sparkcognition™

Case Study

PREDICTING RARE FAILURES IN HYDRO TURBINES

PROBLEM

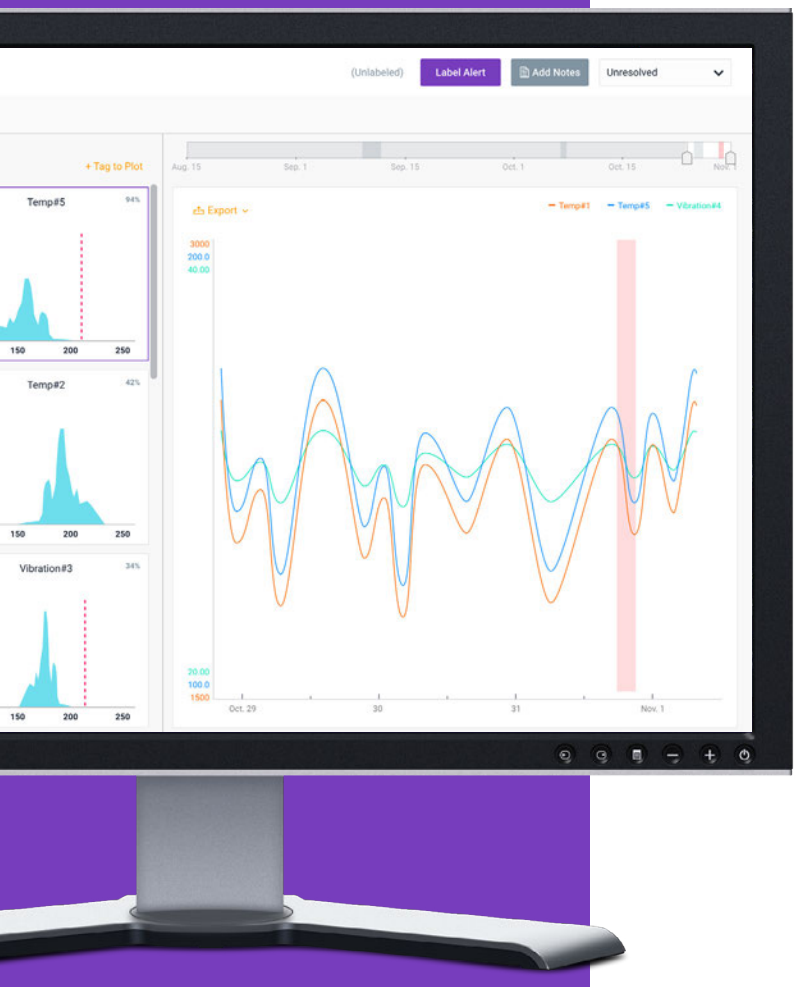
Hydro utility had an unplanned outage with an estimated **$1.5M impact**

PROJECT

Use **sparse failure data** to evaluate how machine learning can predict uncommon failures

RESULTS

The SparkPredict® product identified the large scale outage with one month advanced warning



Hydropower 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 be upwards of $50,000 per day. And 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 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. But because there are so few historical hydro failures to compare against, rich streaming data and legacy statistics-based analyses are not 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 out of their data?

THE EVALUATION

Not being satisfied with this frustrating and error-filled approach, a leading hydropower utility company recently evaluated how they could apply machine learning to better analyze problematic turbine behavior. They were burdened by false positives in their existing analytical platform and recently had a large impact failure in one of their generators which caused a month-long shutdown. Despite the amount of measurements they were collecting and 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 SparkCognition to determine how the SparkPredict product 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 SparkCognition because while they were confident they had usable data, they did not have the in-house data science expertise to put it to use.

