

EXECUTIVE SUMMARY

Session 1 – Network Components

SUMMARY

Globally, the interest of papers submitted, the quality of discussions, the number of participants show that Session 1 on Networks Components is a unique opportunity to share views between manufacturers, Distribution System Operators (DSOs) and research institutes.

To prepare the networks of the future, new solutions and innovative network components have to be designed and implemented.

A total number of 129 papers have been selected for Session 1 and 24 of them have been presented orally during the main session.

MAIN SESSION 1 - BLOCK 1

Diagnosis and maintenance of network components – Part 1: Cables and lines

This first block was devoted to the diagnostic and maintenance solutions for cables and lines components.

Regarding the MV cables, a study presented the evaluation of dry-cured XLPE cables without water barrier using dielectric spectroscopy and showed a clear age dependency of the insulation condition. A second work addressed the efficiency of testing solutions to assess the condition of joints, and showed that a simple insulation tester is able to discriminate heavily degraded cables from cable systems with bad joints.

The influence of pulling forces on premature ageing of various LV and MV cable was analysed and showed that the current admissible pulling values are acceptable.

A new MV cable joint embedding a sensor with characteristics suitable for the monitoring of the partial discharges activity gave promising results to monitor joints condition, even if some aspects need to be assessed to reach an industrial state.

A set of solutions developed and implemented for emergency situation faced by DSO were presented, like an emergency pole kit, an emergency cable kit and a LV/MV mobile generator. These three solutions were mainly thought to be used in case of a crisis, but they can also be used in scheduled maintenance interventions.

MAIN SESSION 1 - BLOCK 2

Diagnosis and maintenance of network components – Part 2: Substations

This 2nd block dedicated to diagnosis and maintenance was split into 3 parts: general methods and tools, transformers and switchgear.

For proper condition-based maintenance of network components, the quality of collected data is essential: practical solutions have been presented to reduce the subjectivity and uncertainty in the condition assessment process.

A specific focus has been put on the “data analytics for asset management” topic in the Research & Innovation Forum where papers from blocks 1 and 2 have been presented: it has shown that solutions are under development, with users and manufacturers working in parallel, but maybe not sufficiently in cooperation, along similar lines.

More and more condition monitoring will be based on connected sensors embedded in the components, but some cost and durability issues remain to be solved. Most of the technologies required for translating the monitoring measurements into health diagnosis are now mature, with more research still needed in the field of mechanical operation and insulation of MV switchgear.

Existing transformers monitoring will allow to operate them according to real-time thermal rating (aka dynamic rating), thus improving their readiness to cope with the future load scenarios of the smart grids.

MAIN SESSION 1 - BLOCK 3

Innovation in Network Components– Part 1: Cables and lines

This third block proposed some innovation or new approaches in the field of cables and lines components, like:

- superconducting cables and current limiters, showing the significant progress in the development of high temperature superconducting (HTS) power devices. Thus, the installation of a complete HTS system (concentric 3-phase cable 40 MVA at 10 kV with fault current limiter) on site as well as its commissioning was reported. A second paper reports the major findings from the in-field activity of a 3-phase fault current limiter 9kV/3.4MVA installed in a MV substation.
- new sensors of different technologies, that were tested in order to get a clear view of their advantages and drawbacks, in the context of smart grid applications with an increased need for measurement.
- line voltage regulators with the description of the benefits of this solution compared to conventional grid expansion.
- monitoring and communication at secondary substation level : a pilot project was described and the learning from planning, installation and commissioning was delivered, as well as the early operational experiences.

The quantification of the environmental impact of MV cables using Life Cycle Assessment method was reported and showed that the use phase has the predominant impact, due to operational losses.

MAIN SESSION 1 - BLOCK 4

Innovation in Network Components – Part 2: Substations

This block has been organized in the following 5 parts: substations, transformers, switchgear, modelling and simulation, storage and LVDC distribution.

Smart secondary substations are becoming, after the smart meters, the second essential brick of smart grids, and their functionalities and specifications are being gradually defined. DER integration in the distribution networks necessitates means for voltage control: choices between the several possible solutions will depend on their respective costs and maybe also on regulatory options.

In the domain of transformers the new energy efficiency requirements in the standards, and the Ecodesign European Directive, have significant impacts on the current designs and manufacturing techniques.

For MV switchgear several incremental innovations are proposed, and also some attempts at more disruptive ones, like solid-state switching for capacitive loads, controlled switching or continuous vacuum monitoring solutions.

The progresses in multi-physics numerical simulation are continuing, and allow reducing the number of design and testing iterations in the development process, as well as better mastering of complex phenomena like internal arc.

Finally battery storage is addressed in a still relatively limited number of papers, but may become an important new type of components at the disposal of the DSOs to meet the challenges of renewable energy sources integration, while postponing or limiting the investments in the network.

ROUND TABLE 2

Telecommunication solutions for Smart Grids

Smart Grids require an unprecedented amount of telecommunications services for its number, variety and extension. Many technologies are available but their selection and use should be always decided with the criteria of quality, availability, resiliency and moreover efficiency. Also the alternatives of either using existing services from telecom operators or building up own telecom infrastructure should be considered and selected under the most strict efficiency guideline.

