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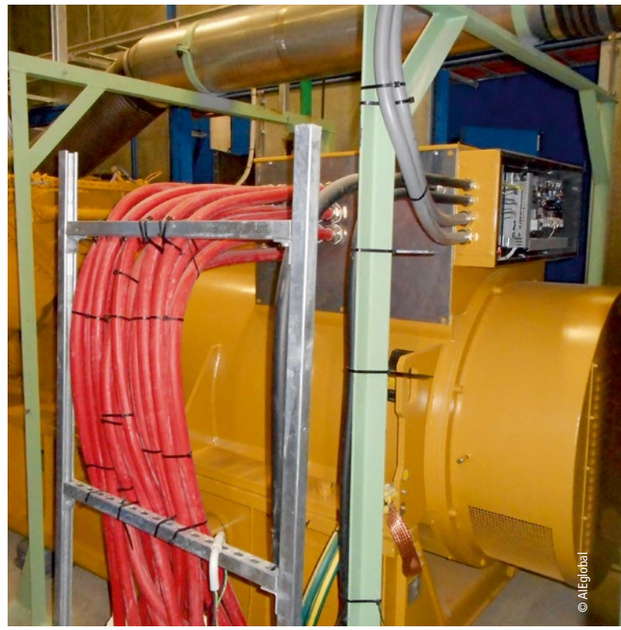
Implementing EtherCAT communications on each generator considerably reduced the wiring requirements and also the central control cabinet size to a single 800 mm tier.

The 8-MW trigeneration plant provides clean electricity for Melbourne Airport and provides backup power when the grid supply is lost.



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8 MW energy plant provides power, heat and cooling for Melbourne Airport

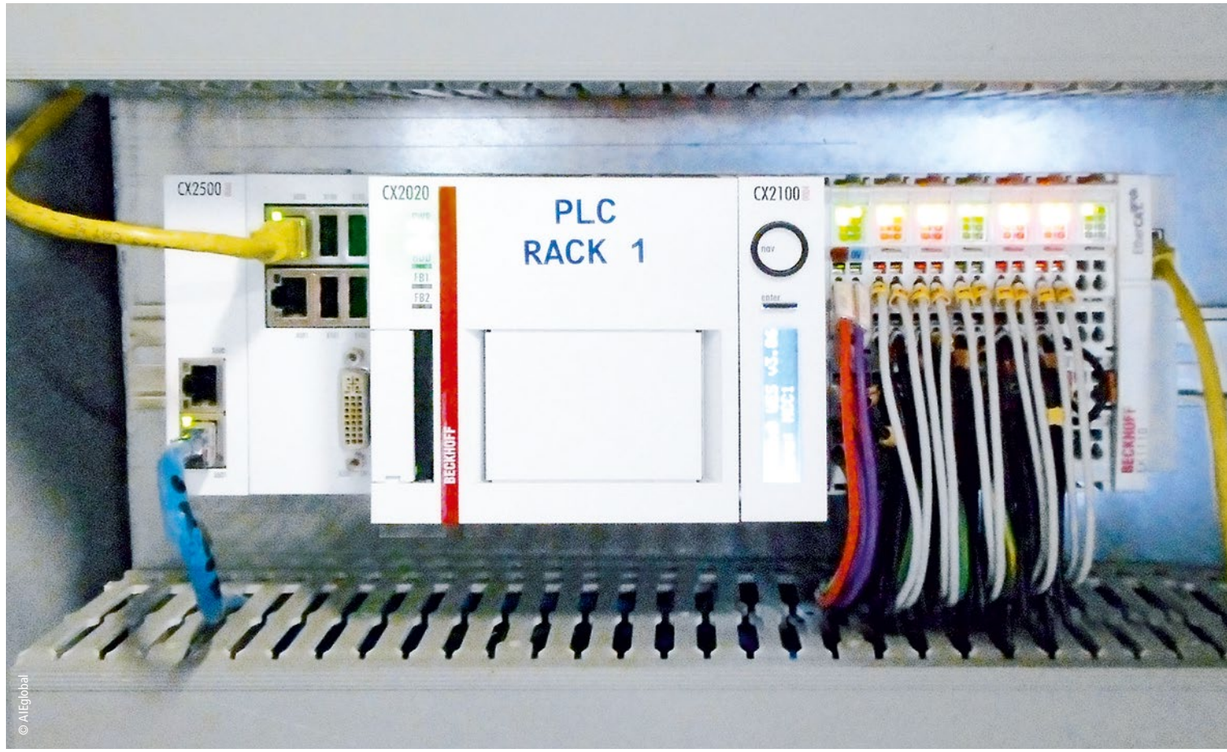
85% efficiency in trigeneration plant with fast process control

In thermal power plants, more than 50% of the energy is usually lost in the form of heat. The natural gas driven power plant at Melbourne Airport, on the other hand, uses the waste heat to generate heat and cooling, thus achieving a much higher energy yield. This is helped by Beckhoff Embedded PCs and EtherCAT I/Os enabling fast control and regulation of the plant, which automatically switches to emergency power supply in the event of a power failure.

