EuroPEX
Association of European Power Exchanges

Flow-based Market Coupling

A Joint ETSO-EuroPEX Proposal for Cross-Border Congestion Management and Integration of Electricity Markets in Europe

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Introduction

ETSO and EuroPEX have previously published separate proposals for congestion management and market operation across borders in Europe. ETSO has described a 'vision' in which Transmission System Operators (TSOs) would support trade between a variety of different markets by taking explicit account of the physical flows of electricity between them ('flow-based modelling'). EuroPEX has described 'Decentralised Market Coupling' as a method to integrate regional energy markets with cross-border congestion management.

In most respects, the ETSO and EuroPEX proposals are consistent and complementary. In particular, both organisations agree that market-based congestion management mechanisms should be used at all borders wherever possible, and that they should be co-ordinated to take account of the inter-dependence of physical flows. Furthermore, both ETSO and EuroPEX recognise that integrated markets are in general more efficient than separate ones, but accept that coupling of regional markets is the most realistic way of achieving efficiency benefits in the short and medium term.

The commonality between the ETSO and EuroPEX proposals has been noted by the Florence Regulators' Forum, which has therefore encouraged ETSO and EuroPEX to work together to develop joint proposals. They have responded by setting up a Joint Working Group (JWG), which has produced this paper describing a new model termed 'Flow-based Market Coupling'. A more detailed report is also available[1].

The work is not yet complete. This is an interim paper designed to expose ideas at an early stage to enable Regulators, Users and other interested parties to join the debate and provide feedback. In particular, it does not attempt to put forward a prescriptive 'blueprint' for a particular market model, but rather to signal a general direction. It is assumed that implementation of changes in practice would proceed through a series of regional initiatives, governed where necessary by the EU Regulation on Cross-border Exchanges of Electricity, together with the associated Guidelines.

Flow-Based Market Coupling (FMC)

Key features

The proposed Flow-based Market Coupling model (FMC) offers significant benefits by integrating two major features:

1. Flow-based modelling: this will provide the means to maximise the inter-regional transmission capacity that can be made available without compromising system security.

2. Market coupling: this will provide the efficiency advantages of integrated markets, subject to the availability of inter-regional transmission capacity.

On borders that are currently managed without market-based methods, such an approach will enable effective inter-regional competition. Where market-based congestion management already exists, it will enhance efficiency by optimising both inter-regional transmission utilisation and market operation.

General principles

At the beginning of their joint work ETSO and EuroPEX agreed that the priority should be to focus on market co-ordination at the day-ahead stage. If the day-ahead markets are sufficiently comprehensive and compatible, they should provide the minimum facilities necessary for market participants to trade their energy and access the transmission system. FMC is proposed as a means of providing such facilities for inter-regional trade. It is also

[1] Flow-based Market Coupling: a joint ETSO-EuroPEX proposal for cross-border congestion management and integration of electricity markets in Europe, September 2004, www.etso-net.org and www.europex.org.

intended to bring the benefits described in the previous section by coupling the regional day-ahead markets using flow-based modelling.

The decision to administer a market co-ordination scheme at the day-ahead stage does not mean that all trading must take place at this stage. A variety of forward contracting options, both physical and financial, is possible.

The principles behind flow-based modelling have been described previously by ETSO. An underlying assumption is that the European system can be operated as a number of single-price regions, each of which can be represented as a single node in a simplified transmission model. The regional nodes are connected by notional transmission circuits. The flow properties of this simplified model are described by 'flow factors', and limits ('bottleneck capacities') are placed on the notional inter-regional circuits to represent the effects of cross-border transmission constraints.

This model is clearly a gross approximation to the complexities of the physical transmission system, and this reduces its accuracy as a congestion management tool. It is, however, expected to provide significant improvements over existing methods, and it is likely that this degree of simplification is necessary to provide adequate market liquidity at each node.

Market coupling has been described previously by EuroPEX. It is based on the assumption that an administered day-ahead market exists in each region (i.e. at each node of the simplified transmission model). Subject to the ability of the transmission model to support the associated flows, market coupling enables the regional markets to trade with each other if it is economically efficient to do so.

The FMC day-ahead markets

Bottleneck capacities and flow factors are required by the day-ahead markets to describe the state of the simplified transmission model used for flow-based market coupling. These quantities are estimated and published in advance to inform users of likely inter-regional transmission conditions, and then updated shortly before operation of the day-ahead market (incorporating, for example, any forward inter-regional capacity options not exercised).

