PROBLEM

A large hydroelectric utility suffered an unplanned outage with an estimated $1.5M impact.

PROJECT

Use sparse failure data to evaluate how effectively machine learning can predict infrequent failures.

RESULTS

Avathon Industrial AI platform identified the large-scale outage with one month of advanced warning.

Hydroelectric power is a unique resource in that it is both sustainable and highly efficient at converting natural, kinetic energy into electricity. Modern hydro turbines are massive assets, producing hundreds of megawatts of power with efficiencies of up to 90%. Because of this high efficiency and the scale of the assets, any scheduled or unscheduled downtime translates into significant opportunity costs that can exceed $50,000 per day. In the worst-case scenarios, catastrophic failure can cause a turbine to be out of service for months, with expensive repair costs and potential disruption to the energy grid.

Utility companies that operate these hydro turbines have a vested interest in performing regular maintenance to prevent unexpected failures. Most maintenance occurs on a scheduled basis where the asset is taken offline, inspected, and repaired proactively if needed. Hydro turbine units are highly reliable, meaning that few examples of unplanned downtime exist. However, these failures, when they do occur, are very costly to their operators.

Given the sensitivity operators have to unplanned downtime, many have equipped turbines and generators with sensors and platforms to collect valuable performance information in real time. However, because there are so few historical hydro failures to compare against, rich streaming data and legacy statistics-based analyses aren't very accurate at predicting true failure events. In fact, they often create more problems by overloading monitoring teams with benign false positives that result in unnecessary downtime to evaluate. This begs the question: Can artificial intelligence help maintenance teams extract more value from this type of data?
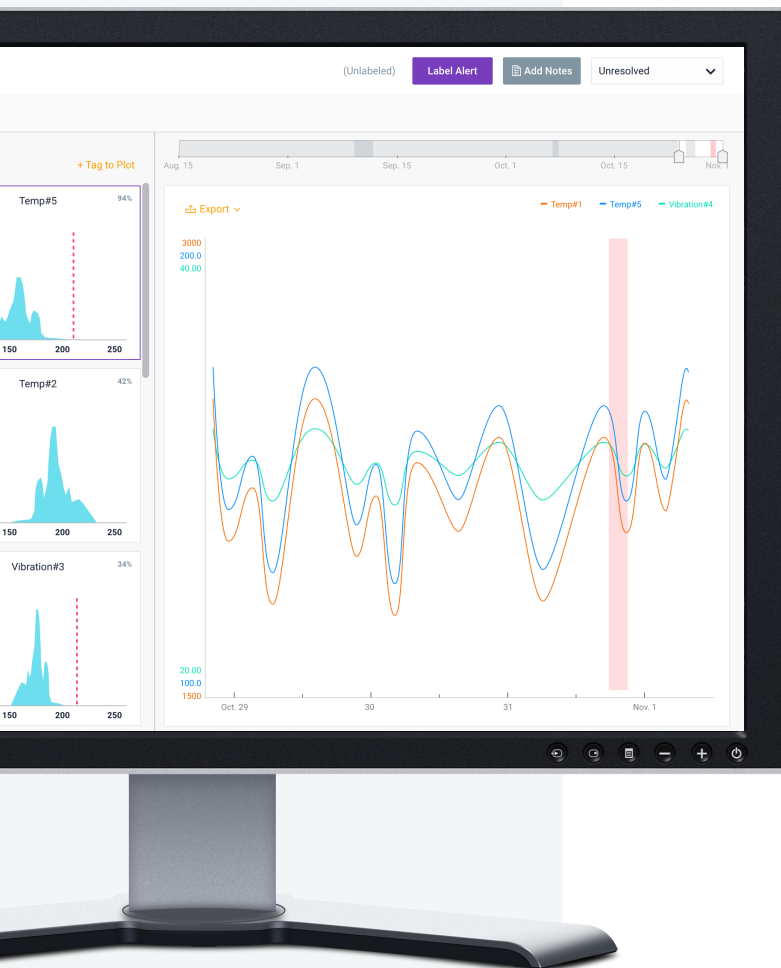

