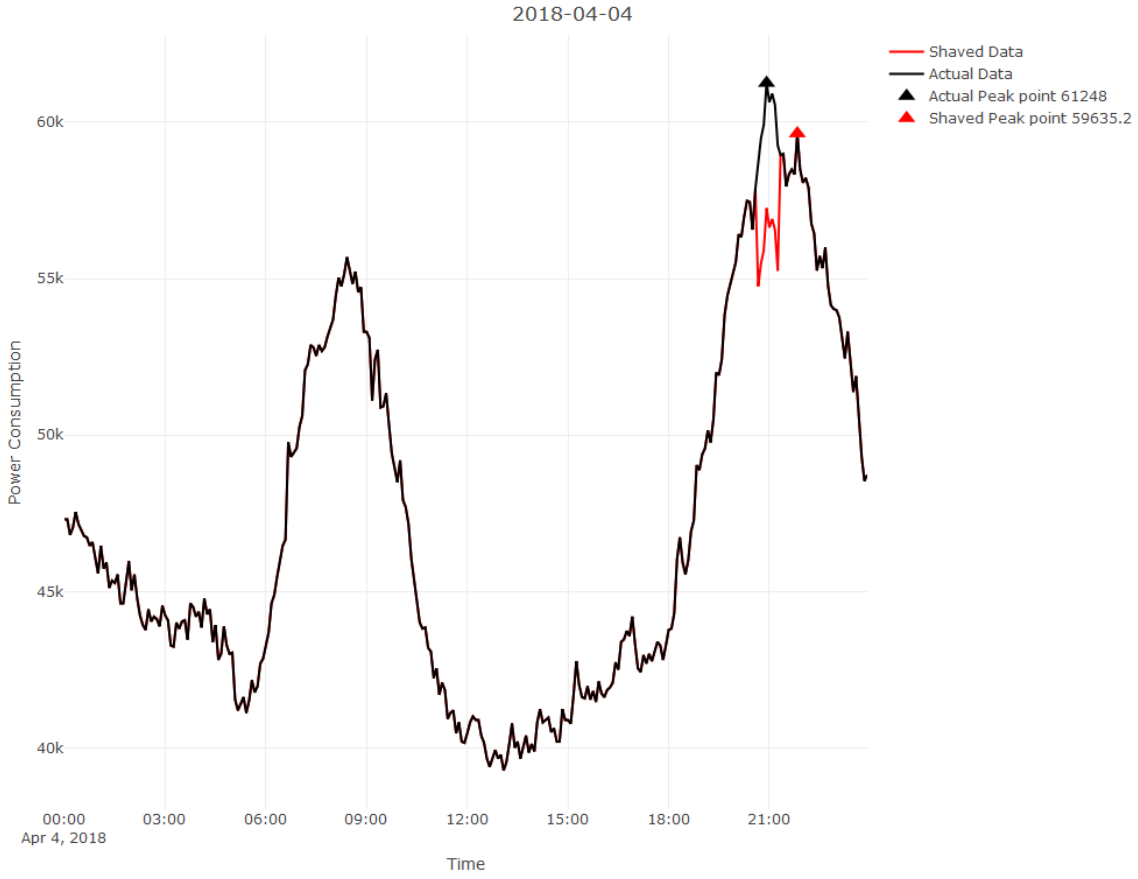

Figure 3: Highest peak day

The digital results of Peak shaving:

As shown in Table (**??**), the expected peak of power consumption is 61248kW occur at 2018-04-04 20:55:00. After the peak-shaving activities, the highest peak of this month reduces to 59635.2kW at 2018-04-04 21:50:00. The monthly energy purchasing cost reduces from $30624 to $29817.6, which saves $806.4.

Table 1: Monthly Results Table

Parameter	April Expected Peak	April Shaved Peak	Total Reduction
Power Consumption(kW)	61248	59635.2	1612.8
Billing($)	30624	29817.6	806.4

The performance of the forecasting system:

In this energy forecasting system, we combine four different models. Table (\ref{tab:table2}) show the monthly performance of each model. There are four machine learning algorithms in total: Cubist, Xgboost,

(feedforward) Neural Network and LSTM (Long short-term memory). The ensemble model combines all four algorithms and battery discharging events base on the ensemble model.

