50th Annual Canadian Consulting Engineering Awards

Ingredion — 15MW Cogeneration Project

Cardinal, Ontario

Category E: Natural Resources, Mining, Industry, Energy

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Q.1 Innovation

Briefly introduce your project, i.e. what was done and why? Then explain how the project demonstrates the innovative application of engineering principles or techniques. How is it distinguishable from similar projects of its type?

The new Ingredion Cardinal 15 MW cogeneration plant is located in Ingredion Canada Corporation's (Ingredion) corn product manufacturing facility in Cardinal, Ontario. Prior to its construction, Ingredion relied entirely on outside sources of electricity and steam supply. Electricity was supplied from the Ontario Hydro One power grid through the neighboring Cardinal Power Plant, and steam was supplied by a natural gas fueled steam boiler in the Cardinal Power Plant. The completed cogeneration plant can supply 95% of Ingredion's electricity demand and 100% of its steam demand.

Gryphon International Engineering Services, Inc. (Gryphon) was the project's design engineering firm from the start of project development in 2009 until commissioning and delivery in 2017. The cogeneration plant was built around a Siemens 15 MW natural gas fired combustion gas turbine generator. A heat recovery steam generator installed at the turbine exhaust recovers turbine waste heat for steam generation. Supplemental natural gas firing burners in the gas stream increase the cogeneration plant steam output to meet Ingredion's steam demand.

The cogeneration plant is designed with high overall plant efficiency in mind. Its feedwater heat exchanger maximizes heat recovery from turbine exhaust, while its building ventilation system directs warm air from the high bay area to the colder ventilation air intake area on the ground level to reduce building heating requirements. Other design feature includes a digital electrical load management system which prevents power export to the grid during normal operations and will allow the cogeneration plant to continue to operate in islanded mode to supply Ingredion with power and steam during utility power outage.

This cogeneration project was notable not for its difference in design but rather its approach to complex site conditions. The production facility's proximity to noise sensitive areas, including a school and residences, created an immediate challenge to meet low noise impact requirements. Coupled with the noise concerns were space constraints. The allocated site was a small area bound on all four sides by equipment, buildings and plant access ways. High voltage power lines, a main steam line, natural gas lines, and an emergency fuel oil supply system—owned by separate stakeholders—were located in the proposed site. Maintaining these critical services during construction to allow continuous operation of the facility with minimum interruption was essential. The project team put substantial effort into developing plans and suitable design for the staged removal, relocation, and integration of services.

Q.2 Complexity

Explain any extraordinary problems and conditions that were overcome.

The space allocated to build the project was exceptionally small with an abundance of utilities, equipment and surfaces located in and around the site. Maintaining the critical services in the site area during construction was essential to allow continuous operation of the Ingredion facility with minimal interruption; however, this was complicated by the services' split ownership among Cardinal Power, Ingredion, and Union Gas. Early on the project team developed a detailed plan for demolition, modification, relocation, tie-in, and work required during construction and thoroughly discussed the plan with each stakeholder to gain their acceptance prior to designing the facility.

Substantial effort was put into developing plans and suitable design for the staged removal, relocation, and integration of these services. Prior to construction, the fuel oil tank and associated piping system were replaced by a new double walled fuel oil tank at a different location and the main steam line was replaced by a temporary steam line supported by shoring piles. Foundations for the heavy equipment and building were designed to avoid impacting the buried high voltage cable duct bank located directly under the new building.

Maintaining site safety was also a particularly difficult challenge due to the proximity of live high energy electrical, steam, and natural gas systems. Discussing the work plan with stakeholders helped to identify and address safety concerns through the system design, construction plan, and construction methods, and ultimately achieved zero total recordable injury rate and zero loss time incident rate.

Q.3 Social and/or Economic Benefits

Explain the social and economic benefits to society provided by your project. Be specific and provide qualitative and quantitative information.

Ingredion's production facility at Cardinal, Ontario, employs a staff of 204 personnel. The facility acquires corn supply from local growers for its corn refining process and supplies animal feed products to local farmers. As such, the Ingredion Cardinal facility is not only a large employer of the area but also a strong supporter of the local agricultural industry. With the addition of the cogeneration plant, Ingredion is able to improve its competitive advantage through lower energy costs, which allows the facility to continue to operate to meet the increasing competitive challenges, sustain employment, and support the local agricultural industry.