Users may submit bids and offers to the regional day-ahead markets to buy or sell energy at the local price. They may also submit price-difference bids whereby they offer to transfer energy between two markets and pay/earn the inter-regional congestion price (i.e., the price difference between the two markets). This enables non-discriminatory day-ahead access for cross-border bilateral energy contracts.

The calculations required to clear the day-ahead markets can be separated into those using only regional information, and those requiring multi-regional information. Iteration is required between the two because 'block' bids and offers (i.e. those specifying a multi-period time duration) introduce complications that cannot be handled by a single optimisation calculation.

- At a regional (i.e. individual market) level, local energy bids and offers in the day-ahead markets can be cleared. This reveals the isolated market clearing price (where local bids equal local offers for each period) and also the relationship between market clearing price and the market being long (exporting) or short (importing) – termed 'import/export curves'. These regional markets can operate according to their own rules – including, for example, offering 'block bids' covering multiple time periods.

- At a multi-regional level the resulting 'import/export curves' are used, together with any price-difference bids and offers, to optimise flows between the regions, subject to the inter-regional transmission constraints represented by the simplified transmission model.

- The resulting hourly prices in each regional market may affect which block bids are accepted, implying a regional recalculation of the import/export curves followed in turn by a revision of the inter-regional flows. This sequence is repeated until it converges, or until the latest time imposed by operational requirements.

In summary, each market produces its own clearing price. All energy bids/offers are matched and settled according to the regional market rules, and the resulting energy flows between the different regions comply with the bottleneck capacities and flow factors.

Alternative forward markets

The FMC day-ahead markets can coexist with several forms of forward market arrangements. These provide opportunities for users to hedge cross-border price risk that they would otherwise face in the day-ahead market. Possibilities could include participation in electricity related financial markets and/or participation in explicit auctions of forward transmission rights. These arrangements would operate independently from the FMC day-ahead markets.

To be of value for operational congestion management, system operation requires 'firm' transmission rights in the sense that users have an obligation to exercise them (if this is not the case, 'netting' of firm schedules is not possible). This implies some means of ensuring compliance with user obligations, either via legal/regulatory sanctions or regulatory/contractual incentives, such as imbalance settlement. However, this does not eliminate the possibility of forward markets in physical options (i.e. rights without obligations), so long as there is an exercise notification process prior to the operation of the day-ahead market. This 'use-it-or-lose-it' (UIOLI) procedure can be used to impose firm obligations on those rights that are nominated. In practice, a 'use-it-or-sell-it' (UIOSI) scheme is also available, because users can effectively sell physical transmission rights in the day-ahead market by submitting offers for counter-flow obligations.

Regulatory/Contractual Arrangements

The FMC model implies a highly integrated set of processes involving TSOs and power exchanges working together at both a regional and multi-regional level. This has implications for accountabilities (since not all power exchanges are regulated), harmonisation (ideally limited to that strictly necessary) and the regulatory/contractual framework that joins the parties together.

Accountabilities

The proposed FMC day-ahead market adds a new factor to the scheme of accountabilities in many European countries because it involves power exchanges as an integrated element in the solving of cross-border congestion. This implies an institutional role that must be made accountable to the general interest in a manner decided by each Member State. There appear to be two ways of achieving this. The institutional cross-border congestion-related functions performed by the power exchanges could be held directly accountable to an industry regulator in the same way as system operation (this is already the case in some Member States). Alternatively, they could be treated as delegated aspects of system operation. In the latter case, suitable accountabilities would need to be provided by regulatory and/or contractual means.

Harmonisation

The structure of the FMC model implies a minimum level of harmonisation. This arises in two ways. First, the need for processes in different regions to meet common requirements necessitates a degree of harmonisation of the processes themselves. Second, the need to publish data and communicate between processes implies a requirement to harmonise process timing and data formats.

Specifically, there is a need to harmonise the methodology for evaluating inter-regional bottleneck capacities and flow factors. The formats in which these values are published, together with the formats for publishing the day-ahead market schedules, should also be harmonised for ease of assimilation by users.

There is no particular need to harmonise the regional market operation or system operation processes themselves, provided the timing and formats of data exchanges with the inter-regional processes are compatible. If the inter-regional processes are replicated in each region, they must be identical across regions, and the schedules provided for physical implementation must be feasible (i.e., compliant with the bottleneck capacities).

Regulatory/contractual framework

There are variations between the legal and regulatory frameworks in different Member States. The framework of multilateral relationships would need to be common, establishing the necessary common rules, but could be established via either regulatory or commercial agreements depending on the situation in each Member State. The framework would need to be enabled as appropriate by local regulatory arrangements.

