CUSTOMER CASE STUDY

Optimizing Power Generation Efficiency with ML-Driven Consumption Forecasting

Predictive machine learning grounded in thermodynamics for proactive industrial efficiency

Solution: Thermodynamic ML Models **Industry:** Power Generation **Use Case Focus:** Consumption Forecasting

GOALS

- Forecast power consumption using thermodynamic ML models.
- Enable real-time, proactive efficiency optimization across units.
- Industrial power generation facilities operate highly complex thermodynamic systems where
- Plant operators frequently struggle with fragmented data scattered across CO2

CHALLENGES

- Sensor data across compressors and turbines is fragmented.
- Off-the-shelf ML models fail to capture thermodynamics.
- Traditional data infrastructures store this information in inconsistent formats
- Furthermore, standard off-the-shelf machine learning algorithms fall short because they

SOLUTIONS

- Build simulation-driven ML models grounded in thermodynamics.
- Embed predictive models into Seeq and AVEVA PI.
- To bridge the gap between pure data science and physical plant operations
- By grounding advanced machine learning models in both thermodynamic physics and

RESULTS

- Enabled accurate power forecasts for proactive system adjustments.
- Designed custom unit models reflecting real-world operating behavior.
- Provided immediate visibility into efficiency metrics and KPIs.
- These custom predictive models are then seamlessly integrated into established industrial

EXECUTIVE SUMMARY

Power generation facilities often struggle to optimize operational efficiency due to fragmented sensor data, generic machine learning models, and delayed insights. This initiative implements thermodynamic-driven machine learning models integrated directly with industrial platforms like Seeq and AVEVA PI. By forecasting power consumption in real-time, the solution enables operators to make proactive, data-driven adjustments to optimize efficiency across critical units like compressors and turbines. This approach bridges physical physics with data science to maximize reliability.

Overcoming Industrial Data and Modeling Hurdles

Industrial power generation facilities operate highly complex thermodynamic systems where minor inefficiencies translate into significant operational costs. Plant operators frequently struggle with fragmented data scattered across CO2 compressors, gas turbines, and other critical generation units. Traditional data infrastructures store this information in inconsistent formats, making unified analysis extremely difficult. Furthermore, standard off-the-shelf machine learning algorithms fall short because they fail to account for the core thermodynamic principles that govern real-world power cycles, leading to inaccurate predictions and delayed, reactive decision-making in the control room.

Thermodynamic Machine Learning Integration

To bridge the gap between pure data science and physical plant operations, this solution leverages template-driven contextualization. By grounding advanced machine learning models in both thermodynamic physics and historical time-series data, the system models the precise physical behaviors of individual generation assets. These custom predictive models are then seamlessly integrated into established industrial software platforms, specifically Seeq and AVEVA PI. This direct integration ensures that high-fidelity predictions are delivered directly into the operators' existing monitoring workflows without requiring disruptive software transitions.

Transitioning to Proactive Power Management

The deployment of thermodynamic forecasting successfully transforms power plant operations from reactive troubleshooting to proactive optimization. Operators now gain continuous, real-time predictions of power consumption alongside live efficiency KPIs. This immediate visibility allows engineering teams to make early, data-driven adjustments to maintain peak system performance, reduce emissions, and eliminate costly energy waste. Ultimately, tailoring each model to its specific physical asset ensures high prediction reliability and sustained operational excellence across the entire power generation lifecycle.