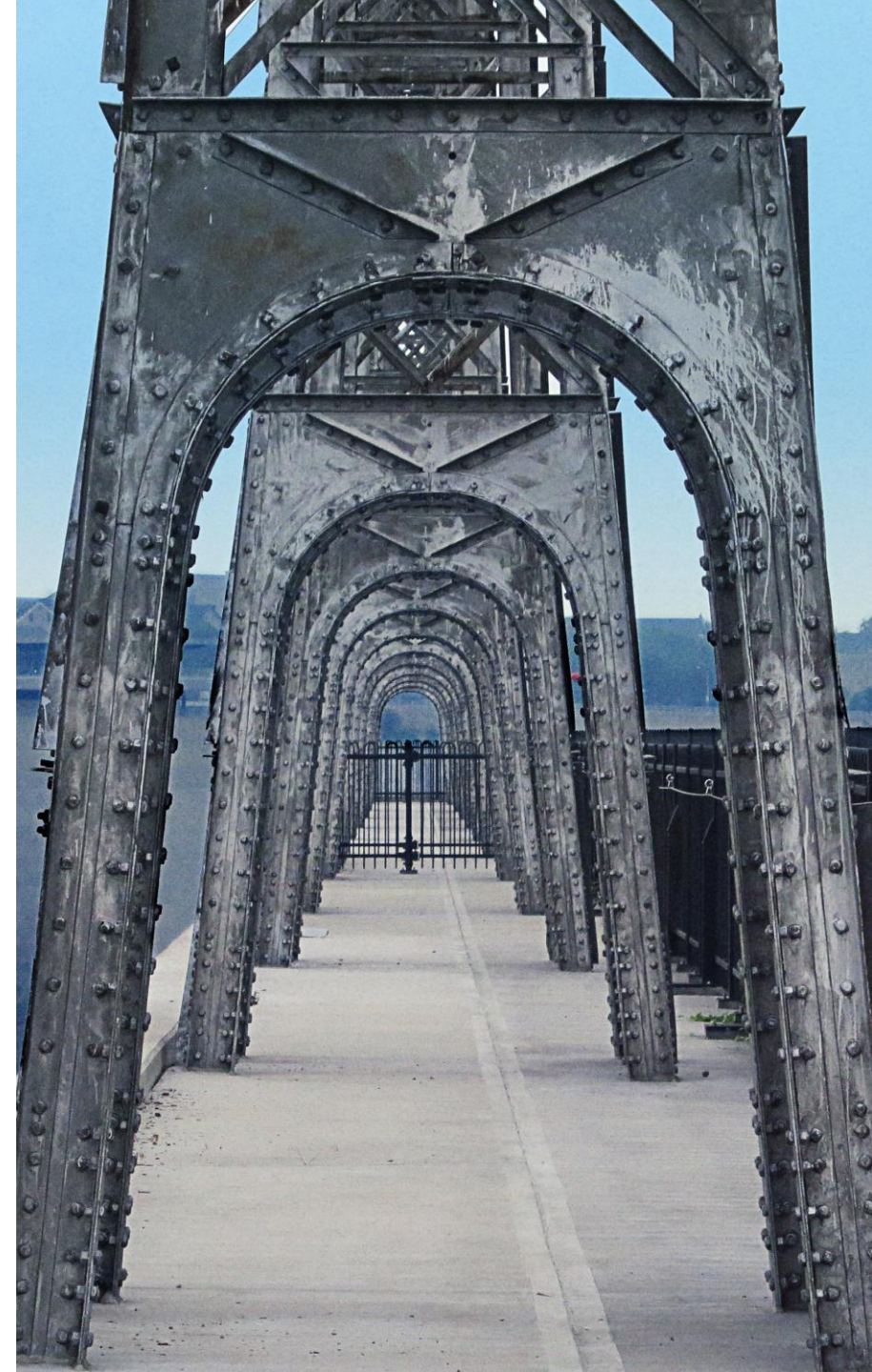




Analytics & Anomaly Detection at Ontario Power Generation

Agenda

- 1 | Introduction & Generation Overview
- 2 | Monitoring & Diagnostic Centre
- 3 | Case Studies
- 4 | Future Vision
- 5 | Key Takeaways
- 6 | Q & A



Powering Ontario

18,910

Megawatts

In-service generating capacity
(Mar. 31, 2021)

