



## **List of data European TSOs need to pursue optimal use of the existing transmission infrastructure**

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### **Task from the Florence Forum and objectives**

The conclusions of the 12<sup>th</sup> Florence Regulatory Forum, held on 1-2<sup>nd</sup> September 2005, stressed the need for increased harmonisation and compatibility of rules in view of the development of regional electricity markets. Participants also highlighted the need for increased transparency to create a fair and efficient market.

As an input to the consultation process on the ERGEG discussion paper on regional markets, ETSO has compiled a high level summary of the physical and market data that, if available to TSOs, may allow further progress towards the optimal use of interconnection capacity, and its related infrastructure between countries/regions, and promote a higher level of transparency on TSO-level. The data referred to in this paper is identified for operational and planning purposes only and assumes that some form of overarching framework for the maintenance of commercial confidentiality is established.

ETSO believes that data from generators and market participants is of particular importance to achieving improvements in transparency and facilitating fair and efficient markets.

As a future step, ETSO has also outlined herein the basic features of a simplified flow-based transmission model, the development of which represents the best means to reach the above goal.

### **ETSO vision on achieving the optimal position**

ETSO considers that an optimised utilisation of the existing infrastructure can be facilitated through a two-step process:

- 1) Making available to TSOs selected "key" physical and market data**
- 2) Progressive development of the ETSO flow-based transmission model**

Within the decentralised context of the IEM, the general pre-requisites for an effective and timely use of available data by TSOs can be identified in the:

- Access to relevant data from market participants
- Efficient data exchange processes and calculations between TSOs, supporting secure system(s) operation
- Regulatory and market frameworks which facilitate the free and confidential exchange of data for the TSOs' operational and planning purposes

The fundamental aspects of an optimised use of the existing transmission infrastructure are the accurate assessment and the efficient handling of the cross-border capacities. In general terms, the evaluation of cross-border capacities relies on an estimation of the physical flows in the interconnected power system. In order to accurately calculate cross-border capacities, TSOs jointly require precise and consistent generation and load schedule information for the assessed point in time in order to calculate load-flow patterns and check potential system security problems.

In reality, generation availability predictions, including intermittent generation such as wind power, can not only be problematic in practice for TSOs in certain situations, but this situation is compounded by the fact that firm schedules are fixed only after all trades have taken place, both within the individual hubs, and between them. From a market participants perspective, in order to trade between hubs, the same issue acts to introduce uncertainty and limit knowledge of the availability of cross-border capacities. As a consequence of this mutual dependence, reliance upon processes aimed at achieving “perfect” forecasts of physical flows for “optimal” capacity calculations are of limited value, since it is final generation and load patterns that primarily determine the actual physical flows.

### **Step (1) - List of “key” physical and market data**

Attached in table 1, ETSO has compiled a list of “key” physical and market data that could ensure further progress towards the optimal use of the existing interconnection capacity and related infrastructure. The table is structured as follows:

- Data is categorised in the first instance dependent upon its origin. i.e. whether data is to be exchanged TSO to TSO or is supplied to TSOs from market participants . For the purposes of this paper the terminology “market participants” includes but is not limited to generators, energy brokers, traders, Distribution System Operators (DSOs), market administrators, and auction administrators etc.
- For each of these categories, data is then divided by the time horizon its availability and its use is most relevant. Three basic time horizons can be identified as follows:
  - o After market gate closure (e.g. Real Time and intra-day)
  - o Before market gate closure (typically one or two day ahead)
  - o Medium and Long term level (up to one year-ahead)

For each time horizon, the data is also subdivided/grouped into different types for ease of reading.

The availability to TSOs of the “key” data identified by ETSO will potentially allow:

- The achievement of a more consistent and accurate knowledge of the interconnected grid behaviour at forecast level. This informative background could facilitate an improved management of system(s) security, in terms of preparation of preventive and curative security measures for operation, and finally result in a more secure and efficient utilisation of the existing infrastructure.
- Performing a more accurate assessment of cross-border capacities at seasonal and operational planning level.

The availability of such data further represents, in ETSO’s view, the first step towards a foundation of data exchange process essential to the aims of the IEM.

In addition, complementary rule based approaches may be considered within market frameworks, which act to increase the firmness of participants positions through, for example, more rigorous deadlines for firm nominations prior to the enactment of compulsory reallocation mechanisms. The further development of simultaneous trade of energy and capacity products is also likely to reduce uncertainty in the use of available transmission capacities.

