ETSO TF 13

Co-operation with Power Exchanges

Final Report

EUROPEAN TRANSMISSION SYSTEM OPERATORS

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0 Abstract

In its first phase of work TF13 has prepared an overview of Power Exchanges (PX) in Europe and outlined a delineation of functions between TSO and PX in order to specify the responsibilities and obligations of the TSO in contrast with those of the PX. The results have been described in the interim report of March 2001. Apart from that a questionnaire was created in order to assess the current situation in the relationship between TSO and PX and to learn more about the key success factors for successful co-operation.

In the second phase of work the questionnaire was evaluated. The results are summarised in the first chapter of this report. Regarding delineation of functions it can be stated that TSOs should perform all functions related to system operation and in the time frame of real time plus some hours while PXs perform functions related to market operation and in the time frame several hours and longer ahead of real time. Based on this assumption functions like operation of intra-day or regulating power market and congestion management are in the focus of both TSO and PX. As key success factors for establishing a close co-operation it is regarded important that TSO and PX share basically the same vision of how the market should work, stick to there roles as defined above and discuss conflicts in common working groups.

As there are no standard requirements for certification of players on the various power exchanges in Europe and not even for certification of power exchanges themselves conditions for a standardised admittance are described in the second chapter. Regarding the PX itself it is essential that PX set their market rules so that they match the grid access rules of the corresponding TSO. Requirements for PX participants can be categorised in requirements in the interest of PX on one side and the TSO on the other. Balance responsibility towards the TSO is the key condition a PX participant has to fulfil.

PX can be used for congestion management like already practiced in NORDEL with market splitting. To gain a better inside how such a system works a computer prototype has been developed that calculates clearing prices and load flows on interconnector lines in a four area model. This prototype is still under development but a short description of the model and its mathematical background is presented in chapter three.

Derived from the results of the questionnaire the role of a PX in a day-ahead market for regulating power is examined in the fourth chapter. Such a role can probably be only in the procurement of minute reserve because the trade of automatically activated primary and secondary controls implies the need for technology and special equipment. In the proposed model a PX could receive all bids for reserve, creates the merit order, does the price fixing and performs the financial settlement. In the process the market benefits from PX´s core business of financial settlement and risk management and their usually accepted role as a neutral and transparent entity. This neutral role of a PX is even more important when balancing power has to be procured for more than one TSO. In a balancing market for multiple TSOs also less regulating power has to be purchased for all TSOs than individually because of a given pooling effect.

1 Results of the Questionnaires on Co-operation with Power Exchanges

In its first phase of work ETSO Task Force 13 „Co-operation with Power Exchanges“ has created a questionnaire in order to assess the current situation with regard to the co-operation and delineation of functions between power exchanges (PX) and transmission system operators (TSO) and to learn more about the key success factors for successful co-operation in the future.

The questionnaire is divided in five sections:

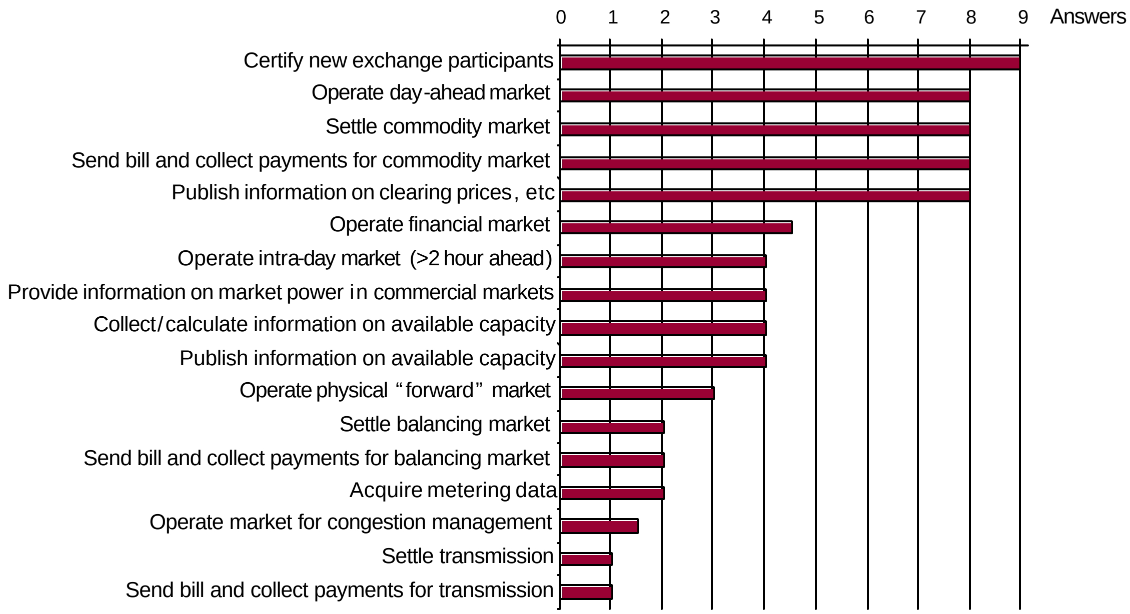
Section	... provides questions to understand ...
1. Roles and Responsibilities of TSO and PX	the nature of the services provided by the TSO and PX and to look at the delineation of roles and responsibilities between both.
2. Physical Delivery and Congestion Management	how physival delivery is arranged and should be dealt with congestion management.
3. Exchange of Information between TSO and PX	the process of exchanging information and the use of standards between the PX and the TSO.
4. Legal status of the PX	the legal status and ownership structure of the PX.
5. Key Success Factors and Potential Conflicts	what will be the key success factors for a successful co-operation between PX and TSO’s in the future and where conflicts could arise.

Nine questionnaires were distributed and returned by the following TSO´s and PX:

	TSO	PX	Country
1.	NGC	UK PX, APX	England and Wales
2.	PSE	Gielda Energii	Poland
3.	REE	OMEL	Spain
4.	REN		Portugal
5.	RTE	PowerNext	France
6. + 7.	RWE Net	EEX, LPX	Germany
8.	The Nordic TSOs	NordPool	Scandinavia
9.	TenneT	APX	The Netherlands

1.1 Roles and Responsibilities of TSO and PX

In this section first the functions currently operated by PXs are examined. The Portuguese PX although not operating yet is included in this diagram with its planned functions for the start. Functions under development are weighted half.



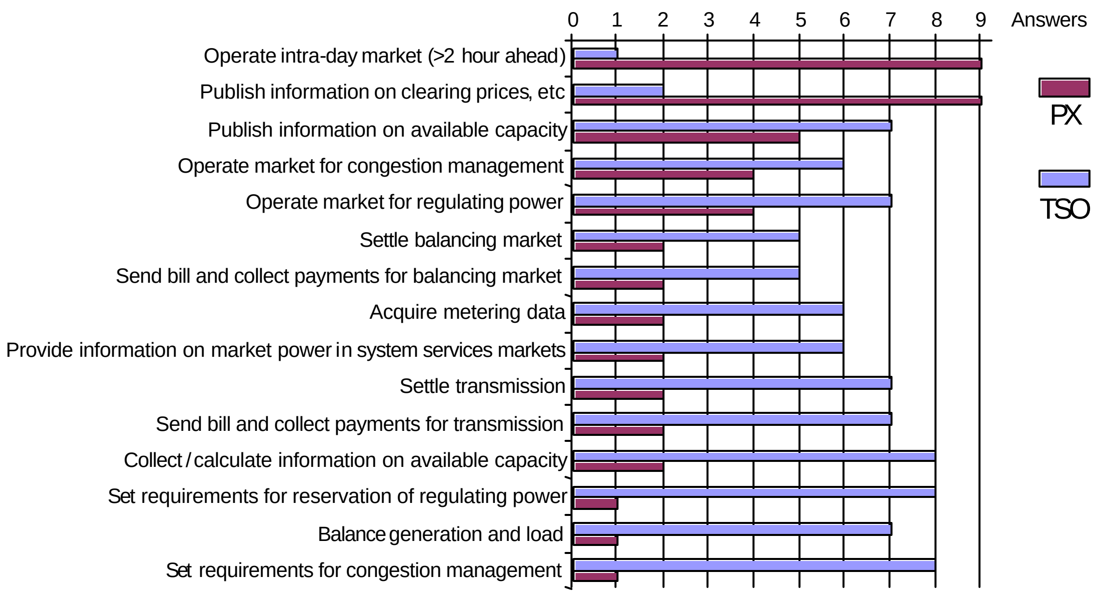
Three different areas can be identified in the diagram with a decreasing number of performed functions:

Nearly all PXs operate the day-ahead market and settle the commodity market (including billing and publishing of clearing prices). Of course all PXs have to certify new exchange participants.

Half of the PXs is able to operate a financial and intra-day market and they publish information on market power and available capacity. A market for physical delivery in the future (physical forward market) is operated by three PXs. Belonging to this second area are not the same four PXs. In fact all PXs are represented in the second area with at least one function which shows that PXs in Europe have got different profiles.

The last six functions are only performed by a minority. Just NordPool operates a market for congestion management to full extent. Settlement and billing of balancing markets are operated by the two Iberian PXs. The other functions will be only part of the business of the Portuguese PX.

