Energy Twin for Monitoring Based Commissioning

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

"This case study is a good example of how AI can improve our work. In this case, AI does not replace an expert; it just makes their work more efficient. AI performs the repetitive and dull part of the job - such as comparing all measured data and detecting anomalies. The expert then spends precious time only with the events that matter and are worth investigating."

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

Energy Twin®

Our goals

Systematic approach

- clearly define metrics for anomaly detection and their evaluation
- prioritizing by estimating the amount of wasted energy
- provide consistent results regardless of the portfolio size

Save the time of the experts

- increase experts' efficiency significantly
- allow experts to focus on in-depth analysis of suspicious events

Solutions

1 Start of the project

Client's requirements

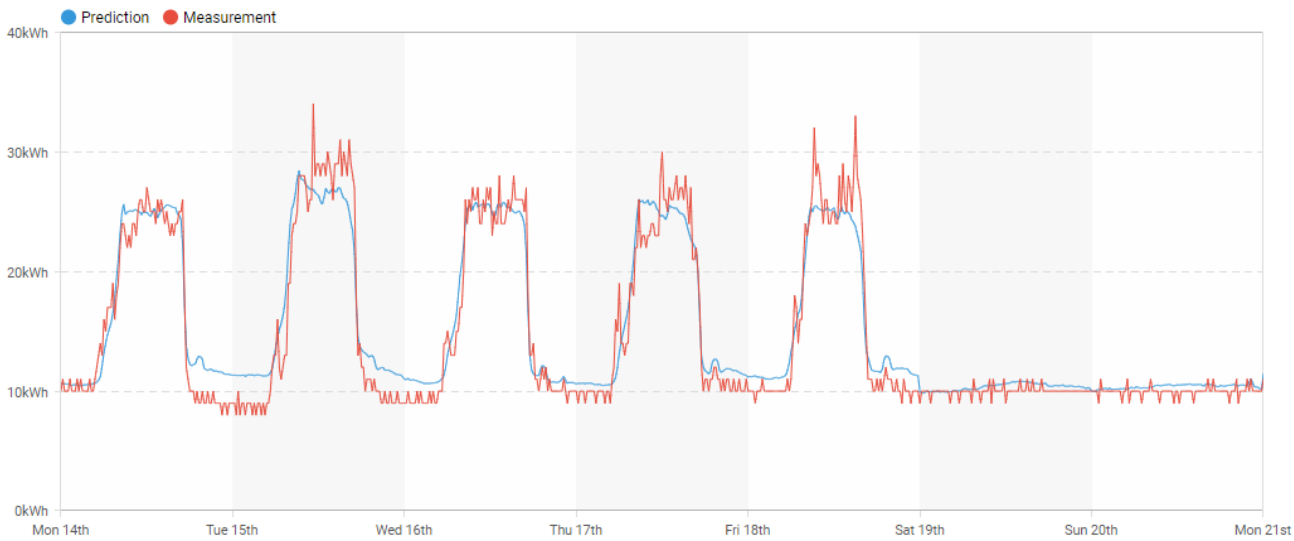
The client needed online monitoring of their portfolio, which consisted of 80 electric site meters representing office buildings of various sizes with known schedules. The goal was to detect any significant deviation from the building's normal behavior and provide a summary for local technician investigation when needed.

Contrator's aim

Contractor's goal was to maximize the time efficiency of his experts as well as minimize the human-error effect.

