CHALLENGES OF A CHANGING INDISTRY: GOING DIGITAL

The Shifting Digital Landscape

How do you lower the cost of electricity and achieve environmental and business goals?

The challenges facing the power industry are many and span from pairing with renewables to competing with newer plants to changing fuel economics. Power plants must adapt and respond to these challenges to remain viable.

Power plants generate an overwhelming amount of data. What do you do with it? How can it help overcome your challenges?

All of this drives the need for a digitally enhanced power plant. But, how do you build it? Can an existing plant become a digital power plant?

A digital power plant applies sensor data and software to do more than human operators can do alone. This is especially relevant as competition continues to drive plant headcount and operating cost reduction while experienced experts retire and retention of even existing knowledge is a challenge.

There are various options for building the software infrastructure that is at the heart of a digital power plant. The first decision to make is whether to develop software internally, invest in a comprehensive software overhaul or purchase application solutions that build on your existing software investments. All of which come with their own set of costs and outcomes. The second decision is to prioritize the challenges that can be cost-effectively addressed and avoid the danger of trying to do too much at once.

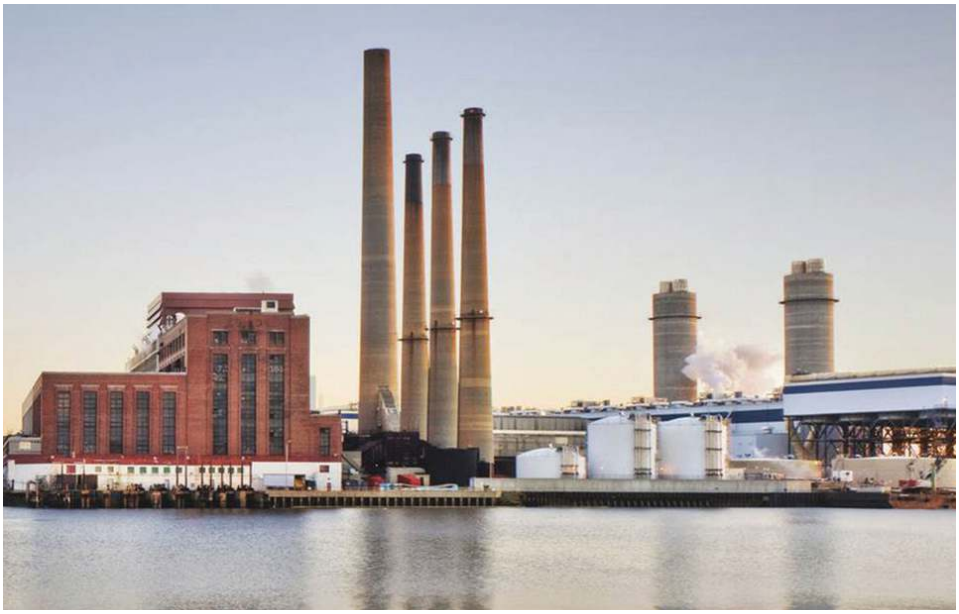
This paper will showcase the strategy used by Mitsubishi Power to define the digital power plant and create their digital solution portfolio, where several factors came together to create an approach that increases plant efficiency, flexibility and profitability.

Listening to the Voice of the Plant

Building a digital power plant starts with data monitoring. In its infancy, monitoring of limited data points allowed for rules-based analytics to be established based on understanding the equipment design and operational profiles. At Mitsubishi Power, more extensive monitoring began at T-Point, Mitsubishi Power's heavily instrumented, commercial power plant in Takasago, Japan. T-Point was built in 1997 to help validate new products in a real, grid-connected power plant that dispatches power to Kansai Electric Power Company. This type of proactive monitoring marked the start of a way to capture and analyze data, creating the voice of the plant.

