CONSULTATION DOCUMENT

"Recommendations relating to the coordination of technical cooperation between Community and third-country TSOs"

1. Introduction and Scope

According to Article 8(3)(c) of Regulation (EC) No 714/2009 ENTSO-E is in charge of providing "*Recommendations relating to the coordination of technical cooperation between Community and third-country transmission system operators".* The aim of the present document is to identify these recommendations. The main focus is on third-country transmission system operators (TSOs) who are not members of ENTSO-E. With ENTSO-E members from third countries there is already a fruitful technical cooperation that needs not be changed.

It should be understood that the present recommendations are non-binding. As ENTSO-E is an association of individual companies it is not empowered to prescribe binding rules for its members. Anything binding would have to be agreed within a contractual agreement. The same is obviously true for non-member TSOs.

The technical cooperation between TSOs worldwide normally takes place under the auspices of Cigré[1], IEEE[2] (as well as IEC[3] when it comes to standardisation), and similar organisations. Only in specific cases, an involvement of ENTSO-E will be useful:

- TSOs have always had expertise on technical aspects of power transmission. Triggered by the EU 20-20-20 targets set by EU leaders in March 2007[4] and by national initiatives, the ongoing decarbonisation of the power industry has introduced previously unknown technical challenges for system operation and network expansion. Sharing of best practice on traditional and new issues will help all involved parties on their way towards a sustainable energy future.
- The members of ENTSO-E have been making experiences with the challenges arising from the liberalisation of the electricity market since the entry into force of Directive 96/92/EC in 1996. Sharing best practice with TSOs from third countries – and also learning from them – will foster the worldwide advancement of efficient power economics.
- To certain third country TSOs interconnections or electrical interfaces exist, some of these TSOs being members of ENTSO-E. Thus, interconnection can be considered as extraordinary cooperation with third-country TSOs. It is in principle possible that further interconnections will be envisaged in the future. As interconnection is a burden increasing complexity, the option of asynchronous interconnection will be of high interest in such cases.

The three aforementioned fields of cooperation will be discussed in the subsequent sections, where technical areas and market related topics worthwhile to exchange experience on will be identified. Another section will be dedicated to extraordinary cooperation.

[1] International Council on Large Electric Systems (http://www.cigre.org/)
[2] Institute of Electrical and Electronics Engineers (http://www.ieee.org/)
[3] International Electrotechnical Commission (http://www.iec.ch/)
[4] http://ec.europa.eu/clima/policies/package/index_en.htm

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 • info@entsoe.eu • www.entsoe.eu

2. Fields of cooperation

2.a Technical cooperation with TSOs worldwide

Expert knowledge on network equipment

Over decades European TSOs have been collecting experience in the procurement and management of network assets such as transformers, overhead lines, cables, substations and high voltage equipment. This experience comprises, among other aspects, life-cycle management of components, design considerations for all kinds of equipment, route selection for lines, real-time monitoring systems, design of air insulated and gas insulated switchbays, and testing of equipment. For the sake of efficient network operation ENTSO-E is willing to share its experience with TSOs from third countries and to learn from them as well.

Technical standards

As there is unbundling between transmission and distribution networks on one hand and generation and supply on the other hand, it has become important to clearly define technical interfaces between them. Even more, many European TSOs were also organisationally separated from the underlying distribution system operators (DSOs), which also makes it necessary to have defined interfaces. High Voltage Direct Current (HVDC) interconnectors not operated by TSOs require clear technical rules as well.

To a great extent, the required interfaces are defined in the network code[5] on Demand Connection, network code on Requirements for Generators, and the network code on HVDC Connections and DC Connected Power Park Modules.

ENTSO-E may play a role in promoting these technical standards. The network code implementation in third countries would have the advantage of creating a level playing field beyond the EU and throughout a broader area, in the mutual interest of both ENTSO-E's and third countries' TSOs. Economies of scale could be exploited in equipment connected to the network by having the same technical standards beyond ENTSO-E. Where it is not efficient to implement the network codes in third countries because these countries already have a profound framework of technical standards for grid connection, it might be helpful to agree at least on common minimum requirements in order to foster the standardization of equipment.

Network expansion planning

Unbundling in Europe affects the process of network planning. Whereas there used to be an integrated planning of generation and transmission within vertically integrated utilities in the past, generation companies and independent power producers can now make their planning with only limited consideration of implications on the transmission network. In other words, the driving forces for the development of the system are now mainly defined by market considerations and less by security matters. Consequently it is necessary to use scenarios on the development of the generation fleet within network expansion planning. Moreover, as cross-border trade of bulk power is deemed beneficial for society at large, European coordination of regional network planning is necessary.

In this context ENTSO-E delivers the Community-wide Ten-Year Network Development Plan (TYNDP), including a European generation adequacy outlook, every second year in line with Article 8(3)(b) of Regulation (EC) No 714/2009. Experience about coordinated network planning in general and the TYNDP in particular should be shared via ENTSO-E, because the TYNDP is an ENTSO-E activity.

