



Benefits and practical steps towards the integration of intraday electricity markets and balancing mechanisms

A REPORT PREPARED FOR THE EUROPEAN COMMISSION

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1 Introduction

1.1 GENESIS OF STUDY

The European Commission (EC) has pursued, and continues to pursue, full implementation of the Internal Energy Market. One of the key areas in which the EC has sought improvement is in the effectiveness with which cross-border interconnectors are used.

In a previous assignment commissioned by the EC, a team comprising Consentec and Frontier Economics reported on the way in which day-ahead congestion management on cross border interconnectors could be improved, *inter alia*, by better integration of energy markets and interconnector capacity auctions. One of the issues raised in that study concerned the potential for fine tuning the use of interconnectors in timescales closer to real time, ie introducing the possibility of intraday trade and trade in balancing services.

Subsequently, the European Commission appointed Frontier Economics and Consentec to look at ways in which trade close to real time could be facilitated and to recommend measures which would help to improve the efficiency of cross-border trade without imposing a disproportionate cost on the systems in question.

This report presents the findings of that study.

1.2 ORGANISATION OF THE REPORT

Our report is organised as follows:

- **Section 2** explores what is meant by intraday trading and the trading of balancing services, setting out the relevant timescales to be considered.
- **Section 3** explores the potential benefits that could be derived from increased cooperation facilitating nearer real time trade.
- **Section 4** considers the options for integration of intraday and balancing arrangements.
- **Section 5** finally sets out our assessment of these options along with our recommendations.

In the annexes, we provide details of three case studies of intraday and balancing arrangements which we undertook as part of this project to inform our thinking. The case studies were:

- the Anglo-French interconnector;
- the Nordic market arrangements; and
- the arrangements between TSO areas in Germany.

2 What are intraday trading and balancing?

In this chapter, we consider the nature of intraday trading and balancing, and place these activities within the context of the overall process within a liberalised energy market.

We first consider participant to participant trading, and then move on to consider the interactions between the System Operator and participants.

2.1 TIMESCALES OF PARTICIPANT TRADING WITHIN LIBERALISED ENERGY MARKETS

Trading between participants within liberalised energy markets typically takes place across a number of different timescales. Figure 1 provides an overview of the key timescales and the predominant trading activity likely to occur in each.

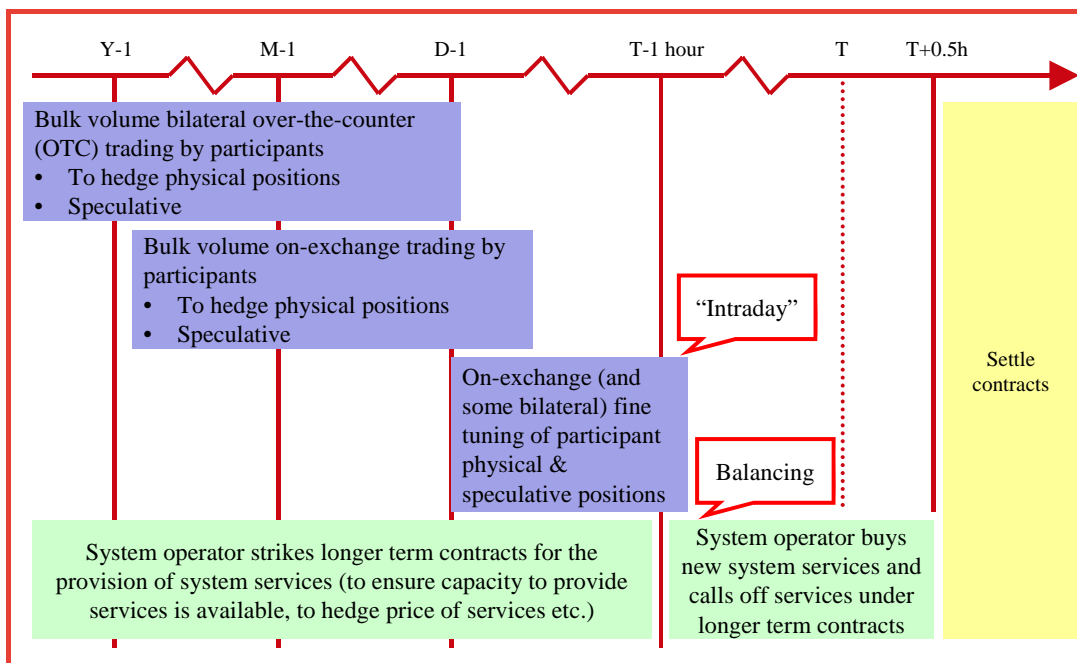


Figure 1: Trading of energy across timescales

Source: Frontier Economics

2.1.1 Up to the day ahead stage

The highest volume of energy is traded in the time periods before day ahead. It is during these periods that market participants will typically aim to cover their physical positions (i.e. contract to purchase electricity to cover their customer demand at a reasonably certain price, or contract to sell energy from their power stations at a reasonably certain price). It is also during these periods that the majority of speculative trading will take place – participants taking different views on the likely medium term evolution of electricity prices.