## **Step (2) - Towards ETSO regional flow-based transmission models**

ETSO has in earlier publications already developed and proposed a methodological framework intended to optimise the use of the transmission system under meshed grids situations through the adoption of flow-based transmission models<sup>1</sup>.

It is envisaged that the exchange and efficient use of the data referred to above would facilitate a linear modelling approach which allows the assessment of capacities based on load flow software. A feasible simplified linear flow-based model has been further investigated by ETSO and its features are recalled hereafter:

1. the usual zonal hub-to-hub model, with aggregated interconnections and the assumption that implicitly the (n-1)-security is guaranteed within these zones. Due to the relatively high level of uncertainty when forecasting operational conditions before real time, this level of approximation could be adequate for a reliable assessment of the transmission capacities, considering the influence of commercial exchanges on physical flows in meshed grids.
2. possibly enhanced with a more refined model, considering additional nodes within hubs and critical lines separately, taking into account some internal lines and explicit N-1 (e.g. there could be several nodes per TSO or just one per control area). Since a key element of the concept is the impact of generation shifting, such a "nodal" resolution especially in the case of large TSOs should not be too coarse.
3. and finally a more detailed model with consideration of phase shifters' impact.

The model would introduce the concept of generation shift keys, which describe the pro rata effect of an additional in-feed to a control area on the different hubs within that control area. It may then implicitly identify generation and load pattern influences on cross border flows. Thus, the dependence on a pre-emptive and exact knowledge of generation schedules (which could be changed just before operation) is less relevant.

The full adoption of an IEM-wide flow-based transmission model of EU electricity system(s) would further allow, as a future perspective, the optimal utilisation of transmission infrastructures.

Before achieving this objective, the exchange of the data envisaged above will however serve and enhance the following transitional steps:

- The data could be used more immediately for more effective assessment of the simplistic but widely implemented bilateral Net Transfer Capacities<sup>2</sup> concept. This process alone may form the basis of a long term solution for electrical systems such as peninsula cases and systems interconnected by DC links.

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<sup>1</sup> "Flow-based market coupling", [www.etso-net.org](http://www.etso-net.org), September 2004, Appendix A; "Coordinated Congestion Management, An ETSO Vision", [www.etso-net.org](http://www.etso-net.org), April 2002.

<sup>2</sup> "Transfer capacity definitions", [www.etso-net.org](http://www.etso-net.org), April 2001.

- From a practical perspective, in the shorter term, a first step towards a regional “flow-based approach” would be that TSOs assess and publish “bundled” NTCs. These would cover more than two TSOs and may form the basis for multilateral allocation procedures to, at least, take into consideration the interdependencies of the cross-border commercial exchanges on the physical flows on neighbouring systems in a more efficient way (today, bilateral NTC values are in many cases assessed multilaterally, e.g. Italy and its four Northern neighbours, the Netherlands and its three neighbouring TSO, the CEE region).
- As a major step, a linear flow based model investigated by ETSO, which is closer to models used for security assessment software, would yield more detailed information while still requiring an increased but moderate volume of data to be exchanged among TSOs.

In elaborating this list of data, ETSO has kept in mind that the resulting transmission model may, in some cases, be provided by the concerned TSOs to an entity with responsibility for transparent and efficient allocation of regional cross-border transmission rights by means of explicit or implicit auctions, potentially involving a single allocation procedure on more than one European interconnection. When a flow based transmission model or, to some extent a “bundled NTC or x-function” model, which is also a first step of linear equation towards the “flow-based” direction, is used for regional capacity allocation purposes, the regional allocation procedure is an optimisation of bids from market participants subject to transmission constraints. Therefore, the market will choose its most economically efficient cross-border trades by itself. As a consequence of this, in highly meshed situations, the TSOs would technically no more be required to predefine ex-ante a fixed sharing of NTCs between several interconnections.

A sound ex-post verification process will further assist the evaluation of the quality of the data and inherently enhance confidence in its application.

### **Legal and regulatory considerations**

The central issue to be addressed is the ability for TSOs to gain access to use and freely exchange data for operational and planning purposes within a legal and regulatory framework, which maintains a high degree of commercial confidentiality for market participants. As stressed during the last Florence Forum, ETSO expects that the enclosed list of data will be helpful for the EC and ERGEG when assessing the possibilities to remove legal and regulatory barriers that are challenging the further development of regional electricity markets, including the necessary harmonisation and compatibility of rules.