Relative root mean square error (rRMSE), which is RMSE divided by the average power consumption of tested day, between 1:00 pm to 12:00 pm to represent the performance of a model on the ability of prediction peak period. In the following formula, n represent number of data between 1:00 pm to 12:00 pm, y_i and x_i are the prediction and real power consumption receptively.

$$rRMSE = \frac{1\sqrt{(\frac{1}{n})\sum_{i=1}^{n}(y_i - x_i)^2}}{\frac{1}{n}\sum_{i=1}^{n} x_i} \tag{1}$$

Average Peak time error represent the mean of daily time different of expected peak time and predicted peak time. Pecentage of daily peak shaved represent the pecentage of days which discharging period coverd actual peak time in this month. For example, 0.8 mean this peak shaving system successfully shaved 80% of daily peak in this month.

Table 2: Monthly Models Performance

Parameter	Cubist	Xgboost	Random Forest	Nerual Network	LSTM	Ensemble System
rRMSE	0.10	0.09	0.09	0.10	0.10	0.08
Average Peak time error	44.68	39.35	29.52	26.13	20.16	27.48
percentage of daily peak shaved	0.71	0.68	0.84	0.87	0.90	0.94

The accuracy of energy forecasting on the highest peak of the month is an important factor to measure the performance of each model. Figure (4) show the performance of each model on the day with highest peak.

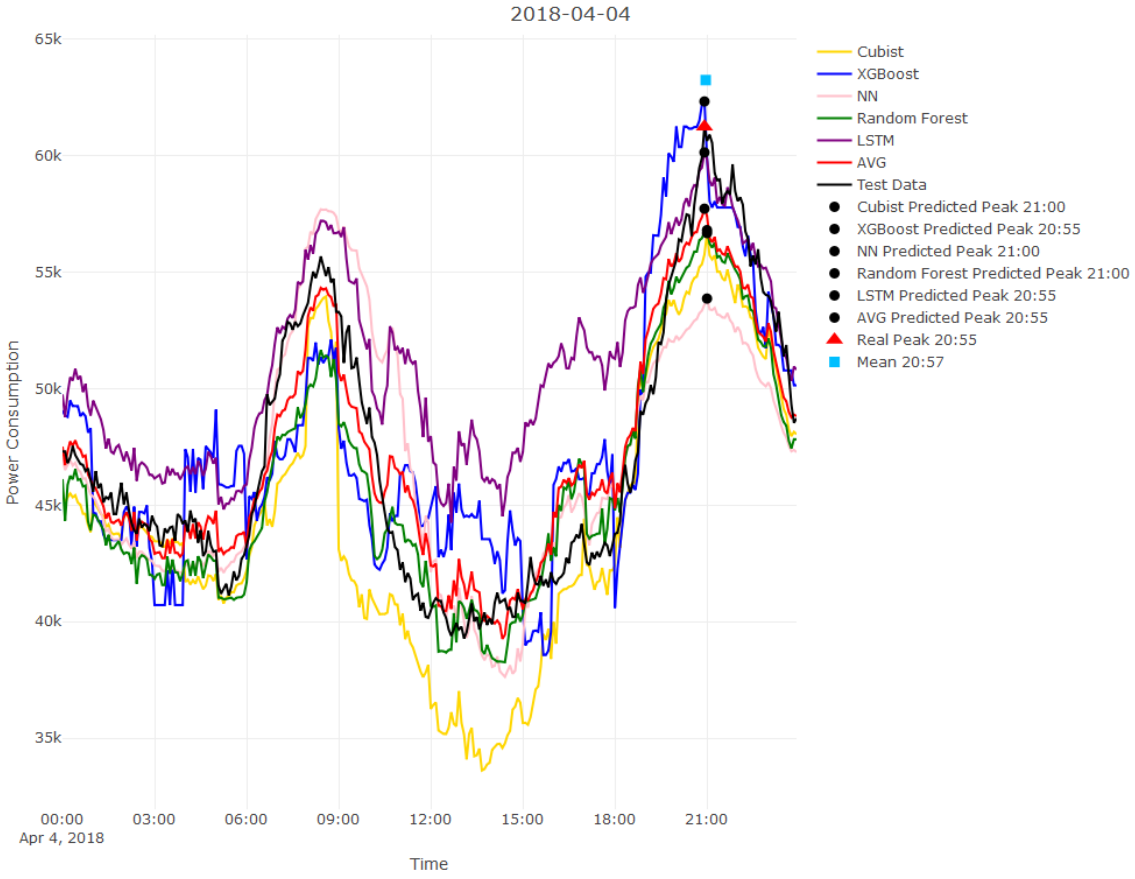

Figure 4: Daily Models Performance

Detailed report:

Top five highest peak days are shown in Figure (5)(6) respectively.