There are also differences between Member States over how some system and market operation functions are performed. For example, settlement of imbalances and ancillary services may be undertaken by a TSO, a power exchange or a third party, depending on the Member State. FMC should be compatible with all these arrangements. However, to simplify the description of the contractual/ regulatory framework below, a single TSO and a single power exchange (PX) are assumed to perform the system operation and market operation functions respectively in each Member State.

One possible set of regulatory or contractual arrangements is the following:

1. A new multilateral arrangement between TSOs to calculate the bottleneck capacities and flow distribution factors, and to distribute any resulting congestion revenue according to the EU regulation.

2. A new multilateral arrangement between PXs to govern the use of cross-border capacity, interactions between regional and inter-regional processes, calculation of aggregate schedules, the arrangements for price-difference bids and the collection of congestion revenues.

3. Arrangements between users and PXs to govern the rules and use of the regional markets (i.e. modified versions of existing PX participant agreements to add the coupling rules and the submission and settlement of price-difference bids).

4. Regulated arrangements between TSOs (or PXs in some Member States) and users (including PXs in some Member States) to establish regional balance responsibility (probably minimal change to existing arrangements).

5. Arrangements between PXs and TSOs to provide to the PXs the bottleneck capacities and flow distribution factors, and to transfer the resulting day-ahead schedules back to the TSOs. (These could be on a local TSO-to-PX or a multilateral basis).

Outstanding issues

The work described in this paper is itself incomplete, and will need to be revised and extended in the light of feedback and comments received. In addition, it has not attempted to address a number of outstanding issues. These include the following:

- The approximations introduced by the simple transmission model (i.e. single-price areas represented as electrical nodes) remain to be quantified.

- The algorithms for generating the simplified transmission model and updating its parameters (bottleneck capacities and flow factors) have yet to be put in place.

- The algorithms for co-ordinating the day-ahead markets need to be developed, with particular reference to the complications introduced by block constraints. The specific need to provide feasibility with respect to both transmission constraints and block

constraints should be addressed.

- Performance measures for both TSOs and power exchanges should be sought, together with regulatory or commercial incentives.

- The specific steps necessary to evolve from current arrangements to FMC will need to be identified. These will be different in different Member States.

- Contractual/regulatory issues remaining to be addressed include: settlement timescales and cashflow, managing changes to the rules, accession of new regions, intellectual property rights, legal jurisdiction, credit risk, and organisation of common activities.

- Inputs should be developed for possible adoption by the EU Comitology procedure.

- Advice should be developed for local development projects.

Conclusions

ETSO and EuroPEX have jointly developed an approach to cross-border congestion management, called Flow-based Market Coupling (FMC), which in their view best meets the needs of both the market and system operation. The result is a model based on regional price areas, with inter-regional trading facilitated by market coupling subject to simplified transmission constraints.

The FMC model achieves a balance between the requirements for effective congestion management, efficient energy markets and practical feasibility.

- Congestion management is improved through the use of a flow-based approach and netting that together increase the potential utilisation of the network.

- Market efficiency is improved in a number of ways:
  - FMC integrates the pricing of inter-regional transmission with that of regional energy, eliminating a source of unnecessary risk while also consolidating liquidity
  - it makes access to other regional markets much easier (in effect, it is inherent for all power exchange participants)
  - it supports a variety of trading options (bilateral or cleared exchange) and products (e.g. block bids).

- Feasibility is high because FMC builds on the existing trading infrastructure and liquidity while also being capable of being extended and developed further over time.

The FMC model only describes arrangements for day-ahead trading. This needs to be part of a broader set of arrangements including, on one side, effective opportunities for participants to hedge price risk and, on the other side, complementary adjustment and balancing arrangements. FMC is compatible with price risk being hedged via a variety of forward physical or financial markets.

The minimum set of regulatory/contractual arrangements necessary to implement FMC has been identified. Some issues concerning the status of power exchanges in some Member States remain to be resolved, particularly regarding the designated nature of the proposed day-ahead market.

The transmission modelling and market co-ordination processes remain to be specified in technical detail. Both should be as transparent as reasonably possible, and the latter is likely to be an iterative process, introducing the possibility of convergence issues.

Subject to the response to this interim report from other parties, ETSO and EuroPEX agree that the FMC concept should be developed further. Eventual deliverables should include inputs for consideration under the EU Comitology procedure, and advice for consideration by local implementation projects.