GE Power Digital

Advanced Controls / Edge Computing

"Our fleet, including at our other two combined-cycle power plants in Cassano and Sermide, will reap the benefits of GE's advanced software solutions."

— Valerio Camerano, CEO, A2A

Business Challenges

The demand for energy is continually growing, and while needs and priorities differ from application to application, the desire for reliable and efficient power remains constant. With flexibility at the forefront of our technology innovation, GE is focused on delivering products that enable gas turbine power plants to operate seamlessly with renewable energy resources.

Operational flexibility is a total plant system capability — each component must complement and enable the capabilities of the others and all must work together to achieve high levels of efficiency. As a manufacturer of all major power plant equipment, GE is uniquely qualified to develop plant-level solutions that carefully consider the capability of each component to satisfy the demand for plant-level flexibility.

Customer Benefits

- Deliver power quickly in response to changing grid demands
- Overcome equipment limitations that prevent you from capitalizing on emerging market opportunities
- Eliminate slow, inefficient start-ups and their associated costs
- Stay online more cost effectively
- Meet more demand within existing markets
- Generate revenue through ancillary markets
- Reduce emissions "events" and potentially costly compliance penalties that can result in financial loss
- Expand your operating window

F-Class

- **40%** reduction in start up fuel consumption (for combined cycle plant hot start)
- **50%** reduction in start up time (for combined cycle plant hot start)
- **3x** increase in fuel variation handling capability
- **+2.5%** increase in peak output to meet short-term demands
- **50%** reduction in start-up NOx emissions
- **2.5x** increase in loading/ unloading rate — up to ±50MW/min

E-Class

- **8%** potential increased output to meet short-term demands
- **10** minute starts for 7EA (<15 min.
  for 9E) vs. 30 minutes normally
- **50%** trip avoidance
- **50%** reduction in start-up CO_2 emissions
- **40%** per minute fast ramp to base load

Solution Description

OpFlex: Flexibility Without Sacrificing Efficiency

GE's position as an OEM enables the use of strong domain expertise to differentiate turbine and plant performance and operability with controls. High-fidelity physics-based models of the plant components are embedded within the controls logic to run in real time, and are the backbone of adaptive control strategies that protect assets and enhance operation. Features and benefits of this model-based control strategy include:

- Startup agility, providing fast, reliable, repeatable starts with low emissions
- Combustion versatility and improved turndown, providing robust operation during variations in weather, fuel and grid
- Load flexibility, for load range expansion, and improved efficiency and responsiveness
- System reliability enhancements for reliable, cost-effective operations

Fast and Reliable Startup

The fast start capabilities of our gas turbines enable power generation in response to sudden demand. With the ability to go from cold iron to full power in as little as five minutes, and to start and stop in short cycles, our gas turbines accommodate fluctuating supply or demand with high efficiency.

Baseload Efficiency

Some gas turbines are required to operate under baseload conditions at certain periods of time. GE's gas turbines are among the most efficient in the industry, reducing fuel costs when providing the maximum amount of power needed by the grid.

Enhanced Ramp Rates

Fast ramping is the rapid increasing or decreasing of plant load, to smoothly track changing load requirements without inducing undue thermal or mechanical stress in the equipment. Grid support services are enhanced to provide operational benefits and better financial returns from the plant.

Part Load Efficiency

During periods of low electricity demand, such as during overnight periods, gas turbines may be required to operate under part load conditions. GE's gas turbines maintain high efficiency levels under part load. This helps you economically operate your plant under a wide range of grid demand scenarios.