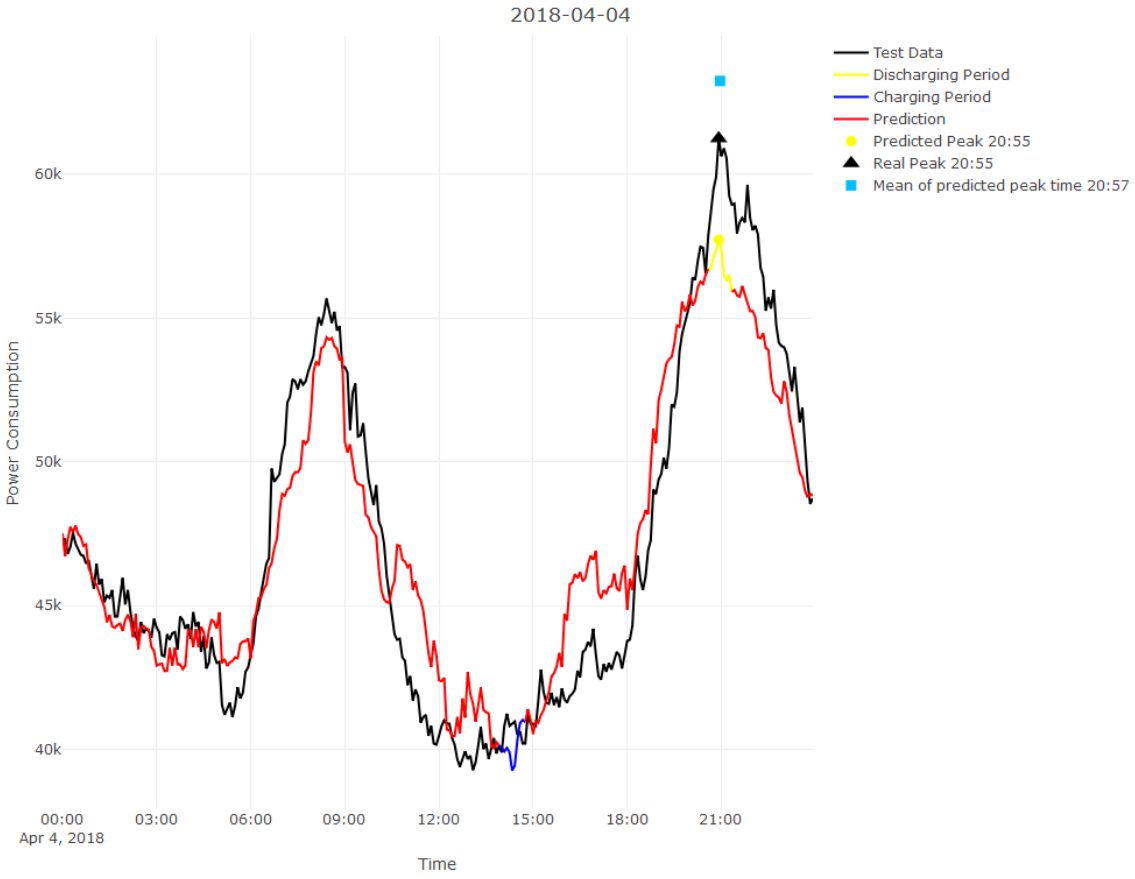

Figure 5: Highest Peak day

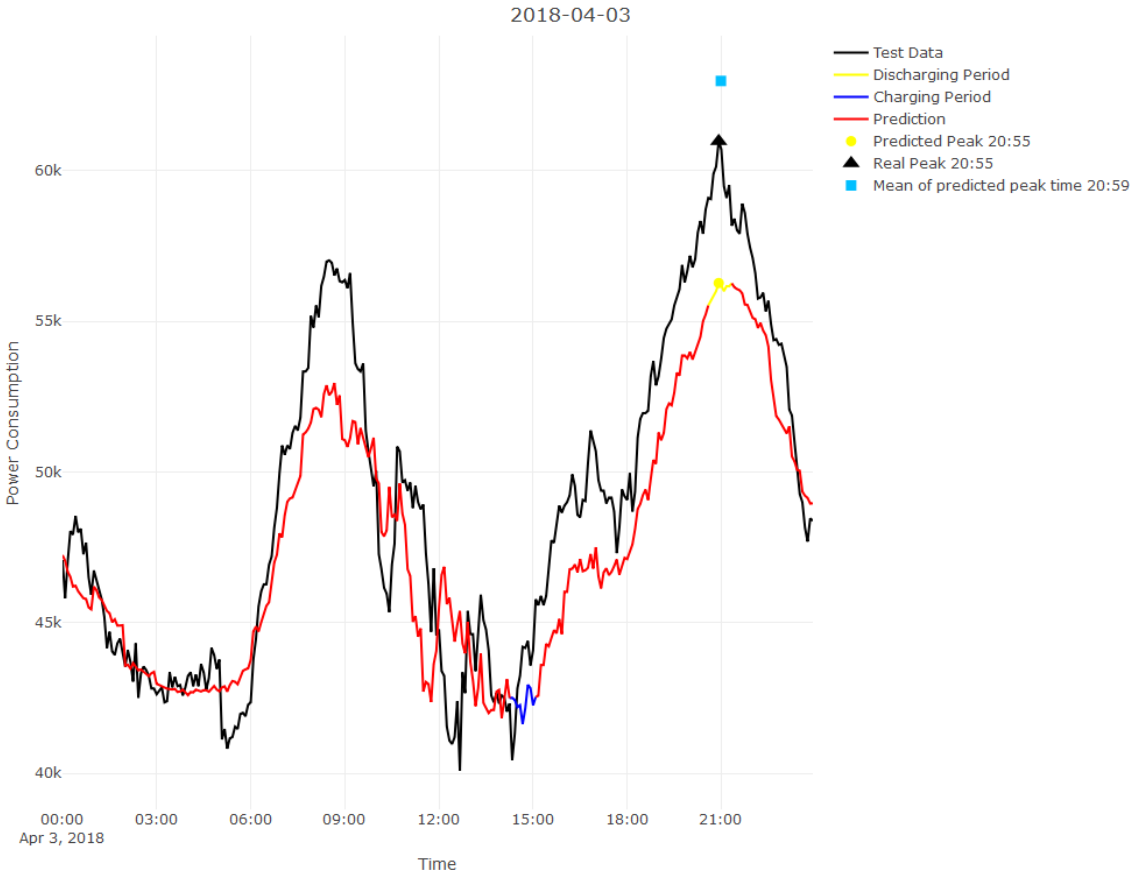