In the second step it is asked which function from a given list could be performed by PXs, by TSOs or possibly by both. Clearly assigned to the PX are functions that deal with the financial and commodity market whereas operation of the grid with its corresponding tasks is indisputably an issue of the TSO. But many functions are at least in a few questionnaires assigned as well as to PX as to TSO:



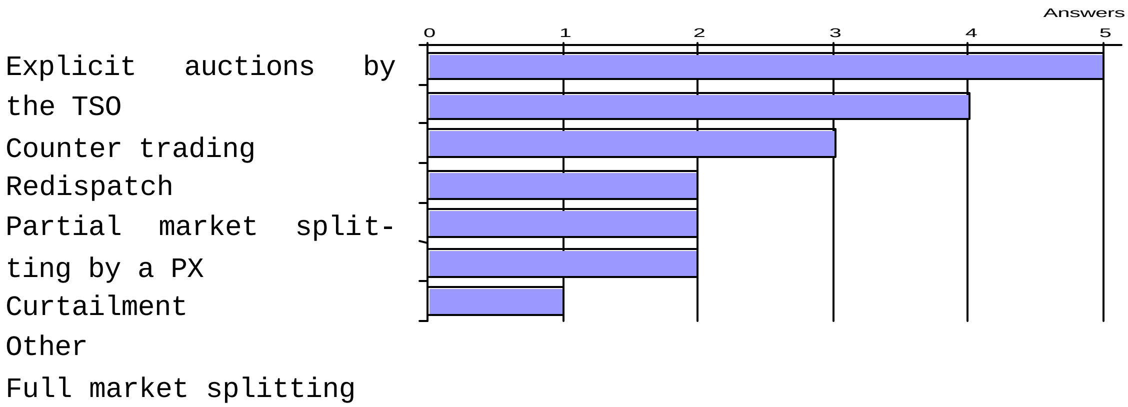
Overall most functions are assigned to TSO. Only in the questionnaire of OMEL the PX is seen as performer of the majority of functions. Operation of intra-day market and publishing of clearing prices is in all cases part of PX´s business and just once resp. twice seen also as possible field for TSOs. Vice versa the ten functions counted from the bottom are mainly assigned to TSOs. Clearly in the focus of both are the operation of a market for congestion management and regulating power. Depending on the framework TSO as well as PX are able to operate such markets. In further work of TF13 these functions are under closer examination.

As criteria who will be involved in which function often is mentioned that

- TSO performs all functions related to system operation while PX performs functions related to market operation
- TSO performs functions in the time frame of real time plus some hours ahead whereas PX operates in the time frame several hours ahead and longer,
- Neutral functions such as billing and publishing of information shall be performed by the party who is responsible for that data.

1.2 Physical Delivery and Congestion Management

In this section first it is asked for methods of congestion management that are applied currently in TSO and PX areas and the experienced difficulties with it:



It can be seen that congestion management is mainly in the hands of TSOs because the most favourite three methods are applied by them. Explicit auction is a transparent and market-based method for allocation of transmission capacity but cannot ensure in all cases the full utilisation of the available capacity. A clear price signal is sent to the market. Vice versa redispatch and counter trading do not send price signals to market participants but provide costs for TSOs.

Full market splitting can only be performed by NordPool and partial market splitting could be applied by LPX but is never done so far because between the German control areas congestions did not take place in the past. Market splitting gives an economic signal to market participants and different market prices can be also interpreted as a signal to the TSO to reinforce the grid. Apart from these methods also curtailment is still necessary under certain circumstances. Curtailment is not seen as an appropiate solution to congestion problems because it is often criticised by market participants as being unfair and non market-based. A special case is Spain where a combination of implicit auction for market transactions and explicit auction for bilateral trade is performed by both PX and TSO respectively.

Towards the auctioning of cross-border capacity PXs are reserved because additional fees arise and if they take part this would mean to compete with its own participants. They favour market splitting instead.

To ensure physical delivery of market results the favourite concept is balance responsibility of PX which is applied with slight differences in every country. It is always the task to balance supply and demand. Some TSO do guarantee the physical delivery inside one hub as long as there are no abnormal conditions like a black out.

1.3 Exchange of Information

Information exchange between TSO and PX is in most cases very limited. In England, Germany, Poland and the Netherlands there is no established exchange of information apart from schedules. The closer the co-operation is the more information is exchanged, e.g. NordPool and OMEL. These two exchange information about the available transmission capacity, regulated volumes and prices from the balancing market, traded volumes on the spot market and much more.

Because little information is exchanged the need for standardising the formats is limited. Only in few cases standards like Edifact, XML, specific text files or MS-Excel sheets have been established whereas text files and Excel sheets transferred via e-mail are not really a very sophisticated and standardised form of exchange. TSO as well as PX mainly use self-developed systems for their data processing.

1.4 Legal

Apart from England and Germany PXs are operating as a monopoly in their area. This is not a legal consequence but just the fact of the non-existence of other PXs in their areas. Bilateral trading is possible and allowed but in Scandinavia cross-border trade is nearly to 100% handled by NordPool. For all PX apart from the spot market of APX in the Netherlands and NordPool in Sweden and Finland a licence is necessary. The licence is given from the financial markets regulation authority in every state. The relation between TSO and PX is a contractual one with the exception of Spain where the roles of PX and TSO are fixed in law.

The ownership structure of PX is mostly dominated by companies from the energy business like traders and TSO´s and companies from the financial sector. Only shares of LPX and Gielda Energii are also partly in the hands of public institutions.

1.5 Key Success Factors and Potential Conflicts

In the last section of the questionnaire it is asked what the key factors for a successful co-operation between TSO and PX are and if there are hints for potential conflicts. To enable a successful communication between the parties common goals for PX and TSO focused on the development of the electricity market are mentioned as important factor. PX and TSO should basically share the same vision how the market should work. It is also necessary that responsibilities are fixed and clearly separated: PX as market operator dealing with the economic part and TSO as system operator working on the technical side. Integrated IT systems can improve the exchange of information.

In order to define a clear delineation of functions a sharp distinction between commercial and technical activities and between the (legal) responsibilities of both TSO and PX is necessary. It is also important to define the relevant time frame for each operation. With such a time frame a delineation of functions can be supported. Operations in real time plus some hours have to be assigned to the TSO as responsible system operator, operations day ahead and longer are more related to the PX as market operator. Based on the assignment of functions according to a time scale following functions may lead to conflicts: operation of intra-day market, operation of market for regulating power and congestion management. As seen in section 1 the possibility to perform these functions is often assigned to TSO as well as to PX.

Conflicts may arise from a competition of TSO and PX to perform the functions that are close to the borderline between technical and commercial activities. Such an overlap can also result from an unclear definition of the role to be performed. Conflicts should be addressed in common working groups and discussions. To settle a matter in court is not seen as a proper solution.

As key success factors for establishing a close co-operation to deal with congestion management a free and open exchange of information regarding constraints and as a method market splitting in combination with counter trade is mentioned. That TSOs should agree among themselves on the methods of congestion management is also asked for.

At the end of the questionnaire other concerns of PX with the TSO in their trading area could be mentioned. An accumulation of similar concerns could not be discovered apart from the expression that a close co-operation between TSO and PX is desirable.

2 Certification of Players on Power Exchanges

Today there are no standard requirements for certification of players on the various power exchanges in Europe. There are not even requirements for certification of power exchanges themselves. However it is likely that certification requirements will emerge and that – as regards the physical spot markets (day-ahead and intra-day) – co-operation between power exchanges and TSOs will be advantageous.

2.1 Requirements on Power Exchanges

Seen from the TSO’s point of view, a power exchange can be considered as a market player: it can nominate transactions (purchases or sales) with other market players (the participants to the exchange). Therefore, the Power Exchange must comply with rules for access to the electricity system, defined by the TSO under control of its regulator. Such access for physical participants such as generators or end users would comprise both grid access and market access (balance associated). However, for a power exchange, as for a pure trader, physical access to the grid is not necessary. Rules applicable to the power exchange therefore include in particular:

- gate closure for nominations of transactions (can be one day, or a few hours before delivery, etc.).
- format for nominations of transactions, and in particular timestep (can be 1 hour, or 30 minutes, or 15 minutes).
- balance responsibility, a contract between the TSO and the power exchange, by which the latter is committed to keep a balance between its purchases and its sales (and to compensate financially for an imbalance, should it occur).

Therefore, it is essential that power exchange sets the market rules so that they are coherent with the grid access rules listed above.

2.2 Requirements on power exchange participants

Taking the well-established spot-market at NordPool as an example, there is no formal requirement today for certification of players. However prospective players on the physical spot market must fulfil the following conditions, which can be categorised in:

- conditions in the interest of the power exchange itself,
- conditions in the interest of the TSO (grid access).

2.2.1 Conditions in the interest of the power exchange

- *to satisfy economic criteria* – financial guarantees that the player will be able to pay for traded power contracts.

A second condition has been discussed but not yet introduced:

- *compulsory education* - regarding the structure of the electricity market, the market rules, risk management etc. Such education - which among others NordPool provides – is voluntary today. It has been the prevailing view that many traditional electricity market players have been used to a similar, although limited, market environment – i e the producer markets – even before deregulation.

2.2.2 Conditions in the interest of the TSO

- *to be balance responsible* – the player shall directly or indirectly be connected to the balance markets (usually run by the TSOs) in each of the physical areas where he intends to trade.

- *to sign a participant agreement* – which among other rules states that the player shall plan for balance between his supply side and demand side when placing bids on the day-ahead spot market.

2.3 Balance responsibility

Of the above-described criteria, the most important one is balance responsibility: a domain that offers possibilities for– or even requires - close co-operation between the balance market (usually run by the TSO) and the power exchange. Balance responsibility is a concept found, under various names, in most European electricity systems. A balance-responsible party – sometimes called balance provider - in a given area is a company who agrees, by contract with the TSO:

- to *inform* the balance market run by the TSO of its production resources (own generation, imports and purchases), and its supply responsibilities (own load, exports and sales) in the area. Both should be in balance in the time frame (hour, half-hour, quarter-hour) used for balance settlement in the area.
- to *bid regulating power resources* to the (usually TSO-run) balancing market. This applies in systems where there is no central dispatch. –
- to take part in *economic settlement* , after the fact, of its company imbalance.
- to satisfy *economic criteria* – financial guarantees that the player will be able to pay for balance power incurred.

The after the fact balance settlement is the calculation of the imbalance of a balance responsible party - i e the difference between its actual production and its actual supply - in the area during each settlement period (hour, half-hour etc).

Here actual production is taken to include the sum of measured production of own generation units, nominated imports and nominated purchases from other balance providers in the area. Similarly, actual supply includes measured load of own customers, nominated imports and nominated sales to other balance providers in the area.

