Finding black sheep in your building portfolio using Energy Twin KPIs

Energy Twin (ET) is a machine learning SkySpark extension for energy consumption analysis. ET is designed for efficient monitoring of multiple buildings using artificial intelligence in order to identify problems and reveal the potential for future energy consumption savings and optimization.

"This case study accurately illustrates the possible practical benefits of machine learning for HVAC operation. Thanks to ET, a significant potential for energy savings was found and fully exploited during subsequent modifications of the building management system resulting in successful savings in energy consumption and building operation costs."

Jan Široký, PhD. - leader of the Energy Twin team

Energy Twin®

Our challenges

- **Identifying the black sheep**
  ET identifies the problematic building among the client's porfolio and determines possible energy savings.
- **Proposed solution**
  A specific solution is suggested based on the problematic building's KPI metrics results, which directly show where the most significant savings potential is and what to focus on.
- **Result validation**
  A result validation is a process based on ET model and measure data after making proposed adjustments.

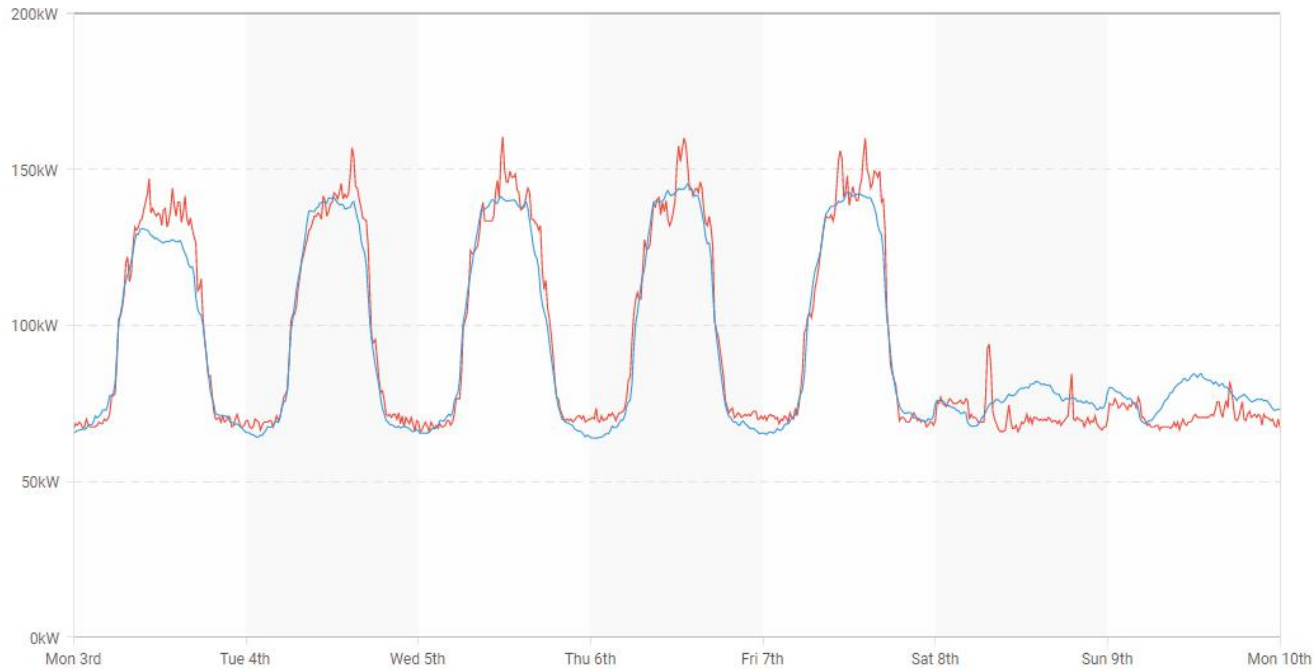
Solutions

1 Start of the project

Our client provided us with energy consumption data from site meters of 15 buildings (.csv file, 15 min period). Our goal was to find 1 building with the most significant potential for energy savings and quantify the potential savings. All sites were analyzed with ET.

2 Model training

To quantify the potential savings and to make predictions, we must create mathematical models. Using ET, a model for every building in the porfolio was created with a year worth of energy consumption data. After performing multiple model simulations you can see how well the models fit the data in the image below.



