NAME :Mika Loukkalahti
COUNTRY : Finland
REGISTRATION NUMBER : 6370

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QUESTION N° :1

Helen's full digital substation study.

Helen is a DSO operating in Helsinki, Finland. Helen is a city DSO with high SAIDI level (less than 3 mins/customer/year). This reliability level has been achieved partly due to high automation level. All Helen's HV/MV substations have been automated with IEC 61850 station bus (specification in 2007) or with serial bus automation and numerical IED's. Helen has invested for a long time in high voltage Gas Insulated Switchgears instead of air insulated ones.

Helen made an investigation starting in 2021 and ending in the beginning of 2022 about full digital substations. The aim was to find out if implementing of the IEC61850 process bus and Low Power Instrument transformers could be possible for new greenfield projects. All of the coming projects will be 110 kV GIS switchgear and 20/10 kV medium voltage switchgear substations. Helen executes substation projects as turnkey projects. Usually, the original vendor of the substation will continue with maintenance agreement for the automation part of the substation.

Helen discussed during this procedure with GE, Hitachi, Siemens Energy, ABB, Schneider, and Siemens. Helen has already two small running fully digital MV substations since 2018, Unigear Digital substations as part of Kalasatama closed loop network. Also, one smaller HV pilot was made with Schneider in 2016. The experiences from both projects were good.

High Voltage IEC61850 process bus

Possible process bus architecture was made for Helen's purposes. PRP-architecture would be needed as well as functional integration of IED's, combining control IED to one of protection IED's. HV process bus is still quite complicated. In Finland there is no experience among service provider's about IEC61850 process bus projects. IEC 61850 process bus does not bring any monetary advantages, because the wiring distances are short: the IED's will be located in the switchgear secondary cabinet or at secondary cabinet next to the switchgear. The process bus would also be quite complicated with time PTP synchronisation. Also, the IED's and process bus and MU implementation types differ from manufacturer to manufacturer. If there would be LPIT's installed, then the process bus would be almost mandatory at HV level.

High voltage LPIT's

Low power instrument transformers have a lot of advantages. Usually, Rogowski coils and voltage dividers are used at HV GIS level. Compared to the conventional instrument transformers they are smaller and save space, the amount of included gas is smaller, they have broad and dynamic CT range for every primary current, they are more safe with low secondary power and have less wirings. Also, the implementing of the new IEC61869 instrument transformer standard is now ongoing process. Again, manufacturers have different

kind of technologies. GIS integrated LPIT's are made with own gas compartment or as bushing between as compartments. The prize levels were still at the same or more expensive level compared to conventional ones.

Medium voltage process bus

Only one manufacturer has IEC61850 process bus at MV level. Process bus is made for distributing the voltages from voltage transformers to other bays without voltage transformer. The process bus is physically combined with station bus. There is also another implementation, where process bus is used. There the whole MV protection is centralised to one or two central computers. The other manufacturers do not use process bus at MV, because they are planning to install voltage sensors to all bays, then process bus in not needed.

Medium voltage sensors

Usually, Rogowski coils and voltage dividers are used as LPIT's. There are separate sensor models, and some manufacturers were developing combined current and voltage sensors located to every bay. At MV one of the biggest advantages of sensors would be the possibility to remove separate busbar voltage measurement bays. In Helen's situation this would mean saving of 4 bays in double busbar and two group substations. The price levels of sensors were at the same compared to conventional ones.

Conclusion

The market is not yet ready for LPIT's and IEC61850 process bus. There are not enough comparable commercial solutions for fair competition and no experience about the projects among the vendors. There are technologies and systems available, but the technologies are not comparable enough. For Helen the LPIT's would bring the economic feasibility for full digital substations for HV GIS and MV substations, but the LPIT market is not ready yet either. It is not possible to specify full digital substation for Helen's next HV/MV projects, there is maybe only optional possibility. Helen waits that the market for LPITs and IEC61850 process bus systems would develop quickly. Also, the advantages of LPIT's should be taken more into discussion also in the protection and automation community. They are too much left to the primary side experts.