75

Stations

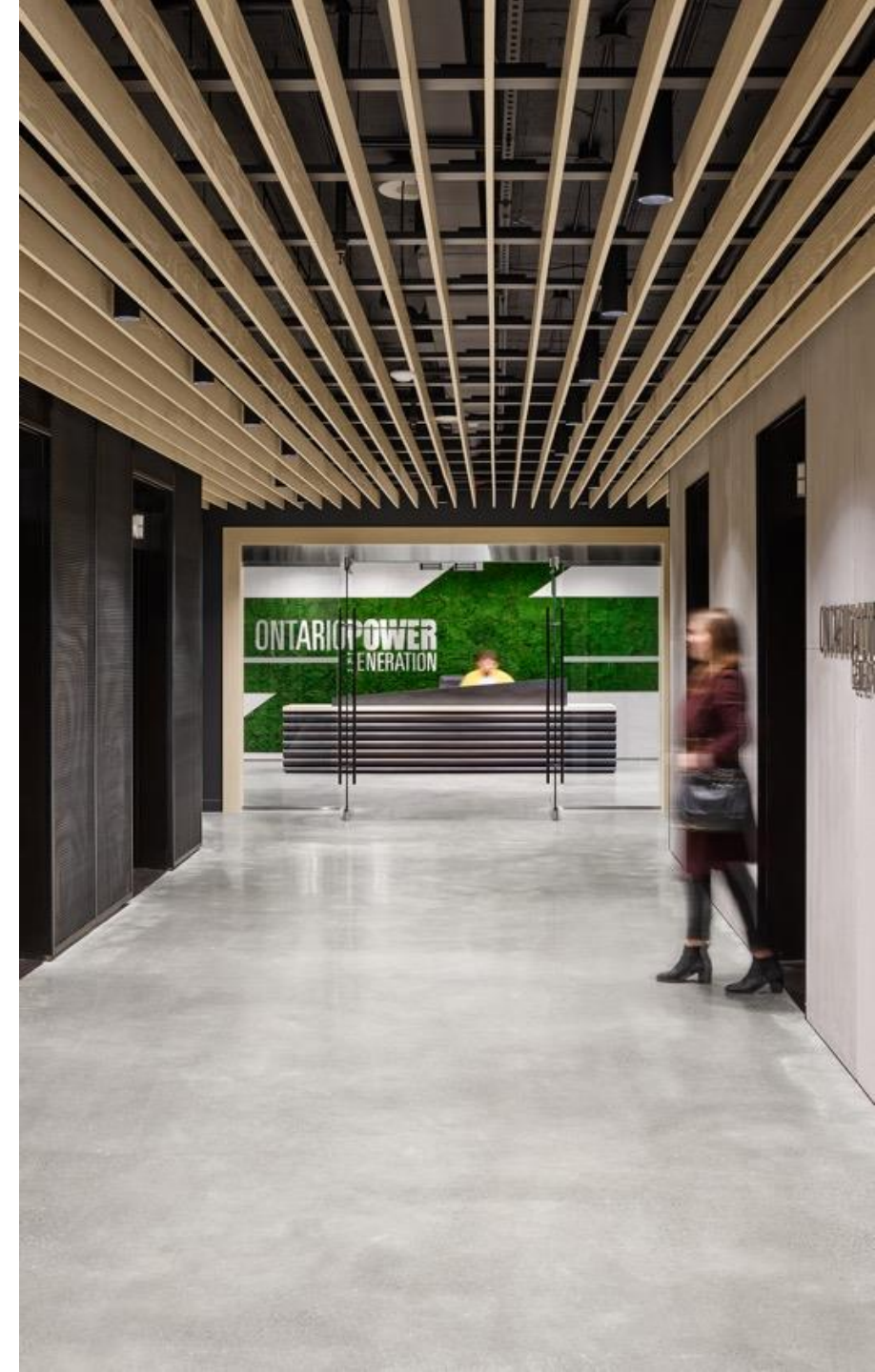
in Ontario

Monitoring Portfolio:

- 66 Hydroelectric stations in Ontario
- 2 nuclear stations
- 1 biomass station
- 1 dual-fueled oil and gas station

Other Generation:

- 4 natural gas-fueled stations
- 1 solar facility
- 86 Hydroelectric stations in US



Monitoring & Diagnostic Centre

Our Mission

Our mission is to get more information into the hands of engineering, operations and maintenance to enable data-informed decision making, prevent costly equipment failures and enable condition based maintenance.



