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E3 series®

*Zuken's software solution for electrical wiring, control systems and fluid engineering.*

# ***Hydro-Québec*** Improves Greenfield Substation Design Productivity by 100% with Zuken E³.series

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Claude Savoie,
Manager of Substation Engineering,
Hydro-Québec

# *Hydro-Québec* Improves Greenfield Substation Design Productivity by 100% with Zuken E³.series

**Hydro-Québec is one of the world's largest hydro-electric power producers with 63 generating stations, 27 large reservoirs and 530 substations used to produce and distribute electrical power around the province and to wholesale customers. Substation design is a major challenge with new greenfield installations, modifications to existing substations and many brownfield projects every year.**

In the past, engineers produced thousands of design documents for each greenfield substation with 2D computer aided design (CAD) drawing software and often made changes with scissors and scotch tape because it took too long to change the design file. The marked-up documents accumulated more and more changes, which made them difficult to understand and often led to errors that required additional time to detect and correct. Hydro-Québec has simplified the design process by implementing Zuken's E³.series cable application management software to manage both the logical and physical design and ensure their consistency. The company has additionally achieved time savings by using subcircuits and templates to duplicate the scores of circuits that are repeated many times both within and across projects.

"By improving our design process we have reduced the design effort required to complete greenfield projects by 50% and achieved substantial savings in brownfield designs," said Claude Savoie, Manager of Substation Engineering for Hydro-Québec.

## Clean, reliable energy supplier

With a total installed capacity of 36,912 Megawatts, Hydro-Québec provides a clean, renewable and reliable supply of electricity to all Quebecers. It also sells power on wholesale markets in northeastern North America. The company's substations play a key role in controlling power flows. For example, they divide long lines into smaller sections, which helps to minimize any disruption to the continuity of service when a section is not functional, such as during a fault or maintenance period.

*Duchesnay substation during construction, a greenfield project that utilised E³.series.*

## Outcomes:

- Design productivity doubled with E³.series
- E³.series manages both logical and physical cable design for consistency
- Design changes automatically propagate ensuring data is synchronized and up to date
- E³.series enables multiple engineers to work concurrently on the same design
- Subcircuit and template usage boosts productivity and eliminates errors.

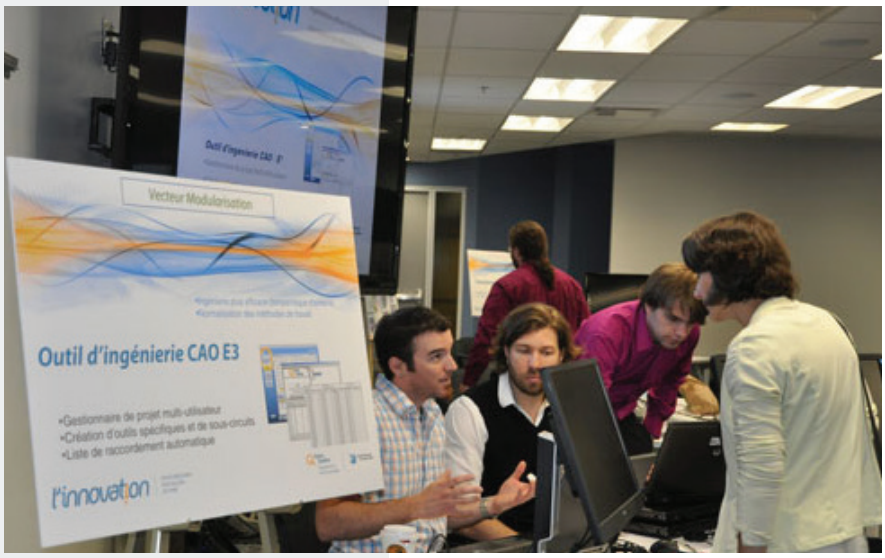
## Hydro-Québec

Hydro-Québec is a major supplier of electricity, relying on clean, renewable energy.

Hydro-Québec generates, transmits and distributes electricity. It uses mainly renewable generating options, in particular large hydro, and supports the development of other technologies, such as wind energy and biomass.

E³.series is Zuken's software solution for electrical wiring, control systems and fluid engineering.

The various components found in a substation include instruments for measuring current and voltage, protective equipment such as circuit breakers for interrupting a line's current, control devices, and disconnect switches which are used to switch energy from one line to another almost instantaneously when sections are out-of-service.