Purchases and sales are taken into account in the imbalances on the basis of reports (ex-ante) from both parties (buyer and seller). In the case of differing reported information for the same transaction, there must be rules of selection, e g cancel the transaction, take the seller’s value, etc. The same applies in principle for physical purchases and sales from a power exchange (spot market), although the institutional character of the power exchange and the relationship between the power exchange and the balance market may be a basis to favour the power exchange report, if reported information differs (see 4 below).

If the imbalance is positive, the balance market will compensate the balance responsible party economically for the excess “balance power” fed into the system. If the imbalance is negative, the balance responsible will have to pay the balance market for the “balance power” taken from the system.

2.4 Financial guarantees

Credit cover is another domain for possible co-operation between the power exchange and the TSO. Indeed, the failure of a market player to pay its bills would impact both the power exchange (for purchased power contracts) and the TSO (for negative imbalance). Also, if a player is barred from the spot market (for any reason although insolvency would be most likely) this will increase the problem for the TSO balance market where the negative imbalance would increase, perhaps to 100%. For these reasons co-operation between the power exchange and TSO could be desirable, as in the Nordic countries. However, co-operation between the power exchange and the TSO in this domain may be complex to organise in other countries compared with the benefits expected.

One difficulty would be the differing natures of settlement. Settlement of a power exchange is a relatively easy matter as all information is available at market closure (i e often day ahead or at least hours ahead). This means that it should be possible to bill customers daily, if it is desirable to reduce exposure to risk. Settlement of balance on the other hand is a very complex and time-consuming process which relies not only on reported purchases and sales, but also on measured values of generation and consumption which have to be collected, aggregated, reported, checked, corrected, re-reported etc, a process which can take weeks. This will automatically increase the exposure.

2.5 Extent of co-operation between power exchange and TSO

As stated above physical purchases and sales on the power exchange should be taken into account when calculating imbalances of balance responsible parties. This requires that each power-exchange participant is a balance responsible party, directly or indirectly, in each area where he wants to trade (with contract with the balance market).

In the case of a poor co-operation between the power exchange and balancing market, the power exchange itself must at least be a balance responsible party in each area where it wants to organise trade. Of course normally there will always be a sale to balance a purchase, and as there are no measured values of generation or load involved, the power exchange should normally always have an imbalance equal to zero in each trading area.

A close co-operation between the exchange and balancing market as regards participant certification would allow both parties to have at all times the same identification of trading areas, and the same reliable list of balance responsible parties in each trading area.

This could have a number of advantages. The risk of the power exchange trading with a participant having no balance responsible contract will be reduced. This in turn reduces the risk of having an imbalance settled by the balancing market. Also, as mentioned above, in the case of different nominations of the same transaction by the power exchange and by a participant, the balance market can take the power exchange nomination.

3 Computer Model on Congestion Management

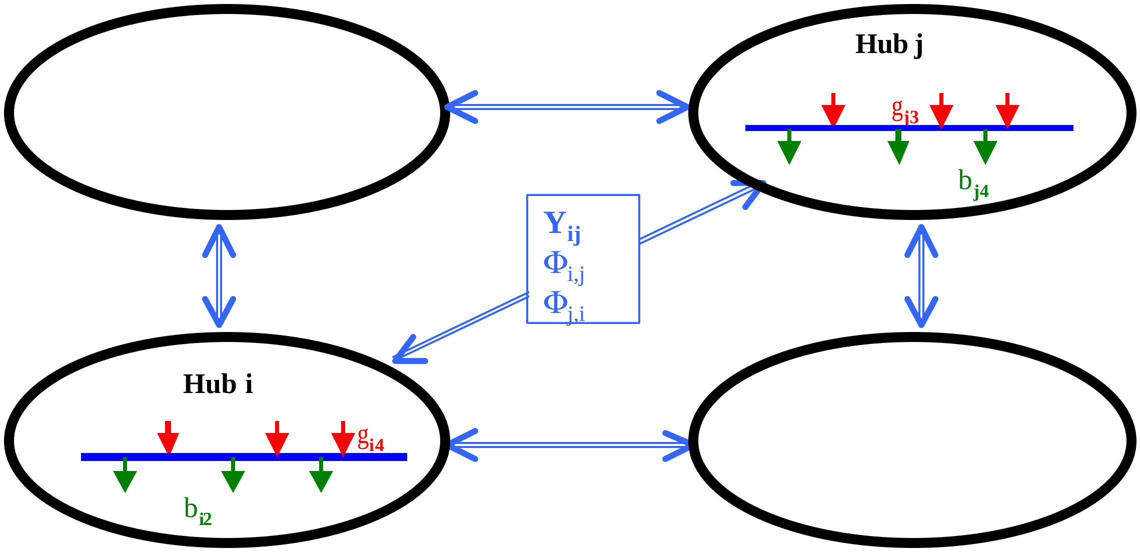
The mathematical background of presently discussed co-ordinated congestion management methods is fairly complex so that principles can only be demonstrated in written form with very simple examples. In order to apply the principles to more realistic grid situations (although still being far away from real network topologies) a computer model was designed which demonstrates market splitting (or market coupling) in a four area model linked by tie lines of known impedance. This model helps to explore the behaviour of the system to get a feeling for the implications and results of changing parameters and can be used to demonstrate ideas to non-experts on these matters.

3.1 The Network Model

We consider a transmission network, split into z electric "hubs" in such a way that :

(1) inside each hub the transport capacities are assumed infinite (or congestions are handled by production redispatch).
(2) the flows of energy [i $\rightarrow$ j] from hub i towards hub j are limited by the capacity $\Phi_{i,j}$ of their interconnection.

The network is thus modelled by a set of z busses linked by connections of known impedance (i.e. the bus admittance matrix **Y** of the network is known).



This approach assumes the following linearisation hypotheses:

(1) line resistances are negligible ($Y_{i,j}$ is the inverse of the reactance i? j)
(2) voltage angle differences are small so that $\sin(\delta_k - \delta_i) \approx (\delta_k - \delta_i)$
(3) voltage magnitudes lie within a narrow range so that a flat voltage profile is assumed.

This model implies two groups of physical constraints :

1. the electric balance of each bus : the algebraic sum of injections and off-takes at each bus k and of the incoming or outgoing power flows must be zero :

$$\sum_{j=1}^{m_k} ?_{kj} - \sum_{i=1}^{n_k} ß_{ki} + \sum_{p=1}^{z} Y_{p,k}(d_k - d_p) = 0 \qquad (k = 1, \ldots, z) \qquad (1)$$

   where δ_k is the voltage phase at bus k (bus z being taken as reference : $\delta_z = 0$) and $\gamma_{k,j}$ $(j = 1,\ldots,m_k)$ and $\beta_{k,i}$ $(i = 1,\ldots,n_k)$ are the set of power injections and withdrawal on bus k;

2. the line capacities :

$$f_{i,j} = Y_{i,j}(d_j - d_i) \leq F_{i,j} \qquad i = 1,\ldots,z\ ;\ j = 1,\ldots,z\ ;\ j \neq i \qquad (2)$$

Remarks

The hubs must be defined rather permanently and all major constraints be located at their tie lines (i.e. possible constraints inside bidding area must be handled by redispatch).

On the other hand, the bus admittance matrix **Y** depends on the topology and thus can change from one hour to the next. Moreover, the flows through tie lines can strongly depend on the geographical production and load pattern, even when a production and the corresponding consumption are located in the same hub.

Possible solutions :

- take locational information into account at the cost of a more intricate model (avoiding if possible a complete non linear load flow)
- define smaller hubs.

NB : Traders do no always know the precise location of the production they sell and buy.

3.2 The "Market coupling" model

The "Market Coupling" congestion management method (wrongly known as "market splitting") is implicit, in the sense that the necessary transmission capacity is obtained indirectly through constraints imposed on the commodity market clearing mechanism: the market actors enter bids and offers for energy to be injected or withdrawn on particular hubs; after clearing, the energy prices include an implicit component related to line congestion.

3.2.1 Markets

To each hub k corresponds to one PX where market participants place hourly sealed offers and bids for a given hour. This k^{th} PX thus collects, for each hour :

- m_k offers, each of which expresses the willingness to sell a volume of energy at most equal to $g_{k,i}$(MWh) - to be injected into hub k - at the minimum price $G_{k,j}$
- n_k bids, each of which expresses the willingness to buy a volume of energy at most equal to $b_{k,i}$(MWh) - to be withdrawn from hub k - at the maximum price $B_{k,i}$.

We suppose that :

(1) buyers and sellers consider only profit when negotiating a product
(2) the auctioning is blind : a buyer cannot identify the corresponding seller(s)
(3) the amounts to be exchanged and the prices are non negative

3.2.2 Clearing

One single clearing mechanism - common to all concerned PXs - results for all market participants in both a right and an obligation[1] to physically inject into hub k (resp. withdraw from hub k) volumes of energy equal to $\gamma_{k,j\ (j = 1,\ldots,m_k)}$ (resp. $\beta_{k,i\ (i = 1,\ldots,n_k)}$), where of course :

$$0 \le \gamma_{kj} \le g_{kj} \qquad (k = 1, \ldots , z\ ;\ j = 1,\ldots,m_k)$$

and

$$0 \le \beta_{k,i} \le b_{k,i} \qquad (k = 1, \ldots , z\ ;\ i = 1,\ldots,n_k) \qquad (3)$$

[1] Since this model implicitly "nets" the transactions on the borders, an accepted bid or offer is not only the right to inject or withdraw but also the obligation to do so. Otherwise congestions will occur (as well as imbalances).

The objective of a market is to maximise the satisfaction of both buyers and sellers ; here it is thus to find the values of the decision variables $\gamma_{k,j}$ and $\beta_{k,i}$ which yield the highest value to the market "surplus"

$$S = \sum_{k=1}^{z}\left(\sum_{i=1}^{n_k} ß_{k,i} B_{k,i} - \sum_{j=1}^{m_k} ?_{k,j} G_{k,j} \right) \qquad (0)$$

In this linear programming problem, dual variables give the following shadow prices[2]

- for constraints (1) the "market clearing prices" MCP_k of each hub,
- for constraints (2) the marginal value $V_{i,j}$ of interconnection capacities Φ_{ij} and
- for constraints (3) the marginal value of the bids' and offers' maximal volume.