2 Model training

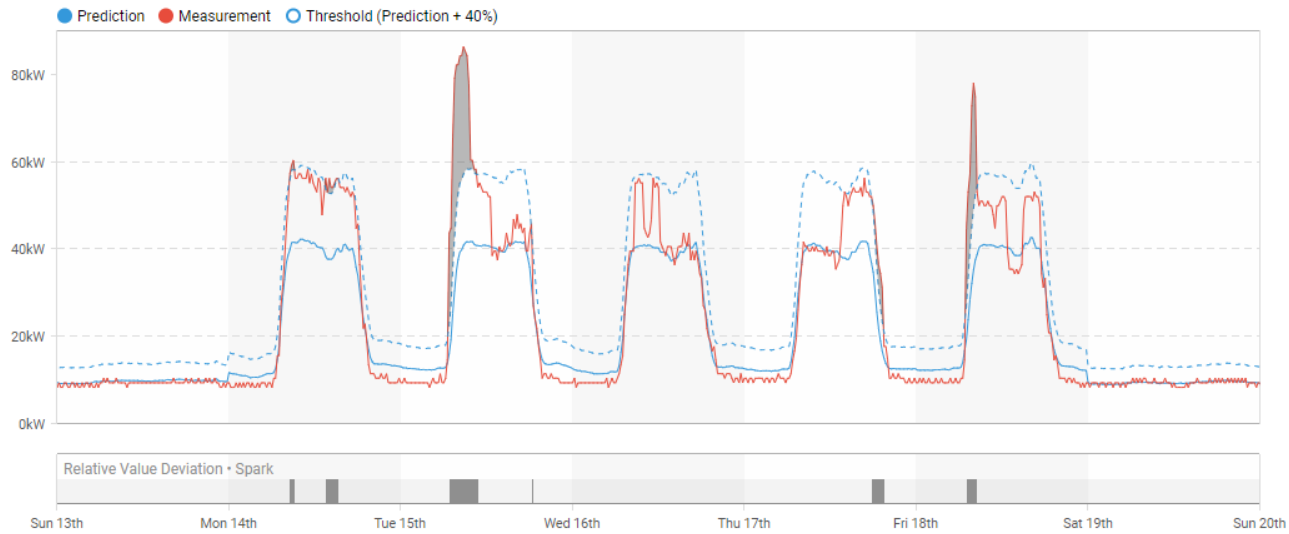
For each site meter from the client's portfolio, a model was identified using ET. The models were based on at least one year worth of data with a 15 min sampling period. The resulting good fit of the data can be seen in the image below.



Website
et.mervis.info

3 Sparks definition

ET has many available sparks; in this case, the Relative Value Deviation spark is ideal. The threshold is defined using the relative difference from the predicted value. This spark is recommended for a portfolio with different absolute values, in other words, a portfolio including buildings of various sizes. As shown in the image below, the spark is activated when the measurement is greater than the predicted value by +40%.