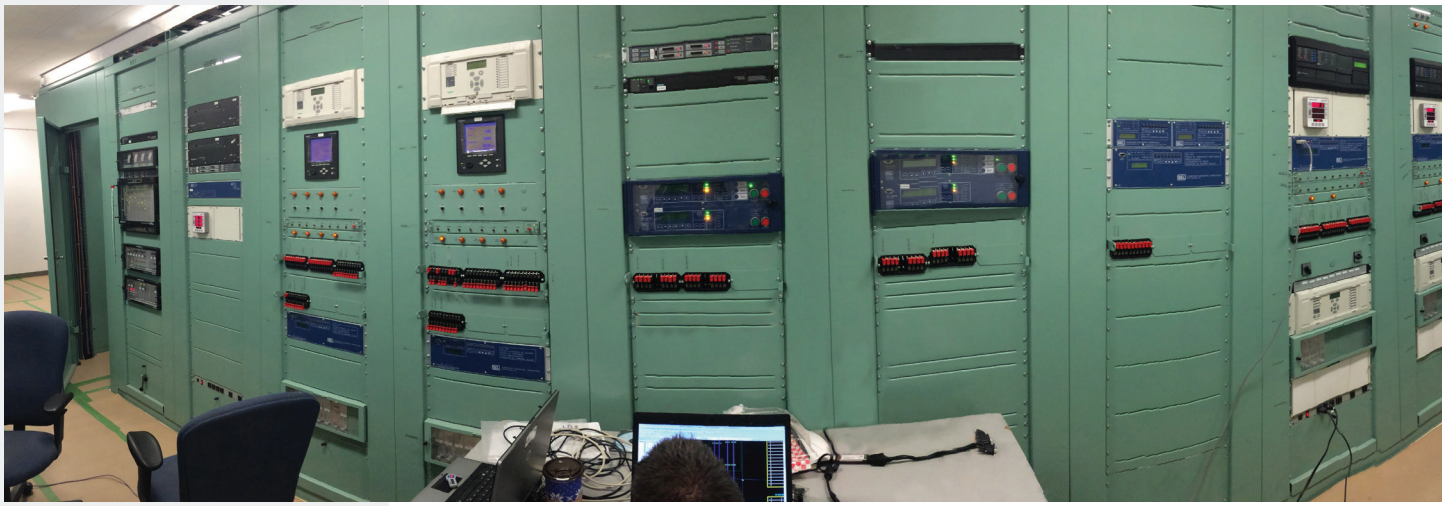

*Patrick Cloutier, Jonathan Beaulieu and Samuel Carrier present E³.series to other Hydro-Québec engineers at the company's Innovation Day.*

Savoie supervises 45 engineers and 35 technicians as well as several external engineering firms who are responsible for substation design. In the past, engineers created and maintained well over 1,000 wiring diagrams and panel layouts for substations by selecting symbols to represent equipment and snaking cables through the diagrams to connect them together. They created parts lists and cable lists by entering each part on a spreadsheet as they added it to a drawing.

The first pass usually went relatively smoothly but the process got more complicated when changes were required. For example, if space was tight, simply adding a cable that stretched from one sheet to another might require considerable redrawing of both sheets to make room for the new cable. Moving a component required moving all the cables connected to that component and reconnecting them in the new location. In some cases these cables might pass between numerous drawings and each of these drawings had to be located and updated to properly implement the change. Each change to the wiring diagram required a corresponding change to the parts list and cable lists and this was easy to overlook or enter incorrectly, leading to inconsistency between drawings and costing time and effort finding and correcting the errors.

## Changes often made on paper in the past

Hydro-Québec engineers found that it was faster in most cases to make the many changes required during the design process by marking up the paper schematics. The problem with this approach was that the more changes that were made, the harder it became to understand the schematic, which increased the likelihood of errors. "The marked-up drawings made sense to the person who created them but they were very difficult for others to understand," Savoie said.



*Hydro-Québec substation in the Nord-du-Québec region was commissioned in the fall of 2015.*

"For example, if the owner of the substation later decided that it needed another alarm it was often difficult to determine which cable it should be connected to."

Considerable time had to be spent checking and rechecking the drawings and the assembly process was hampered by the need to manually follow connections from sheet to sheet to understand the design intent. Prior to commissioning, all the changes made on paper had to be entered into the design system and this provided another opportunity for errors to occur.

Savoie decided to consider alternative design solutions. The company's engineers benchmarked 10 different software packages. One key advantage of E³.series revealed during the benchmarking process is that it manages both the logical and physical design so that information only needs to be entered once and the software keeps all the different design documents in sync.