Notes :

I. The capacity of a non-congested line has no marginal value (the shadow price of non active constraints are zero).

II. When n lines are congested, (n+1) markets are "driving", i.e. their MCPs are mutually independent, because they result from the price of the last (partially) satisfied bid or offer on their hub. The other MCPs depend linearly of the driving MCPs. In particular, when no line is congested, there is a single MCP for all hubs, corresponding to the last (partially) satisfied bid or offer in all hubs.

3.2.3 Settlement

Each seller and buyer gets an identical price for energy handled on hub k : buyers pay $\beta_{k,i}$ MCP_k € for each cleared bid and sellers receive $\gamma_{k,j}$ MCP_k € for each cleared offer.

The difference between funds collected from buyers and paid to sellers is equal to the total price of the flows on congested lines

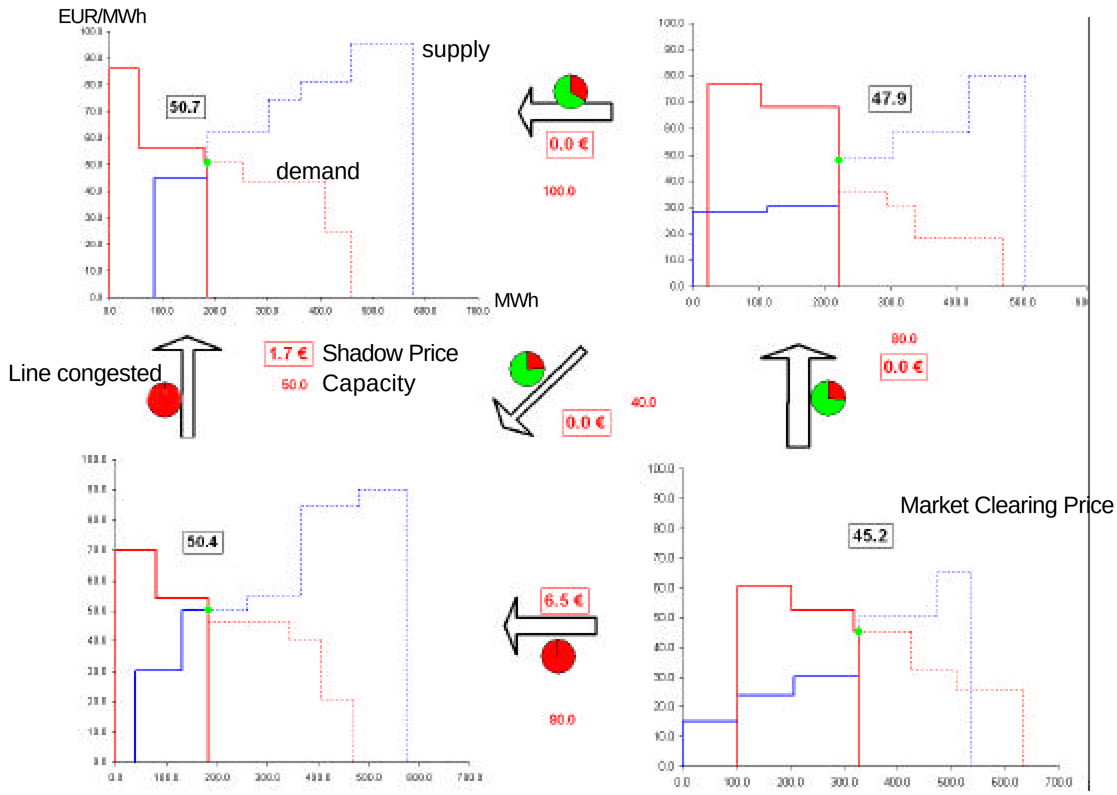
$$\sum_{k=1}^{z} MCP_k \left(\sum_{i=1}^{n_k} ß_{k,i} - \sum_{j=1}^{m_k} ?_{k,j} \right) = \sum_{k=1}^{z-1} \sum_{q=k+1}^{z} \left| f_{k,q} \right| V_{k,q}$$

and can be handed out to TSOs (for instance to be invested in increasing interconnection capacity).

Remark

[2] In linear programming theory, to each constraint is associated a dual variable which provides its "shadow price" or economic marginal value, i.e. the variation of the objective function when the constraint undergoes a unit variation.

1. All physical trade between areas must be handled by one and only one PEX per area[3] and all of them must be strongly co-ordinated.
2. In a meshed network where explicit (co-ordinated) auctioning must coexist with market splitting, the co-operation between PX**s** and TSO**s** becomes vital.



In the above representation examplary results of the computer prototype in a four area model can be seen. In each area a supply and demand curve and between the areas the available capacity is assumed. The algorithm calculates the market clearing price in each area and visualises the direction of energy flows between the areas by arrows. Next to the arrows the actual load on the interconnector lines is given by circle diagrams. If the line is congested they are coloured red and the shadow price is calculated. The behaviour of the system can be studied by changing the available capacity or demand and supply curves and watching their effect on load and market clearing price.

[3] which does not imply that a PEX must be located in "its" area

3.3 The "Co-ordinated auctioning" model

The congestion management method known as "co-ordinated auctioning" is explicit, in the sense that market actors must obtain the necessary transmission capacity separately from the commodity they trade. The commodity prices do not result form this model and can for instance be set by mutual agreements (bi- or multilateral contracts).

3.3.1 Auction

The auctioned products are "multilateral accesses" (MA). An MA is the right and the obligation to perform - during a given hour - a **balanced** set of physical injections and withdrawals located in various hubs.

In order to obtain an MA, net users submit (one or several) multilateral access bid (MAB) to a central auctioning office. An MAB is a **non necessarily balanced** set of proposals for injections and withdrawals : MAB number i includes for each hub k an offer to pay $G_{k,i}$ € per MW injected into this hub (with a maximal injection of $g_{k,i}$ MW) or[4] $B_{k,i}$ € per MW withdrawn (with a maximal off-take of $b_{k,i}$ MW).

3.3.2 Clearing

When cleared, MAB n^r i becomes an MA and gives its owner the right and the obligation to inject $\gamma_{k,i}$ MW or to withdraw $\beta_{k,i}$ MW in each hub k, where of course

$$0 \le \gamma_{k,i} \le g_{k,i} \quad (k = 1, \dots, z\ ;\ i = 1,\dots,n)$$

and

$$0 \le \beta_{k,i} \le b_{k,i} \quad (k = 1, \dots, z\ ;\ i = 1,\dots,n) \qquad (4)$$

Each MA must be balanced:

$$\sum_{k=1}^{z}\left(?_{k,n} - \text{ß}_{k,n}\right) = 0 \qquad (i = 1,\dots,n) \qquad (5)$$

The objective of this capacity auctioning is to select the MABs with highest offered price and which globally respect constraints (1), (2), (4) and (5). In terms of linear programming, the goal is to find the values of the decision variables $\gamma_{k,j}$ and $\beta_{k,i}$ maximising the objective function

$$\sum_{k=1}^{z}\sum_{i=1}^{n}\left(\text{ß}_{k,i}B_{k,i} + ?_{k,i}G_{k,i}\right)$$

under the said constraints.

[4] This "or" is exclusive : nobody will offer to pay for injecting and withdrawing in the same hub.

3.4 Spot / Bilateral compatibility

Various scenarious are possible to make bilateral transactions compatible with bilateral transactions; for instance :

- year-, month- and week-ahead capacity allocation for bilateral exchanges via co-ordinated auctioning
- day-ahead spot market splitting with the remaining capacity (PXs can acquire capacity for their market through the year/month/week auctioning)

Difficulties in continental Europe :

- highly meshed network and strongly interdependent transmission capacities
- present electricity markets not compatible
- not acceptable to exclude bilateral trade between bidding areas

4 Possible Role of PX in Day-ahead Balancing Markets

4.1 Remarks

1. The balancing mechanisms are central in the operation of electrical systems. It thus seemed necessary to include here a short recall of relevant issues of the transmission management.
2. Information concerning the present situation in some ETSO countries is included in *[brackets]* in the text.

4.2 Operation of the Transmission System

4.2.1 Balance responsible parties

The concept of "Balance Responsible Party" (BRP) exists in many countries *[B: Access Responsible Party, D: "Bilanzkreis", F: "Responsable d'équilibre, NL: "Programma Verantwoordelijk", S: Balance responsible companies/Balance providers]*.

It allows:

- to designate a party which bears the balancing responsibility of a set of transactions, taking advantage of (partial) cancelling out of individual unbalances,
- to unlink financial transactions from physical delivery.

Although the implementation may differ between countries, a BRP usually defines

1. a "**perimeter**" i.e.
    - a set of injection/off-take points ; each network node is assigned to a BRP, but parts of injections/off takes can be assigned to different BRPs,
    - a set of import and export contracts and loss compensation contracts

2. a **person** who is responsible for
   - information transmission to TSO
   - and financial compensation of unbalance.

4.2.2 Program submission

A program is a notification of the planned energy exchanges of a BRP for each period of a given day (most often 96 periods of 15 min[5]); it includes the scheduled injections and off-takes, the scheduled sales and purchases to and from other BRPs and the scheduled imports and exports.

In some countries the programs must also describe injection and off-take schedules *[D : for power stations >100 MW]*. Each BRP submits programs to TSO(s) on D–1 and before a "gate closure" time *[PL: 11:00, D : 14:30, UK : H-3.5[6], NL : D-1 12:00, N: D-1 19:00]*. Changes are sometimes allowed after gate closure, under certain circumstances *[NL : H-2[7], N: H-2, D: until H-15 min when a power station fails]*.

