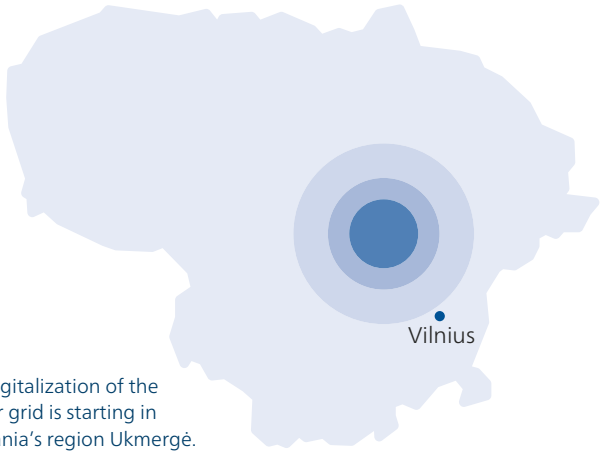
A BIG STEP FORWARD

Litgrid realized the first digital substation in the Baltics

Litgrid operates a national transmission grid of over 7,000 km (4,350 mi) power lines and 236 substations in Lithuania. The company is also responsible for integrating the national power system into the European power infrastructure and electricity market. The major part of the power system was developed in the 70's. In order to sustain reliability, the grid's equipment is renewed with new technologies. The digitalization of the Vidiškės transformer substation in the Ukmergė region is one such story.



The digitalization of the power grid is starting in Lithuania's region Ukmergė.

Every year, Litgrid starts and completes the reconstruction of 5 to 8 transformer substations (TSs). The plan for 2012 included the reconstruction of Vidiškės TS which had been in operation for over 35 years. The substation was not of particular significance for the transmission system and does not have very important users, which made it ideal for such a project. This way Litgrid was able to limit the potential risks while introducing a new technology that was untested and unfamiliar to both the staff and the contractors.

Where to start?

A survey of the main equipment manufacturers and suppliers such as ABB, SIEMENS, ALSTOM and GE was their first important task. The survey enabled Litgrid to learn about the offers and preparedness for supplying equipment such as the merging unit for the process bus and the RPA (relay protection and automation) equipment that ensures interoperability in the horizontal communication within the optical data network. Meetings and discussions were held to present the new equipment for the process bus. In the end, Litgrid was able to conclude that the project should not encounter any technical obstacles. This was the start signal for preparing technical specifications for this turnkey project – it was the first of its kind in the Baltic countries.

From conventional to digital

While the equipment of various manufacturers had specific characteristics and requirements for the installation there was one common technical aspect: a process bus where the data interchange takes place between the RPA equipment by means of GOOSE digital messages under IEC 61850 protocol. For that, the current and voltage measurements must be digitalized by the merging unit and sent to the RPA equipment under IEC 61850-9-2LE (Sampled Values data stream). Additional requirements have been considered like the mandatory national rules for the installation of RPA equipment:

- Secondary circuits from each connection's current and voltage measuring transformers and process signals have to be connected to the relays through the merging and switchgear control units with fibre optic cables under the IEC 61850 protocol.
- The merging and switchgear control units used for the current and voltage measurements of the connections and the digitalization of process signals must be installed inside or outside of an interim terminal's cabinet in the 110 kV open switchyard of the connection (depending on the manufacturer's recommendations).

The technology was new and its use was not widespread, the number of digital substation facilities in operation were still small, and the decision to not set any other specific requirements had been made; the equipment suppliers and manufacturers were free to select technical solutions that were appropriate for them.

Choosing a partner

Prior to starting the project, Litgrid did not know which devices were required for the adjustment of equipment in the process bus in operation and the RPA IED's routine checks, testing and potential repairs during the service life of the transformer substation. The situation was similar to that of 1998, when the modernization of TS's in Lithuania's transmission grid had been started including the implementation of RPA equipment. Equipment that was used for electromechanical relays for many years proved to be completely unsuitable for the adjustment and testing of the new RPA equipment. Therefore, the first CMC 256 devices were acquired in 1998. Today the CMC 256 / CMC 356, CT Analyzers, CPC 100 and other OMICRON equipment are the main tools for engineers performing adjustments and maintenance on RPA equipment and checking the characteristics of current and voltage transformers.

The main reason why OMICRON testing devices have become standard tools for engineers in Lithuania is the ongoing technical support, which is readily available and highly efficient. A special mention should be made, in particular, of the online library with test templates, which is being constantly updated along with the emergence of new RPA equipment on the market. Furthermore the personal contact with OMICRON also led to a partnership: Litgrid took interest in testing digital substation equipment at a CIGRE session in Belgium in 2014 by visiting OMICRON's booth. And the OMICRON Academy organized training sessions for relay protection and automation engineers from the Lithuanian transmission network in Vilnius during the same year.

Meeting needs

OMICRON presented its DANEO 400 in 2012. The device appeared just in time with its dedicated design for comprehensive testing tasks on data networks and IEC 61850 equipment. The IEC 61850 protocol visualization facilities implemented in the testing equipment's software are very valuable to engineers as they help them understand how the technology works by visualising the "virtual" cables. The following OMICRON hardware and software was used during the realization of the project:

- CMC 356 with updated Test Universe v3.10 software supplemented with IEC 61850 software modules: GOOSE Configuration Module, Sampled Values Configuration Module, and IEDScout
- CPC 100 with updated Sampled Values test card
- DANEO 400 for the substation's data network adjustment and quality checks

Unlike conventional substations, a digital substation requires testing whether the digitalization of analogue current and voltage measurements are correct. The quality of the measurements and their compliance with IEC 61850 must also be determined. Furthermore, the accurate operation of the equipment within the TS's data transmission network must be verified, as well as the GOOSE messages communicating via the merging units, the controllers of the drives of primary switching equipment and RPA equipment in the process bus. With OMICRON's testing solutions, Litgrid was able to meet all of these needs.

Conclusion

The TS was put into operation in July 2016. The first maintenance session is planned for the end of summer in 2017, with the participation of the RPA equipment manufacturer, in order to assess the functionality of the new generation of RPA equipment manufactured under IEC 61850.

An analysis of the digital substation has led to the conclusion that IEC 61850 equipment has very good prospects as a future technology. The number of cables connecting microprocessor equipment and basic equipment in the substation was reduced. If this technology is used, consequently the TS reconstruction costs would be cut significantly due to the minimization of cable communications between units. This, in turn, would lead to the reduced need for related secondary circuit equipment.

The main disadvantages are related to flaws and the insufficient functioning of the software for the microprocessor RPA equipment, merging units and units for the conversion of binary input/output values into digital values encountered during the implementation of the project.

Any deficiencies and difficulties which were encountered in the construction of the digital substation are temporary. The Litgrid team acquired significantly new experience and knowledge of the rapidly growing IEC 61850. And it became clear that Litgrid is already well equipped to handle this technology.

The team of the Transmission Grid Department of Litgrid

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Paulius Raila
Protection Engineer, Litgrid