



Digital Hydro Asset Performance Management from GE Renewable Energy

Enabling intelligent asset strategies to optimize performance



How can you make your Hydro Power Plant operation safer and more reliable while helping to ensure optimal performance at a lower sustainable cost?

You need to predict and prevent failures in a timely manner. But to do that, you need to better manage your data across the enterprise.

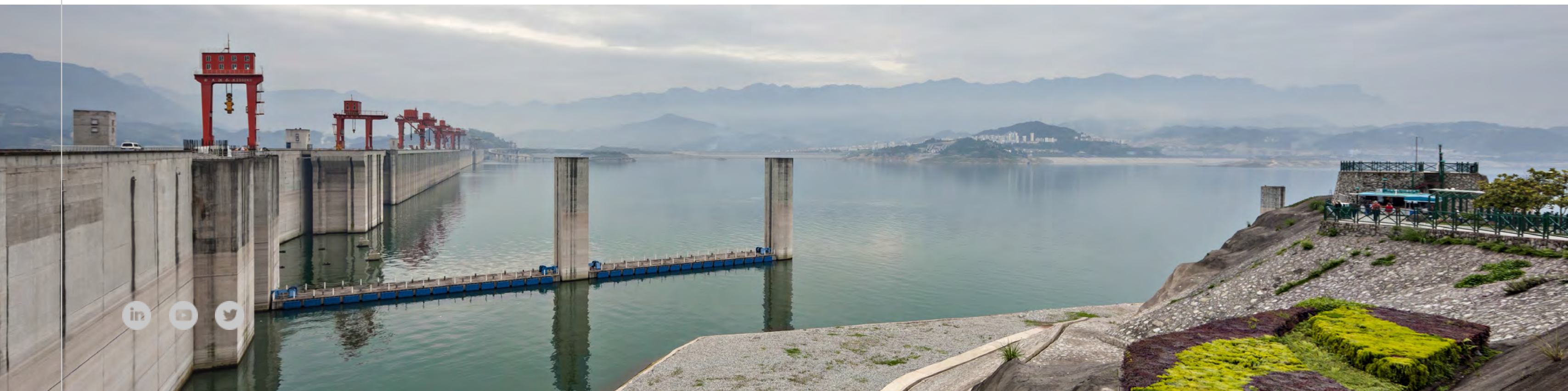
You've invested in assets, processes, and systems on a massive scale to meet your business objectives while managing your risk around safety, financial, and environmental events. These produce enormous amounts of data that can either keep you informed to help you make smarter decisions—or leave you vulnerable to blind spots and risk.

You need the ability to:

- Collect, analyze, and visualize the data that is crucial to your assets' health—all in one place
- Prioritize your work by determining which assets are most critical to the overall health of your operation
- Understand the true status of each asset
- Predict equipment and process issues with greater accuracy before they occur
- Assure mechanical integrity of your assets and compliance with regulations

- Learn from continuous, real-time analysis and visibility to understand the options for mitigating potential problems while balancing associated costs, risks, and benefits
- Define and manage asset strategies with a risk-based approach for improved planning and efficiency

You need an **intelligent asset strategy** for each asset—to collect and manage all your data and information to make the best decisions that help maximize overall asset and operational performance.