Q.4 Environmental Benefits

Explain how your project addresses environmental/sustainability issues.

Ingredion's operations are optimized through the provision of more efficient and locally based power while making contribution to emission reduction. This natural gas fueled cogeneration plant provides a net 25% reduction of greenhouse gas emissions when considered a displacement of the output from a fossil fuel utility plant based on US EPA greenhouse gas emission reduction calculations. The gas turbine generator also uses dry low emission technology to minimize NOx, CO and other emissions.

Although the plant is near the St. Lawrence River, air coolers were used for power generation cooling to minimize impacts to the river.

The project was near noise sensitive areas, including a school and residences. Its low noise impact requirement was met by carefully selecting equipment, using silencers, and strategically placing noise sources. Turbine intake and lube oil cooler fans were placed on the opposite side of plant building as the receptors with the power plant building acting as a barrier to block noise transmission.

Q.5 Meeting Client's Needs

Explain the client's main project goals and how you met them.

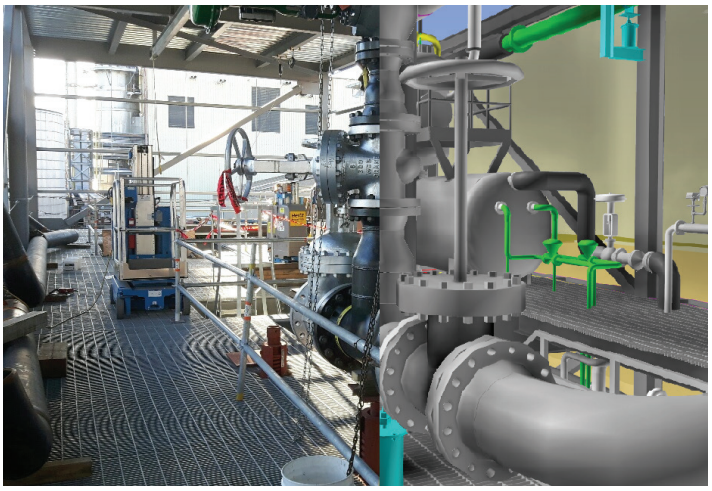
The designer, constructor, commissioning team, operation group, stakeholders, and utility companies worked together to deliver a cogeneration plant that met Ingredion's project budget, schedule, and intended goals. Consistent planning, progress monitoring, responsible engineering design, communication, and team coordination were the instruments behind the project's success.

Ingredion's primary goal was to improve energy supply reliability while lowering energy costs. With the addition of the cogeneration plant, Ingredion no longer needs to depend on the utility as the sole source of power supply and can continue to operate their production facility when there is a utility power outage. Utility power supply is retained only for backup and to meet peak power demand during summer. At the same time, Ingredion does not need to depend on a more than 20-year-old steam boiler as its sole source of steam supply. The cogeneration plant can supply Ingredion's peak steam demand, and the steam boiler is retained for backup purpose only. With the efficient on-site cogeneration of power and steam, the cogeneration plant provides Ingredion with 25% of annual energy cost reduction.

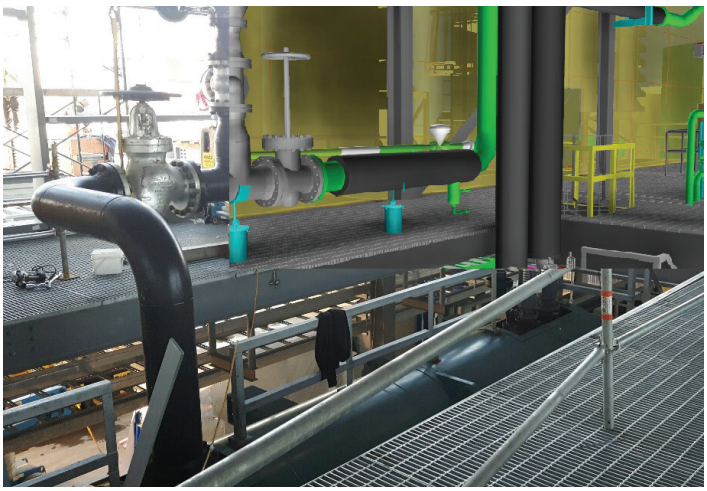
Photo - Gas Turbine Generator Front Section