An example was given from the USA of the possible impact of local integrated telecommunication on energy optimisation. An overall view of available technologies and solutions was provided by one equipment supplier. One example of available telecom services was described by one worldwide operator committed to the smart grids development, and adopted solutions in different countries were presented by two DSOs.

As a conclusion of the discussion it can be stated that telecommunication technologies able to meet smart grids needs are available. Recommendations of suitable technologies depending on factors like data volume, criticality of information, context of the implementation could be given, and orientations for further development were proposed.

ROUND TABLE 4***SF6 Substitution: Alternative Gases***

SF6 was enabling a new class of medium voltage switchgear in the 1980^{ies}. In the last ten years the discussion of the ecological footprint of fluorinated gases has also covered SF6, leading to the introduction of a closed loop reuse of SF6. Nevertheless in the last years the discussion regarding alternatives increases steadily. To cover the topic technical specialists of insulating fluid manufacturer, equipment manufacturers, design offices and a representative of the IEC SC17 were invited to the roundtable. The different aspects of gaseous alternatives like N2, O2 and CO2 mixtures as well as new composite gases were discussed. The interaction with the audience covered a wide range of aspects, like the issues of single sourcing, on-site-handling and infrastructure and pricing for the new gases. There was a consensus that alternative solutions are available for electrical insulation purpose. The kind of gas used is mainly dependent on the compactness needed, as a direct replacement of SF6 without geometrical changes is not possible for nominal voltage levels above 10 kV. A more challenging task has been seen for the switching performance of the alternative gases. Here the SF6 performance cannot be reached so that only gas mixtures seem to be suitable, nevertheless additional R&D is necessary. A major topic for manufacturer and utilities is still the pricing of the new gases. From a standardization point of view, it was explained that the existing standards are sufficient to guarantee the functionality and safety of the equipment, whereas for the years to come a continuous implementation of experiences and results is expected on different aspects including for example long term stability or impact of by-products. It can be concluded that the utilization of SF-alternatives is in the process of reaching the stage of pre-industrialization and may play an increasing role in the next years.

ROUND TABLE 6***Smart Secondary Substations – Technology Development and Distribution System benefits***

The scope of this RT was to describe the first part of investigations conducted in the frame of the Working Group CIRED 2014-1 devoted to technology and benefits of smart secondary substations.

The WG had to evaluate the smart concept for every component of secondary substation. This wide scenario has been divided in 5 main topics: MV components, LV components, MV/LV transformers, remote control system and devices and monitoring and protection system and devices.

First of all, the solutions adopted in different networks and countries have been investigated, highlighting each one's specific advantages. So, the forum has assessed most common, both traditional and "state-of-the-art", MV and LV components, MV/LV transformers and protection systems, comparing them in terms of capability, reliability, performance and cost-efficiency. An overview of future tendencies in "smart" secondary substation components as also been provided, as resulting from ongoing innovation projects and CIRED acts and papers.

The conclusions of this first part of WG have highlighted some scenarios that deserve investigation during the second part of WG:

- increase the performance and functionalities of secondary substation apparatus for example installing MV circuit breaker instead of MV switch-disconnector to interrupt fault currents on the feeder;
- increase the level of protection and control and measuring energy flows;
- integrate all different functions and information, for example combining MV network information with LV network ones;
- introduce better performing apparatus in the secondary substation to improve the quality of LV networks, for example installing LV circuit breaker instead of LV fuses;
- imagine further innovative services, investigating on such things as smart consuming, smart city services and user demand management.

RESEARCH & INNOVATION FORUM SESSION 1

The forum has been an opportunity for in-depth and interesting exchanges with the audience on innovative research works performed in connexion with different Universities in the field of data analytics for asset management: results given by various methods based on models and data analytics applied to the condition assessment and remaining lifetime estimation of cables, transformers and substations were described.

POSTER TOURS

Two guided interactive poster tours have been organised for each block. An average number of 30 delegates attended each tour.

CONCLUSIONS

The rich discussions that took place in Lyon about the many issues related to network components show that power distribution systems are facing two main challenges:

- How to improve the maintenance and replacement policies of the huge fleet of components that constitute distribution networks, in order to improve power quality while keeping costs as low as possible?
- Which new and innovative components will allow a better service and bring appropriate responses to the new challenges associated with the revolution of Smart Grids?

Many new solutions for diagnosis and maintenance optimisation are being developed by research institutes, solution providers or system operators and implemented by utilities. The quality of data is critical in this field and some interesting work was presented on this issue. The topic of sensors was also discussed, including sensors embedded in components, which raised many questions and valuable debates.

Many new and innovative components were presented, in fields as varied as superconducting lines and fault current limiters, solutions for the control of voltage in networks where decentralised generation is connected, switchgear, design of smart secondary substations, decentralised storage... The deployment of Smart Grids will be made possible by the implementation of innovative components such as sensors, components based on power electronics or incorporating local intelligence or communication capabilities. This raises many questions: what will be the reliability of these complex components? how to guarantee interoperability? when will the needed standards emerge? how fast will these new components be introduced in the networks?

An effective cooperation between equipment manufacturers, DSOs and research institutes is a key factor to design and implement the innovative solutions which are needed.