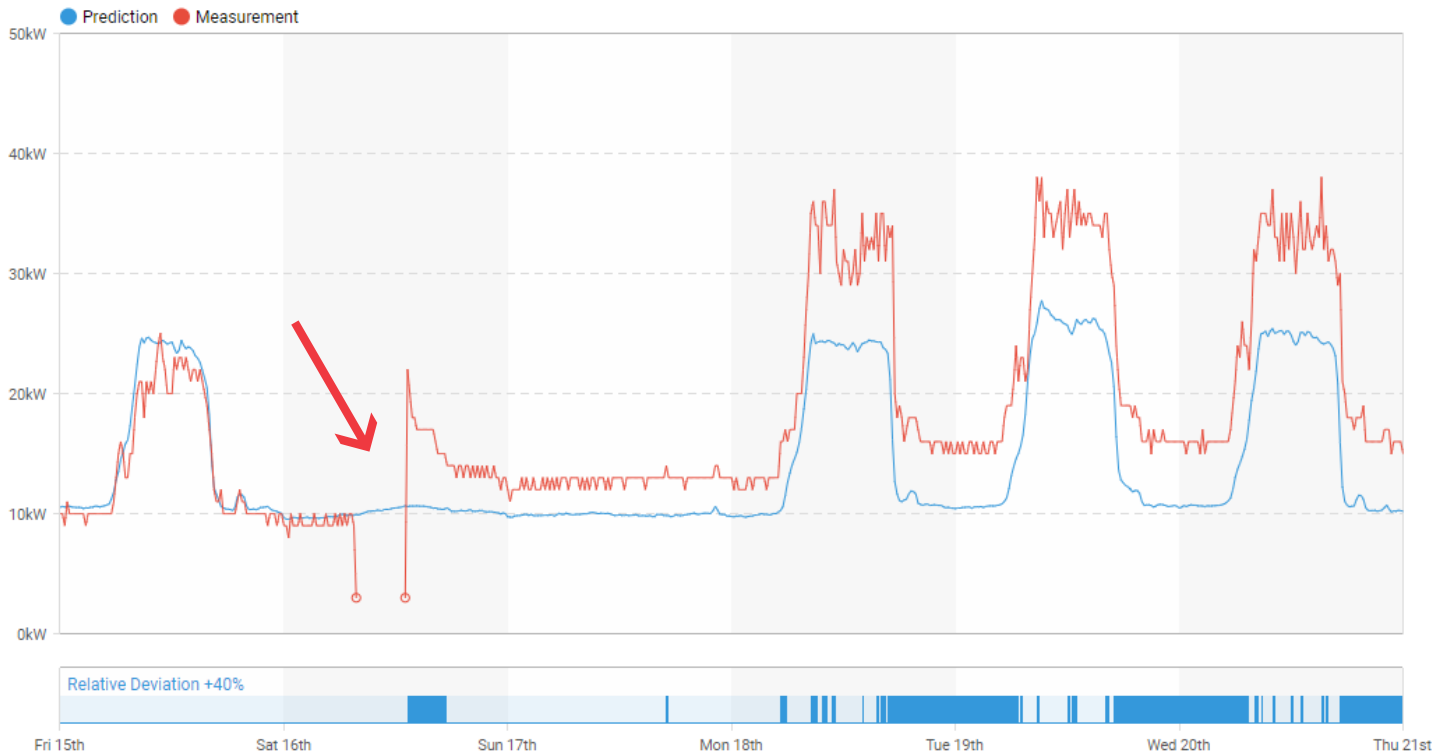


4 Sparks evaluation

Every week only 30 minutes of expert's time are needed for supervising the whole 80 buildings portfolio on average. ET can prioritize buildings by estimated wasted energy. As you can see from the results below, Site 2 is identified as a problematic building worth investigating.

Site	Rule	Duration	Cost	Sat 16th	Mon 18th	Wed 20th	Fri 22nd	Sun 24th	Tue 26th	Equips
Site 2	Relative Deviation +40%	7.29day	1,091kW							Equip 2
Site 9	Relative Deviation +40%	2.18day	412kW							Equip 2
Site 14	Relative Deviation +40%	1.73day	315kW							Equip 1
Site 7	Relative Deviation +40%	18.25hr	303kW							Equip 2
Site 18	Relative Deviation +40%	14.75hr	194kW							Equip 1
Site 5	Relative Deviation +40%	15.75hr	178kW							Equip 1
Site 11	Relative Deviation +40%	4.5hr	78.48kW							Equip 2
Site 12	Relative Deviation +40%	9.5hr	72.66kW							Equip 1
Site 19	Relative Deviation +40%	4hr	31.24kW							Equip 2
Site 15	Relative Deviation +40%	1hr	28.37kW							Equip 1
Site 4	Relative Deviation +40%	1hr	15.35kW							Equip 2
Site 10	Relative Deviation +40%	1hr	4.306kW							Equip 2

According to the detailed chart, we can see an abnormal change in energy consumption at the end of the week.