### **Conclusions and suggested next steps**

The availability and appropriate use of the “key” physical and market data discussed in this paper will assist TSOs in an improved management of system security and a more efficient utilisation of the interconnection capacity and related existing infrastructure, while promoting a higher level of transparency on TSO-level.

The availability of “key” data in the list furthermore represents the first step towards the progressive foundation of that data exchange process, essential to the functioning of flow-based transmission models.

The ETSO agenda for the future includes the detailed definition of the required business processes for the assessment and utilisation of the regional flow-based transmission model above described. On these aspects, ETSO is of course willing to provide further information and context for this proposal, and to participate in the further market and regulatory Fora concerned with development in this area.

**Table 1: List of “key” physical and market data to progress towards the optimal use of existing interconnection capacity**

Data origin	Time horizon			Notes
	Following day-ahead market gate closure (Real time/intra day)	Before day-ahead market gate closure (One/Two days ahead)	Medium/long term (M/LT)	
<p><b>Information provided to TSOs by market participants</b></p> <p>As market participants are meant: generators, energy brokers, traders, Distribution System Operators, market administrator, auction administrator</p>	<p>TSO INTERACTION WITH MARKET</p> <ul style="list-style-type: none"> <li>- Unforeseen intra-day variations to flow notifications (O)</li> <li>- On-line measurements of major internal generation units (above a defined level) (G)</li> <li>- Market driven (traders &amp; market participants) variations to cross-TSO flows (O)</li> <li>- Unplanned generating plant outages in congestion related zones (G)</li> <li>- Intra-day trading positions (O)</li> <li>- Generation/demand schedules (e.g. based on supply and demand bids) (G)</li> </ul>	<p>TSO INTERACTION WITH MARKET</p> <ul style="list-style-type: none"> <li>- Unexpected short-term unavailability of major generation units (G)</li> <li>- Best estimation of generation schedules notifications (with particular reference to wind generation) (G)</li> <li>- Unforeseen TSO-induced but market related day-ahead measures to secure network driven variations to flow notifications (e.g. preventive countertrade) (O/T)</li> <li>- Schedules on interconnections per trader (O)</li> </ul>	<p>TSO INTERACTION WITH MARKET</p> <ul style="list-style-type: none"> <li>- Auction administrators: capacity volume allocations (O)</li> <li>- Min/max value of installed power of major generation units and reactive power limitations (G)</li> <li>- Info on generators availability, particularly in areas of heavy congestion (G)</li> <li>- Plan of maintenance of major generation units (G)</li> <li>- When a defined degree of firmness of the planning procedure is reached: Long-term plan of new generation units, in terms of installed capacity, timing and location. Possibly, transient and dynamic stability parameters (G)</li> <li>- New connection information to enable long term system planning and optimisation (T,G,O)</li> </ul>	<p>Where relevant, within operational timescales, this could include the sharing of market price signal information, including that applicable to capacity auction clearing prices and balancing and ancillary services between TSOs</p> <p>Part of the information from market participants to TSOs mentioned in the table is already available for some TSOs</p>