Figure 6: 2nd Highest Peak day

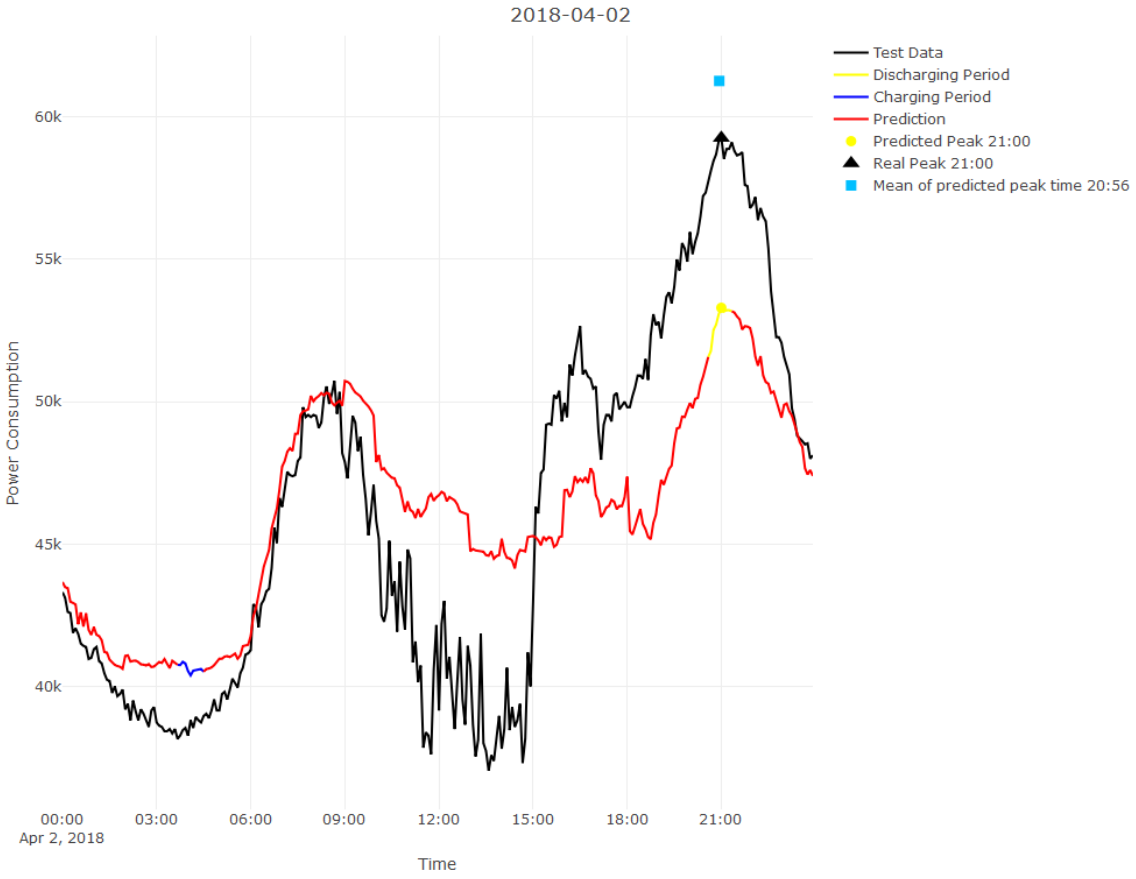

