

ARTICLE

How the PI System™ supports CBM

Moving from reactive to proactive in the T&D sector

Executive summary:

Harnessing the power of data: Real-time condition monitoring, predictive maintenance, and advanced analytics once seemed out of reach for the Transmission and Distribution sector – complex regulations and aging assets combined to create a cycle that seemed impossible to break. The PI System offers a path forward to saving time and money by maximizing asset lifespan and production capacity while avoiding costly delays due to unforeseen circumstances. This white paper will show how the PI System helped T&D companies move toward condition-based maintenance (CBM) and optimize their operations by making decisions based on data, not intuition. It will also examine how CBM can lead to more advanced modeling and serve as the first step on a larger journey toward digital transformation.

The PI System: From preventative to predictive

The PI System is an industrial data management platform that enables users to analyze real-time and historical data to extract critical insights about asset health. By connecting disparate data sources, management, engineering, subject-matter experts, operations, and maintenance staff have access to a single source of truth and can share information and insights across the organization.

The PI System seamlessly manages the data-collection process, enabling engineers to spend their time analyzing collected data and making recommendations. Unlike calendar-based inspections and periodic assessments, the PI System detects small but critical equipment changes so teams can quickly take action.

By using the PI System for CBM, transmission and distribution companies gain multiple advantages:

- First, using the PI System alters the procedure from a periodic assessment to an online, dynamic, real-time assessment of asset health.
- Second, the PI System enables engineers to conduct streaming analysis and create a subsequent condition score.

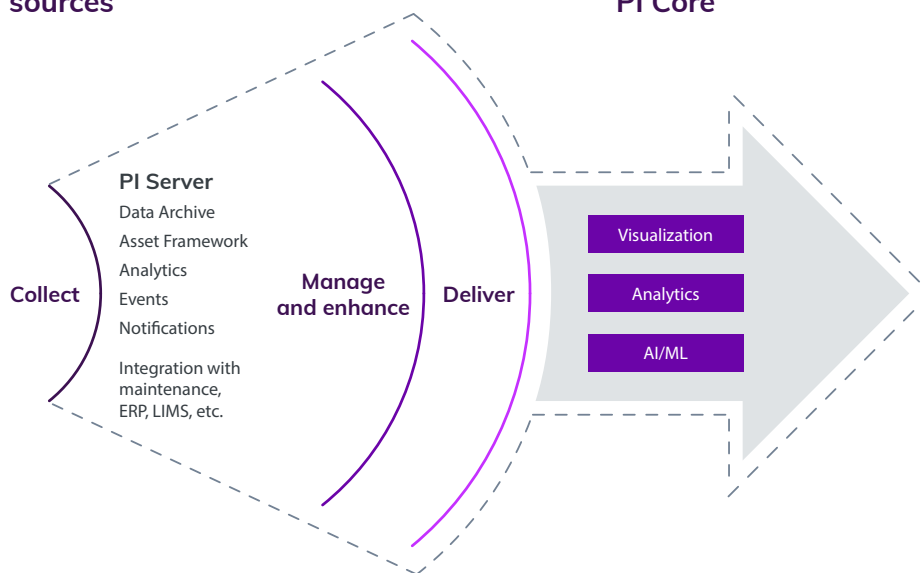
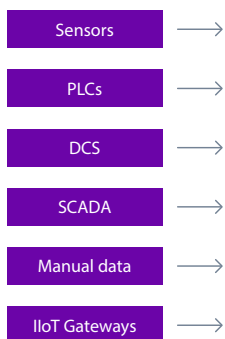
- Third, engineers can create additional context by organizing real-time PI System data by critical events and leveraging analytics to derive subsequent insights. These events supplement this new, highly detailed data analysis (Figure 1).

Beyond real-time condition monitoring and preventative maintenance, the PI System lays the groundwork for future predictive maintenance strategies. Users can leverage historical and real-time asset data from the PI System to train Artificial Intelligence (AI) and Machine Learning (ML) models.

Asset Framework provides necessary data structure and context, while PI Connectors and PI Interfaces ensure a seamless data transfer to any external solutions. Once users leverage AI/ML tools to determine maintenance predictions, operators or maintenance staff can visualize those predictions directly within the PI System. Not only do these predictions offer unprecedented situational awareness, but teams can also easily see – and mitigate – potential catastrophic issues while optimizing asset availability.

Operations data infrastructure

Operations data sources



Data consumers

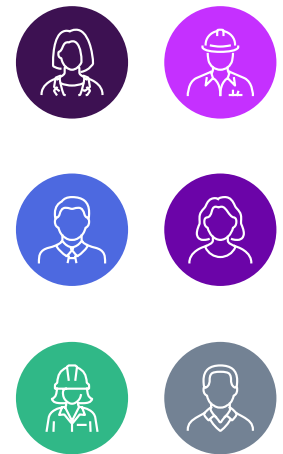


Figure 1: The PI Core software portfolio collects, enhances, and delivers real-time operations data in mission-critical environments.