THE EVALUATION

Not being satisfied with this frustrating and error-filled approach, a leading hydropower utility recently evaluated how they could apply machine learning to analyze problematic turbine behavior better. They were burdened by false positives in their existing analytical platform and had recently had a large impact failure in one of their generators, which caused a month-long shutdown. Despite the measurements they were collecting and the number of alerts triggered by traditional physics-based models, the utility did not foresee any indicators of this major disruption. In search of an innovative solution to these problems, their business planning lead engaged with Avathon to determine how its Industrial AI platform could provide better predictive analytics that would enable them to protect against rare, expensive failures and reduce the time and cost they spent performing maintenance. They chose Avathon because while they were confident about having usable data, they needed more in-house data science expertise to put it to use.
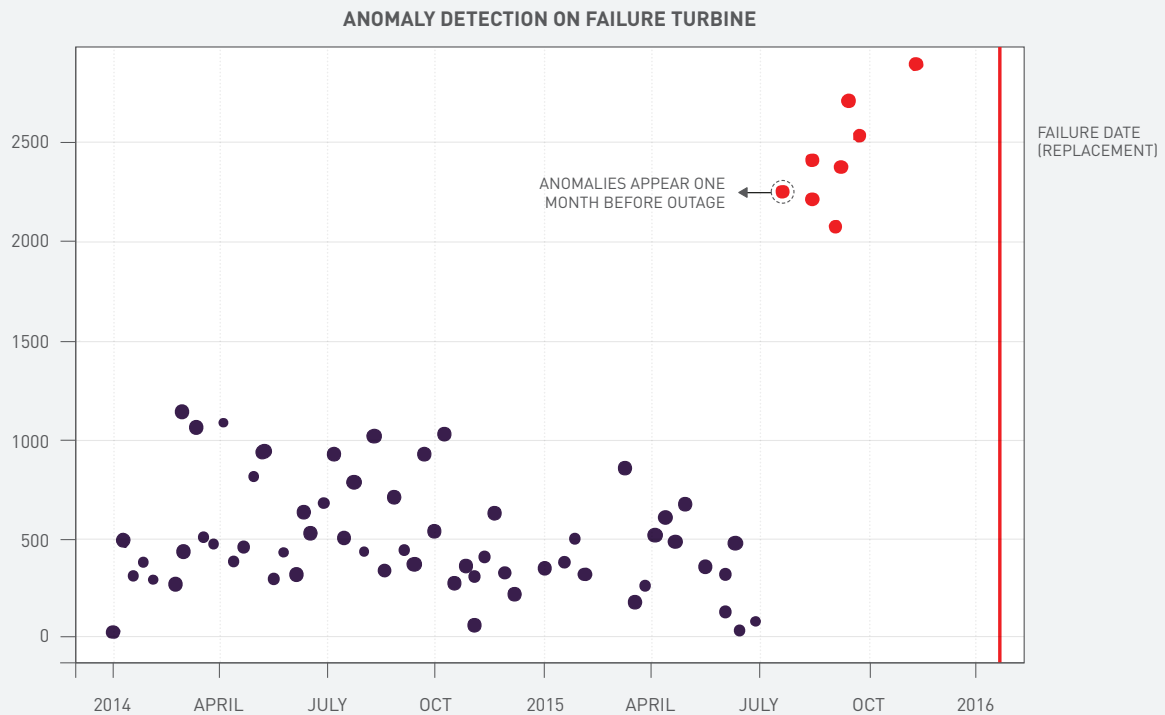
THE PROJECT

For the initial engagement, the hydroelectric utility decided to evaluate the Industrial AI platform's performance in two key areas and compare the results against their existing, statistics-based solution:

- Could the Industrial AI platform detect changes to the generator before known events that occurred in one of their turbines?

- What additional insights could the Industrial AI platform provide to the engineering teams to help them improve maintenance?

Avathon was given two years of data for one turbine, which had experienced several failure events during that time.

ANOMALY DETECTION ON FAILURE TURBINE

FAILURE DATE
(REPLACEMENT)

ANOMALIES APPEAR ONE
MONTH BEFORE OUTAGE

THE RESULTS

From the given collection of sensors, the Industrial AI platform identified 40 tags that measured important variables such as generator speed, power output, temperature readings, oil level, vibrations, and shaft gap measurements.

Within six weeks of receiving the data, data scientists used Avathon's Industrial AI platform to build, train, and tune an unsupervised machine learning model. Unsupervised learning is especially powerful when predicting rare failures since there is little failure information, and none of it is consistently documented. Instead of comparing to previously known indicators, this type of model adapts to the unique behavior of the asset. By flagging anomalous behavior, the Industrial AI platform can identify indicators for unknown failures. Using this approach, the Industrial AI platform accurately identified the turbine failure events within the data set with over one month of advance warning, successfully fulfilling the first project criteria. Additionally, the Industrial AI platform exposed key leading indicators for the events with explainable AI. In particular, the utility wanted to see how multiple sensors related to one another and how small, subtle deviations from historical measurements contributed to incipient failure modes. The Industrial AI platform identified nine sensors whose values had changed. Some, including oil levels, changed as much as 40% from historical levels, while others moved up or down slightly from their historical averages.

The results of this insight are twofold. First, engineers have a deeper understanding of how the asset is performing, allowing for a more robust root cause analysis. Second, Avathon's Industrial AI platform can train on harmful states, such as the incipient failure modes observed in this example, to recognize patterns in future operations, allowing for quick and proactive remediation of problems before they become highly disruptive. This level of insight matched what the utility sought to improve maintenance processes.

Based on these results—which exceeded the set goals for the project—the company moved forward to plan a pilot program for four additional turbines to understand deploying the solution at scale.

ABOUT AVATHON

Avathon, a leader in Industrial AI, extends the life of critical infrastructure while advancing the journey toward full autonomy. Avathon's Industrial AI platform empowers commercial and government customers with scalable, secure, and value-driven solutions that enhance efficiency and resilience across heavy industry.

To learn more about how Avathon's AI solutions can unlock the power in your data, visit www.avathon.com.

Contact Avathon today at info@avathon.com