Customer Success Story:
Synchronous Condenser Conversion
Investor owned utility

Eaton converts retiring generating units to synchronous condensers to enhance grid reliability

Location:
Central USA

Challenge:
Convert three retired coal-fired generators to synchronous condensers to support voltage stabilization on the grid for safe, reliable electric power transmission

Solution:
Eaton's customized turnkey synchronous condenser conversion solution covering all aspects of the facility design and build process with a standardized approach that facilitates rapid deployment of conversions

Results:
A successful synchronous condenser conversion and control system update ensuring all machines work together to support voltage regulation, enabling the utility to automatically respond to grid conditions for enhanced grid reliability

"The U.S. Energy Information Administration predicts that most of the planned retirements through 2020 will be coal- and natural gas-fueled steam turbines. The use of distributed energy resources continues to rise, creating a multitude of new system operation and reliability challenges for grid operators."

Background

As grid and generation sources evolved, this utility evaluated their options to meet grid requirements and provide their customers with safe, reliable and responsive service. The resulting plans included retiring a coal plant that was built over 60 years ago.

However, the utility discovered through the system planning process that voltage support on its transmission system would be adversely impacted by the retirement of such a large generating asset.

To address this issue, the utility decided to convert the retired generators to synchronous condensers. By converting the generators to synchronous condensers, the utility would be able to automatically stabilize voltage conditions on the electric power transmission grid as well as provide physical inertia and short-circuit current capacity to ensure safe, reliable power delivery.

Challenge

Synchronous condenser conversions are complex technical projects that require a high degree of specialized knowledge and project management capabilities. These conversions not only involve major changes to mechanical and electrical distribution systems, but also updates to the control, protection and operating elements that support these systems, demanding a holistic approach to modernization.

To convert the existing steam turbine generators, the utility needed a project partner that could lead the project, including all aspects of the facility design and build for the mechanical systems, electrical systems and advanced protection and control systems.

Based on Eaton's demonstrated success in similar projects and confidence in the company's technical approach, Eaton was awarded a turnkey project including the full scope of the electrical and mechanical solutions.

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Solution

Eaton's strategy for the project was centered on creating a standardized solution for the units and a system designed to "stand alone" as much as possible from the existing infrastructure. This allowed the utility to decommission large portions of the facility without impacting the operation of existing synchronous condenser units.

Control and design elements were structured to facilitate rapid development of similar solutions for future conversions, with standardized design elements for hardware, software and operator interfaces. To support a smooth transition for operations staff, Eaton emulated synchronous condenser conversion control sequences and operator interfaces that were implemented during the earlier conversion project.

Eaton converted the machines by disconnecting the turbine, replacing the excitation and control systems, and performing extensive modifications to cooling, lube oil and other auxiliary systems. The machine's stators were rewound, a new pony motor, medium-voltage drive and new thrust bearing were installed, and extensive power system modifications were performed.

Additionally, as the turnkey system integrator, Eaton utilized experienced partners for key project elements such as mechanical engineering and manufacturing of static excitation systems.

Eaton also developed the testing and commissioning plan and used Eaton's structured commissioning process, which incorporates well-defined checkpoints and deliverables to support a successful project.

Eaton implemented a PLC-based control system to handle all machine startup, synchronization and dispatch functions. The control system ensures all machines work together to support the 138 kV bus voltage while sharing load equally amongst all online machines.

Following project completion, Eaton provided detailed operations and maintenance manuals based on project documentation. These were developed in addition to a robust training program designed to help operations and maintenance staff with the transition.

Results

The synchronous machines are equipped with modern-day digital excitation systems that can support high-level adaptive voltage control strategies. The system can automatically supply fault current to the grid, lowering system impedance and improving transient response during faults. Due to relatively long thermal time constants, the synchronous condensers can also supply many times their rated output for short-time durations for reliable operation.

By removing coal-fired boilers and converting existing generators to synchronous condensers, utilities are addressing these challenges through the ability to provide automatic voltage regulation that is responsive to grid conditions along with physical inertia and fault current capacity to enhance grid reliability.

The synchronous condenser system is automatically set to respond when needed. This feature requires very little human operation and reduces cycling of other grid elements, such as capacitor banks that provide voltage support.

According to the U.S. Energy Information Administration, nearly all of the power plants in the United States that were retired from 2008 through 2017 were fueled by fossil fuels. The organization also predicts that most of the planned retirements through 2020 will be coal and natural gas fueled steam turbines. The use of distributed energy resources continues to rise, creating a multitude of new system operation and reliability challenges for grid operators.

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