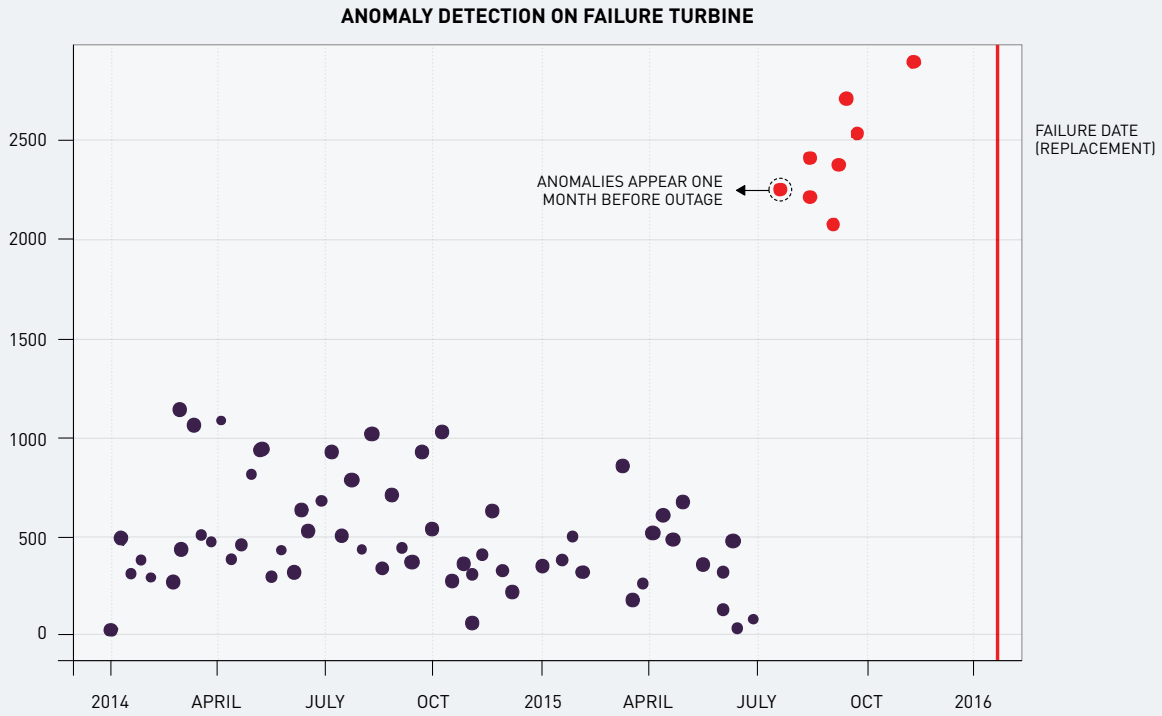
THE PROJECT

For the engagement, the hydro power utility company wanted to evaluate the SparkPredict product's performance in two key areas and compare the results to their existing, statistics-based solution:

- Could the SparkPredict product detect changes to the generator prior to known events that occurred in one of their turbines?
- What additional insights could the SparkPredict product provide to the engineering teams to help them improve maintenance?

SparkCognition was provided with two years of data for one turbine which had experienced several failure events between 2015-2016.

Contact SparkCognition today at info@sparkcognition.com



THE RESULTS

From the given collection of sensors, the SparkPredict product's data scientists identified 40 important tags which 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, the SparkPredict product's data scientists researched, trained, and built 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 SparkPredict product can identify indicators for unknown failures. Using this approach, the SparkPredict product accurately identified the turbine failure events within the data set with over one month advance warning, successfully fulfilling the first project criteria. Additionally, the SparkPredict product 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 SparkPredict product elevated 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 past distribution means.

The result of this insight is twofold. First, engineers have a deeper understanding of how the asset is performing, allowing for more robust root cause analysis. Second, the SparkPredict product is able to train on harmful states, such as the incipient failure modes observed in this example, in order to recognize patterns in future operation, allowing for quick and proactive remediation of problems before they become highly disruptive. This level of insight was exactly what the utility company was looking for to improve their maintenance processes.

Based on these results which exceeded the set goals for the project, this utility company is now evaluating the SparkPredict product in a pilot program for four additional turbines in order to understand how the solution can be deployed at scale.

ABOUT SPARKCOGNITION

We catalyze sustainable growth for our clients throughout the world with proven artificial intelligence (AI) systems, award-winning machine learning technology, and a multinational team of AI thought leaders. Our clients partner with SparkCognition to understand their industry's most pressing challenges, analyze complex data, empower decision-making, and transform human and industrial productivity. To learn more about how SparkCognition's AI applications can unlock