AVEVA

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WHITEPAPER

Addressing challenges with real-time distributed data shared across the grid

Executive summary:

Renewable energy is unpredictable, but that does not mean it is unusable. New tools and technologies are helping utilities harness the full potential of wind, solar, and other renewable energies by optimizing grid performance, detecting potential interruptions, and more.

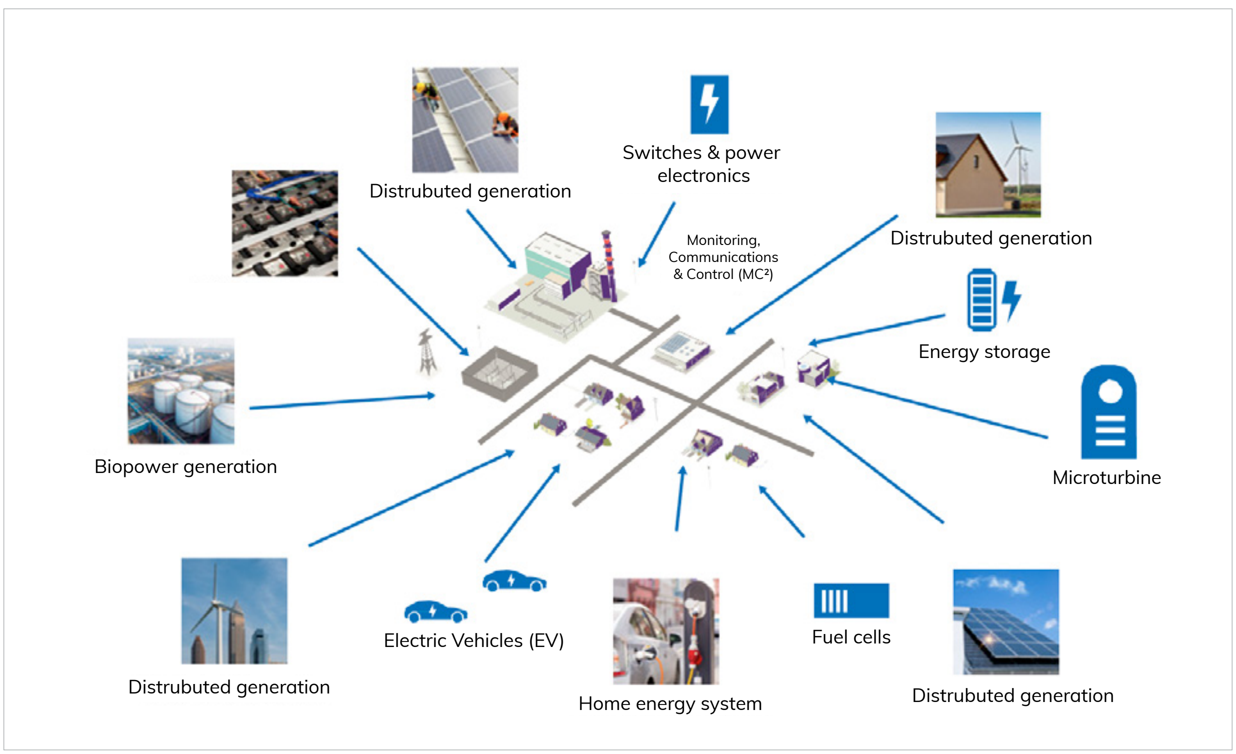
Ensure the successful integration of renewable resources while maintaining stability and optimizing grid management

The growing use of renewable energy is providing new opportunities for users to reduce carbon footprint and energy costs. However, the unpredictability of solar, wind, and other renewables makes it difficult to maintain stability and optimize grid management.

The key to ensuring the successful integration of renewable resources may lie in the availability of real-time series data collected from distributed data points, often described as the Internet of Things (IoT). But the huge amount of data collected from these data points operating at the edge of the grid must be processed, and a number of different formats in use must be smoothly integrated; the lack of data granularity and existing data silos presents additional challenges.

To address these edge-of-the-grid issues, a new community of energy suppliers, service providers, storage vendors, software suppliers, and Electric Vehicle (EV) charging platforms are offering distributed real-time data using an IoT model that can help utilities, Independent System Operators (ISOs), and large commercial and industrial energy users to work together to optimize web operations.