Most often programs must be **balanced**[8] *[D, B, F, NL, S, PL, N]*, which implies that the global system is also balanced. However, in the UK parties are allowed to submit unbalanced programs and in Nordel the BRP is free to choose if suddenly occurring imbalances (generator failure) are taken to the Balancing Market or solved on their own by starting another generator. The TSO is in charge of counter weighting the global predictable unbalance (the sum of program unbalances). For that purpose, the TSO must purchase balancing offers and bids *[UK]* or turns to an asymmetric clearing[9] in the PX *[Elspot]*. (see below 4.5.1.1)

4.2.3 Program feasibility check

After gate closure, the TSO checks the consistency and feasibility of submitted programs:

For countries where programs must be balanced, the programs consistency entails that if a BRP "A" has declared a netted scheduled supply to another BRP "B", then B must have declared the same netted scheduled purchase from A. Inconsistencies can be

- internal (i.e. discrepancy in programs of one BRP)
- external (i.e. discrepancy in programs of two BRPs, both on the same hub or not)

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5 *[B, D (except for international exch : 60')]* but sometimes 48 periods of 30 min *[F, UK] or 24* periods of 60 min *[PL]*.

6 with an "Initial program notification" on D–1, 11:00

7 the 1500 first changes are free, the next ones are charged

8 with or without the losses

9 the PX clears more bids than offers (or vice-versa) to compensate for the initial imbalance

If inconsistencies are detected, the concerned programs are either refused *[NL]* or automatically modified on the seller's side *[F]* or on the buyer's side *[D, PL]*. Inconsistencies concerning international exchange programs must be solved by resorting to pre-defined common rules. The feasibility check of submitted programs includes congestion forecast and management, as well as voltage (reactive power) control. If infeasibilities are detected, the TSO redispatches generation [and load], sometimes via the PX by a market splitting procedure.

4.2.4 Balancing power forecast and reservation

Using forecasting tools, the TSO estimates the possible unbalance. It contracts with producers or consumers the power reserves necessary for the real time balancing resources (see below).

4.3 Unbalances

In real time, each control area is prone to unexpected global deviations from scheduled generation and demand. The area's instantaneous unbalance ΔP is

- o the difference between the area's programmed international exchange and its actual value

- o or, equivalently the sum of
  - all BRPs' internal unbalance,
  - the losses in the area's transmission system,
  - the exchanges through "virtual" tie-lines,
  - the "konto",
  - the internal and external inconsistencies,
  - the international exchanges resulting from the primary control (see below).

4.4 (Real time) balancing resources

Unbalances must be managed in real-time or very close to it. Balancing resources are either under control of the TSO (and then can be further classified as automatic or manual) or of network users :

4.4.1 Automatic short-term controls

When an unbalance occurs (resulting from the disrespect of programs either on the generation or the demand side or on both), the primary and secondary controls operate in order to restore the impaired balance and the security of the system[10]. In UCTE countries, these controls are implemented according to published UCTE rules. NB: these rules were published before the European directive and could be adapted to the new situation.

4.4.1.1 Primary control

The primary control[11] adjusts the generation-demand balance of the total interconnected system. It operates through the joint action of the turbine speed regulator of a number of power stations located in the whole interconnected area (decentralised control).

This action is automatic, triggered by a frequency deviation from a preset value, and proportional to

- the frequency deviation
- the UCTE-defined participation coefficient[12].

The primary control's result is to stabilise the frequency inside a pre-defined bandwidth. Its activation delay must be shorter than 15 to 30 sec (depending on the total unbalance of the interconnected system). UCTE rules prescribe the minimum amount of primary reserve that has to be available per control area.

In order to qualify for primary control a power station must satisfy technical requirements such as: minimum action time (15 min), control band *[D: > 2% nominal capacity]*, restore time (15 min after reference frequency re-attained), maximum neutral band (10 MHz), …The power stations, which participate to the primary reserve, are chosen according to rules that may differ between countries. *[D: all units > 100MW]*

4.4.1.2 Secondary control (or load frequency control)

The set of secondary controls[13] set up in each control area[14]

- adjusts the frequency to a preset value
- adjusts the balance of all but one control areas.

Each secondary control operates through an on-line control loop set up in its control area, which affects the set-point of generated power of a number of power stations located in the

[10] When all these controls fail to restore the balance, the TSO invokes emergency procedures consisting mainly in heavy load reduction.
[11] does not adjust the frequency, as it is sometimes believed
[12] see UCTE rules
[13] There is no automatic secondary control in Nordel. The load frequency balancing is done manually by using the balancing market
[14] does not adjust the balance of each control area, as it is sometimes believed

area (one centralised secondary control per control area). Each secondary control's action is automatic and proportional to a combination of

- o the "area control error" ACE = $\Delta P + k.\Delta f$,
- o and the ACE integral over time.

The coefficient k should be close to the area's power-frequency characteristic ; therefore the secondary control acts only in unbalanced control area(s).

The joint result of secondary controls is to bring the frequency back to its preset value, which restores the impaired primary reserve when the frequency has drifted. Its activation delay must be shorter than 30 sec. UCTE rules prescribe the minimum amount of secondary reserve that has to be available in a control area. In order to qualify for secondary control a power station must satisfy technical requirements such as: frequency band, rate of change, stand-by duration, availability, … The power stations that participate to the secondary reserve are chosen according to rules witch may differ between countries. *[D: all generating units may offer and TSO chooses according to the merit order]*.

4.4.2 Longer term (non automatic) balancing mechanisms

Primary and secondary controls are fine tuning systems, operating in a time frame of a few seconds up to minutes. Since longer term balance is easier -and cheaper- to maintain, economic efficiency requests that, on terms of 15 minutes and longer, coarser adjustment systems take over. They are called "tertiary reserve" or "minute reserve" (although these names cover sometimes different concepts), and are most often manually operated. It is useful to distinguish their action during normal operation and after an incident:

4.4.2.1 Post incident : Tertiary reserve

When important unbalances occur (typically the loss of a large generation unit), the automatic controls operate and preserve the global security. To cope with other possible incidents, the primary and secondary reserves must be restored as fast as possible and "tertiary reserve" generation must be called in[15]. The tertiary reserve is activated manually within 5 to 15 min of an important unbalance,. It is co-ordinated in TSO control centres and often operated by tele-control *[very seldom fully automatic]*.

In UCTE countries, the amount of tertiary reserve available in a control area is defined by a UCTE rule : "if the loss of the biggest generation unit is not covered by the secondary reserve, a tertiary reserve must cover the complement ; this tertiary reserve must not necessarily be located within the control area". The tertiary reserve suppliers are producers and consumers, who can respond quickly by changing their generation or off take (hydro units, gas

[15] tertiary reserve can also be called in for real-time generation redispatch (emergency congestion clearing, voltage control,...)

turbines, other thermal units operating below their generating capacity, or remote load control).

Generation units (or loads) participating to the tertiary reserve must satisfy requirements such as availability, response time *[D: 5 min, PL : 15 min]*, metering requirements, and technical competency. *[B: all power stations >75MW must participate, D: all generators can]*.

4.4.2.2 Normal operation : Balancing market and balancing reserve

On the other hand, in normal operation, each BRP strives to respect its balance obligations but its net outcome, averaged over a "settlement period", is generally slightly over or under target[16]. The positive and negative unbalances of all BRPs partly cancel each other, bringing short-term inadvertent energy exchanges between BRPs, which must be settled ex-post (let's call this the balancing market).

However, the BRPs' unbalances do not cancel each other out completely and the control area experiences a resulting net unbalance. The TSO is in charge of organising the compensation of this control area unbalance. Therefore it must contract with producers, which accept to modulate their generation according to a "fine tuning" signal (let's call this the balancing reserve). The amount of necessary "Balancing reserve" is determined by the TSO, based on estimations from optimised forecasting tools. Most often, this balancing reserve is not clearly separated from the tertiary reserve.

4.4.3 „Energy Reserves“

Each BRP should organise its generation portfolio so that its long term balance is ensured, taking into account the possible long unavailability of an important part of its generation means. This operating reserve is under the BRP's responsibility only and falls outside the scope of this note.

4.5 Balancing resources markets (or Regulating Power market)

The settlements for the supply of balancing power and for its use resort to two different models; the two sides of this trading should be treated separately.

4.5.1 Supply of balancing resources

According to the classification of balancing resources above, a number of markets can be organised :

[16] e.g. because international schedules with their 1h step time frame are not flexible enough to follow the customer's demand forecast or the hydro or wind generation

4.5.1.1 Market for ex-ante redispatch

[UK: see appendix 3.8 for a very short description of the ex-ante market]

4.5.1.2 Market for Automatic controls

The technology of primary and secondary controls requires special equipment and attributes (for automatic activation and the control loop); verification procedures must ensure that these requirements are fulfilled. This is hardly compatible with a short term market. Therefore, primary and secondary controls and reserves are usually contracted on a long term basis by TSOs from power station operators.

4.5.1.3 Market for Tertiary and Balancing reserve

The distinction between Tertiary reserve and Balancing reserve is seldom very explicit, in spite of their differences.

In most countries, the TSO is in charge of contracting tertiary and balancing reserve:

- The potential suppliers make offers (volume and price) for upward/downward regulation *[N: on hourly basis].* Offers must be passed on before a notification closure *[N: H-2]*
- Offers are normally called in their merit order, except if congestion would result.
- Reserve suppliers receive
  - either the price "as bid" *[UK, PL]*
  - or the "balancing price" *[N]*, i.e. the highest (resp. lowest) used offer for regulating up (resp. down) , calculated per balancing period.
- Capacity market : reserve suppliers sometimes receive an "availability fee" even when their offer is not called (power and energy separately accounted) *[N]*.
- Penalties are charged to suppliers unable to provide the called power (non delivery charge).
- In order to improve the market fluidity, continuous information on balancing offers notified and executed should be provided *[NL].*
- The balancing market should be watched over. Anti gaming measures are to be taken *[NL]*.

4.5.2 Use of balancing resources

4.5.2.1 Primary and secondary controls

Primary and secondary controls are ancillary services; their cost is socialised (via the network access fee). Some exception exists *[E: use of secondary reserve charged individually]*.