Website
et.mervis.info

3 KPI metrics

KPI metrics implemented in ET allowed us to determine which parts we should focus on. We have chosen Site 9 since the energy savings potential was the most significant in Setback Ratio and Heating/Cooling Load Reduction KPI in the portfolio. After the ET model analysis, we concluded that the chillers weren't integrated into the building's control system. Theoretical savings potential was estimated as the sum of the two metrics mentioned above.

Site	Heating/Cooling Load Reduction	Setback Ratio
Site 9	-38,001kWh	-86,786kWh
Site 3	-34,231kWh	-15,432kWh
Site 7	-26,297kWh	-9,261kWh
Site 8	-20,878kWh	-4,961kWh
Site 4	-18,360kWh	-22,046kWh
Site 11	-17,005kWh	-11,916kWh
Site 5	-16,498kWh	2,630kWh
Site 13	-16,419kWh	-39,809kWh
Site 6	-12,424kWh	-3,640kWh
Site 16	-11,778kWh	-11,464kWh
Site 12	-10,469kWh	-7,321kWh
Site 2	-8,965kWh	-531kWh
Site 15	-7,766kWh	-10,155kWh
Site 14	-6,340kWh	-1,889kWh
Site 10	-5,762kWh	-16,422kWh
Site 1	-5,363kWh	-2,634kWh

4 Investment project

Based on ET results, a local investigation was carried out. As expected from ET analysis, the investigation concluded that cooling machines weren't integrated into the control system, which resulted in significant energy overconsumption during the night and over the weekend. In addition, the control logic of other air handling units was not correct. The investment estimate of modifying the control system was compared to the theoretical savings potential, and as a result, the client allowed the reconstruction since the return rate was estimated within 1 year.

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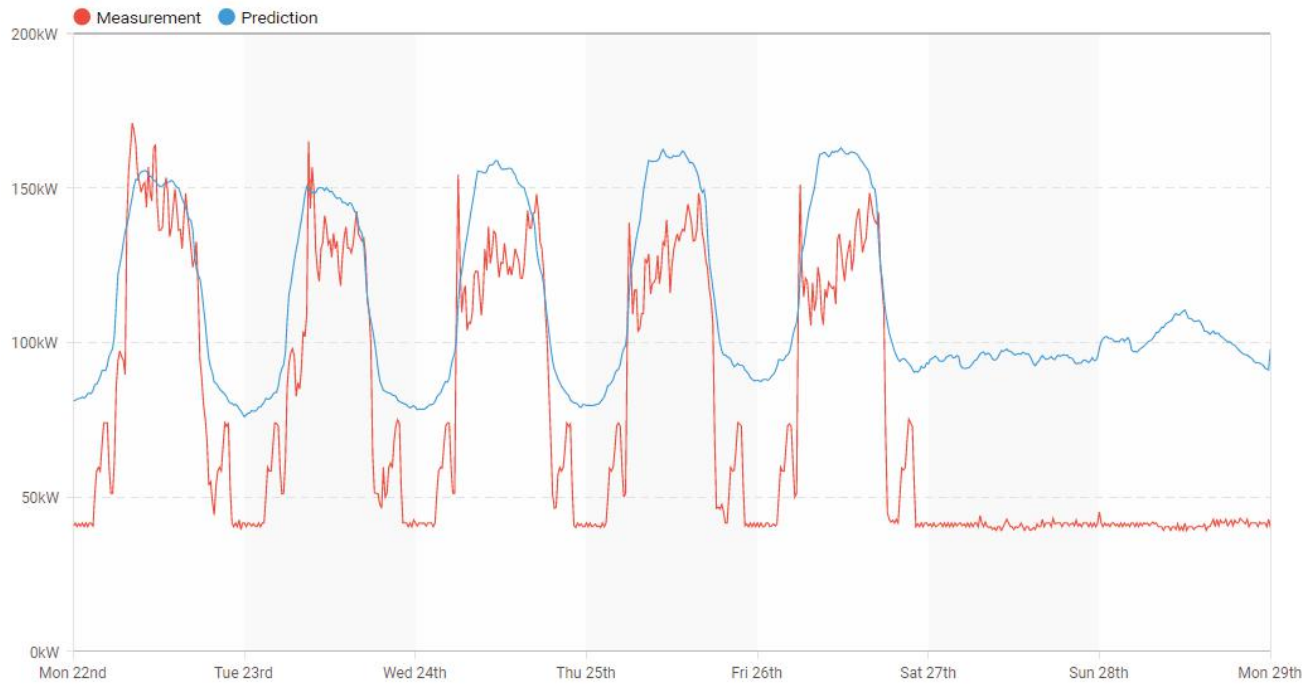
5 Post-instalation period