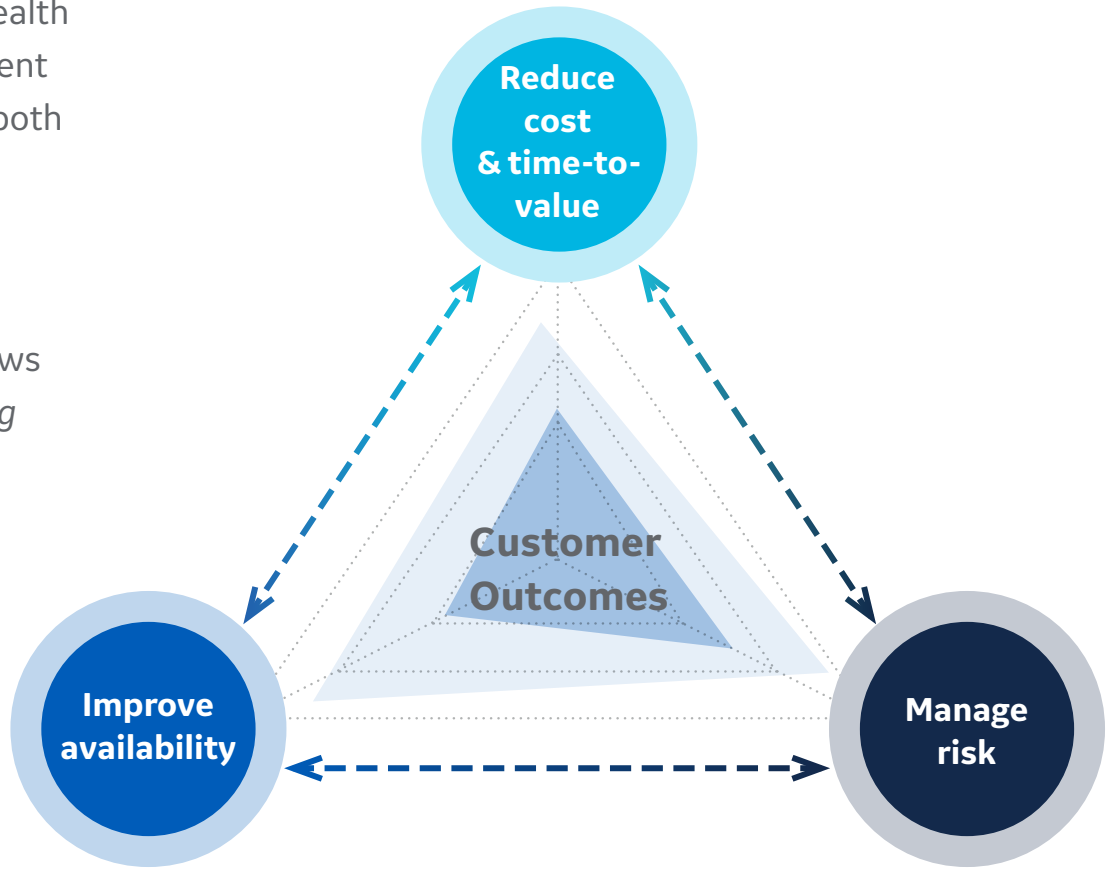
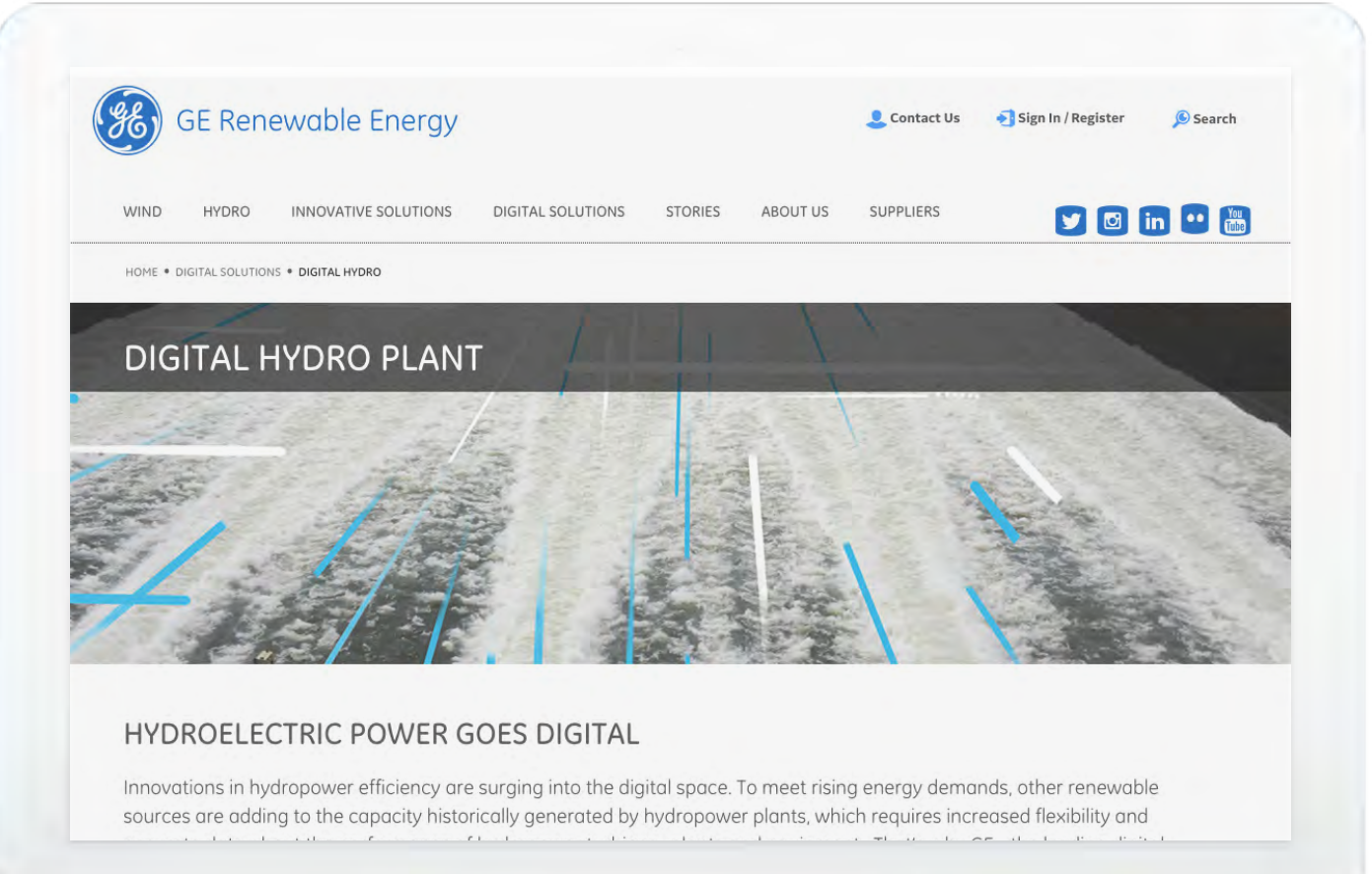
Digital Hydro Asset Performance Management from GE Renewable Energy

[Digital Hydro Asset Performance Management \(APM\)](#) from GE Renewable Energy helps asset-centric organizations drive safer and more reliable operations while facilitating optimal performance at a lower sustainable cost by enabling [intelligent asset strategies](#).

APM's holistic and risk-based intelligent asset strategies balance performance and cost by considering design, operational procedures, and maintenance plans for all assets. With APM, you get an enterprise-wide view of the impact of asset performance management activities to help you make the best decisions.

APM provides best-practice work processes for reliability engineering, maintenance analysis, and environment health and safety (EH&S), as well as the capabilities of equipment data capture, integration, and visualization, along with both predictive and diagnostic analytics.

APM includes software, services, and business-process support. Built on Predix, the operating system for the Industrial Internet, APM manages collaborative workflows between experts and operational teams while *balancing cost, availability, and risk*.