Monitoring & Diagnostic Centre

KPIs & Results

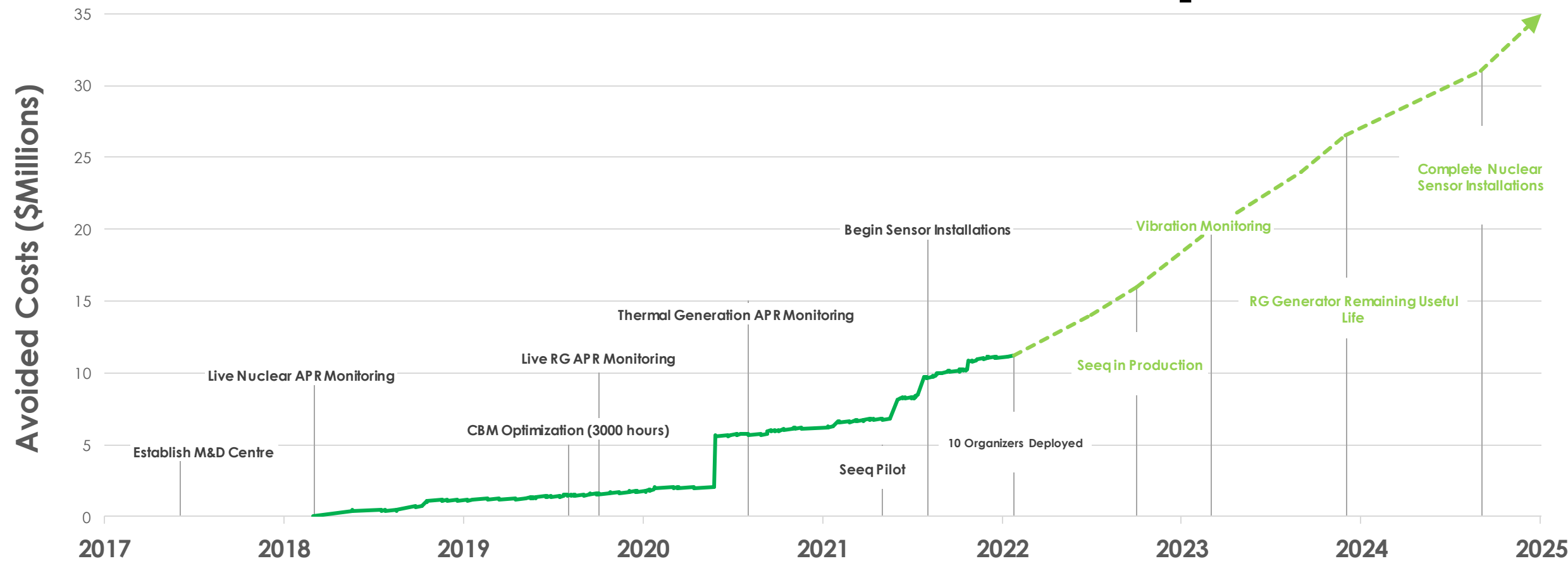
- *Key Operations Metrics:*
 - **2300** Assets modeled & monitored
 - **25,000+** Unique Parameters monitored
- *Outcomes:*
 - **\$11M** Avoided Costs
 - **\$400k+** (3100+ hours/year) CBM Benefits
 - **100+** equipment failures avoided





“Success Breeds Success”