Figure 7: 3rd Highest Peak day

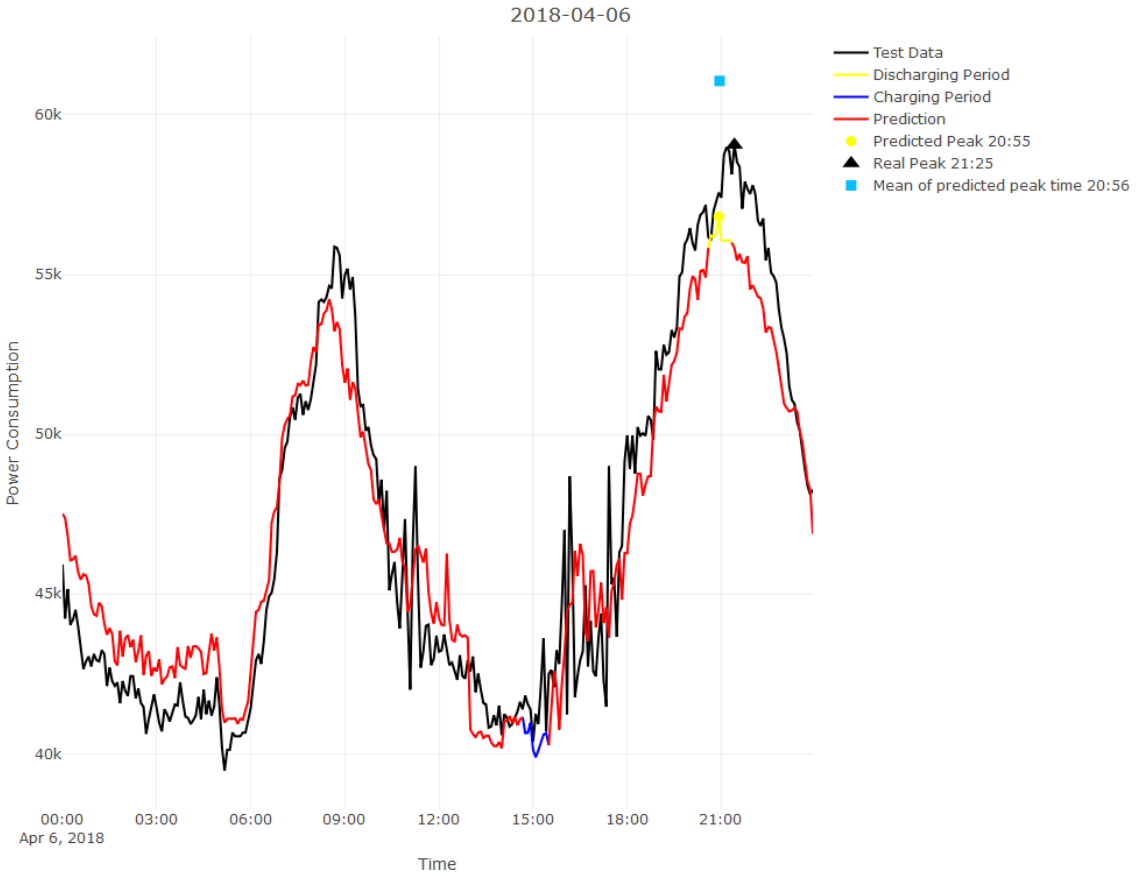