APM works across all assets (rotating, non-rotating, and process), all OEMs (GE and non-GE equipment and machinery), and all industries, across the plant and across the fleet.

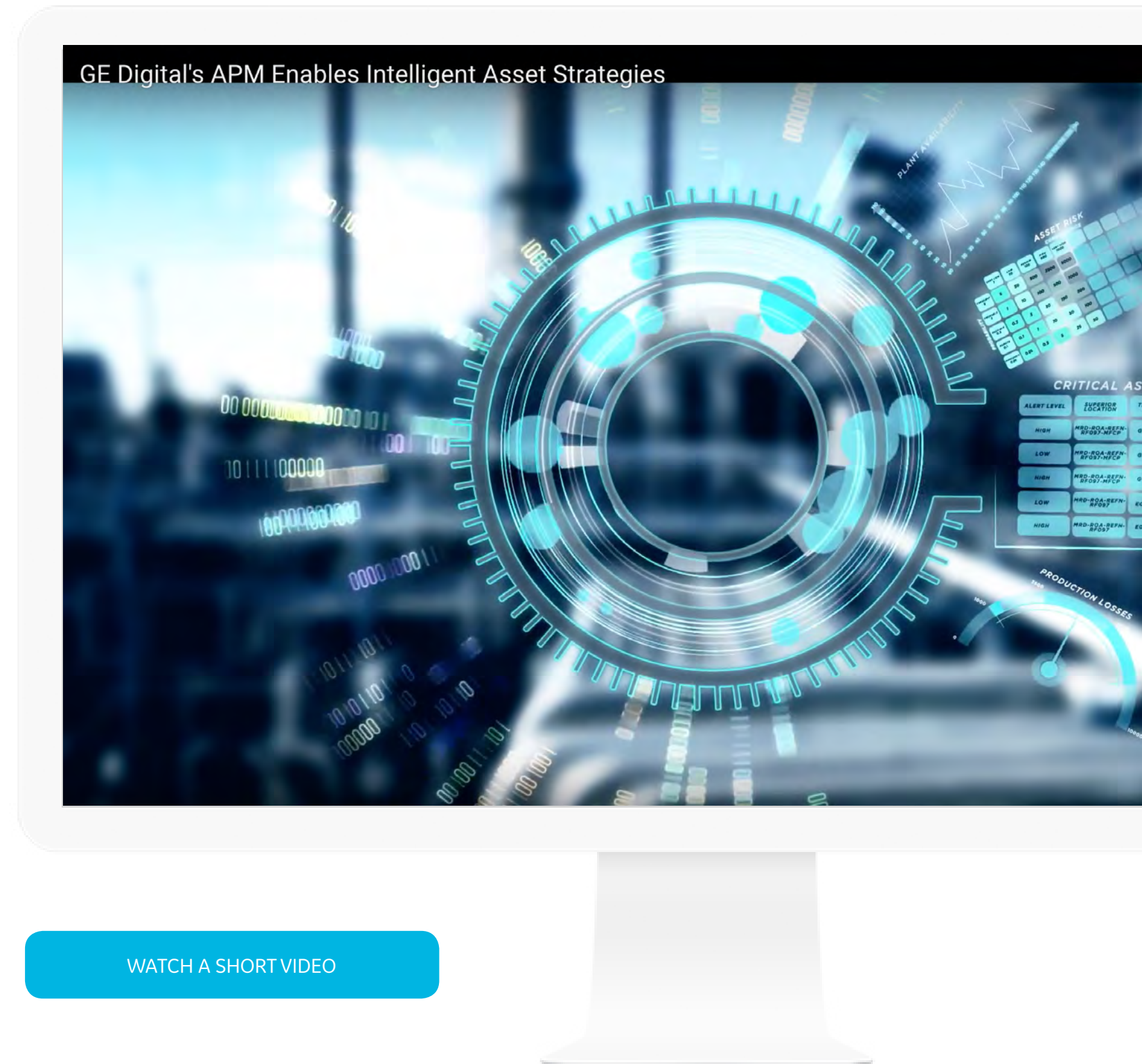
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Intelligent asset strategies for your HPP can help you answer these critical questions for all your assets

- How critical is this asset?
- What is the history of this asset, and what is its current health?
- In what ways could this asset fail, how could I mitigate failure, and what would it cost?
- What would be the consequence of this asset's failure on my business?
- What action should be taken now, and what should be our overall strategy to optimize business objectives?

Digital Hydro Asset Performance Management from GE Renewable Energy should be viewed as a continual, evolving process. Operational conditions and demands will change over time, equipment will age and be replaced, upgrades and improvements will be implemented, and pressure to reduce costs will always be present. APM enables dynamic performance management and a continuous loop of improvement.



WATCH A SHORT VIDEO



Benefits of Digital Hydro APM:

- Reduces unplanned downtime and increases availability and reliability by helping to ensure that critical assets and systems are monitored and protected from emerging threats.
- Reduces costly emergency repairs by detecting problems early, turning unplanned downtime into planned downtime.
- Reduces often unnecessary routine preventive maintenance—which also introduces risk and decreases availability—and helps you move to more efficient and proactive condition-based and risk-based maintenance.
- Reduces inventory costs by determining spare parts requirements based on failure rates, logistical constraints, and downtime and consequence costs.
- Protects the health and safety of employees and the environment by reducing asset-related incidents.
- Improves workforce productivity by prioritizing maintenance based on criticality and cost.
- Maintains technical expertise (tribal and organizational knowledge).
- Delivers continuous improvement.
- Lowers total cost of ownership delivered via a software-as-a-service (SaaS) model that provides flexibility and access to business insights where it matters—with edge, cloud, and hybrid configurations.
- Provides the ability to operationalize your own in-house analytics by using APM’s capabilities.
- Provides a standard way to connect machines, data, and people to deliver faster time-to-market; a well-designed, consistent interface for a superior user experience; dynamic scalability to meet growth needs; and extendibility to grow functionality as business needs evolve.