What are intraday trading and balancing?

The contracts traded during this time period are likely to vary – for example, they could include forward contracts for physical delivery, futures contracts which are financially settled against a reference price, or option contracts.

Equally, the mode of trading will vary. Long term contracts (e.g. contracts with a term of a year or more) will tend to be traded via a broker, or bilaterally with known counterparties (“over-the-counter” contracts). Contracts which are shorter in duration, and which are traded closer to the day ahead stage, may be traded “on-exchange”.

2.1.2 Day ahead

In many (but not all) markets, day ahead is an important point in time. There is often an important market which trades at this time. For example, NordPool operates its auction market day ahead (Elspot), as does the Spanish market operator OMEL.

By this time, participants have a significant amount of information in relation to both production and consumption. Retailers will know with some certainty what their own customer demand is likely to be (as they will have a good understanding of forecast temperature, cloud cover etc) and generators will have a reasonable understanding of the plant on the system at present, and the likely schedule of plant operation for the next day. While there is a lot of information available at the day ahead stage, it is important to note that there is still significant scope for error in all forecasts. Demand conditions can easily change within a day. Similarly, generation conditions can change – either through power station operational issues, or increasingly as a result of wind forecast errors.

In the majority of markets¹, by the day ahead point, participants have covered their positions (i.e. they have contracted for their own physical consumption or production, and have closed out any speculative positions they had opened). Hence, the day ahead market is around the time when “fine tuning” of the portfolio commences. As new information is discovered in relation to physical demand and supply balance, participants adjust their contract position accordingly.

2.1.3 Intraday

Following any formal day ahead market, during intraday trading participants continue to fine tune their positions in the light of new information about their own production and consumption position and also the overall system position. In that sense, intraday trading may be viewed as an extension of day-ahead fine tuning. Participants will undertake this fine tuning to ensure that:

¹ In some markets – those with a mandatory pool – all volume must be bought and sold through the day ahead market, as it is the route by which physical production and consumption schedules are derived. These markets are more typical in the US than in Europe.

- **They have exploited all profitable opportunities for generation (or load reduction²):** if, in the run-up to the point of delivery, it becomes clear that the underlying demand and supply fundamentals of the market are not as they were expected to be, then there may be profitable opportunities for participants with flexible physical resources (e.g. flexible sources of generation or load management) to make good any physical shortfall; and
- **Their contracted energy position is close to their expected physical energy position:** If they are short energy (i.e. if they sell more than their expected production net of own consumption or buy less than their expected consumption net of own production – perhaps because they own a plant that has tripped) they may face a relatively high and unattractive price for the difference in volume. If they are long energy (i.e. if they sell less than their expected production net of own consumption or buy more than their expected consumption net of own production) they may receive a relatively low and unattractive energy price for the difference in volume.

Clearly factors relating to the fundamental demand and supply balance of the power system will therefore influence intraday trading volumes – for example:

- **Power station outages:** if major plants which were expected to be producing fail near the point of delivery, then similarly, the participant(s) with that plant in their portfolio will seek to fine tune their contract position to their new expected production level via intraday trading with those with flexible resources, or those who had not yet traded to a balanced portfolio.
- **Changes in wind forecast:** increasingly, as wind power becomes an important source of energy, changes in wind forecasts can have a significant impact on the position of players with wind in their portfolio. As Figure 2 shows, the error of wind generation forecasts reduces gradually over time, with significant improvements in accuracy around the 3 hour ahead stage. Hence, as wind forecasts change as delivery comes closer, participants with wind generation in their portfolio will typically seek to fine tune their contract position via intraday trading.
- **Changes in demand:** if the level of demand changes from that which was forecast at the day ahead stage or earlier, then similarly parties will look to fine tune their contract positions via intraday trading.
- **Changes in imports / exports:** if the expected level of import or export from interconnected systems changes (for example, as a result of a change in the supply or demand conditions on that system), the parties may look to fine tune their contract positions via intraday trading (they may also

² Throughout this report we refer for convenience to ‘generation’ when, where the context allows, this should be taken to be ‘generation’ or ‘dispatchable load’.

look to the parties on the other system to remedy the situation – it will depend on the details of the import / export contracts).