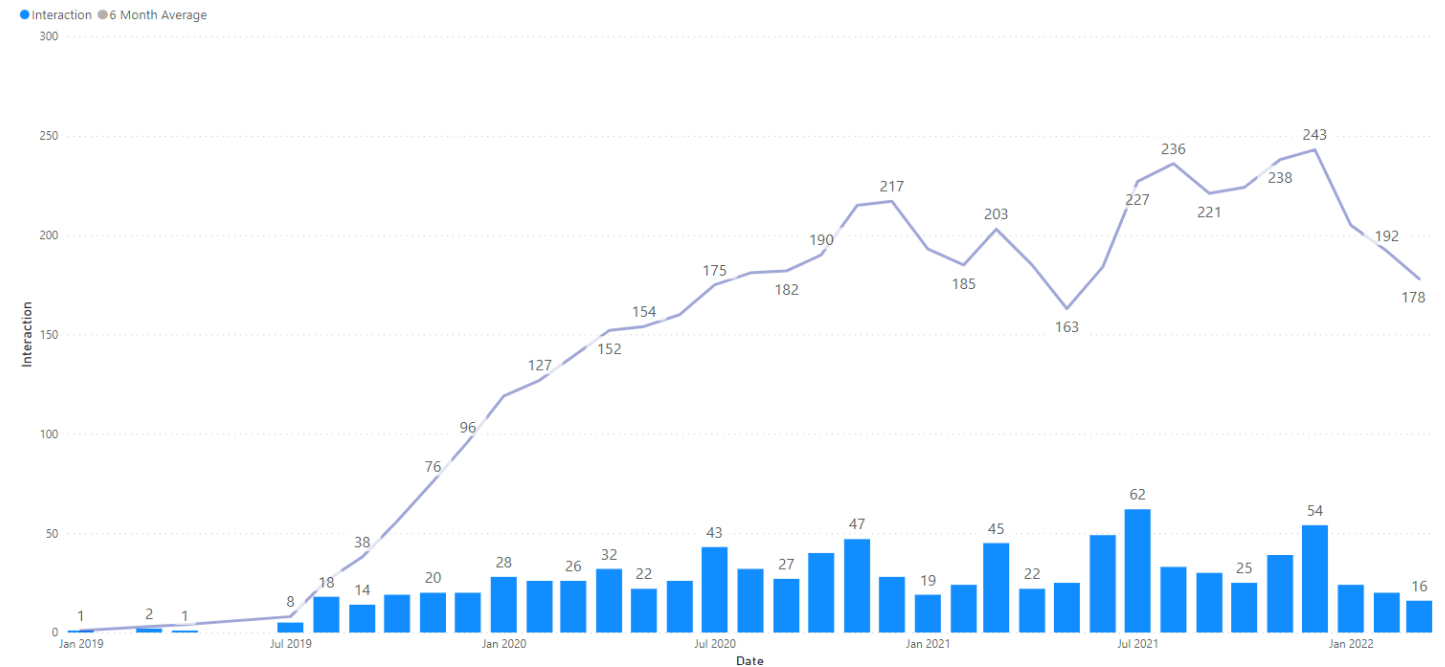
M&D Centre Results & Roadmap



Station Engagement

“Success Breeds Success”

- Success in our base monitoring program led to steady increase in new requests and ideas
- 20+ requests per month for new monitoring
- Complex use cases and difficult to execute with our existing toolset



M&D Centre station Interactions (New Requests & Notifications) by Month



Case Studies

Case Study: Leak Rate Forecasting



CHALLENGE

- Hydrogen cooling system leak may require a forced outage to repair if leak rate exceeds operational limits.
- Changes in leak rate are difficult to monitor and forecast because Operations calculate leak rate by hand using local analogue pressure gauge data.



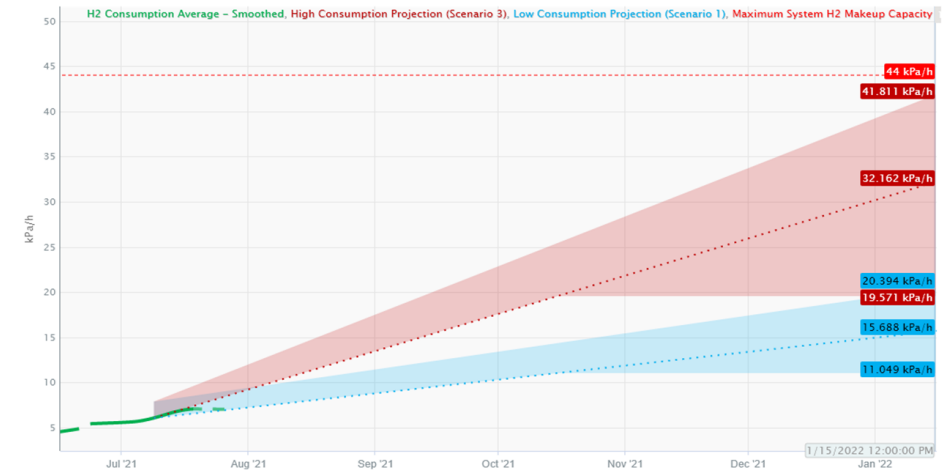
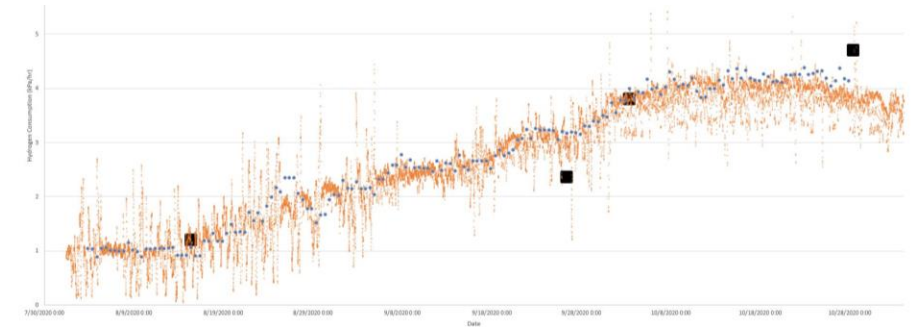
SOLUTION