4.5.2.2 Unbalance evaluation

The power unbalance is averaged on a period of time *[NL B D : 15 min., F : 30 min., E PL : 60 min]*. Unbalances on smaller terms are deemed stochastic and compensated by system services.

Some countries *[E, PL]* also charge "program deviations", i.e. metered energy - programmed energy (injection and off-take taken separately).

4.5.2.3 Price of unbalance

1. In some countries, general principles governs the price setting *[NL : TSO's net result = 0]*

2. The unbalance is charged to the BRP *[F, NL, E, PL]* or to the G and L parties *[P]*.

3. Unbalances are sometimes charged differently when they remain inside a predefined tolerance band.: *[*
   - *D : band = 5% monthly load peak of BRP*[17] *(deviations inside band may be compensated in energy)*,
   - *F: band = max. of {* *2.5 MWh,*
     10% of energy corresp. to subscribed access power in off-take nodes,
     10% of energy corresp. to subscribed access power in injection nodes
     },
   - *P: 5% - 3 different tolerances*

   On the other hand, in some countries any unbalance, however small, is charged. *[NL, E, PL*[18]*]*.

4. Charges are usually different for shortage and for surplus *[NL, PL]*

Tariffs can be fixed *[P]* or derived from the balancing market *[NL: highest called bid sets the price, D, PL: function of procurement cost, F]* or derived from the spot-market price with additional prices if upward or downward bids are called *[S]*

5. An extra fee is sometimes charged for long-lasting unbalance *[F: average positive or negative unbalance > 20% maximum allowed]*

4.6 Possible Model for Use of PXs in Day-ahead Balancing Markets

Up to now existing PXs have no role in the balancing trading. *[at least in B F D NL E PL P]*. In this chapter a model of possible role of PX in the procurement of regulating power is described. The way the costs of procurement are settled to the BRP or network users is not in

[17] E.ON Netz and RWE Net do not offer a tolerance band because of a symmetric price system for control energy

[18] implementation of tolerance band is planned for the near future

the focus. Some TSO´s believe that a balancing market maybe can benefit to some extent from the use of PXs but this view is not shared by all TSOs.

4.6.1 Preconditions

To limit the various theoretical possibilities to a sensible and straightforward model with benefits for the market certain preconditions can be identified:

- It does not seem possible to entrust third parties (PXs) with the trade of primary and secondary controls because these are automatically activated and that implies the need for technology and special equipment, the implementation of a verification process and much more. These controls are also contracted on a long term which does not fit to day ahead procedures. Therefore the model focuses on the manually activated controls and describes the role of PX in balancing reserve market for tertiary or minute reserve.

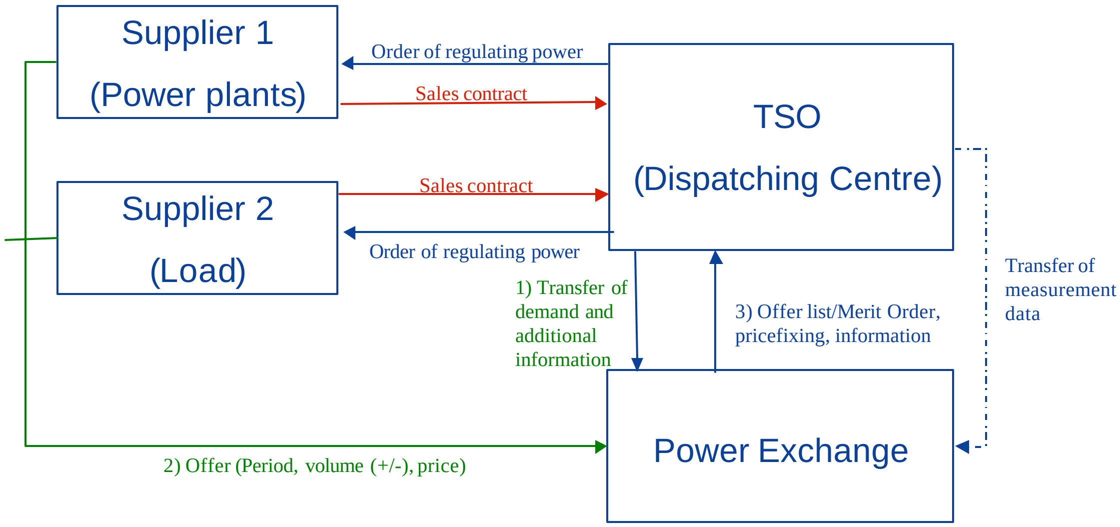
- For the longer term reserves, technical aspects are crucial as well. The role of any third party will probably remain lower, qualitatively and quantitatively, than the TSO's role. All balancing resources include technical aspects which can be managed by TSOs only. If a TSO decides to entrust a subcontractor with the trade of balancing resources, a technical relationship between the TSO and this third party (information exchange, co-ordination...) must be organised, that is much stronger than for the "normal" energy trading.

- In a balancing market, only one PX that is subcontractor to the TSO should be included. There is no sense of competition of two or more PX in the process of procurement and the establishment of two markets. On the contrary this would hinder from reliable operation.

- In several countries offers for balancing reserve can be made up to some hours before delivery. Such an intra day market is more difficult to handle with the use of a PX because the procedures a PX already performs are based on a day ahead concept. The role a PX can play will be significantly smaller the closer it comes to real-time operations. Therefore only a day ahead balancing market is taken into account.

4.6.2 Model of Balancing Market for a single TSO

The operation of a balancing market with the use of a PX could be realised in the following way:



The TSO calculates his demand for minute reserve and transfers it to the PX together with additional information. The demand can be calculated once or vary over time. The bidders place their offers at the PX day ahead. Based on the offers the PX generates a merit order and hands it over to the TSO. On the actual day the TSO uses this list to order regulating power from the supplier. This order is legally ensured by a sales contract between the TSO and the supplier. For settlement of costs the TSO transfers measurement data about the really used offers back to the PX who does the refunding.

4.6.3 Evaluation of PX Use

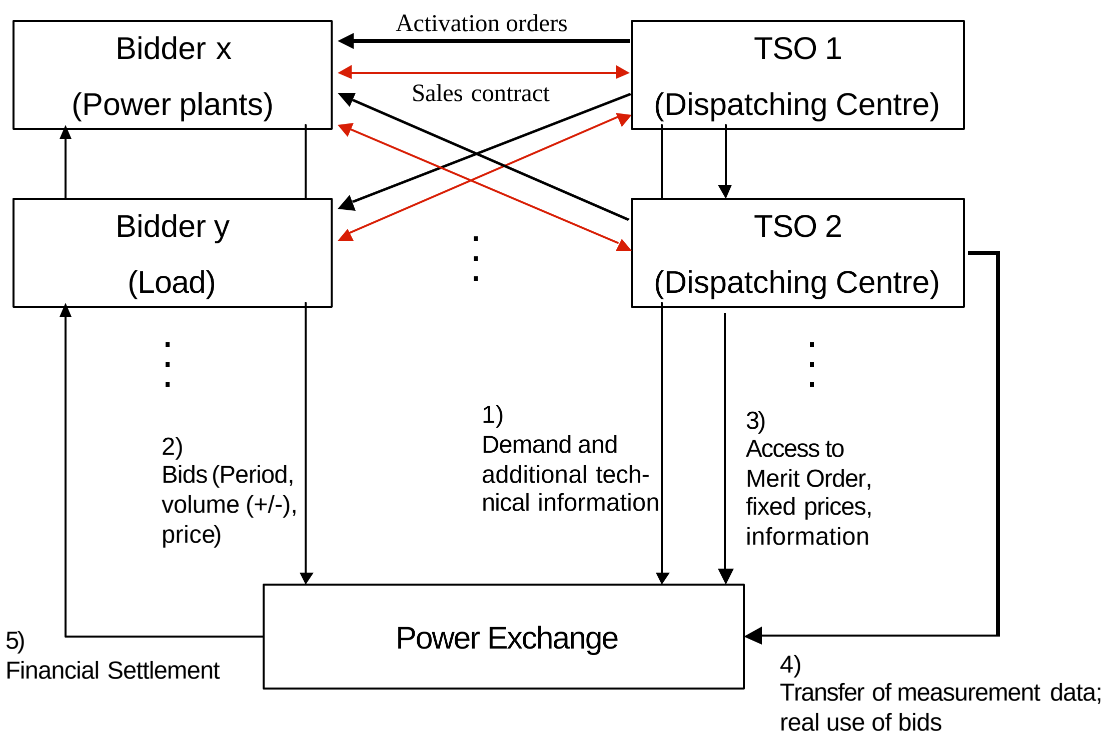
The use of a PX as subcontractor to the TSO like in the given model implies certain advantages. PXs are usually accepted by market participants as a neutral and transparent entity. Because of their operation under public law traders can rely on correct and non-discriminatory behaviour. The whole trading process and fixing of prices can be monitored continously.

A core business of PXs is also the financial processes of settlement and risk management. This would enable them to perform the financial processes in a balancing market quite easily. If the TSO has not established a balancing market yet both parties benefit from the cooperation because both bring their core business together and no one has to develop procedures on its own.

The TSO is the one responsible for system security. If he uses a subcontractor he has to ensure safe operation there because he is the one which bears the consequences of failures. A TSO perhaps feels more comfortable if everything is in his hands and can be influenced directly. To reduce this risk liabilities have to be defined carefully in the contractual relation to the PX.

4.6.4 Model of Balancing Market for several TSOs

In a balancing market for a single TSO the role of a PX will be more or less the one of a subcontractor who acts on behalf of the TSO. In a common balancing market for several TSOs the situation will differ slightly. Compared with the balancing market for a single TSO the PX is now in a more central position.



1)

First step in the process is the declaration of demand. This will not be not the sum of all demands the TSO have got in a single independent market because the call to reserves is not synchronous. A probablistic approach is needed to determine the necessary minute reserve of several control areas taken together. One must however take into account the possible congestions to bring reserve power into the area in need.