Photo - Heat Recovery Steam Generator Steam Drum

Photo/3D Model Composite - Piping Installation

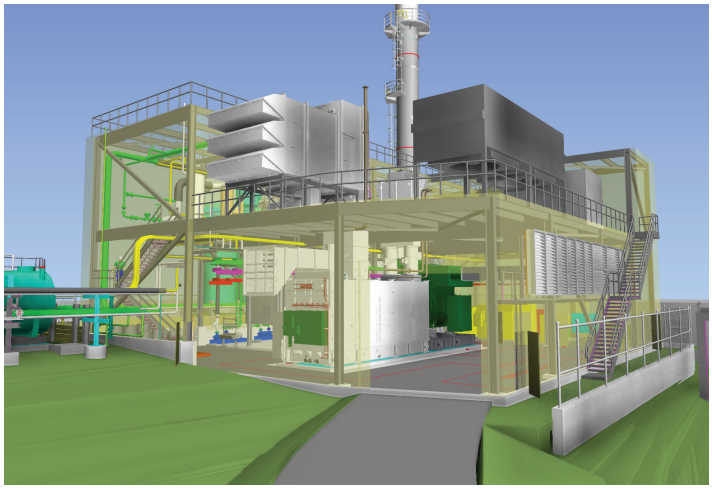


Photo/3D Model Composite - Piping Installation



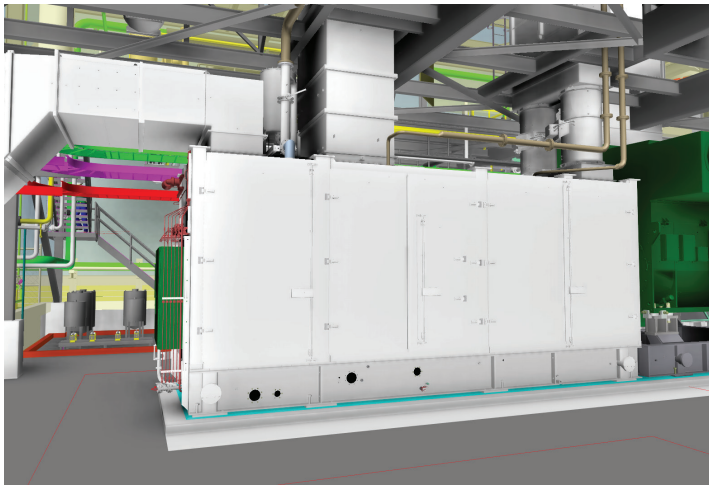
Photo/3D Model Composite - Steam Header Installation

Photo/3D Model Composite - Access Stairs Installation



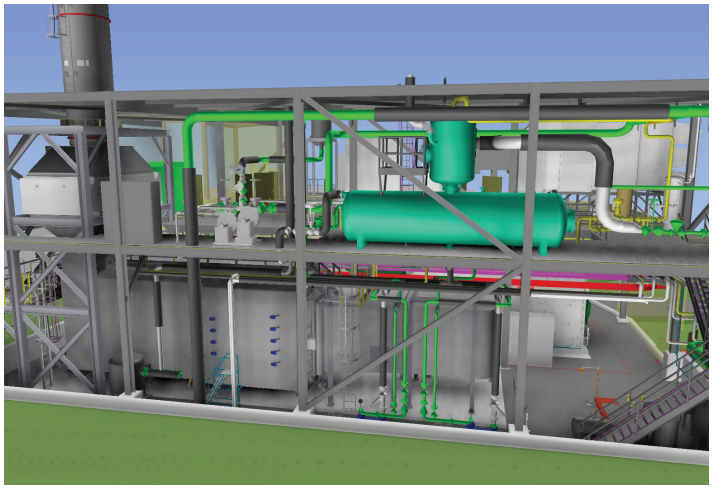
3D Model - Plant Overview

Photo - Plant Overview



3D Model - Gas Turbine Generator Overview

Photo - Gas Turbine Generator Overview



3D Model - Heat Recovery Steam Generator

Photo - Plant Overview and Fuel Oil Tank