In addition to organisational changes, the need for network expansion is massively increased by the integration of Renewable Energy Sources (RES). As RES are not always decentralised but can also be found concentrated in remote areas, e. g. in case of offshore wind power, directional power flows over long distances are playing an increasingly important role. Several members of ENTSO-E are already reacting to that challenge by planning the first backbones of on overlay network based on novel HVDC technology connected

[5] Network codes are a set of rules drafted by ENTSO-E, with guidance from the Agency for the Cooperation of Energy Regulators (ACER), to facilitate the harmonisation, integration and efficiency of the European electricity market. The present status of code developments can be found on a dedicated website: http://networkcodes.entsoe.eu/

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 • info@entsoe.eu • www.entsoe.eu

to the existing Alternating Current (AC) network. Exchange of technology related knowledge is promising with respect to technical effectiveness and tendering efficiency.

Another aspect of network expansion is the increased need for mechanically switched reactive power compensation devices and Flexible AC Transmission Systems (FACTS) in the absence of classical synchronous generators. As the decommissioning of conventional generation has an impact not only on the steady state load-flow situation but also on network stability, the respective system stability studies are highly challenging and can profit from knowledge sharing.

Coordinated system operation and operational planning

Increased intermittency and new load-flow patterns challenge system security. European TSOs tackle this issue by increased coordination not only via ENTSO-E and its regional groups but also within Regional Security Cooperation Initiatives (RSCIs). Certain global data exchanges take place on a pan-European scale via an IT tool for real-time data exchange at pan-European level, the European Awareness System, being an ENTSO-E project. Even deeper coordination is achieved in the field of operational planning within the RSCIs by common planning processes from the outage coordination timeframe until close to real-time.

Technical cooperation with the non-member state Albania is already taking place in this context as the Albanian network needs to be modelled within load-flow and contingency analyses. More generally, ENTSO-E and its members are ready to share experience on how to coordinate system operation among numerous TSOs.

Security management

New IT technologies and cyber security have become a concern which TSOs have to tackle without being backed by an integrated company with central functions. In times of terrorist threats, protection against intentional destruction of network equipment and cyber-attacks on Energy Management Systems and System Control and Data Acquisition (EMS/SCADA) is a worldwide challenge. Moreover, due to high metal prices, protection against theft is getting increasingly important. ENTSO-E deals with these topics and is willing to share its experience made so far and to learn from worldwide best practice.

2.b Cooperation in the field of markets and regulation

Impact of unbundling on system operation

Zonal market design fosters liquidity and efficiency of the electricity market but also leads to non-consideration of possible temporary network congestions inside bidding zones in the power plant dispatch. Thus, business processes for market related remedial actions, including communication with power plant operators and neighbouring TSOs, have been developed by ENTSO-E members.

Moreover, market-based procurement and activation of ancillary services have been developed in contrast to the regional monopolies for the entire value chain applied in the past. There are ongoing activities as to cross-border balancing and even the sharing of reserves among TSOs. The respective framework is being formalised by the network code on Load Frequency Control and Reserves and the network code on Electricity Balancing. ENTSO-E members collected abundant knowledge on these topics from different synchronous areas while the network codes were drafted. Knowledge on business processes for market related remedial actions and on the coordinated procurement of ancillary services can be shared with interested TSOs from third countries.

Managing market congestion

Driven by liberalisation the commercial exchanges have grown dramatically and by consequence, the demand in transmission capacity exceeds the offer on the international interconnections. This requires a framework for managing market congestion. This framework has been developing rapidly during the last years, including joint auctions for long term capacities, market coupling initiatives for the day ahead and intraday markets, and market driven planning of interconnections. Right now, the framework is being formalised in the network code on Forward Capacity Allocation and the Capacity Allocation and Congestion Management Guideline, the latter being subject to an early implementation project.

The integration of TSOs from non-member states in the framework of managing market congestion already takes place for third-country TSOs with interconnections to other ENTSO-E members, e. g. TSOs from

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 • info@entsoe.eu • www.entsoe.eu

Norway and Switzerland. With TSOs without interconnections, the sharing of experience in this field can be of mutual benefit.

Further market and regulation related topics

In member states where TSOs are organisationally separated from the underlying DSOs they had to establish well-defined interfaces for grid service. Precise definitions are needed as to which asset is maintained by whom and how to coordinate planned outages in commonly used substations. Even more obviously, outage coordination with generation companies had to be established as a new business process.

Further challenges arise in the management of Demand Sid Response (DSR). Whereas this concept has a potential of contributing to the balancing of the transmission system the responsive loads are mainly connected to distribution networks and are possible controlled by independent market players rather than by network operators. This constitutes the need for suitable market arrangements beyond the mere technical implementation in order to exploit the potential from DSR.

Practically managing the interfaces to DSOs and generation companies beyond what is standardised according to the network codes is an activity of ENTSO-E members rather than the association. Nonetheless ENTSO-E can act as a knowledge hub in this field.