Potential Benefits:

3-40%

EH&S incident reduction

2-6%

Increased availability

10-40%

Reduction in reactive maintenance

5-10%

Inventory cost reduction

5-25%

Gain in employee productivity

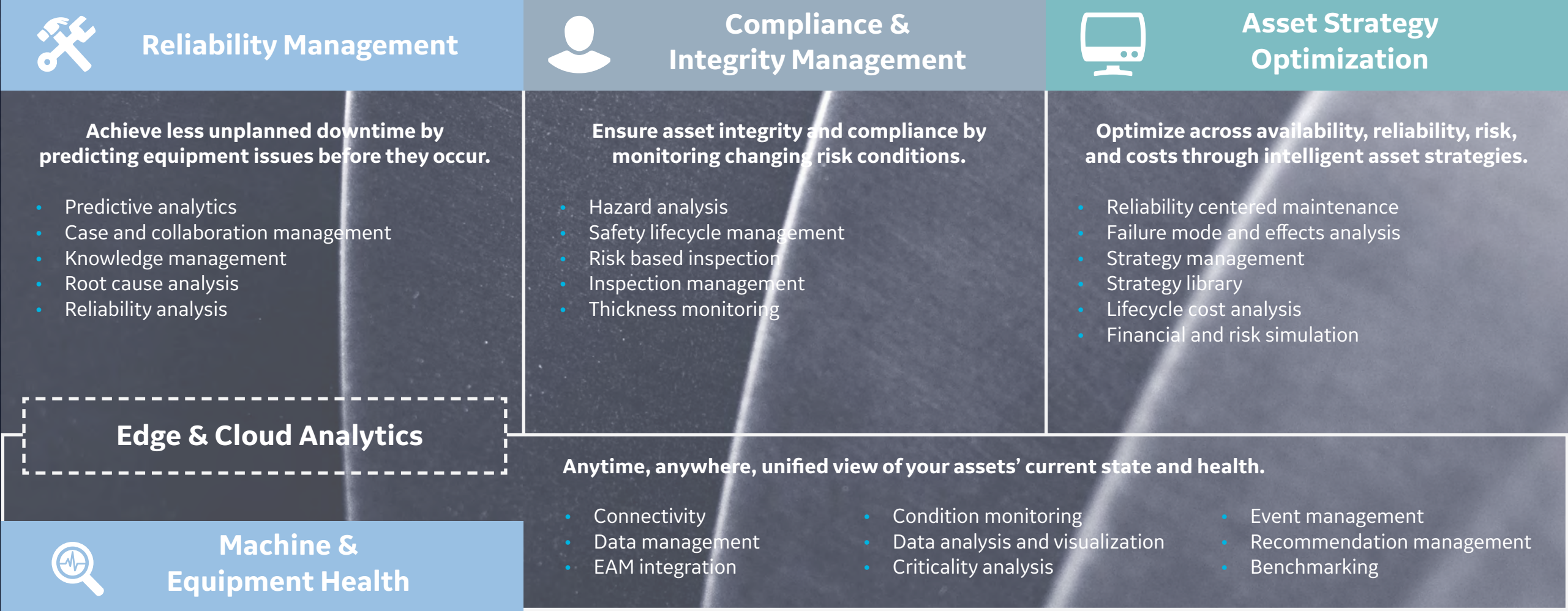
5-25%

Reduction in IT total cost of ownership



**Based on GE Digital's APM assessments across multiple industries, best practices and value drivers.*

Digital Hydro APM from GE Renewable Energy includes Machine & Equipment Health, Reliability Management, Compliance & Integrity Management, and Asset Strategy Optimization.



Machine & Equipment Health

Need visibility of real-time availability and reliability of your machines and equipment?

Machine & Equipment Health from GE helps you get a unified view of your assets' current state and health—anytime and anywhere.

Machine & Equipment Health is not only the foundation of APM, but also the common enabler across all other APM solution offerings: Reliability Management, Compliance & Integrity Management, and Asset Strategy Optimization.

Machine & Equipment Health includes:

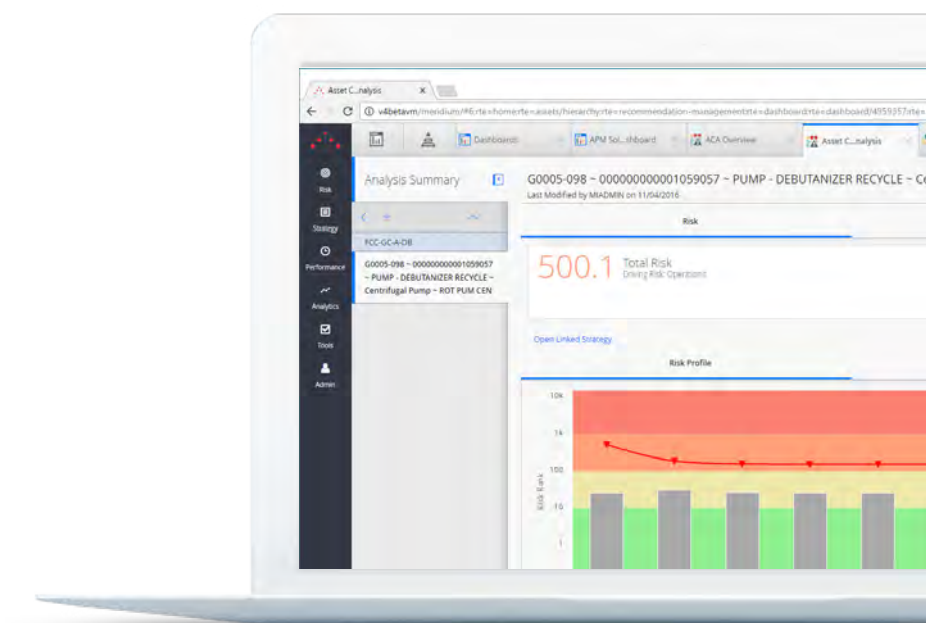
- **Connectivity**
Allows for the secure collection, intermediate storage, backhaul, and administration of time-series and enterprise data from external sources to edge/on-premises and cloud-based APM applications—one time during setup or continuously.
- **Data management**
Includes structuring and contextualizing data to the lifecycle asset model to provide a unified view of asset data and enables APM applications and analytics to consume APM data through governed and consistent APIs. Leverages artificial intelligence (AI) and machine learning to automate the ingestion, modeling, and mapping of disparate data sources into a canonical asset-oriented model.
- **EAM integration**
Gathers existing valuable information from business systems and transfers it into APM to conduct meaningful analysis that drives business decisions and helps build an intelligent asset strategy aligned with corporate objectives.

- **Condition monitoring**
Determines and reports the current health of the asset in its operating context and provides anomaly detection by calculating metrics and driving rules-based exceptions. Condition monitoring supports both continuous surveillance via data monitoring as well as discrete or periodic surveillance via rounds and calibration management.
- **Data analysis and visualization**
Provides capabilities to query and present asset data. Users can perform additional analyses by using underlying time-series data and other data types to validate a detected anomaly and determine root cause. Enables creation of dashboards by using preconfigured KPI templates and widgets.
- **Criticality analysis**
Provides a standard process for assessing and managing the criticality of systems and associated assets. It allows for the prioritization of assets based on a risk-rank method so that resources can be effectively managed and utilized on the most important assets and systems.
- **Event management**
Triggers impact assessments and investigations and provides contextual visualization of events, notifications, and automated response workflows.
- **Recommendation management**
Enables users to centrally manage all recommendations that have been derived from a variety of analyses and inspection types, including reliability analytics, reliability centered maintenance, failure mode and effects analysis, and root cause failure analysis, among others.

- **Performance benchmarking**
Asset Answers, our benchmarking solution, provides instant benchmarking of a company's physical asset performance against global industry peers as well as internally—asset-to-asset and site-to-site. The tools and KPIs empower users to clean, filter, and interpret performance data to systematically diagnose and isolate under-performing assets. Monthly data refreshes mean organizations can always compare against current market performance, ensuring both practitioners and managers have the equipment insights they need to maintain their competitive advantage.

Machine & Equipment Health delivers:

- Visibility of equipment status and issues—anytime, anywhere.
- A holistic view that brings together real-time data, alarms, events, and other operational data to get a clear picture of asset performance.
- Better decision-making through a single source of truth that crosses organizational silos.



Reliability Management

Need to identify impending failures early?

Reliability Management from GE Renewable Energy predicts equipment issues before they occur to help reduce unplanned downtime.

Reliability Management includes Machine & Equipment Health, plus:

- **Predictive analytics**

Enables the analyst to anticipate or identify failure of an asset with longer lead time to improve reliability and performance by modeling the asset's expected versus observed states. The analyst can leverage structured time-series data and unstructured data, including process parameters and condition alerts in the context of the assigned maintenance strategy and actual maintenance performed. It can also compare operating conditions and performance with other like assets.

- **Case and collaboration management**

Allows experts to record interaction and information about an issue over the lifecycle of mitigating it. Case functions include expert interpretation and collaboration around an integrated evidence set and support of a proactive recommendation and action workflow.

- **Knowledge management**

Captures experience and leverages it for future analysis—threat evidence, interpretations, and actions in context of outcomes. Cognitive analytics improve data quality and value by extracting structured data from unstructured information, such as long-text data-sets, which are often found in inspection notes fields.

- **Root cause analysis**

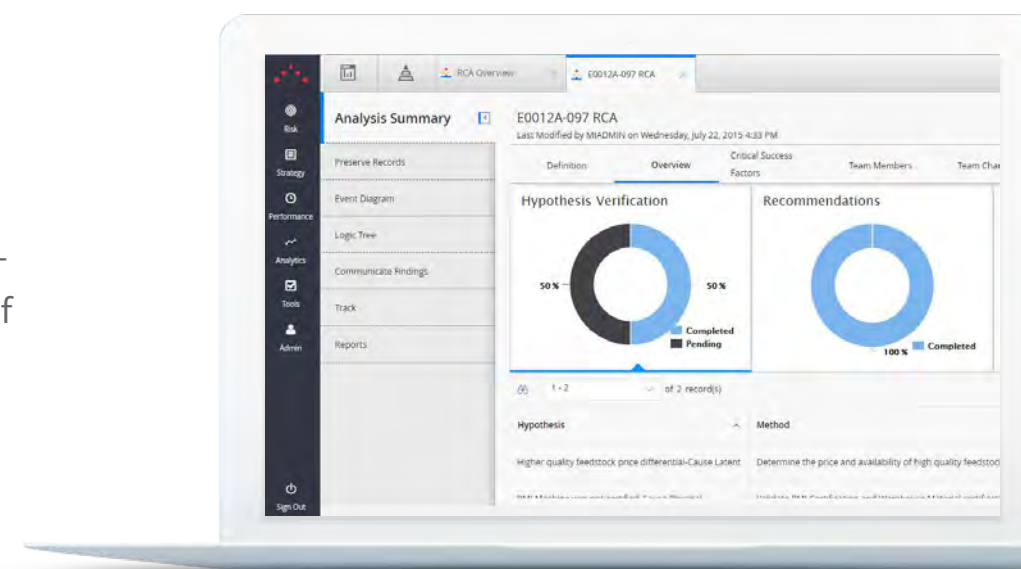
Enables better understanding and analysis of the underlying causes of failure and captures and institutionalizes that information to help prevent future occurrences.