2)

The commercial information in bids is limited to energy price and demand rate, type of product and volume. Regarding volume it has to be decided what the minimum acceptable volume should be. There is a trade-off between small quantities to allow also small parties the entrance to the market and bigger amounts to assure an accurate operating without the need for calling to many offers at the same time for the same period. The requested minimum volumes range from 10 MW in the Nordic market to 100 MW in E.ON Netz. In order to receive demand-side bidding there may be the need to agree on small quantities.

In the Nordic market and England & Wales the bidders do not receive a capacity fee because the capacity is not reserved the day before. This is justified by the mechanism of a day-ahead market that allows the bidder to assess the probability of his bid being accepted quite accurate because he gets feedback on his bidding every day. Fixed costs can be included in price building. Nevertheless reliable volumes of control energy are essential for system security and the renunciation of a capacity fee is depending on sufficient generation capacity in the whole market.

Another question to discuss is the declaration of location of production. Shall bidders be free in choosing a power plant short before delivery is required by the TSO or do they have to name a power plant more in advance, i.e. day-ahead, and are less flexible? Flexibility in production is of economical importance for generators and TSOs need arguments for an early declaration of the production unit related to a bid. These arguments are based on possible congestion problems. In order to avoid that energy should be delivered from a congested area the foreseen place of production has to be known. The TSO has to assess if there is enough capacity available for transport and if not he must take the next possible offer from the list. In Sweden there are geographical areas rather than power-plant identities applied. These areas are separated by the most common potential bottlenecks. The main reason for this is to avoid overloading bottle necks during the balancing process and also to provide a tool for countertrading.

3)

In a balancing market for a single TSO the merit order will be generated by PX and sent to the TSO. This does not seem a stable process if several TSOs are included. To ensure a good co-ordination it is better to store the merit order list at the PX. The TSOs have real time access to the list and are able to take the offers in order. A taken bid is marked in the list and only the next bid is available. If bidders have problems in delivering because of power plant failures they have to contact either the PX or one of the TSOs in order to mark the bid as not available anymore. Proceeding that way there is in theory no need for a 24h-service of the PX. But to ensure the access to the merit order list for all TSOs despite of possible computer system failures service staff has to be available at PX under all circumstances.

4)

After a bid was chosen it has to be ensured that the required amount of energy is really produced in a given power plant or a pool of plants. Watching the online measurement of the power plant to see if the bid has been activated may not be sufficient as long as the TSO does not know the planned production for the consumption market the power plant is committed to. If the power plant is assigned to a balancing circle and does not reach up to the bid this will cause imbalances that have to be paid by the balancing responsible party. In that case the charges for imbalances must be higher than the bid to create an incentive for production according to the bid.

5)

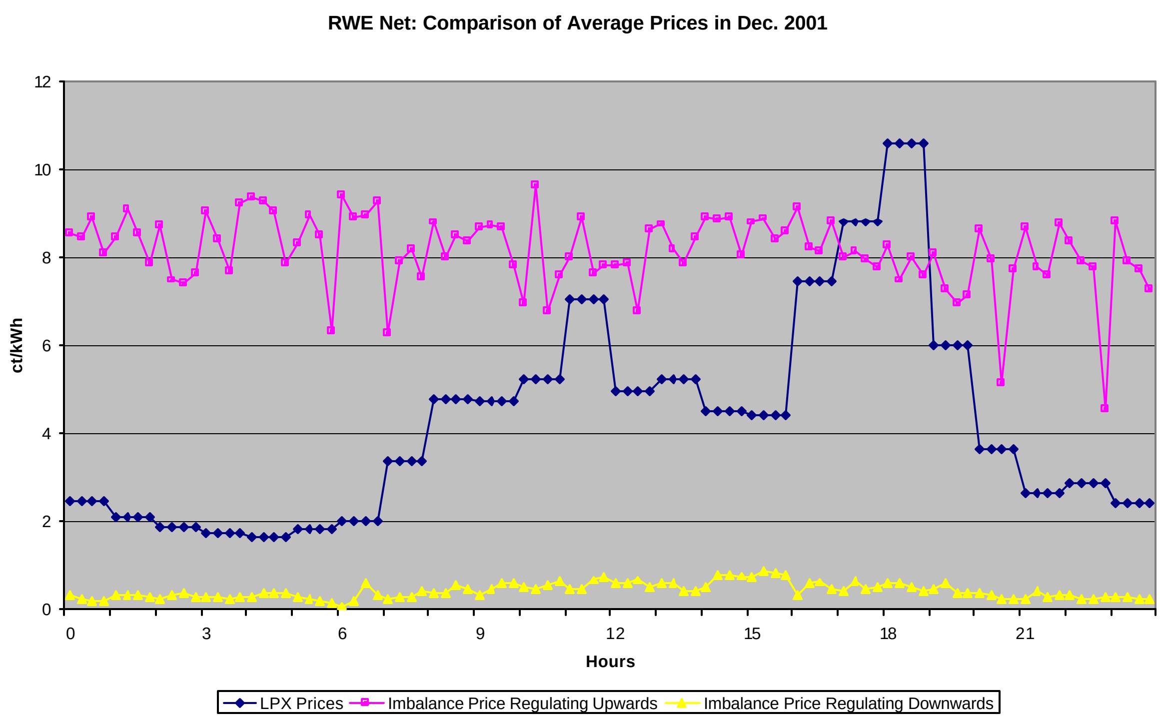
For financial settlement purposes it is recommended to apply marginal pricing rather than pay as bid. With marginal pricing the TSO do not need to care if they get cheaper bids than the others when more than one TSO calls for reserve simultaneously. The PX will pay the bidders the marginal price and will invoice the TSOs for delivery at the same marginal price.

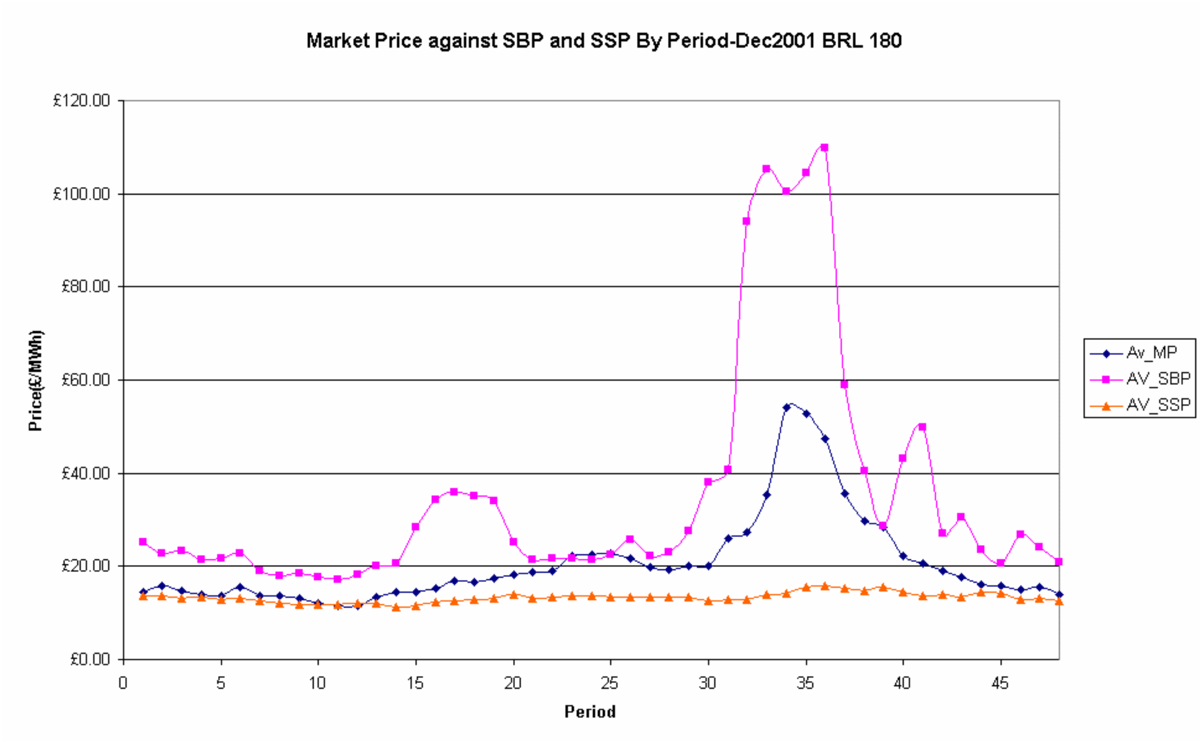
4.7 Relevance of PX Prices for the Price of Imbalances

ETSO TF 7 „Benchmarking“ has presented a report on principles and prices for the settlement of imbalances. This survey on seven European countries gives a substantial overview of the different conditions for settlement and pricing methods. In addition it is analysed in this chapter if there is an interdependency between imbalance prices and PX prices. As PX reflect the market behaviour it could be supposed that the development of imbalance prices correlates with PX prices if balancing power is purchased by the TSO for short periods.