2.c Extraordinary cooperation via interconnection

Motivation for extraordinary cooperation

During the last decades, ENTSO-E's TSOs have created an integrated electric system which is one of the largest in the world and which has reached the highest level of security and quality of supply. It consists of a set of synchronous areas being Continental Europe, Nordic, Baltic, Great Britain, and Ireland and Northern Ireland. The connections between the synchronous areas have been realised asynchronously via HVDC interconnections. The technical rules of the different synchronous areas are based on specific technical frameworks and have been designed according to

- a defined or desired security level,
- a given structure of the grid, and
- a given generation portfolio.

Originally, extensions of synchronous areas were driven by the desire to exchange frequency containment reserve in the case of large generation unit outages. Later, the option for commercial exchange of electricity became another driving force for the extension of synchronous areas or asynchronous interconnection between them. However, synchronous interconnection of new partners results in challenges.

Challenges of interconnection

Interconnection leads to strong interdependencies between neighbouring networks. The system has structural oscillation modes having their origin in the "elastic" characteristics of the electromagnetic link between generators, associated with the inertia effects of the rotating elements in the generators and in the effect of the controllers, mainly the voltage controllers of the generators. Among the most critical modes, there are low frequency modes which correspond to interactions between groups of generators located at different zones of the electric systems. They lead to the so called inter-area oscillations. A poor damping of these kinds of oscillations may lead to severe risks for system security. These phenomena are generally linked with bulk power transits via a high impedance interface. The remedy to these oscillations can be the limitation of transits at the interface. As this goes against the economic interest of the interface, most frequently Power System Stabilizers are installed on the generators in order to damp the oscillations.

The complexity of the abovementioned phenomena requires extensive studies (for which a well-proven process exists) and custom-made solutions for any synchronous system extension. In other words, it is impossible to qualify for synchronous interconnections by applying a predefined set of technical rules. The opposite is the case: the application of technical rules from ENTSO-E's regional groups may even be impossible in other systems because they have different structures and sizes. Moreover it has to be understood that synchronous extension may have benefits for the smaller system being connected but it only brings increased complexity and operational risk for the larger system.

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 • info@entsoe.eu • www.entsoe.eu

Given these challenges, ENTSO-E strives for a compatible parallel operation for new interconnections. This means that any inadmissible negative technical impact on ENTSO-E's regional groups and the newly connected TSO will be avoided by individually defined measures and rules for the interface, thus constituting a firewall against disadvantages. Such compatible parallel operation is successfully in operation at the high impedance synchronous interfaces towards Turkey and Morocco.

Unlike synchronous connections, asynchronous HVDC connections are not prone to inter-area-oscillations. Moreover, they do not transmit fault levels and avoid the propagation of disturbances. In case of Voltage Source Converters they can also contribute to reactive power control in the AC network.

Future approach to extraordinary cooperation
With an HVDC connection, coordination to achieve and maintain synchronism is not required and each synchronous system can vary its frequency without affecting the power flow on the HVDC interconnection. Therefore, ENTSO-E's preferred approach to reach compatible parallel operation in future interconnection projects is via HVDC connection. Such interconnections should only be realised after a thorough analysis of costs and benefits. Where interconnections to third countries exist, proper integration in data exchange and operational processes is crucial to safeguard the security of supply in real-time operation.

Besides the mastering of technical challenges, there are market related preconditions for extraordinary cooperation. When a third country wishes to access the Internal Electricity Market (IEM) the principle of reciprocity should apply, i. e. the same rules that are valid inside the IEM should be applied to the power industry of the country seeking access. Therefore, third countries requesting interconnection should already have implemented the 3rd energy package or should be bound to implement it by a negotiated contract with the EU. Such a contract, for example, is the membership in the Energy Community[6].

3. Recommendations

With regard to information exchange as discussed in sections 2.a and 2.b, the following is recommended:

- ENTSO-E Secretariat acts as a contact point for worldwide TSOs which are interested in deeper information exchange in addition to the well-established organisations mentioned above.
- External requests for information exchange are forwarded to member TSOs via ENTSO-E's committees, being a high-priority dedicated information channel towards members.
- On a voluntary basis member TSOs indicate their willingness to enter in an information exchange. This should be guided by the principle of mutual benefit because ENTSO-E members are committed to efficiency in the interest of society at large in their respective countries. ENTSO-E Secretariat establishes the contact between the requesting and the member TSO.
- In case ENTSO-E working groups desire technical information from non-member TSOs, ENTSO-E Secretariat will offer the service to collect and coordinate the information needs before approaching the non-member TSO.

With regard to interconnection as discussed in section 2.c, the recommendations are as follows:

- For ENTSO-E members no change in the technical cooperation is necessary.
- For new interconnections, if any, the ENTSO-E recommends compatible parallel operation via HVDC.
- Third countries requesting interconnection should already have implemented the 3rd energy package or should be bound to implement it by a negotiated contract with the EU.

[6] The Energy Community is a community established between the EU and a number of third countries to extend the EU internal energy market. The Energy Community transposes and implements the EU's 3rd energy package.

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 • info@entsoe.eu • www.entsoe.eu