- **Reliability analysis**

Provides a comprehensive set of analytical tools to help understand causes of asset failure patterns and the true cost of failure.

Reliability Management helps you:

- Effectively and efficiently plan maintenance to help optimize operations by detecting equipment problems early
- Collaborate on issues while automatically capturing best practices



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Compliance & Integrity Management

Need to ensure compliance with ever-expanding regulatory requirements?

Compliance & Integrity Management from GE Renewable Energy helps to ensure asset integrity and compliance by monitoring changing risk conditions.

Compliance & Integrity Management includes Machine & Equipment Health, plus:

- **Hazard analysis**

Hazard analysis is both a regulatory requirement and an integral part of an overall risk-management process, which is focused on identifying and assessing risks and managing their reduction. This methodology is based on international standards, such as the IEC 61882 Hazard and Operability Studies (HAZOP studies) Application Guide, and is fully integrated with other APM strategy lifecycle management tools.

- **Safety lifecycle management**

Addresses the need to maintain and manage the reliability and performance of critical process-instrumentation and safety-instrumented systems as well as compliance requirements. Based on international industry standards such as ISA 84/IEC 61511 and IEC 61508, this solution helps enable the management of all phases of the safety lifecycle, from design through operation and maintenance to eventual decommissioning.

- **Risk based inspection**

Improves safety, containment reliability, and environmental compliance in high-risk industrial environments by profiling fixed and linear-asset corrosion and containment threats. Also prioritizes risk-mitigation strategies based on failure probabilities and consequences. API-RP-580 certified, and the first software certified to the 3rd edition of API RP-581.

- **Inspection management**

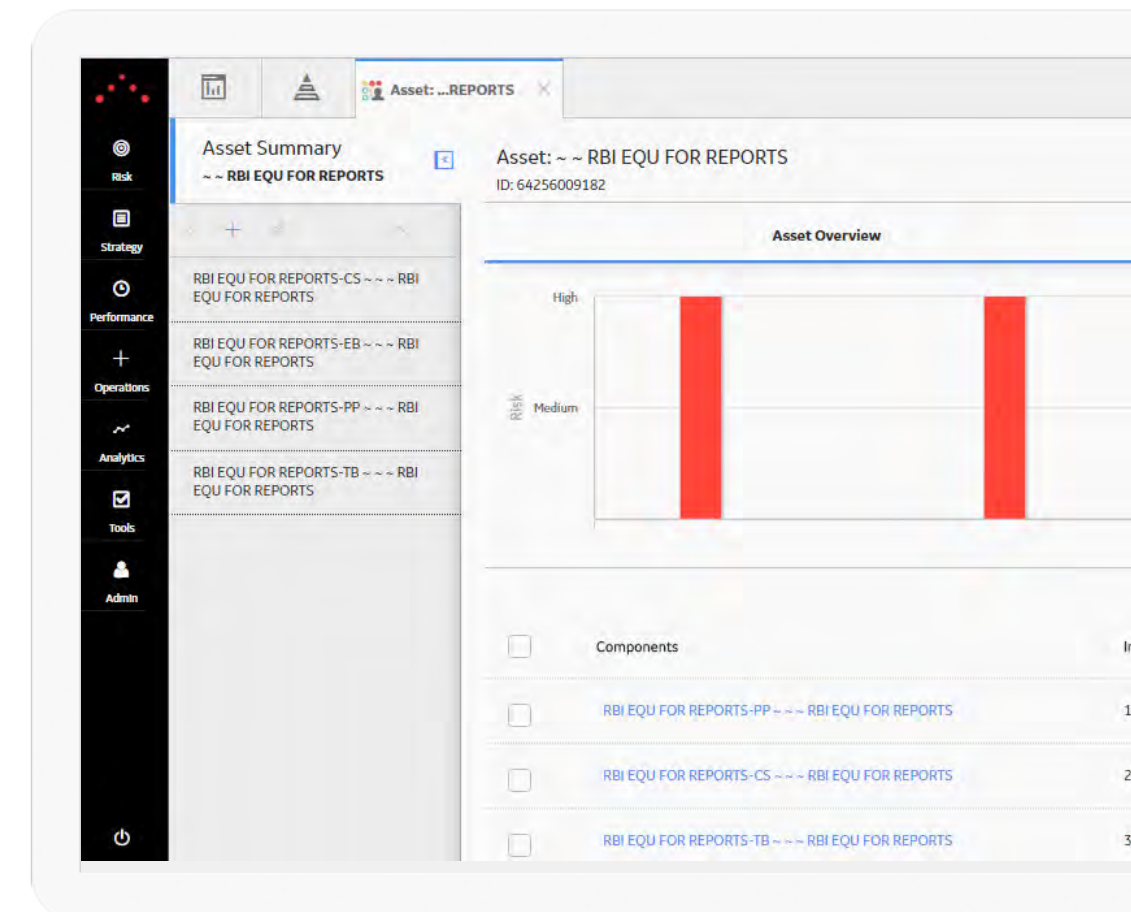
Provides the capability to drive large-scale inspection programs and ensure compliance with federal, state, and local requirements, including the API standards. Inspection management allows asset owners and operators to manage inspection plans, document the condition of an asset, and track inspection recommendations to closure.