Data origin	Time horizon			Notes
	Following day-ahead market gate closure (Real time/intra day)	Before day-ahead market gate closure (One/Two days ahead)	Medium/long term (M/LT)	
<p><b>TSO to TSO</b></p> <p>(i.e. TSO-internal data to be exchanged between TSOs)</p> <p>This assumes that all commercial and legal barriers are removed to enable the use of this information for operational and planning purposes only. This may mean some form of overarching confidentiality agreement between TSOs and market participants is established.</p>	<p><b>REAL-TIME NETWORK MONITORING</b></p> <ul style="list-style-type: none"> <li>- On-line measurements/tele-signals on interconnectors and the portion of transmission grid electrically close to the interconnection (typically first two internal nodes) (T)</li> <li>- Intra-Day/Real Time modifications of Phase shifting transformers on transmission grid and qualitative description of expected effects (T)</li> <li>- Line rating changes resulting from unforeseen system events (T)</li> </ul>	<p><b>OFF-LINE NETWORK ANALYSIS</b></p> <ul style="list-style-type: none"> <li>- Base case elaboration from the delivery of verified and consolidated sets of DACF-input data (T,G), after the harmonisation of exchange programs with neighbours. Results of DACF security analyses on request (note: also DACF generation-day data may still be changed intra-day)</li> <li>- Best TSO's estimation of the range of global balance (and possibly sub regional balance) of the control area expected for day D<sup>1</sup> and generation shift keys as defined in the text<sup>3</sup> (G)</li> <li>- Info on possible scenarios of wind generation forecasts<sup>2</sup> (O)</li> <li>- Day ahead asset-related technical limitations on neighbouring TSO that could affect Inter TSO optimal operation or security (T)</li> <li>- Best estimation of bottleneck interconnector capacities and influences of commercial exchanges on physical flows (e.g. through flow factors), including volumes, profiles and counterparties (T)</li> <li>- Firm aggregated nominations of yearly and monthly transmission rights (T)</li> </ul>	<p><b>OFF-LINE M/LT NETWORK ANALYSIS</b></p> <ul style="list-style-type: none"> <li>- Results of long-term interconnection capacity assessments and allocation arrangements, with main contingency analysis and description of the scenario of simulation including the balance of single control area therein simulated. (T)</li> <li>- Modeling of Phase Shifting Transformers and their expected operational mode in normal conditions and in the case of the loss of other grid elements (T)</li> <li>- Basics of the strategy of intervention of the protection systems used in neighbouring transmission grids (e.g. settings, timing) (T)</li> <li>- UCTE Snapshot complete models at monthly level at least for peak and off-peak period (e.g. Wednesday 10h30 and 3h30<sup>4</sup>) and equivalents for NORDEL and GB &amp; Ireland (T)</li> <li>- Details of rules used for long-term n-1 security analyses on 380-220 kV grid (T)</li> </ul>	<p>General remark: some of the information in the table is already exchanged between TSOs</p> <p>1: Generally, even a gross estimation (typ. 1000 MW) of global balance for major countries can allow a good forecast of flows through predictive algorithms</p> <p>2: already used by some TSOs.</p> <p>3: definition and exchange of generation shift keys are complex and subject to further investigation</p> <p>4: or another appropriate point in time e.g. to cover regional peak loads</p>

Data origin	Time horizon			Notes
	Following day-ahead market gate closure (Real time/intra day)	Before day-ahead market gate closure (One/Two days ahead)	Medium/long term (M/LT)	
	<b>REAL-TIME/INTRA-DAY NETWORK ANALYSIS</b> <ul style="list-style-type: none"> <li>- Results of n-1 security analyses, in case of violations impacting on inter-connected grid operation or threatening cascading effects (T)</li> <li>- Intra-day asset-related technical limitations on neighbour TSO that could affect Inter TSO optimal operation (T)</li> <li>- Intra-day/real time modifications of interconnector capacity , including volumes, schedules and market counter-parties (T, O)</li> </ul>	<b>UNPLANNED SYSTEM UNAVAILABILITY</b> <ul style="list-style-type: none"> <li>- Short-term unexpected unavailability of interconnectors and internal lines affecting inter-TSO operation, possible updating of transmission grid maintenance plan and info on special network conditions (T) <sup>2</sup></li> <li>- Unexpected short-term unavailability of major generation units (T)</li> </ul>	<b>PLANNED SYSTEM UNAVAILABILITY</b> <ul style="list-style-type: none"> <li>- Plan of unavailability of interconnection lines and internal lines affecting inter-TSO operation (this also applies to limited availability cases) (T) <sup>2</sup></li> <li>- Plan of major generation units unavailability for year Y+1 (T)</li> </ul>	Where relevant, within operational timescales, this could include the sharing of market price signal information, including that applicable to capacity auction clearing prices and balancing and ancillary services between TSOs
	<b>INTRA-DAY SYSTEM MODIFICATIONS</b> <ul style="list-style-type: none"> <li>- Modifications on exchange programs determined by intra-day market results affecting physical flows on other control areas (T;O)</li> <li>- Unforeseen system events (O) or constraint related events resulting in use of TSO related Balancing Services</li> </ul>			
	<b>UNPLANNED UNAVAILABILITY</b> <ul style="list-style-type: none"> <li>- Unplanned outage information relating to inter-TSO operation (T)</li> </ul>			

(T) = Origin of information is TSO; (G) = Origin of information is Generator; (O) = Origin of information is 'Other' (market participant)