



## Beckhoff Embedded PCs control hydroelectric power plant

Among renewable energies, hydroelectric power generation has the highest share worldwide; mountainous countries in particular, such as Colombia, are seemingly made for generating electricity with water. The hydroelectric power plant La Ínsula, which was built in the Colombian province of Caldas on behalf of the power supplier, Central Hidroeléctrica de Caldas, has an effective output of 33 MW. The control, protection and monitoring of the hydroelectric power plant is based on a Beckhoff control platform with Embedded PCs, EtherCAT I/O and TwinCAT automation software; it was installed by the Argentinean company, ICSA Automation.

ICSA Automation, with headquarters in Luján de Cuyo, Mendoza, Argentina, specializes in the automation of hydroelectric power plants and wind farms worldwide. Established in 1982, the company has to-date completed over 400 projects in 24 countries, thereby accumulating extensive know-how. In 2010 ICSA automated the Colombian hydroelectric power plant La Ínsula, which is fed by the Chinchiná and Campoalegre rivers and consists of three Francis turbine units. For this plant ICSA developed an integrated control, protection and measuring system based on Beckhoff technology.

### **Embedded PCs perform complex control, protection and monitoring tasks**

The ICSA control systems for hydroelectric projects contain various subsystems, such as voltage regulators for the generators, turbine inlet valve controllers, turbine speed monitors, mains quality meters, brake controllers, a cooling system, lubrication system, main voltage switch and synchronization devices. The various protective relays represent a very important subsystem

and communicate via the IEC 60870-5-104 protocol with the CX1020 Embedded PC. Their major tasks are: the operation and coordination of several generator subsystems during the automatic starting and stopping procedures, synchronization of the unit, adjustment of the set values for the effective power and voltage, temperature monitoring, event monitoring with a resolution of one millisecond, control of the switchgear, measurement of the electrical variables, monitoring of the auxiliary electrical and mechanical generator systems, control of the cooling system and monitoring of the power plant's wastewater system. The controllers exchange data over Ethernet; hard wiring is provided as a redundant transmission medium in case of emergency.

The plant is controlled and monitored via a local operator station with Scada software. This includes a graphic display of the turbines, the generators, the switchgear, the auxiliary systems, etc. Further tasks of the Scada software are: alarm processing, displaying event sequences, displaying graphic tendencies, report production, historical data storage, machine operator assistance, etc.



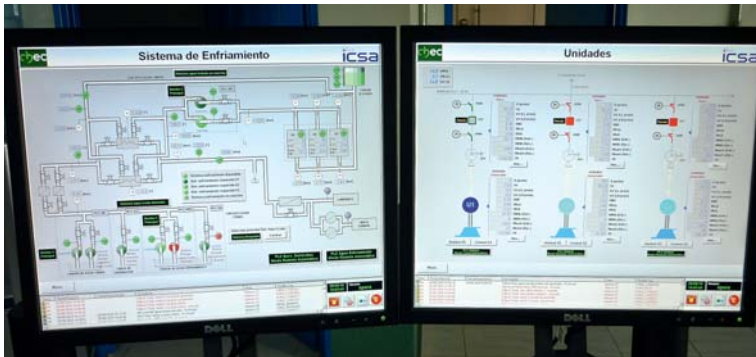
In 2010, ICSA Automation automated the Colombian hydroelectric power plant La Insula, which is fed by the Chinchiná and Campoalegre rivers.

Inspection of the turbines. Three Francis turbine units with vertical axles produce electricity with a total effective output of 33 MW.



The plant is controlled and monitored via a local operator station with Scada software.

A total of four CX1020 Embedded PCs are used for the control of the generators and for auxiliary functions.



The various subsystems communicate via the IEC 60870-5-104 tele-control protocol, which is supported by the TwinCAT PLC automation software. The Beckhoff control architecture enables remote monitoring and control from two different control centers, which receive all necessary data for the correct operation of the power plant, such as alarms, status data, events, measurements, etc.

**EL6688 external synchronization interface ensures precise time synchronization**

One of the most important tasks in hydroelectric power plants is recording the changes in state and the sequence of events ("SOE"). This function allows the digital inputs to provide events a timestamp with a resolution of one millisecond, to buffer them locally and, finally, to transmit them without loss to a higher monitoring level. This critical task is performed by each Beckhoff controller. The time synchronization is accomplished using the IEEE 1588 Precision Time Protocol. The EL6688 EtherCAT Terminal, as an IEEE1588 external synchronization interface, and a master GPS Clock in the control room of the power plant ensure precise time synchronization within the local network.

**Universal control programming with TwinCAT PLC**

The Beckhoff Embedded PCs were installed at different control levels. A total of four CX1020 Embedded PCs are used for the generators and auxiliary functions, while the cooling system, pump house and suction pump are each controlled by a CX9010. The Embedded PCs receive the signals from the field via the connected digital input and output terminals. Programming is accomplished universally using TwinCAT PLC automation software. The TwinCAT PLC Modbus RTU library is used for the connection of the controllers with the mains quality meters and the operator interface. Communication between the controllers, the local Scada system and the remote monitoring center takes place via the IEC 60870-5-104 telecontrol protocol, which is integrated into the TwinCAT PLC library.

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