- **Thickness monitoring**

Provides the ability to calculate remaining useful life and inspection priority based on corrosion rates or thickness measurements. Can be integrated with a variety of data loggers, thereby streamlining the collection of thickness data. Tasks associated with thickness monitoring can also be integrated into EAM/CMMS systems and our other APM solutions.

Compliance & Integrity Management helps you:

- Prioritize assets based on risk using globally accepted and proven methodologies
- Facilitate compliance using real-time field information to manage inspection plans and implement intelligent asset strategies



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Asset Strategy Optimization

Need to optimize your assets' performance?

Asset Strategy Optimization from GE Renewable Energy helps optimize across availability, reliability, risk, and costs through intelligent asset strategies.

Asset Strategy Optimization includes Machine & Equipment Health, plus:

- **Reliability centered maintenance (RCM)/failure mode and effects analysis (FMEA)**

Enables industry-standard RCM and FMEA methodologies that identify the probability and consequences of asset failure and determine the optimum mitigating actions—including maintenance and condition-monitoring strategies—to reduce risks to acceptable levels.

- **Strategy management**

The strategy management capability provides a common methodology to define actions and their mitigated risks for any asset, providing the ability to evaluate existing plans with basic qualitative risk analysis that is both straightforward and easy to use. Managers can validate existing plans or consider strategy options to update and implement plans that are more effective in managing risk.

- **Strategy library**

The strategy library provides professionally designed asset strategy templates that include likely risks and recommended mitigating actions for more than 600 common equipment categories. Actions may include advanced predictive-analytic blueprints that enhance the effectiveness of Machine & Equipment Health.

- **Lifecycle cost analysis**

Enables asset owners to understand the true “whole life” costs of their assets from procurement through salvage. Captures all relevant cost data associated with individual assets, groups of assets, and entire asset fleets. By informing decisions when to repair and when to replace, the performance of asset strategies can be optimized over the long term.

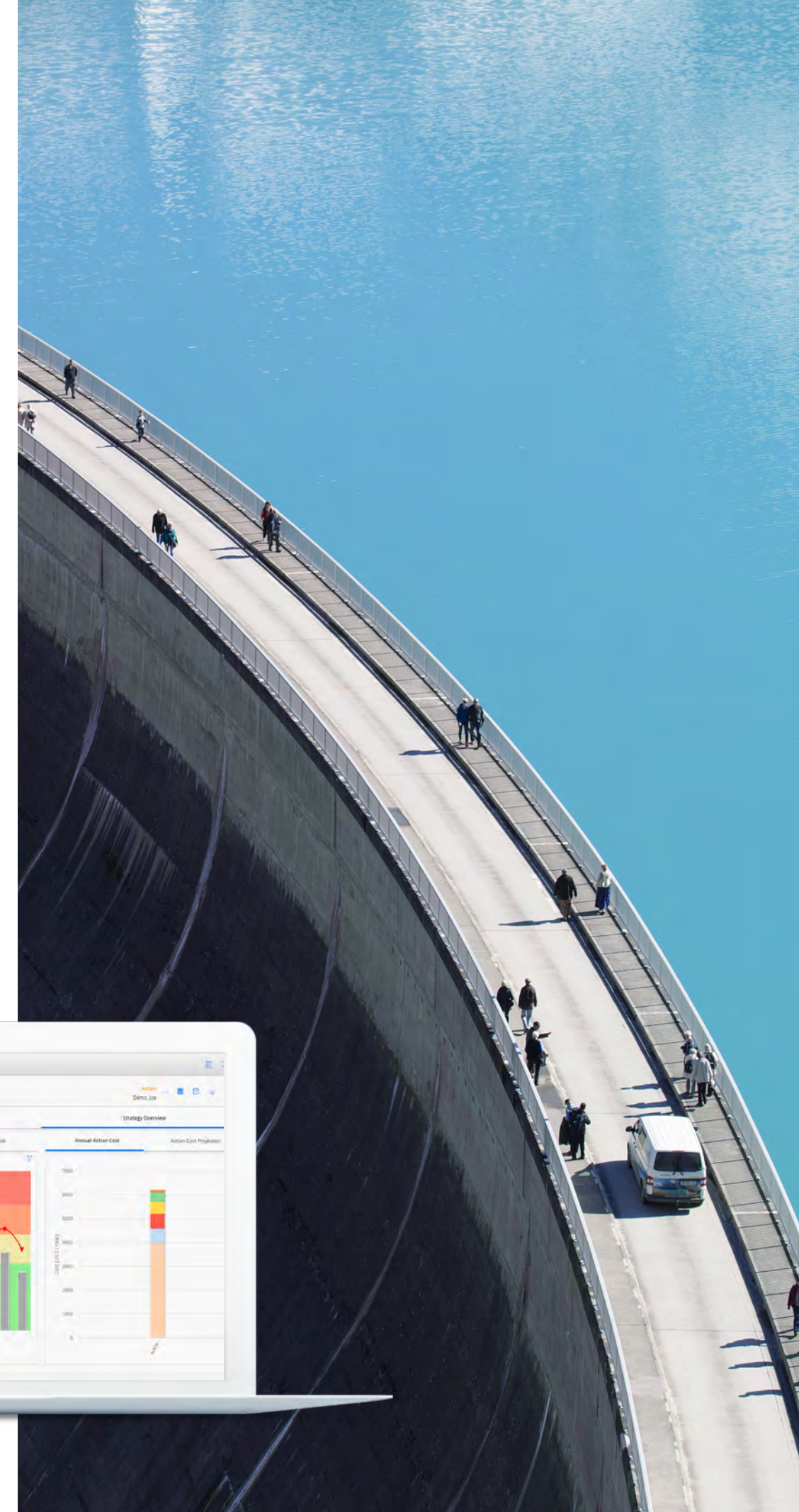
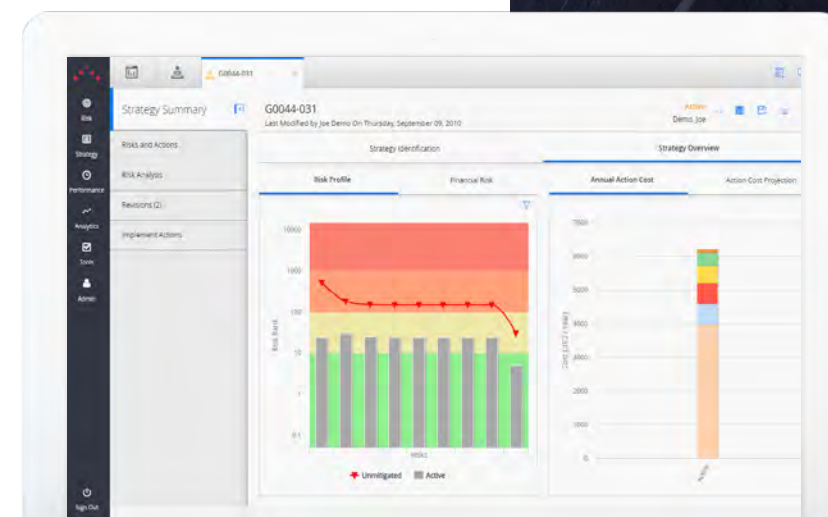
- **Financial and risk simulation**