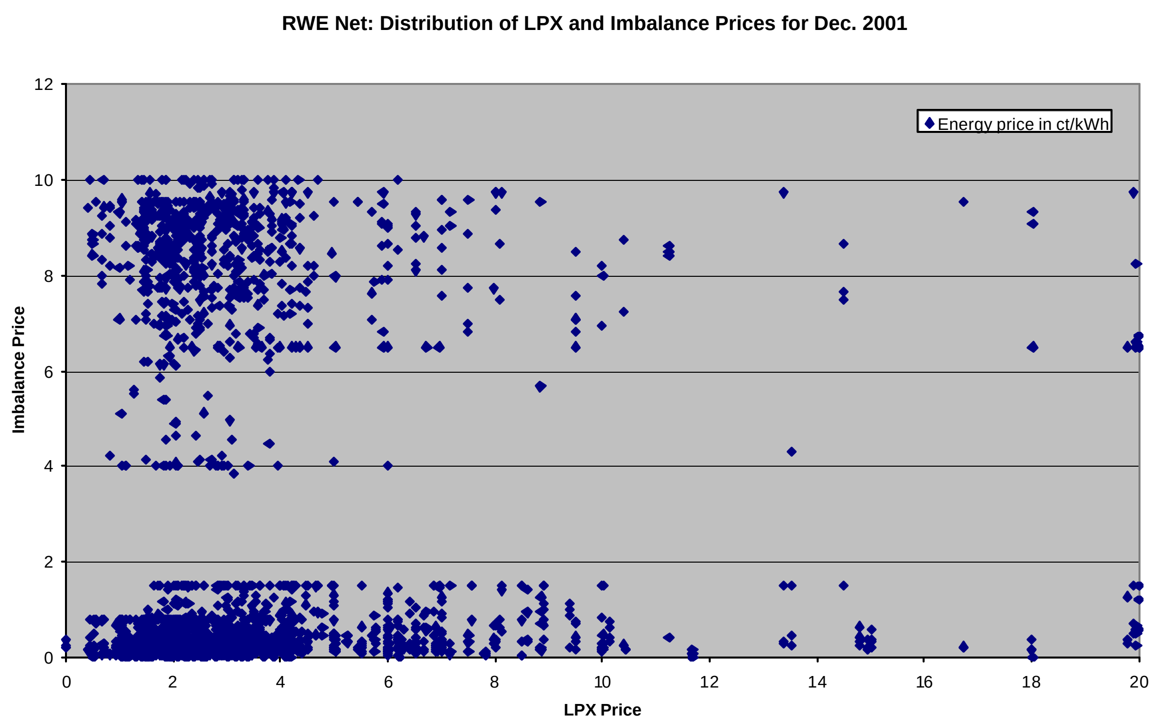
To evaluate a possible link both prices have been compared for the month of December 2001 exemplary at England & Wales and Germany (RWE Net). In the first two diagrams below an average is calculated for each daily metering period (UK: 30 min., D: 15 min.) based on the same metering period of every day in December 2001.

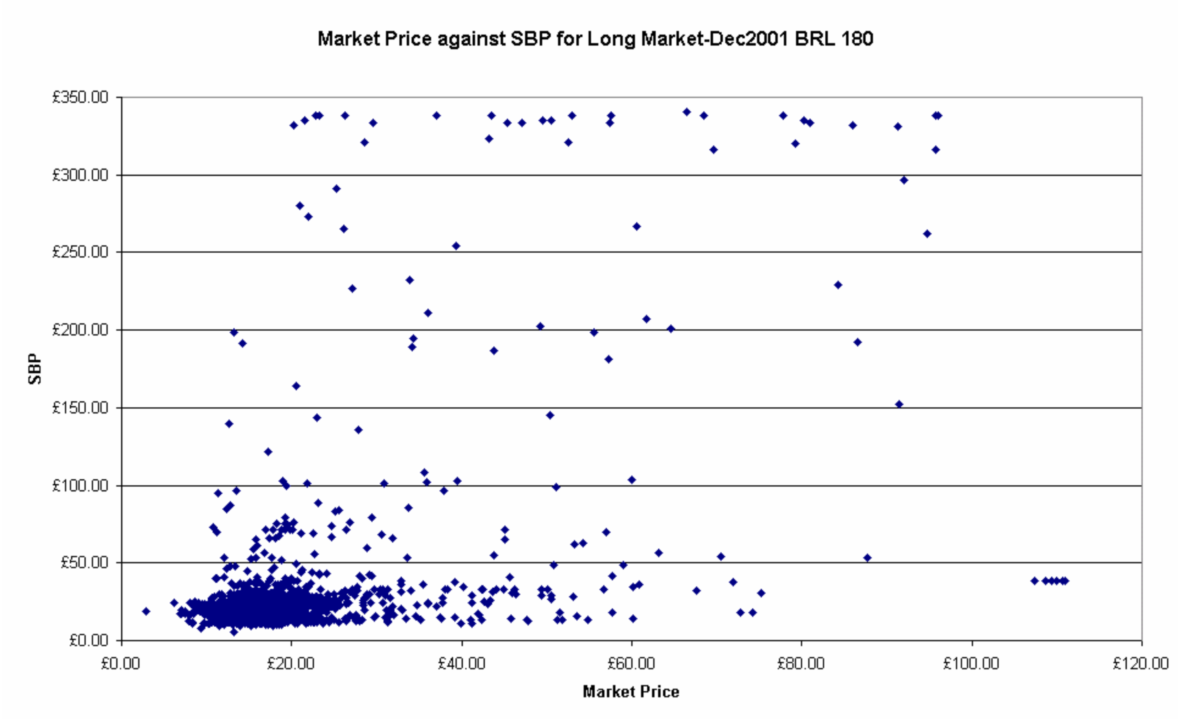
The PX price in the UK shows a peak only in the evening hours whereas at LPX in Germany also a midday maximum can be recognised. This characteristic pattern cannot be identified in the imbalance price curve at RWE Net. The price for regulating upwards oscillates more or less around a fixed value of 8 to 8.5 EUR ct/kWh. In the UK the System Buy Price (SBP for regulating up) shows a clear peak in the equivalent metering period where the PX price has got its maximum (between 5 and 6 p.m.). Another relative maximum of the SBP around 8 to 9 a.m. does not correspond to the PX price which is only slowly increasing in this period.





In the following two diagrams the combination of imbalance price and market price is dotted for each metering period:





The graph of RWE Net shows an accumulation of dots for LPX prices from 1 to 5 EURct/kWh and an imbalance price between 0 and 1.5 ct/kWh on the one hand and 6 to 10 EURct/kWh on the other. Imbalance prices for regulating upwards and downwards are separated by a corridor. Assuming both prices are approximately linearly dependent on each other would imply that dots are distributed along a straight line with a gradient of 100%. As it can be seen there is not such an obvious link.

In the graph of England and Wales Balancing Mechanism Prices the System Buy Price is sketched for the situation where the market (control area) is long which is more often the case than a short market but also for a short market the overall pattern remains the same. As well in this diagram the dots do not stick to a straight line but more likely form a rectangle with a clear centre down left.

From this exemplary evaluation can be concluded at least that a relationship between PX and imbalance prices is clearly not linear and far from being evident. This seems to be reasonable because market participants can rely to a certain extent on a characteristic pattern of daily PX prices but have no hints to predict if a control area is long or short in a given period of time. Furthermore if participants would rely on a fixed level of imbalance prices a cap should be recognizable at the spot market. To gain more insight in the complexity deeper studies need to be done. As the relationship is also depending on the different market rules concerning price system and tendering this needs to be taken into account then too.

4.8 Appendix: Ex-ante market in the UK

The "New Electricity Trading Arrangement" (NETA) includes the following principles :

Balancing Bids/Offers[19]

- *Voluntary market organised by a "Market Operator"; TSO is always counter party*
- *Before gate closure, each BM unit*[20] *may submit balancing offers and bids: an offer is the willingness to operate a BM unit at a higher generation or a lower demand level than the one notified (vice versa for a balancing bid)*
- *A bid or offer includes*
  - *the largest accepted deviation from FPN*[21] *(constant on a settlement period)*
  - *and the associated price (may be negative).*
- *Offers and bids are submitted in pairs : for each offer an undo-bid of the same volume and vice versa.*

Bids acceptance

- *After gate closure up until real time, TSO may accept all or part of any Offers (or Bids) to raise (or lower) power level above (or below) FPN. Acceptance of part of a bid or an offer is consistent with the BM unit's dynamic parameters (rates of increase / decrease, stable levels of operation,...).*
- *Accepted bids and offers are firm on the TSO: to cancel an offer's purchase (for instance if the decision to purchase was incorrect), the TSO purchases an opposite bid*
- *TSO pays accepted offers at their price. BM units pay accepted bids at their price.*

TSO can make money by arbitrage trading between offers that are lower than bids (usually on different BM units).]

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[19] *Generation and demand are not necessarily related; therefore parties can elect deliberately to be in imbalance.*

[20] *Basic unit of trade for the balancing mechanism. Either*
- *a relevant (i.e. >50 MW) generation unit*
- *or a relevant individual demand (>50MW), possibly aggregated according to available metering data*
- *or a (generation/demand) unit offering balancing services*

(condition : appropriate electronic links with TSO)

[21] Final physical notification

5 Conclusion

Based on the results of the first phase of work in which an overview of PX in Europe was presented and a delineation of functions between TSO and PX was outlined this report describes the possible nature of relationship between PX and TSO in various fields. Starting with the process of certification of players on PX a computer model is described for potential use of PX in congestion management and a balancing market under possible participation of PX is developed. In these descriptions it is tried to assign functions according to both entities´ core business: The TSO as the one responsible for system security and PX in operating a market place for energy trading. As already stated in the answers to the questionnaire the awareness of this delineation might be a key factor for successful co-operation of PX and TSO in the future. Both PX and TSO can benefit from close co-operation not only to their own advantage but also to the development of the market. To support this development of the electricity market will be a major task for TSO as well as PX. On side of PX this task can be tackled first by harmonising products and procedures among themselves.

TF 13 intends to set out some ideas and develop them towards feasible models. Nevertheless this report cannot deliver definite answers or solutions. Ideas need to be reflected in the concrete situation of each country and each TSO and the individual framework of regulatory and legal conditions, market opening and interests of market participants and political bodies. These conditions have to be taken into account in order to specify the models accordingly. Such work is necessary but goes far beyond the scope of TF13.

In the past years the electricity market was under rapid movement. This development will further proceed in the future. PX in Europe will try to offer more services for their participants which implies repercussion on the TSO as long as new products are not purely financial. Besides new services it is of course also possible that PX in central Europe start operating in more than one country. Currently, trading in central Europe is still dominated by bilateral transactions. Soon clearing houses will offer their services that release traders from credit examinations of their counterparts and mitigate credit risks resulting from OTC electricity trading. TSO need to establish a relationship towards clearing houses comparable to PX as business equals a lot. If now TF 13 is ending its work this cannot equate with ending the work on improvements of co-operation with PX or clearing houses. There will be new tasks evolving.