- Implement continuous leak rate estimation using on-line system pressure data and publish live report
- Predict when leak rate will cross operational limits.



RESULTS

- More accurate and timely leak-rate information available to all stakeholders in near-real time.
- Forecast showed low probability of exceeding operational limits before the next planned outage, allowing the team to avoid a forced outage.



Case Study: Condition Based Maintenance



CHALLENGE

- Cooling water pump is being operated much more frequently than designed
- Increased risk to reliability and remaining useful life of motor and circuit breaker



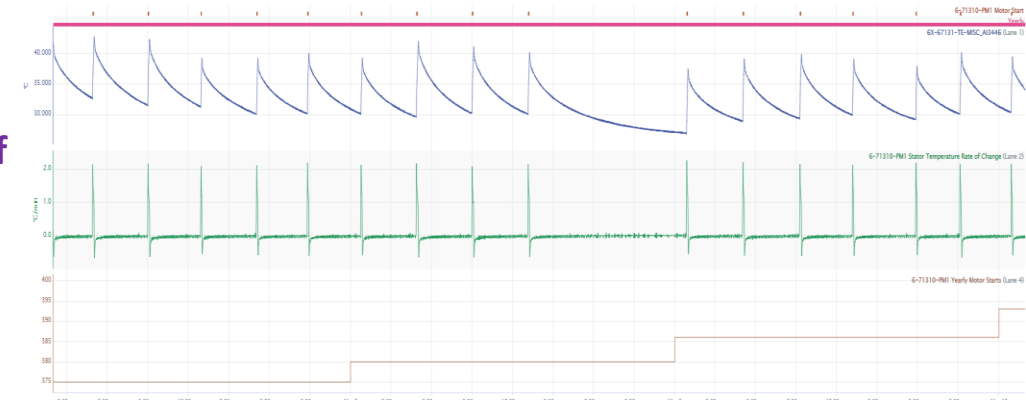
SOLUTION

- Analyze historical data to understand true condition
- Implement on-line monitoring to track motor/circuit breaker duty cycles.
- Alert engineers when cycle counts approach OEM limits.



RESULTS

- Strategy ensures circuit breaker maintenance is completed prior to reaching OEM cycle limits
- Significantly reduces risk of in-service failures



Case Study: System Simulator



CHALLENGE

- Frequent nuisance alarms on temperature monitoring system resulting in high-demand for fuel handling resources
- Increased risk to de-rating, outage critical path delays, and equipment degradation



SOLUTION

- Develop simulator of system logic with Data Lab
- Adjust system parameters in simulator and back-test with historical data to perform alarm sensitivity analysis



RESULTS

- Daily nuisance alarms reduced from 150 to ~0/day
- Analysis provided confidence that tuning system parameters will reduce alarms and mitigate risk
- Program can be used going forward to further fine-tune parameters on other units.

