The European Association of the Electricity Transmission and Distribution Equipment and Services Industry

T&D Europe Position Paper on
"Standardisation to foster electricity grid deployment / renovation"
16th July 2012

Position expressed as support to the European policy for Energy infrastructures

0. Executive Summary

T&D Europe members support the idea of grid renewal and propose some ideas about the need or impact of standardisation on this renewal process.

After reviewing the expected changes and the identified challenges, the different parts or domains of standardisation are considered for their specific situation.

The overall position is that the current situation of standards already allows renewal of the grid, as most of the solutions which can be implemented on a short term are already covered by standards, both international and European. Some forecasted evolutions in the infrastructures and the way the network will be operated could need additions on the long term, but these topics are currently not mature enough to be part of standardisation, as feed-back from experiments is fundamental to drive standardisation.

1. Introduction

Our industry is a key player for the envisioned grid renovation within the European Union, as well it is a significant contributor to all the standardisation processes at the various national and international levels. Therefore, T&D Europe has a unique position to appreciate the current situation of the standardisation concerning the power equipment used or expected to be used on electrical networks.

The ageing of the electrical infrastructures, the foreseen modifications of the energy mix in Europe, the required improvement of the grid efficiency and the subsequent massive integration of renewable energy will require large adaptations and changes of the European electrical system.

Current challenges:

- existence of remnant interconnection bottlenecks on the transmission grid which prevent the sharing of generation and spinning reserves and lead to keep coal fire plants to pass peak loads;
- lack of grid codes harmonization between TSOs / countries, leading to additional cost and, in some instances, inadequate defence plans;
- integration of off-shore wind farms;
- integration of large scale and small renewables;
- difficulty to create new transmission overhead lines;
- need for increase of the transmission capability of the grid to accommodate the increase of consumption.

Future challenges:

- to share renewable resources at continent level (wind generation, solar generation, etc.);
- to enhance grid energy efficiency;
- to maintain stability while introducing changes;
- to contribute to the reduction of CO_2 emissions (minimising the need for fossil fuel power generation);
- to develop and implement modern energy storage of large capacity (hydro pump (Norway, Alps, Pyrenees, ...);
- to transmit energy over long distances (>2000kms);
- to transmit energy through submarine cables laid at unprecedented depth, or buried lines;
- to increase power flow controllability so that to be able to manage stochastic renewable power sources, on both distribution and transmission levels;
- to set appropriate mechanisms (market regulation + grid technical resources) able to balance generation and consumption at various time scales.
- to cope with the emission levels limits of magnetic fields

D.C. transmission is very attractive since it combines key benefits compared to A.C. transmission:

- reduced losses over long distances
- no limitation for submarine of underground transmission
- power flow controllability
- large blackouts prevention through firewall effect

This paper does not address the topic of associated communication and automation functions, which are dealt with under the generic designation of "smart grid".

2. Analysis

2.1. A.C. Grids:

Conventional equipment (transformers, switchgear, etc.) is available and already covered by existing standards.

FACTS (Flexible A.C. Transmission Systems), whether made of passive components or based on power electronic devices combined with static controllers, are used to control active and reactive power flow in real time to enhance controllability, power transfer capability and post-fault recovery of power transmission systems.

FACTS provide:

- fast voltage regulation
- power transfer increase over long distance A.C. lines
- damping of active power oscillations

- load flow control on meshed systems

Similar functions could be implemented on the distribution grid to cope with the difficulties of integrating distributed generation.

FACTS is a mature and scalable technology and no need for further standardisation is identified.

Introduction of higher transmission voltage level (higher than currently used, i.e. 400 kV) should be considered, even if being a political challenge, for European grid but standards are available.

A.C. grid codes, dealing with interoperability, need harmonization across European TSOs so as to ease the foreseen penetration of wind energy. It could be addressed through standardisation as well as regulation or voluntary agreements. Standardisation would be a way to open the discussion to other stakeholders.

2.2. D.C. Grids:

Existing D.C. transmission involves point to point schemes with a specific function in the overall transmission system:

- to connect a 50Hz grid with a 60Hz grid
- to interconnect non-synchronized power systems
- to get across a sea (IFA2000 between UK and France)
- to transmit bulk power over large distance like in Brazil (from hydro power generation in Amazonas NW region to Sao Paulo region) or China (from SW China with hydro power generation to Shanghai region).

In such point to point schemes, one manufacturer is generally in charge of complete system, and therefore standardisation needs are limited. Nevertheless, implementation of converters into the A.C. system requires fulfilling some performance criteria (harmonic distortion, insulation coordination,) which might deserve some standardisation effort.

Future D.C. grids will be multi-terminals, meshed grids, able to control power flow in any directions. Such D.C. grids do not exist for the time being, and no standard is available. Here, standards will be necessary, as much as they are for A.C. grids. The work going on as presented here below is expected to cover the need in the future, but is currently lacking of actual technical feed-back due to the very limited experience on the field.

Technical activities have been performed in CIGRE already for years, and the following topics are addressed, with sharing of background information and experimental results:

- JWG B5/B4.25 has performed study and provided their deliverable in the Brochure 484 "Impact of HV D.C. stations on protection of A.C. system" (December 2011)
- B4-52: feasibility of a large pan-European D.C. grid
- B4-56: D.C. grid codes

- B4-57: HV D.C. converter models
- B4-58: HV D.C. grid control (power flow, voltage)
- B4-59: HV D.C. grid protection
- B4-60: HV D.C. grid reliability and availability

Furthermore, IEC has started considering D.C. grids on some limited scopes by establishing a Technical Committee (TC115: High Voltage Direct Current (HVDC) transmission for DC voltages above 100 kV) and work is already launched on several general topics. Due to the currently limited market size, and the lack of experience, it seems preferable to keep the work at the worldwide level and to prevent splitting it between several regional areas.