Utilities use the PI System™ to collect, manage, and analyze data for transmission and distribution groups. Through new business models, innovators are also able to use the PI System as an IoT platform that collects, stores, analyzes, and visualizes real-time sensor-based data from the grid edge, which can be used by the centralized grid to optimize the uninterrupted availability of energy resources. The following are three examples of the PI System being put to work in innovative, edge-of-the-grid applications.



Grid operators can use real-time data to integrate distributed energy resources.

Case study

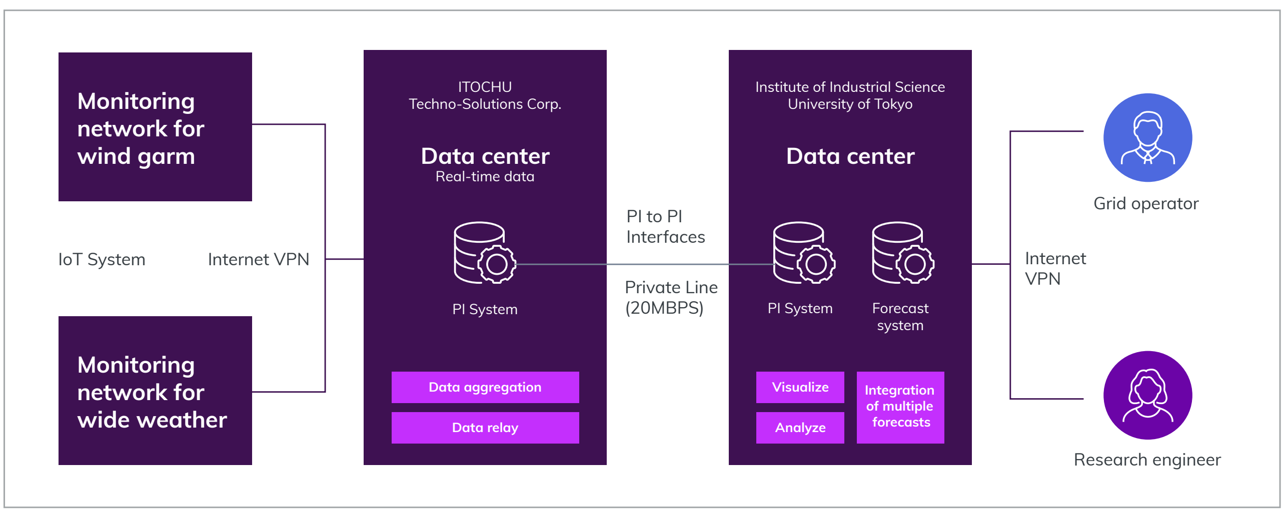
Itochu provides weather monitoring and forecast system

Following the Fukushima Daiichi nuclear disaster in April 2011, the government of Japan promoted renewable power generation. To address a concern that rapid increases in variable energy may affect grid stability, Itochu, a system integrator and service provider, created a monitoring system to forecast wind power output generation to improve integration of renewable energy sources in eastern Japan.

Working with NEDO, the national research and development agency, Itochu created a wide area network consisting of more than 40 wind farms, 114 weather data stations and the Japan Meteorological Society's 400 surface weather station sites. The PI System acts as an IoT platform to collect renewable energy data, such as power output, along with weather data, including wind speed, wind direction, pressure, and temperature, to contribute to wind power output forecasts in eastern Japan. This data improves the ability to forecast Variable Renewable Energy (VRE) to manage the integration of wind energy into grid operations.

Itochu uses the PI System to collect massive amounts of IoT data that help researchers increase the accuracy of wind power forecasts in eastern Japan. It stores VRE data such as wind, PV power output, SCADA, and wide area weather data such as wind speed direction, temperature, pressure, and humidity, to develop VRE forecasts in order to optimize the demand supply and frequency adjustment.

Working with its partners, Itochu has been able to improve the overall accuracy of its wind power forecasts with the exception of wind ramps caused by low pressure weather systems. In the future, Itochu will continue to expand its IoT system and further develop forecasting techniques. The goal is to improve control of power output fluctuations with a combination of storage and operation of large-scale generators and batteries to optimize power system operation.



Real-time data from wind farm and wide area weather stations contribute to wind power forecasts.

Case study

Enphase energy: Shares PV data

While the rollout of solar photovoltaic (PV) capacity can help diversify U.S. power sources, utilities need to smoothly integrate solar energy from highly distributed residential rooftops and small commercial sources. How can utilities achieve accurate, highly granular, and near-real-time visibility?