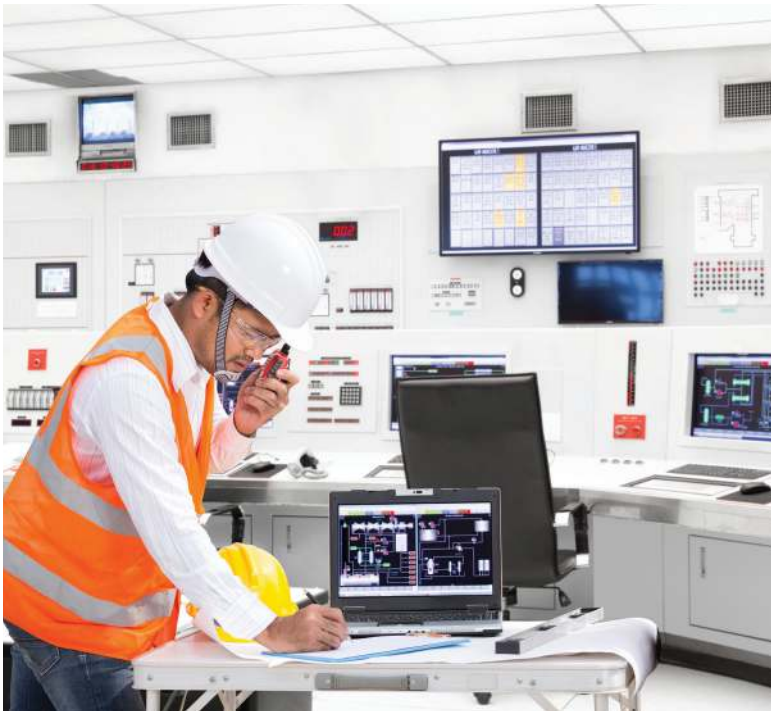
Each plant faces different challenges. Some are based on environmental factors or operating modes unique to that plant. Therefore, the experience of each plant adds valuable feedback to validate designs and improve O&M practices from fleet-wide learning. As a result, Mitsubishi Power saw the potential of correlating real-time data from multiple plants to drive efficient O&M processes and superior product development.

In 1999, technology evolved and allowed Mitsubishi Power to build a Remote Monitoring Center (RMC) in Takasago, Japan. The RMC allowed for the centralized collection and analysis of fleet-wide data from power plants around the world and established the foundation of the digital power plant. The RMC was so successful in data analysis and improving the reliability of existing and new plants that Mitsubishi Power built regional monitoring centers in Orlando, Florida, USA, and Alabang, Philippines.



As digital technologies evolved, Mitsubishi Power began using statistical reasoning analytics to investigate the relationships between variables and expanded the ability to use data from the plant to make informed recommendations that proactively provided customers with expanded O&M support. This led to more frequent interaction between Mitsubishi Power and customer experts. Results included improved reliability and the knowledge to support predictive maintenance, shorter outages and extended outage intervals. Technology hasn't stopped evolving. Advances in machine-learning (ML) and artificial intelligence (AI) increasingly allow utilization of algorithms that learn from data without relying on rules-based programming and require less support from human experts. This is becoming a game changer.

As AI and ML technology grew, Mitsubishi Power sought partnerships with best-in-class software companies to implement these capabilities into the digital power plant. This advances O&M support to optimize performance and, combined with the integration of external factors such as weather forecasts and anticipated grid conditions, is leading the way to the cognitive power plants of the future.



Channeling the Voice of the Customer

Data and the knowledge derived from that data are important, but they're just a part of the story. You also need the voice of the customer. This provides the perspective needed to create actionable knowledge from the data.

The RMC provided the voice of the plant and created a closer relationship with customers. Then, Mitsubishi Power Users' Groups and annual Users' Conferences with owners and operators around the world facilitated conversations that shared a broad range of best practices and insights related to the challenges in the power market and gave Mitsubishi Power a better understanding and prioritization of customers' needs.

This close collaboration, combining the power of the equipment design and total plant knowledge of Mitsubishi Power and the customer's engineering, operations and maintenance experts, is proving instrumental in targeting advancements in digital technology to solve challenges in the power industry.

Armed with the fleet-wide data and customer feedback, and leveraging technical advancements, Mitsubishi Power partnered with customers to develop pilot programs to create digital solutions based on real-world challenges, like the varying demands of the grid and evolution of competitive wholesale power markets, which ultimately led to the creation of TOMONI™. Tomoni is a Japanese word meaning "together with" and embodies Mitsubishi Power's approach to the digitalization of power plants.