Ideally, important facilities such as public authorities, hospitals or airports can at least partially maintain their operations when the grid supply is lost. To this end, the 8 MW power plant at Melbourne Airport is able to provide backup power. In normal operation, the plant covers part of the airport's energy needs with the grid-parallel supply of clean power. The contract to design and install an automation system for the complex power generation plant was awarded to engineering firm AIEglobal, based in Lake Wendoree, Australia. It specializes in automation and electrical engineering services for the manufacturing and building sectors. The project was implemented under the direction of lead electrical engineer Gary Brown.

The system comprises four sets of 2 MW natural gas driven generator sets. Heat exchangers on the engine exhausts provide hot water for general airport consumption and a source of heat for one of the two absorption chillers, which can generate cooling using the heat energy input. Further water heat exchangers on the engine jackets provide heat energy for the second chiller, which is used in times of higher cooling demands. As a result of trigeneration, also called combined cooling, heat and power generation, the overall plant has proven to be capable of transferring 85% of the gas energy input into usable energy for the airport.

The EtherCAT I/Os installed on each genset significantly reduced the amount of cabling required for connecting to the central control room.



Seven CX2020 Embedded PCs were selected to automate the four 2 MW generator sets, the heat exchangers and the overall plant control system, as well as the connection to the SCADA system.

Substantial cost savings

AIEglobal used seven CX2020 Embedded PCs for the automation of the generator sets (gensets), hot water reticulation and overall plant control including HV substation circuit breaker switching. For fail-safe plant operation, the controllers are configured in a ring topology network along with a primary and secondary redundant SCADA system, with all communications using OPC UA.

Heat exchangers on each generator's engine exhaust and engine jacket feed two separate heat exchanger systems, with high-temperature hot water being generated by the exhaust gas boilers. Distributed EtherCAT I/O are used on each generator set for system networking. Implementing EtherCAT communications on each generator considerably reduced the amount of electrical wiring required for connecting to the central control room. The central control cabinet size could also be reduced to a single 800 mm tier. The cost savings of this approach are substantial, and by using EtherCAT there is no performance degradation as is common with several other fieldbus types in extensive installations. The I/O scan time for the four gensets and central controller I/O is less than 1 ms, which enables optimum response times for fast PID control and control during emergency power conditions. To further ensure a high reliability level, EtherCAT redundancy was implemented on all remote I/O modules.

Short cable runs in the Modbus RTU network

The system comprises over thirty variable speed drives for pump and fan control controlled via ten Modbus RTU serial communication networks. Each Modbus network uses an EL6021 EtherCAT Terminal as Modbus master terminal connecting to an average of four VSDs (variable speed drives). This approach keeps the RS485 cable runs short, enables connections based on required functionality and consequently achieves the high performance necessary for PID control of important process variables by the relevant CX2020 controller.

Common protocols in process automation

The automation of the trigeneration project required the use of a broad range of communication protocols. The CX2020 controllers, along with the directly connected EtherCAT I/O proved very powerful in this respect. Listed below are the protocols used and their communication functions:

- OPC UA: CX2020 to CX2020 and SCADA system to CX2020
- Modbus/RTU: CX2020 to variable speed drives, circuit breakers and energy meters (electrical and gas)
- Modbus/TCP: CX2020 to gensets, Ethernet gateways to third-party genset controls, Modbus RTU gateways, circuit breakers, HV and LV systems and HMI units for the gensets
- M-Bus: CX2020 to gas energy meters (implemented in TwinCAT)
- DNP3: CX2020 to SCADA system

Productivity in IEC 61131-3 programming

By far the biggest expense in implementing modern control systems is the cost for software application. This includes the functional description in the initial design, coding, commissioning as well as ongoing support and fault diagnostics. Gary Brown explains: "Based on many decades of experience, I have found that the use of the IEC 61131-3 line-based graphical function blocks provide the highest level of useful information on the PLC programmer's screen. The TwinCAT Engineering platform, based on Visual Studio, provides a very fast and efficient method for program entry, debugging and ongoing support. Most conventional PLC systems use a spreadsheet type of presentation for programming, which is often slow and tedious to use and limits productivity."

He concludes: "I have noticed over recent years the software implementation of control system projects using high-level languages that were not designed for real-time control, doesn't always work as intended. IEC 61131-3 has evolved over many decades, and for very good reasons. So we were very glad that TwinCAT Engineering provided us with a user-friendly interface for IEC 61131-3 programming."

More information:
https://aieglobal.com.au
www.beckhoff.com/cx2020
www.beckhoff.com/twincat