Enphase Energy, a manufacturer of microinverters, AC battery storage, and smart PV technologies, deploys the PI System, via Connected Services, to collect site-level data such as secondary voltage and PV production. This data is made available to help utilities integrate PV energy from Enphase customer installations.

Enphase gathers information collected from smart microinverters and aggregates site data. The result is a low-cost solution for utilities that does not require additional screens or new software. Using PI System's Asset Framework (AF), utilities combine Enphase site data with SCADA or meteorological data to perform analytics that simplify the integration of solar resources into the grid.

To support its utility customers, Enphase needed to organize its data into a format that is relevant to the utility. Enphase collects data microinverters from home's solar panel, moves it to the Envoy gateway, and then disseminates the data to utilities. Enphase takes advantage of the flexibility of the AF templates to make the data relevant to utilities. For example, the utility may be interested in data for a zone that represents a group of houses or may want to know if the houses in a specific geographic area belong to the same segment of a distribution circuit.

Itochu solution

Itochu uses a PI Interface™ to stream the power and weather data using a unified file format into the PI System, with these PI System components:

- **Asset Framework (AF):** Organizes the past, real-time, and future data in an easy-to-navigate hierarchal format to manage data, perform roll-up analysis, and develop templates that describe each turbine
- **Notifications:** Sends alerts of high wind ramps that can affect the grid
- **PI ProcessBook®:** Enables the creation of charts and displays to visual critical data
- **PI Coresight™:** Provides the ability for engineers and analysts to visualize and access VRE and weather data from desktop displays, laptops, or other mobile displays
- **PI DataLink®** to analyze data in Microsoft Excel

As PV generation penetrates the grid, utilities are increasingly attentive to voltage regulation and the ability to link voltage data with photovoltaic production. The voltage data that utilities currently collect takes about 24 hours to percolate through the system; Enphase systems can collect that data faster, and at a finer resolution.

Faced with growing PV capacity, utilities increasingly need timely and detailed data about PV generation capability and performance. Since many utilities use the PI System, data can be presented in a format that is both familiar and useful to utility operators. By partnering with developers of the PI System, PV developers can offer utility energy management solutions that address their needs in the evolving PV market.

Enphase energy solution

As utilities integrate more data from outside providers such as meteorologists, Enphase is using PI Cloud Connect services to securely acquire that data. The company can also use PI Integrator for Esri ArcGIS to display asset data at distributed locations. Finally, Enphase uses Notifications to allow utility operators to set alarms when data reaches predetermined critical levels.

Enphase will can use Event Frames to perform analysis on voltage trends. By using Event Frames, operators can calculate statistics on frequency and duration of voltage spikes that fall outside the optimal range that the utility is trying to achieve.