Turndown for Emissions and Cost Control

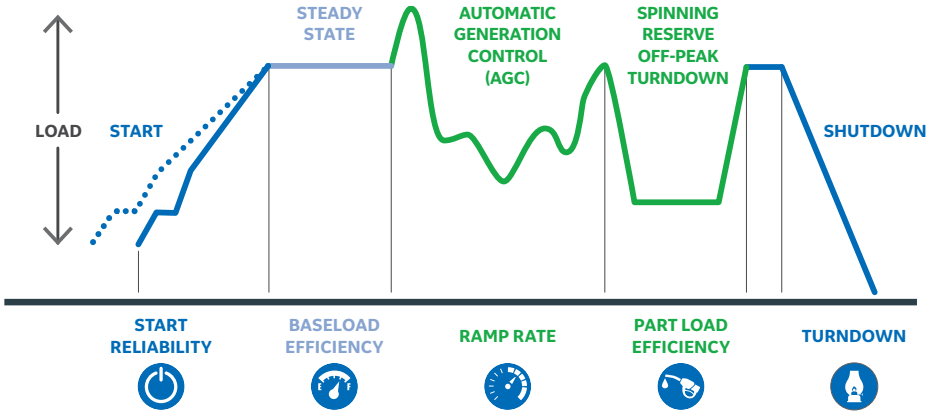
This capability extends low emissions operation to lower load levels, enabling reduced fuel consumption and lower total emissions at minimum loads. This translates to improved economics to remain online during off-peak demand periods to alleviate shutdown and startup costs. This enhanced turndown capability also extends the available load range for operation, improving dispatch flexibility and enabling greater participation in regulating reserve markets.

Reliability

This capability provides added reliable, cost effective operations, slows performance degradation, recovers lost performance and extends availability of assets. A new set of analytics reduces false alarms and system trips, thereby reducing overall downtime for trip recovery and improving plant productivity.

Mark VIe Plant Control System

The ability to protect, control, monitor and improve performance of the entire plant is critical to realizing its greatest value. GE's Mark VIe based control system unifies and simplifies protection, control and monitoring of the entire plant to enhance performance and deliver predictable operation.



Using a modular Predix machine-enabled platform, the Mark VIe control system provides a flexible and scalable architecture for applications ranging from turbine-level to plant-level control. This modular approach facilitates future technology upgrades and protects against obsolescence.

To simplify plant operations and maintenance, the plant control system includes the following primary elements that share common architecture, software tools, and operator interfaces.

- Mark VIe Turbine Control Panels for each gas turbine and steam turbine
- Mark VIe Distributed Control System (DCS) platform for HRSG and plant control
- Mark VIeS Safety Controller, a locked configuration, when required for SIL certification
- ActivePoint* HMI with enhanced visualization, alarm rationalization, and server-based thin client deployment
- Comprehensive defense-in-depth cyber security system
- Historian and On Site Monitor (OSM), with secure connectivity to the Predix cloud and to GE's Remote Monitoring and Diagnostics Center

Notable Features of the Mark VIe Control System

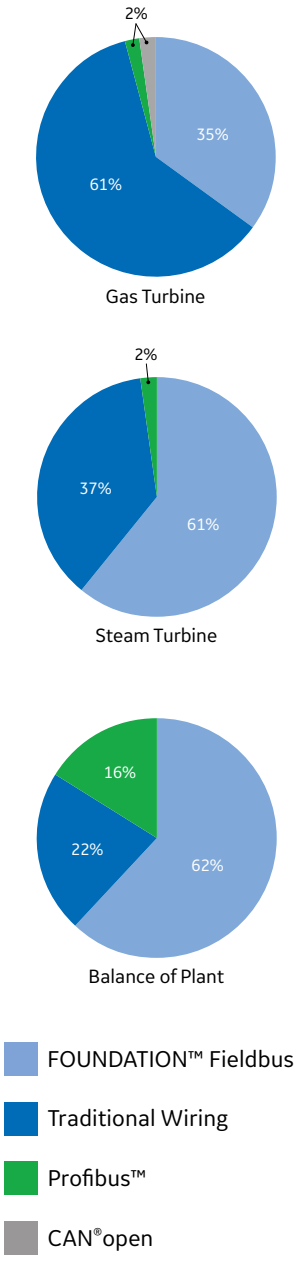
Digital Bus Protocols

GE's Mark VIe Plant Control System hosts several digital data bus technologies to facilitate communication among the controllers and sensors, as well as the actuators and electrical equipment. In contrast to traditional methods, digital bus technologies allow several signals to be transmitted over one set of wires for control and monitoring purposes. Digital bus devices can also exchange additional information with the controller and remote platforms, such as identification, health, diagnostics, and control settings.