Enables simulation of the effect on cost and risk of changing various aspects of the asset strategy. Simulation results from several options are presented in comparison with the existing strategy, so you can select the optimum strategy for activation.

Asset Strategy Optimization helps you:

- Optimize predictive maintenance decisions, reducing maintenance costs while balancing risk
- Increase asset reliability and availability, minimize downtime

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Building a single version of truth with Digital Hydro APM - Hydro Power Producer in Canada

APM's Generation Performance and Reporting Software (GPRS) helped a leading Canadian power producer report generation data for NERC compliance. It avoided errors in manual data entry and misses in reporting timelines, while aggregating data from multiple sources.

APM's GPRS application along with Root Cause Analysis (RCA) and Policy Manager customizes generation verification test data and hourly/daily performance data. Furthermore, APM's Asset Strategy Optimization application with Reliability Centered Maintenance (RCM) and Failure Mode Effects Analysis (FMEA) helps the Hydro Power Plant operator reduce reactive maintenance and improve reliability.



Extending Time Between Overhaul (TBO), reducing Mean Time To Repair (MTTR) with APM - EDSB, Local French Utility

A local French electricity distribution utility needed to accurately and remotely determine severity of heated bearings. APM's Machine & Equipment Health application connected the 5 MW Francis Turbine and its 2 Guide and 1 Thrust Bearings to GE's Remote Operating Center at France. The data acquisition and processing system processes over 2 terrabytes of data each month from 11 sensors and a local 3D HMI.

The automated diagnostics, Remaining Useful Life (RUL) prognostics, and vibration monitoring and diagnostics determined shaft displacements in radial direction without any shock or rub. As a result, the bearing was declared safe, not needing any inspection or resultant machine stoppage.

The result - An estimated 1% increase in availability by way of avoiding unnecessary downtime, costs otherwise incurred for inspection and loss of production.



Get started with Digital Hydro APM today

GE Renewable Energy leverages decades of experience, cutting-edge data science and analytics technology, and the scale of \$1 trillion in managed assets to offer a full suite of APM solutions powered by Predix, the operating system for the Industrial Internet. APM balances traditionally competing priorities—reducing costs, improving availability, and managing risk—to provide intelligent asset strategies that help maximize asset performance and productivity.

Are you ready to make your operation safer and more reliable while helping to ensure optimal performance at a lower sustainable cost?

GE Renewable Energy's Digital Hydro Asset Performance Management Solution Today!

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About GE

GE (NYSE: GE) is the world's Digital Industrial Company, transforming industry with software-defined machines and solutions that are connected, responsive, and predictive. GE is organized around a global exchange of knowledge, the "GE Store," through which each business shares and accesses the same technology, markets, structure, and intellect. Each invention further fuels innovation and application across our industrial sectors. With people, services, technology and scale, GE delivers better outcomes for customers by speaking the language of industry.

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About GE Renewable Energy

GE Renewable Energy is a 10-billion-dollar start-up that brings together one of the broadest product and service portfolios of the renewable energy industry. Combining onshore and offshore wind, hydro and innovative technologies such as concentrated solar power, GE Renewable Energy has installed more than 400+ gigawatts capacity globally to make the world work better and cleaner. With 13,000 employees present in more than 55 countries, GE Renewable Energy is backed by the resources of the world's first digital industrial company. Our goal is to demonstrate to the rest of the world that nobody should ever have to choose between affordable, reliable, and sustainable energy.

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