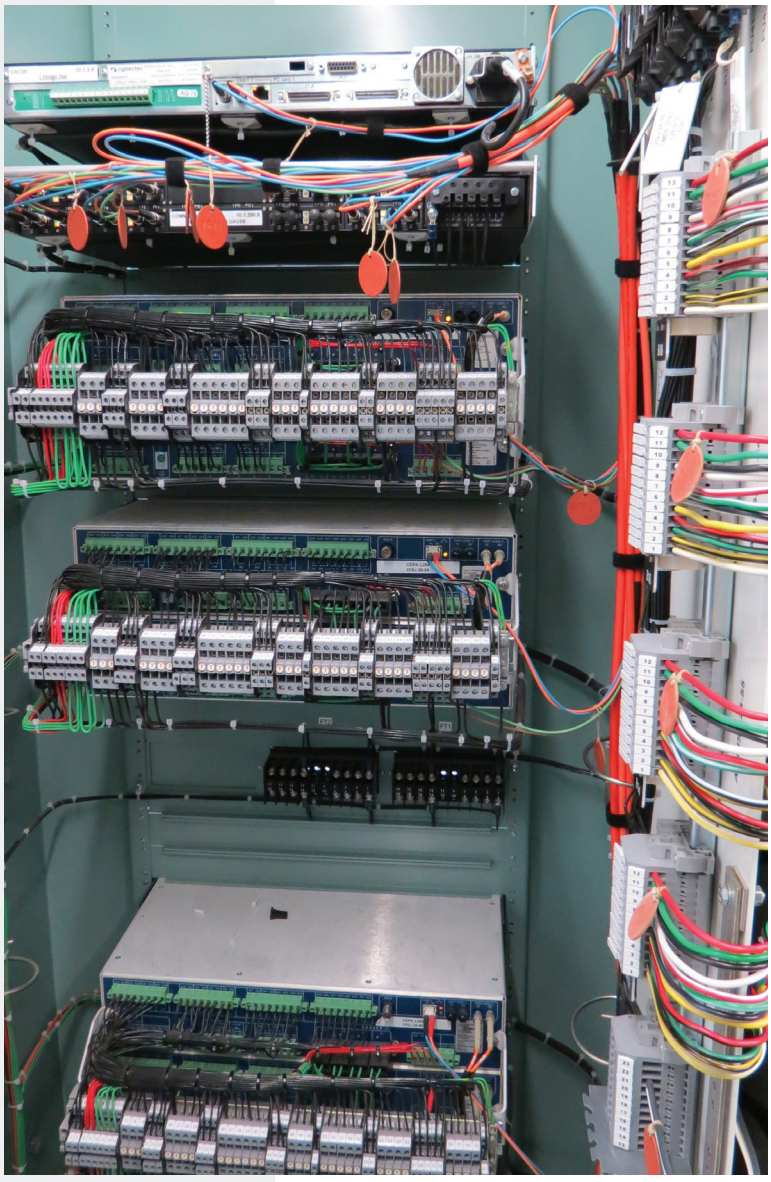
*Hydro-Québec's Jean-Sebastien Labbe performs testing at the Romain-1 substation.*

For example, the software automatically keeps track of what is connected to what so an engineer can drag a component from one location to another, even from one page to another, and the software will automatically update the cables and cross-references across each of the sheets they traverse. Furthermore, adding a new component automatically updates the parts list and cable list. Another key factor in the decision process was the ability of the E³.enterprise, the multi-user access edition of E³.series, to make it easy for multiple engineers to all work simultaneously on the same design. Multi-disciplined teams of engineers and technicians share the same project and data and any changes carried out by the separate teams propagate through to the other sections of the design, ensuring all data is synchronized and up to date.

## Subcircuit and templates manage repetitive circuitry

Each new substation design contains many circuits that have been used on previous projects and these circuits are often repeated. In the past, engineers and technicians sometimes cut and pasted circuits but the time savings were not great because the designer usually needed to manually reroute the cabling on the wiring diagram, which was typically the most time-consuming part of the process. Hydro-Québec engineers now use E³.series to create template circuit diagrams that specify repetitive circuitry. These library entries are not simply drawings, but also have the intelligence to know, for example, how many and what type of connectors are contained on each component. Technicians can now simply drag these templates and drop them into the current drawing and all of the affected cables are automatically moved and properly connected in the new location. "The ability of E³.series to manage circuits as templates provides a substantial improvement in productivity and helps avoid errors," Savoie said.

It would have taken a tremendous effort to convert Hydro-Québec's hundreds of existing substation designs to the new software. Instead, the company designs brownfield projects in E³.series and creates virtual circuitry to represent points where the new circuitry connects to existing panels. The virtual circuitry is often important to the success of the project because key components are often duplicated in brownfield projects so that one can operate while the other is being upgraded in order to maintain electrical power to customers. These components are incorporated in the virtual circuitry so that instructions can be provided for their management during the commissioning process.



*The Saint-Jerome substation in the Basses-Laurentides region was designed as a greenfield project with E³.series.*

## Scripts automate error detection process

Hydro-Québec engineers developed C_Sharp and Visual Basic scripts that run inside E³.series to verify the integrity of their work. For example, these scripts look for terminal blocks that have two or more wires connected to them, wires within cables that are not arranged in the normal order, connectors that do not mate properly with one another, assemblies with more wires than pins, etc. so they can be verified manually. E³.series also simplifies the manual checking process by enabling engineers to simply click on a signal to trace its route through the design. The E³.series database automatically tracks each of the components used in the project so this information can be reported and used by the assembly team. When the checking process has been completed and the design is approved, engineers export the parts list and cable list from the design as an Excel spreadsheet and upload it to the company's control system.

"Our new automated methods have substantially increased our productivity," Savoie concluded. "We are now able to complete greenfield projects in approximately half the time required in the past and our productivity on brownfield projects has also improved. The time savings comes primarily from E³.series' ability to manage the logical as well as the physical design, which enables the software to understand what change our engineers and technicians want to make and automatically update many aspects of the design that had to be done manually in the past. These improvements are highlighted by the fact that our design staff and external contractors required about 80 seats of our previous design software. The productivity improvements provided by E³.series make it possible to get the same work done with only 41 seats of the new software."