Figure 8: 4th Highest Peak day

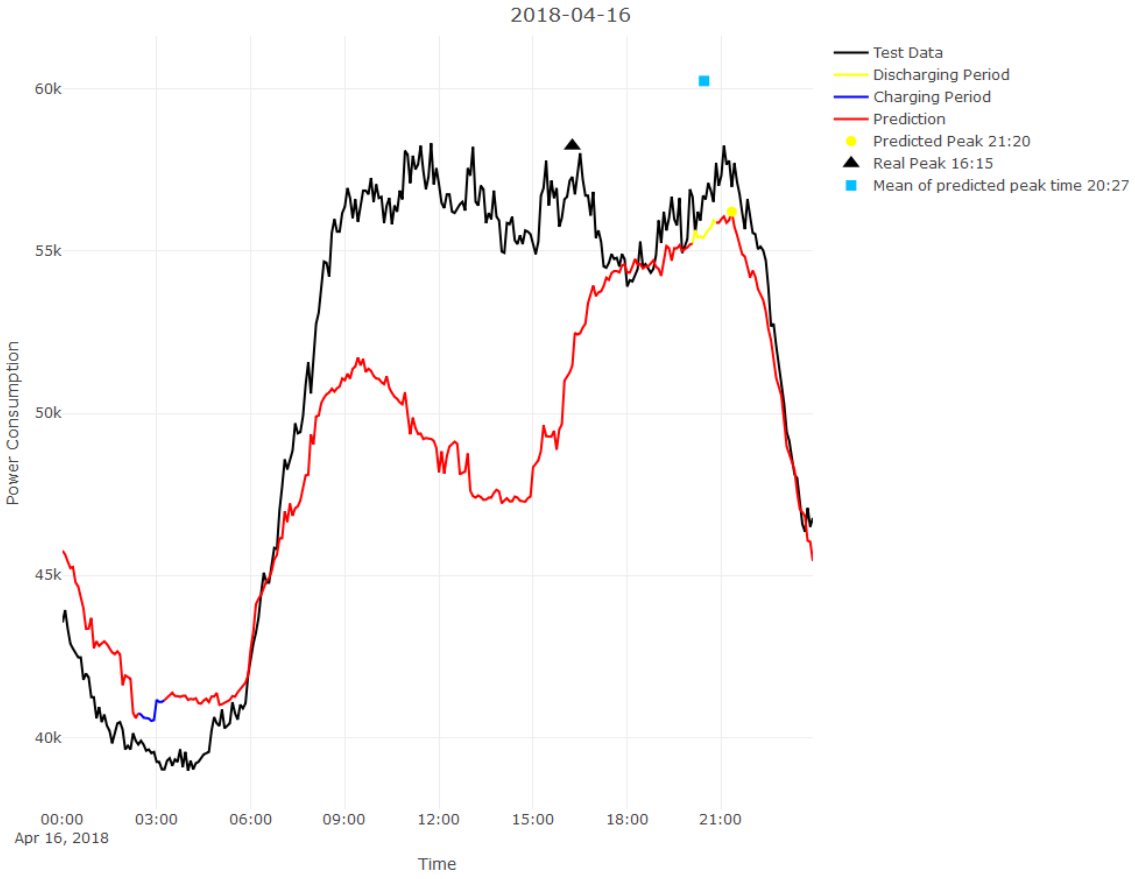

Figure 9: 5th Highest Peak day