Customer story

PowerStream (now Alectra): Improving equipment availability through CBM

In 2016, an unexpected spring ice storm caused trees to fall on power lines in southern Ontario, Canada, creating a blackout that impacted 50,000 PowerStream customers. Notifications from the PI System gave vital outage information in real time, helping ensure that power was restored as quickly and safely as possible. While the PI System helped PowerStream during this unexpected event, the groundwork had been laid many years before.

Prior to the PI System, the company used a time-based maintenance model. In 2012, the company deployed the PI System and Asset Framework, the contextualization layer of the PI System. Now, PowerStream monitors 30,000 PI System tags in a prioritized condition-based model.

The PI System is a key system to the company's computerized maintenance management system (CMMS). Real-time asset data from the PI System is used to prioritize and optimize maintenance tasks based on asset health, criticality, and risk. Notifications give team members real-time updates, providing immediate information to field teams when an equipment event or outage occurs. With real-time visibility into the asset conditions, the company is more proactive, catching issues early, leading to an improvement in overall equipment reliability.

With access to real-time insights, PowerStream takes equipment down for maintenance based on data, not time. This has led to a decrease in equipment failure and operational costs.



Key PI System components for CBM

Data collection

PI Interfaces and PI Connectors are foundations of the PI System infrastructure and provide a standard mechanism for collecting time-series data and asset metadata from disparate data sources. The PI System supports over 450 standard interfaces and a growing number of connectors.

T&D companies can use PI Interfaces and PI Connectors to link to data sources such as Advanced Distribution Management Systems (ADMS), Supervisory Control and Data Acquisition (SCADA) systems, Computerized Maintenance Management Systems (CMMS), Geographic Information Systems (GIS), Advanced Metering Infrastructure (AMI) systems, Energy Management Systems (EMS), Intelligent Electronic Devices (IED), sensors, servers, applications, networks, and other databases.

Key capabilities of the PI System for CBM are:

- Efficient, secure, and real-time data management is realized from a variety of sources.
- Standardized and centralized data is accessible across the enterprise.

- Numerous ways to display asset health information, including configurable dashboards and visualizations.
- Performance trending and analysis determine each asset's operating context (limits) and asset health
- Asset Framework organizes data streams and related processes, giving critical context for future analysis.
- Event Frames convert raw data streams into meaningful insight.
- Predictive warning notifications send alerts, enabling rapid response.
- Serves up data to other advanced analytical tools and engines.
- Integrates business and operational systems to connect employees, business partners, suppliers, and markets.

Storing, managing, and enhancing data

An essential PI System component, PI Data Archive™ stores future data and also receives real-time and historical process data from operations and other sources. By organizing streams of business-critical data into a single comprehensive format, the PI Server enables asset maintenance management, operations engineering, and executive management to achieve grid resiliency and more accurately plan future business operations.

Asset Framework (AF) enhances data comprehension through a consistent naming convention or representation that can be understood by all PI System users. AF specifies each asset and its attributes in an easy-to-navigate infrastructure for accessing data, naming assets, and defining processes for an entire organization, ranging from the entire network down to individual pieces of equipment. The use of standard templates simplifies the definition and addition of models, assets, processes, and calculations to the framework (Figure 2).

Analytics allows consistent equations, counters, and calculations to be applied to similar equipment across the entire network and assets. Analytics can be simple, like counting operations on a circuit breaker, or more complex, like calculating critical health scores on individual assets up to system wide.

Event Frames automatically bookmark PI System data related to a specific asset and related condition. Each event frame has a start and end time, enabling users to calculate the duration of an event and capture the associated data or condition.

Notifications leverages the flexibility of AF by allowing users to configure custom alerts based on any data source. With Notifications, users can configure the platform to send alerts whenever specified equipment exceeds preset parameters. Notifications can also integrate with line-of-business systems such as SAP, Maximo, or Cascade. With Event Frames and Notifications, one can automate condition detection through work-order generation for inspection or maintenance of an asset.