Digital bus connection methods and the additional information provided decrease total installed cost by significantly reducing the amount of effort spent on interconnecting wires and terminations, thus, simplifying and speeding up checkout and commissioning. A typical 9HA plant with digital bus technology will realize approximately $1 million in cost savings. The technology also can provide long-term operational benefits to power plant owners and operators through improved fault detection and diagnostics.

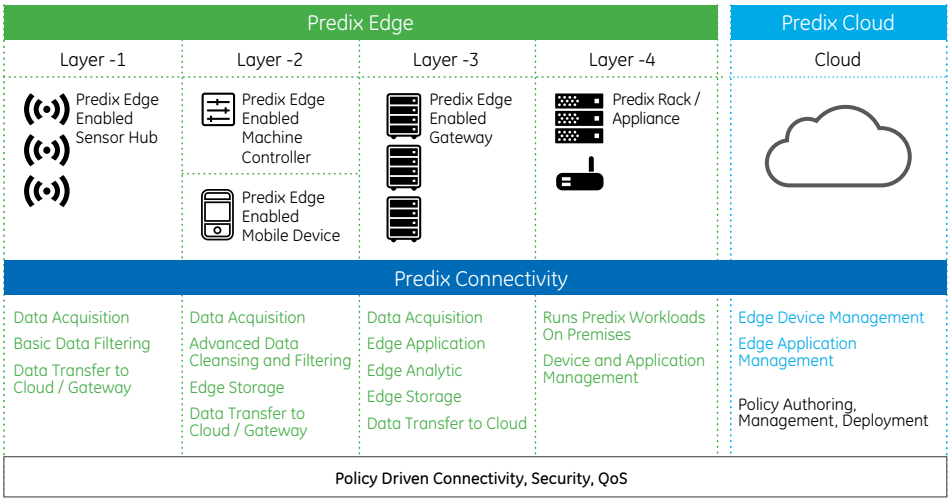
ActivePoint HMI (Human Machine Interface)

To improve worker efficiency, reduce operating costs, and deliver a superior power plant user experience, GE engineered the ActivePoint HMI in close collaboration with more than 100 operators globally. The ActvePoint HMI is in compliance with ISA 18.2, the High Performance HMI Handbook, and other industry standards. It is a total solution enabling system monitoring and controlling from any device, anytime, anywhere. HMI screens for all GE power generation equipment will conform to this new design guideline to provide a common interface across the entire plant and to create a user experience that is visually appealing and enhances situational awareness.



Alarm and Protection Rationalization

GE's new alarm management system is fully integrated into the ActivePoint HMI. Alarms are now directly represented and actionable within both HMI screens and dedicated lists, and are based on GE's three-step alarm rationalization process (Design, Categorization, and Alarm Prioritization). By applying common philosophies and rationalization rules across all equipment within the plant, enunciated items are categorized as Events, Diagnostics, Alerts, or Alarms (levels 1, 2, and 3) to greatly improve operator responsiveness.



Actionable alarms can be reduced by as much as 80 percent and are organized into parent-child hierarchies to simplify determining root causes. The alarm management system details the urgency, consequences, potential causes, and suggested actions. Using the Mark VIe distributed control system (DCS) for controlling the entire plant enables enhanced alarm configuration and presentation capability, as well as an integrated operating experience across GE equipment.

Similar to alarm rationalization, GE developed a consistent process for rationalizing the controls protection system associated with plant equipment (Trips, Shutdowns, Runbacks, Pre-Start Checks, and Permissives). Trip optimization reduces or eliminates nuisance trips. Startups are streamlined through the categorization of pre-start checks (not required for startup) and permissives (required for startups).

Edge Computing Architecture

As part of an overall edge architecture for digital, several layers of processes are required to accommodate the needs of data ingestion, real-time analytics and transmission to the Predix Cloud. These fall into the four categories of Edge Enabled Sensors, Edge Controller, Edge Gateways and Predix Appliances. Together, these components are orchestrated to both transform and deliver data for cloud based processing as well as deliver edge-based analytics required for immediate on-premise decisioning.

Advanced Controls / Edge Computing Solution Applicability

Gas Fossil

For information on GE Power Digital Solutions:
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