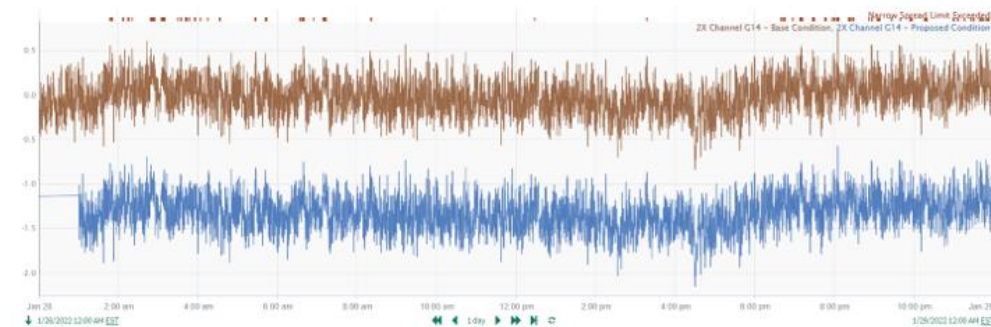


Figure 3: Seeq Output Example of a Channel's Alarm Disparity Under Base and Proposed Conditions
(Source: Seeq Workbench Analysis)



Future Vision

Monitoring Expansion

- Connection to local process and vibration data logging systems across the fleet.
- High value sensors and technology to improve monitoring coverage of key failure modes:
 - Vibration probes
 - Temperature probes
 - Battery Monitoring Systems
 - Transformer Dissolved Gas Analysis
 - Electrical Signature Analysis
 - Ultrasonic Sensors

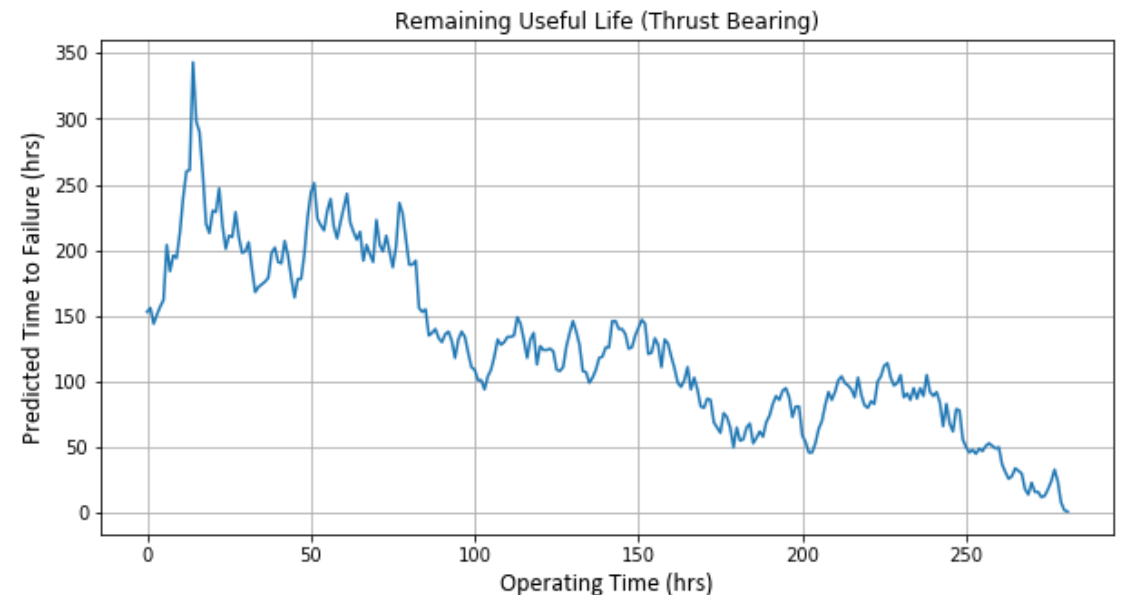


Sensor Deployments



Digital Twins & Remaining Useful Life

- Advanced modeling using machine learning and physics-based methods
- Classify failure types and probabilities
- Forecast remaining useful life
- Operationalize with Seeq Data Lab



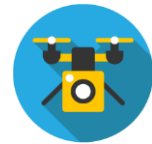
Key Takeaways



100+ prevented equipment failures resulting in **\$11M+** avoided costs



Base M&D program success led to new opportunities which required Seeq to execute



Additional sensors will provide greater failure mode coverage



Advanced analytical solutions to be operationalized in Seeq

ONTARIO
POWER
GENERATION

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tomorrow begins.**

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