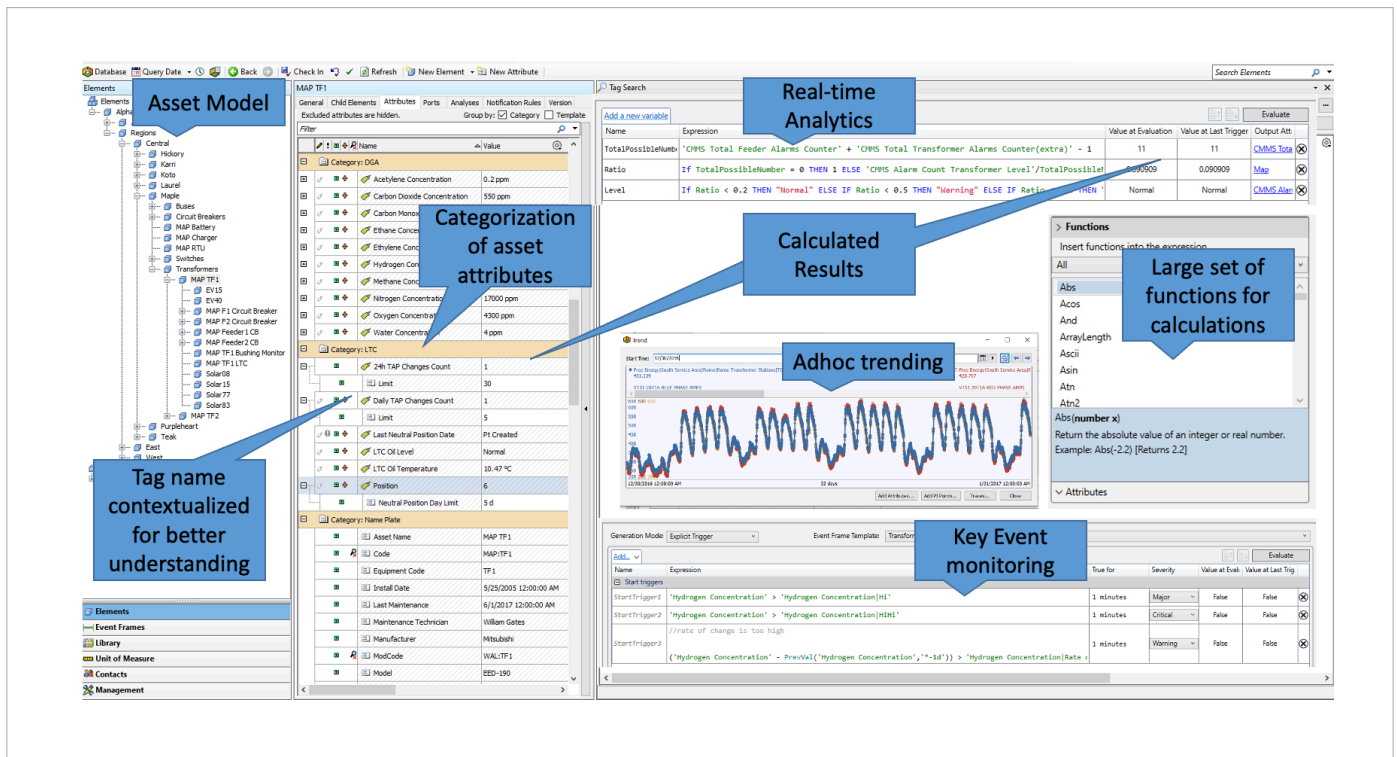


Figure 2: Asset Framework identifies organizational assets and equipment using a consistent naming convention.



Data visualization and delivery

PI DataLink® is an add-in for Microsoft™ Excel™, enabling direct access to PI System data within a worksheet. PI DataLink offers powerful tools for gathering, monitoring, analyzing, updating, and displaying PI System data and events.

PI Vision™ is an intuitive web-based visualization tool that delivers fast, easy, and secure access to all PI System data. Users gain insight into plant operations

by creating interactive graphical displays or conducting ad hoc analyses. Users can create displays using either real-time or historical data residing in the PI System.

PI Vision's browser-based interface facilitates collaboration and sharing of insights – without installing software locally. Since the PI System enables data aggregation from disparate sources, PI Vision provides a window to all PI System data.