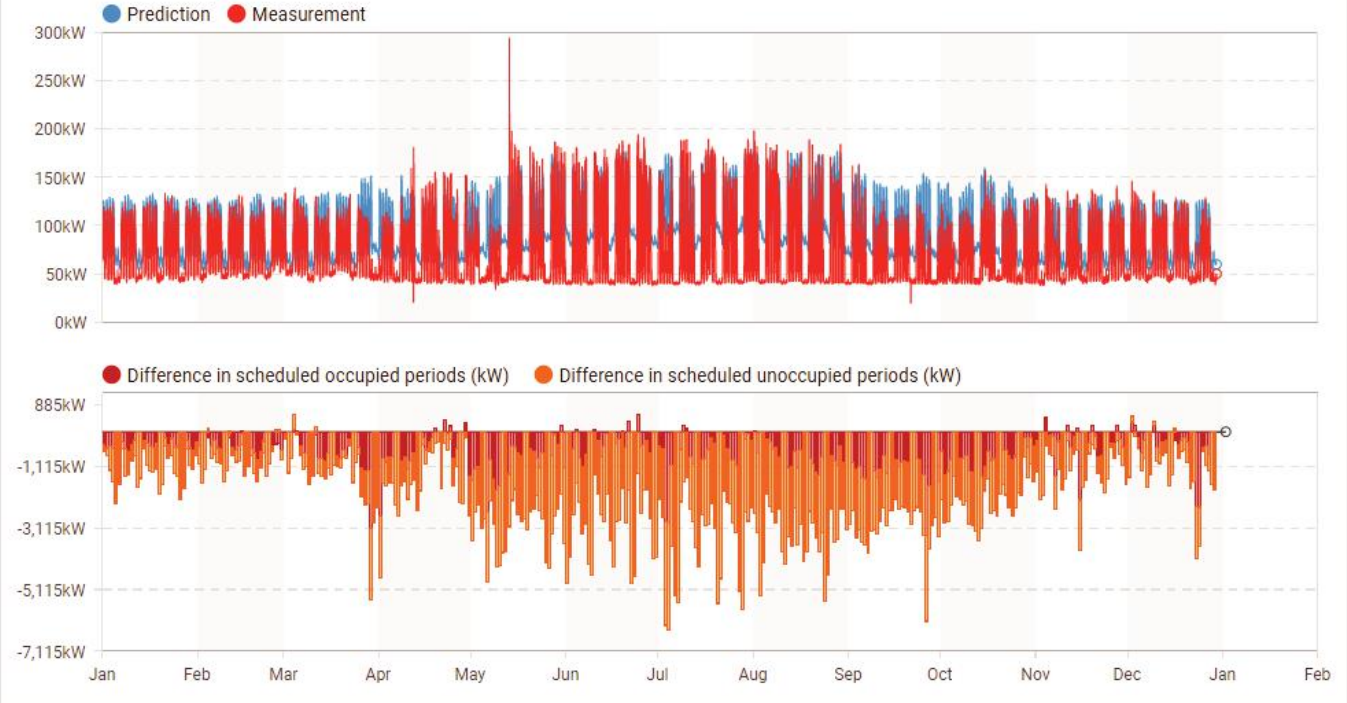
Here you can see an example of one week after the reconstruction and modification of the control system. As predicted, there is a visible decrease in energy consumption over the weekend. The efficient energy consumption management during the nights resulted in more significant savings than predicted.



6 Evaluation

After the reconstruction, the energy savings were determined from comparing the building's ET model before reconstruction and measured data after reconstruction. The savings were 195 MWh per year, resulting in an 18,000 USD decrease in operating costs per year. The graphs below show significant savings during the summer as expected.

Scope	Relative difference	Absolute difference	Measurement	Prediction
All data	-30.8%	-195,460kW	634,935kW	830,395kW
Scheduled occupied periods	-18.3%	-44,379kW	242,565kW	286,944kW
Scheduled unoccupied periods	-38.5%	-151,166kW	392,808kW	543,974kW



Savings

195 MWh **18,000 USD**

Final energy savings were 195 MWh per year, resulting in an 18,000 USD decrease in operating costs per year.

Continous commisioning benefits

Online anomaly detection – immediate reaction to deviations from expected consumption.

Prevention of savings and optimized state degradation,

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