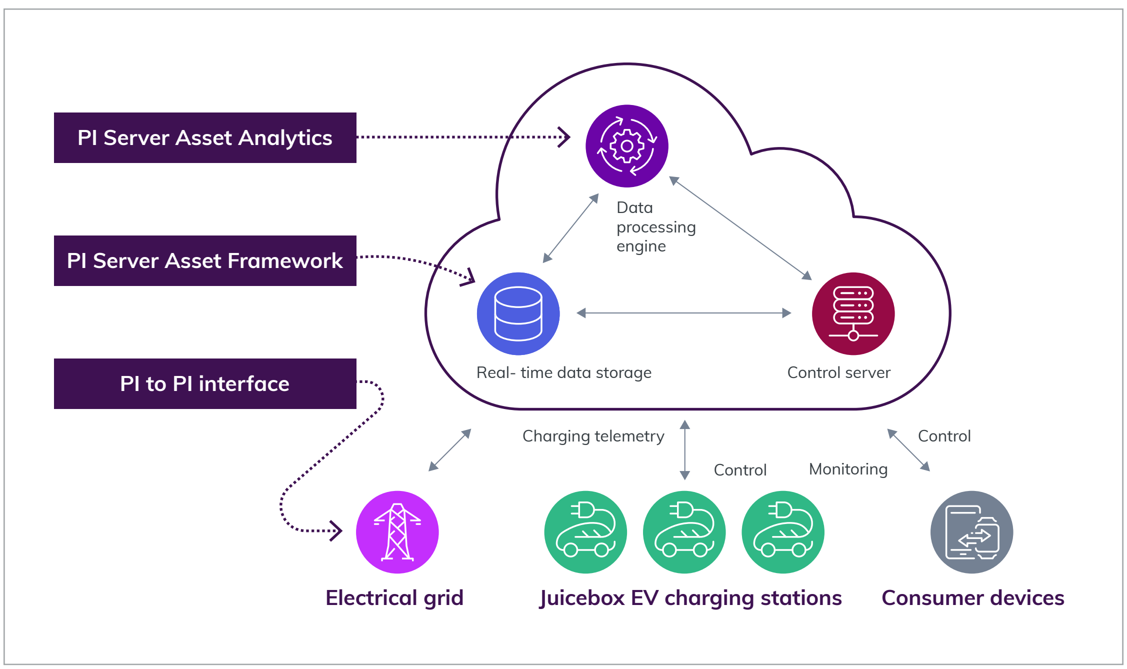
Case study

eMotorWerks: Controlling volatility in demand management

Widespread adoption of Electric Vehicles (EVs) has faced two large hurdles. One is convincing the consumer that electric cars are convenient, reliable, and easy to operate. That hurdle was partly addressed by the emergence of the Level 2 EV charger, which provides faster charging time. The second hurdle is the question of whether the existing energy grid can support the increasing demand a successful electric car market would generate.

The growing market is already affecting demand: EV charging creates large electrical loads that are concentrated both in time and location, resulting in high energy costs due to peak usage and the need to add energy sources in response to demand that can't be met by renewable sources that are affected by weather and time of day. The addition of dirty energy generation defeats the intent of electric cars and strains electricity distribution, threatening overall stability and reliability.

eMotorWerks is addressing the demand issue with a smart network, called JuiceNet®, of Level 2 EV charging stations, called JuiceBox® stations that incorporate grid sensing and response. The chargers also use smart phone and computer interfaces that enable users to manage, time, and monitor charging and electrical source information. For the consumer, the result is faster, cheaper EV charging controlled from a smartphone: the user can set a time to charge and a charge rate, for example, based on cost or available source. For energy suppliers, such as Independent Service Operators (ISOs) and Regional Transmission Operators (RTOs), having EV demand managed by a smart endpoint will allow the EV market to come on to the grid without overburdening it.



JuiceBox EV charging stations use real-time data and analytics for cloud-based load management and cloud-based energy market engine.

Smart EV networks at the edge of the grid will generate data that will help ISOs and RTOs, as well as local utilities, to make decisions about grid-load balancing and to understand long-term trends. What's more, as technology advances make EVs much more appealing, car manufacturers can better understand the market benefits and the efficiency and operation of their battery-charging systems.

Integrated into eMotorWerks' JuiceNet platform is OSIsoft's PI System, which combines sensor-based data from eMotorWerks' network of JuiceBox charging stations with data from electrical utilities and ISOs. The result is a robust, complete overview of charging loads and real-time grid conditions used in the JuiceNet load dispatch algorithms, providing eMotorWerks EV customers with faster, easier, and more secure access to the status of their charging stations.

eMotorWerks uses the PI System to collect and store real-time data from the JuiceBox chargers, including charging-state amperage, voltage, power, power factor, frequency, temperature, and charging session energy. The PI System performs the analysis for the JuiceBox to process, analyze, and make decisions at the grid edge to trigger responses to key events.

The PI System also incorporates a cloud-based energy market engine that reads data from PI-to-PI transfers of data from ISOs, utilities, and large commercial customers for wholesale pricing and to determine the best way to respond to events.

eMotorWerks solution

Asset Frameworks organizes basic data points from the UDP JuiceBox Listener. PI System forms a shared data ecosystem that enables eMotorWerks to provide valuable cloud-based services to ISOs and utilities to deliver superior charging performance and efficiency.

PI System-based load management allows eMotorWerks to manage thousands of stations with sub-3-second control latency for instantaneous response to grid events. Other services include frequency regulation and peak shaving.

Conclusion

Variable renewable energy places new strains on the stability and optimization of the grid. Using the PI System as a data infrastructure, a diverse group of enterprises is gaining insight into grid events and the ability to optimize distributing resources to support grid management. These companies' offerings are diverse, spanning service provision and research, renewable energy generation, large-scale energy storage, and consumer-market products. Common to all these new players on the edge of the grid, though, is the ability to deeply integrate with the entire grid: the ability to quickly respond to grid conditions, to address demand, and optimize availability, all while reducing cost.

OSIsoft is now part of AVEVA