Finding a Digital Fit

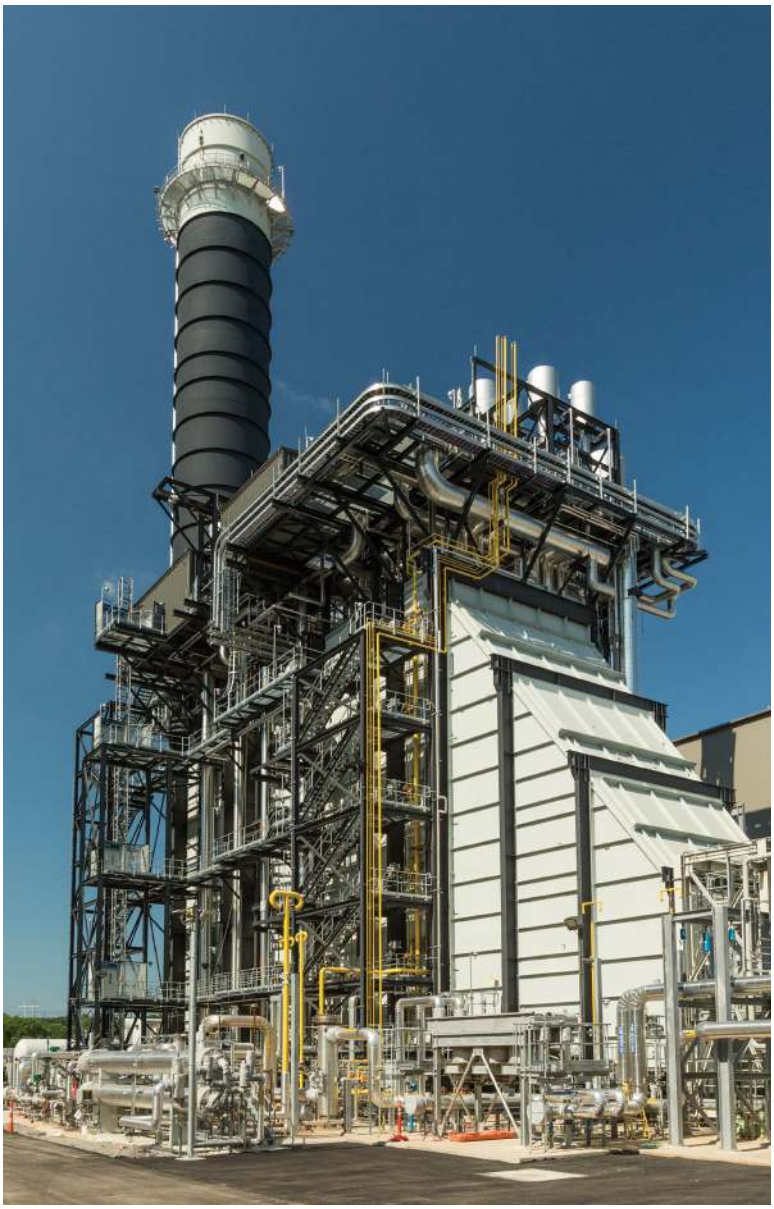
Early on, Mitsubishi Power recognized that power plant digitalization is not a "one-size-fits-all" solution. They utilized the Users' Groups to gauge the best path for their customers to create a digital power plant. Users' Group surveys of power plant owners and operators made it clear that User strategies differed significantly, emphasizing the importance of a flexible approach.

One thing that was clear is that most owner/operators had a strong preference for a data foundation that was compatible with the existing control systems, business processes and software systems they had in place and their employees were familiar with. Therefore, Mitsubishi Power developed a strategy to integrate TOMONI™ with customers' existing data management infrastructure.

The OSIsoft PI System™ software is the data infrastructure most commonly used in the power industry for collecting and managing plant process and operational data. Mitsubishi Power had been using the PI System in RMC applications for over a decade and, in 2016, entered into an alliance agreement with OSIsoft to make its software an integral part of many TOMONI™ solutions.

Mitsubishi Power took further steps, working with several other best-in-class software companies to expand its portfolio of data analytics, data visualization and digital control strategies. It is also leveraging advanced O&M data management, knowledge accumulation and knowledge-sharing tools to optimize digital delivery of O&M support for its customers.

Partnering with leading software providers accelerates implementation, permits scalability and reduces the labor and skills required to develop software independently. Therefore, customers save time and money while benefiting from a customized solution.



Harnessing Potential

By harnessing plant and fleet-wide data and bringing together human insights and knowledge from Mitsubishi Power experts and customers, TOMONI$_{TM}$ digital solutions are helping plants around the world lower the cost of electricity and achieve environmental and business goals.

Driving the future, Mitsubishi Power recently broke ground on a new, digital power plant, their second heavily instrumented plant in Takasago, Japan. This plant will be the most advanced GTCC power plant in the world, fully integrated with TOMONI$_{TM}$ solutions, with a goal of becoming the world's first cognitive power plant, capable of autonomous operation.

Evaluating Your Future

When deciding on the strategy to create your digital power plant, the following evaluation criteria are imperative:

- Consider your end goal in creating a digital power plant.
- What is/are your problem statement(s) or desired benefit(s)?
- What are your priorities and timeline?
- How much digitalization is needed for your existing plant?
- Consider the advantages and disadvantages of building solutions through collaboration versus your own self-development.
- What approach pairs best with the processes and capabilities you have currently?
- What is needed to accomplish your end goal? Budget? Infrastructure?

As you evaluate how to make your power plant digital, we're here to help strategize the best options for your situation.

TOMONI$_{TM}$
Mitsubishi Power is leading the development of the digital power plant of the future with TOMONI$_{TM}$, a suite of digital solutions enabled by decades of O&M and plant knowledge. Our solutions are driven by customer collaboration and use advanced analytics and adaptive control to lower the cost of electricity and achieve environmental and business goals.

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