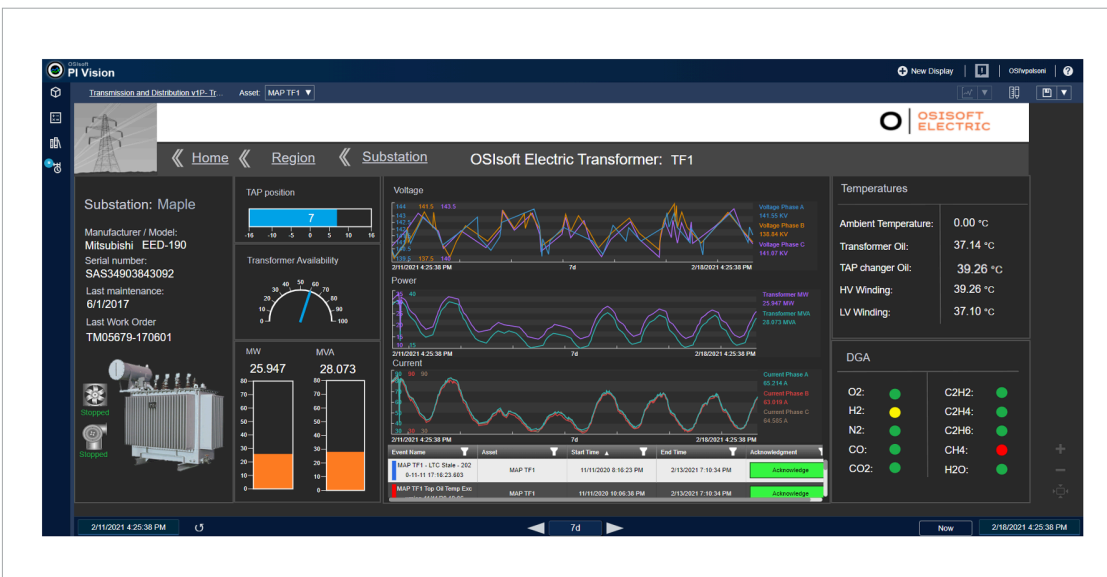


Figure 3. PI Vision display of Power Transformer operations and asset health.



Customer story

PSE&G: CBM extends asset life

PSE&G serves approximately 4 million gas and electric customers in the New Jersey area. With \$14 billion in assets, the company needs to ensure that every piece of equipment is running at optimal levels. However, the average age of PSE&G's assets exceeds 40 years. Equipment was vulnerable to failure, and the risk of liability or a system outage was high.

The company was in a predicament. Maintenance expenditures were eroding earnings, but large capital expenditures to replace old equipment would provide no new revenue. Moving from scheduled maintenance to condition-based – and ultimately predictive – maintenance was the key to mitigating failure and extending asset life. The company estimated that moving to CBM would reduce overall maintenance expenses by 10-20% in just five years.

With limited capacity to determine asset condition, decreasing expertise in both field maintenance and engineering, and asset information in disparate systems, PSE&G needed a single solution for its CBM needs. The company chose the PI System to collect and consolidate its operations data. Using Asset Framework, the company created asset models and built an algorithm and calculation framework. The PI System was integrated with PSE&G's CMMS, enabling teams to perform maintenance planning and integrating with SAP to generate work orders.

The PI System quickly demonstrated its value. After an alert flagged a performance anomaly, an inspection showed coking contacts. The assembly was immediately cleaned and new contacts installed. Without replacement, the contacts would have failed when an additional load was added during a T10 transformer replacement. PSE&G conservatively estimates that avoiding this failure saved approximately \$1.5 million.

Looking ahead: Building a resilient T&D system for future benefits

Today's Transmission and Distribution market demands that electric utilities deliver high reliability, a safe and resilient grid all at a low cost. However, many utilities still use multiple, disparate data systems, limiting visibility and leaving companies to rely on static equipment-condition assessments and reactive maintenance strategies. Reducing maintenance costs and preventing catastrophic failures hinges on proactive CBM-based techniques that leverage real-time operations data.

Not only can CBM reduce overall maintenance costs, but it can also impact processes across the enterprise. CBM data can inform asset management strategies and vendor performance reviews and enable root cause analysis techniques as well as environmental monitoring and regulatory compliance. As CBM strategies mature, T&D companies can optimize operations well beyond the control room to boost system reliability and grid resilience and optimize outage planning.

The PI System provides utilities with a single source of truth for operations and non-operations data. The PI System collects and manages information from multiple isolated sources across the enterprise and presents that data in a way that allows management, engineering, operations, and maintenance staff to share and analyze information. From there, they can work together to optimize operations and maintenance strategies, maximize asset life cycles, predict outcomes, and, ultimately, drive bottom-line results.

As the costs of remote monitoring gear and analytical software remain affordable, T&D companies will continue to adopt CBM as a best practice foundational to asset management programs.

The rolling out of CBM along with advanced analytics, using real-time performance data and predictive algorithms, has a direct positive impact on system reliability, reducing risk and lowering operating costs. It can help T&D companies prevent asset failures, concentrate asset management efforts on critical assets, avoid excess maintenance work or premature asset replacements, and grow and retain the valuable knowledge of in-house experts.

Many utilities are being more proactive, pushing to harden and modernize their grids and cybersecurity to boost efficiency, safety, reliability, and resilience. Regulators are considering major proposals to require upgraded systems as utilities prepare to spend huge amounts of capital to create a grid capable of accommodating new digital technologies and increasing amounts of variable power generation originating from the wind or sun. CBM is one of the most cost-efficient ways to buy utility companies more time during these times of change. CBM allows T&D companies to maintain their existing grids while obtaining the necessary capital to upgrade their infrastructure.

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