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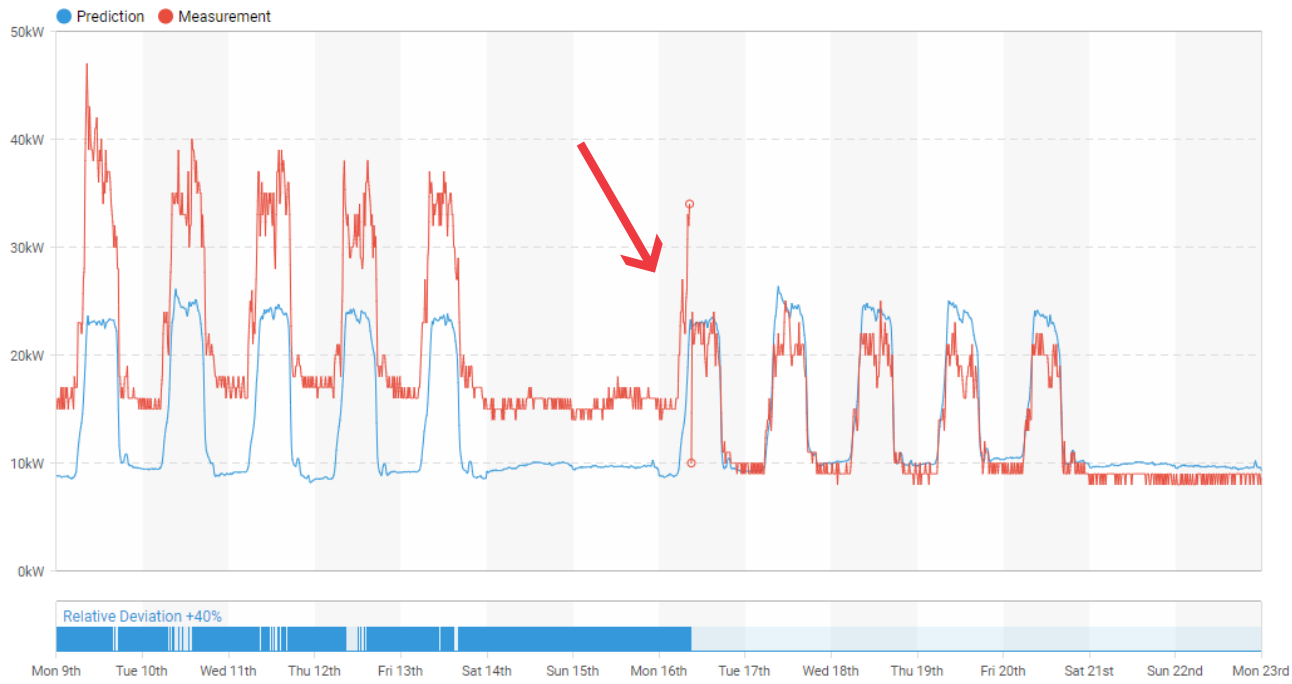
5 Local Investigation

Based on ET analysis, Site2 was identified as a problematic building worth investigating. The local investigation concluded that a technician was changing meter current transformers and misplaced them for a transformer with a different multiplication factor.

6 Fixing the problem

After finding the source of the abnormal energy consumption and fixing it, one can see that the model fits the measurement, and there is no active spark in the image below. As a result, daily energy consumption was lowered by 160 kWh, which is 58 MWh per year, ensuing in financial savings. The critical question is, how long could this problem stay undetected in such an extensive building portfolio? It would probably be until the next yearly billing period or, in the worst case, until the meter was due to routine replacement.



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7 Conclusion

With such a large portfolio, something happens every week. Other anomalies within this project were revealed, such as non-stop operation of air doors due to manual regime override or non-stop operating of local electrical heaters.

However, the primary purpose of this case study is not the wrong transformers or other anomalies; it is to show the advantages of the systematic and scalable approach to continuous energy consumption analysis. Using ET on your portfolio will allow you to identify all significant anomalies in your data with minimal effort.

Benefits

With ET you will be able to

- provide better outputs with less effort
- maintaining high-standard services regardless of portfolio size
- focus on the most severe anomalies

Technical specification

- various types of anomaly detection algorithms (absolute value change, relative value change, standard deviation based change, daily prediction and measurement difference integral change)
- open API - implement your own detection using ET predictions

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