Here are key areas which could be addressed through standardisation:

System architecture

- Bus / meshed / rings...; Monopole / bipolar / symmetric monopole; Fault currents; Ratings (voltage, current); VSC / LCC / combination; Interface with existing A.C. system

Overall control system

- Power flow; D.C. voltage; Start and stop behaviour

Protection system

- Fault detection principles; D.C. fault clearing concept; Communication and interoperability

Functional specifications for key components

- HVD.C. cables; A.C./D.C. converters; D.C. breakers; D.C./D.C. converters

2.3. Switchgear

Existing international and European standards for A.C. equipment are enough to give answer to the possible new requirements of the future A.C. transmission and distribution grids.

It is clear that the equipment will evolve and that some new classes and tests might be necessary in the future. But there's no reason to initiate any standardisation work on this sense in medium term.

For D.C. applications, no reference currently exists and little experience is available so far to support standardisation work. The topic needs to be documented through technical bodies, with actual feed-back, before reaching a mature enough condition for valuable standardisation. The various works currently going on have a significant risk of lacking consensus, due to the limited number of skilled stakeholders worldwide.

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2.4. Transformers and similar equipment

Considering distribution transformers, and linked with network stability issues due to renewable generation, it is forecasted that remote operated, or locally automated, on-load tap-changers will be requested. However, experiments are needed in order to identify the proper characteristics (number and values of steps, load profile of these transformers, operation duties of the tap-changers...) and there is no need for prior regulation/standardisation. Standards will come later for market optimisation.

Regarding transmission, procurement of transformers remains a project based business, with a limited number of units per year, and case-by-case specifications; technical matters are already covered by existing standards, which are used for specifications. In that context, no standardisation work is identified on short or medium term.

For both transmission and distribution, the possible large increase in power electronics could call for further specification about harmonics behaviour for instance; however, such changes will then be introduced in the existing standards through a normal revision process.

Considering the energy efficiency of the electrical system, then the current work around losses of transformers, and technologies providing so-called low losses transformers, should be addressed also. The current situation of the standardised loss levels (Kneeled standards, dealing only with distribution transformers) could be impacted by such technologies. The European Directive on energy efficiency should anyway be the main driver for this point.

2.5. Power electronic

Power Electronic systems have been an important, if niche, part of transmission grids since the 1950s, but their importance in the last 3-5 years has increased enormously as the grid infrastructure adapts to the challenges posed by much greater integration of renewable energy sources. Power electronic applications for T&D systems currently fall into two main categories: High Voltage Direct Current (HVDC) and "Flexible Alternating Current Transmission Systems" (FACTS). HVDC is used for point-to-point transmission of large amounts of energy from remote generation sources to load centres, for inter-connecting AC grids whose frequencies cannot be synchronised, and embedded within AC systems as a fast power-flow control tool to improve system stability. FACTS applications are aimed mainly at increasing the amount of power which can be transmitted on an existing AC system. Both types of application are now becoming more important as a result of the shift away from fossil-fuel-based generation towards generation from renewable sources, especially wind power. Large-scale renewable energy sources are often at long distances from where the power is needed, posing major problems of how to transmit the power. In many cases the existing AC network is too congested, but FACTS equipment may be used to improve power flow on strategically important AC lines. However, the fastest growth in power electronic systems on the grid is in HVDC, since HVDC offers the possibility of creating an "overlay grid", mainly formed from underground or undersea cables to avoid environmental objections. A very important new application for HVDC is in the connection of large off-shore wind-farms to the on-shore grid, with both the UK and Germany embarking on very ambitious plans in this respect. Most HVDC systems to date have been point--to-point but an increasing number of new HVDC systems are being designed for "Multi-Terminal" operation, and feasibility studies are under way to consider the implications of building a "DC Grid" over-laid on the existing AC grid.

In terms of standardisation, there is a well-developed standardisation framework within IEC for point-to-point HVDC systems using the established "Line Commutated Converter" technology, and standards are being developed for the newer "Voltage Sourced Converter" technology. The greatest need for standardisation now lies with the subject of DC grids, to ensure inter-operability of HVDC converters supplied by different manufacturers.

2.6. Accessories

Cables and lines are not in the scope of T&D Europe. The standardisation is managed both at international level (IEC) and at European level (Kneeled), with a significant part of it being actually influenced by the European market and manufacturers. Standardisation bodies are more active at the regional level (i.e. European) than international, due to the local conditions on one hand, and to historical habits on the other hand.

For accessories which define often the border between conductors and other parts of the network (as transformers or switchgear), the related standards deal also with dimensions and tolerances to ensure interchangeability. The existing choices cover well the current requirements of the A.C. network and have also options which provide significant margin for increasing, if needed, the overall power transfer of the networks. No lack of standardisation is identified concerning power frequency networks.

For the possible D.C. applications and networks, no reference exists so far and available accessories, designed for A.C. are used. The experience for possible equivalence between A.C. and D.C. is then under construction. International bodies already address these topics, and some works are already running, for instance about bushings.

Other accessories are not interfering with T&D Europe, and therefore are not considered here.

3. Synthesis

The current vision of our industry, regarding the standardisation for electrical equipment, both for transmission and distribution, is that the existing collections of standards already cover in a satisfactory way the main needs. These standards originating for the international level ensure that the market is widely open to providers, and that the most effective solutions can be chosen by specifying according to these standards.

Ability to define technical standards for D.C. grids is important for Europe to be able to move forward with pan-European transmission grid planning, but this is not sufficient. However, technical standards should remain consistent with the international level, to keep the European industry in position of supplying the worldwide market.

The T&D Europe industry is concerned about Europe ability to move forward as quickly as other big regions in the world.

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