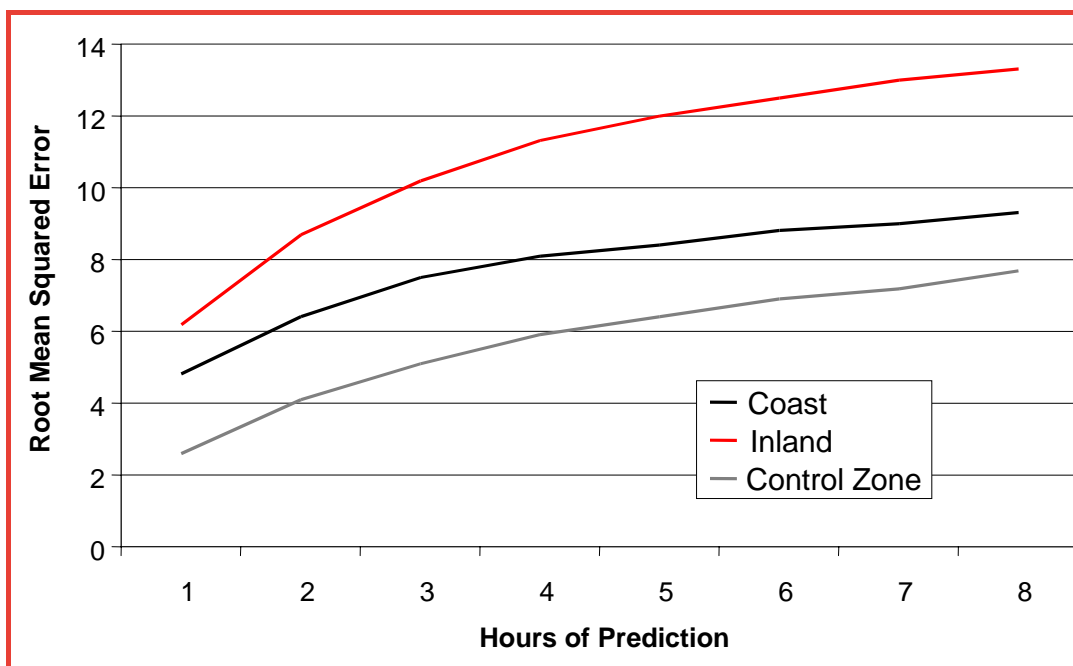


Figure 2: Forecast errors for wind generation in relation to length of forecast and location

Source: Based on ISET (2002)

2.1.4 Gate closure

Given the need to ensure second by second balance of supply and demand at each location on the power system, at some point participant trading has to cease and the power system has to pass to centralised control by the System Operator.

That point is typically known as Gate Closure. At this time, all participants submit data to the System Operator setting out:

- intended consumption schedules for the next period by location; and
- intended production schedules for the next period by location.

Once these data have been passed to the System Operator, bilateral trading among participants for physical delivery must cease – further trading could result in changes to these notified volumes, which would in turn make the System Operator’s job difficult (they would have no fixed starting point). The only trading among participants which continues (and then only in some systems) relates to trading out of imbalances – that is, parties with a “long” imbalance trading with parties with a “short” imbalance. However, this trading only affects participants’ financial positions and does not affect their commitments to deliver or consume power.

What are intraday trading and balancing?

2.2 SYSTEM OPERATOR ACTIVITIES ACROSS TIMESCALES

Having considered short term participant trading, we now move on to consider the activities of the System Operator across market timescales. We first consider the objectives of the System Operator and the physical resources and services used to fulfil those objectives, before turning to the commercial arrangements for the procurement of these services in a liberalised energy market (“balancing arrangements”).

2.2.1 Objectives of system operation

Having received intended production and consumption schedules ahead of delivery, the System Operator’s objectives are to:

- verify whether, on the basis of current forecasts, supply and demand will equate at each point on the network given finite network capacity;
- ensure that, where part of an interconnected network, the total import or export into neighbouring countries is as scheduled, in order that imbalances on one system do not create issues on neighbouring systems; and
- ensure that, as a contingency against forecast error, there is sufficient reserve on the system to ensure that supply remains secure in the event of reasonably probable events.

Ensuring demand equals supply at each location on their system

Trading between participants should, provide there are sufficient financial incentives to achieve a balanced position, result in profiles of production and consumption which broadly equate across the system and within defined periods of time³.

This is not sufficient from a physical system operation viewpoint:

- supply and demand must be balanced second by second; and
- supply and demand must be balanced at each location on the network taking into account finite network capacity – it is not sufficient to have net consumption in the south of a country exactly equal to net generation in the north if there is insufficient network capacity to transport the generation south. Unless the forward energy markets are nodal in design⁴, energy market participants will not take all finite network capacity into account in their trading⁵.

³ More exactly, across settlement periods – typically between a quarter of an hour and an hour.

⁴ There are no nodal energy markets at present in Europe – they are more prevalent in North America (e.g. PJM).

⁵ In zonal markets (e.g. Norway, Italy), scarce network capacity between zones is taken into account in participant trading – however, this still leaves intra-zonal congestion, and errors in the forecasts of zonal transmission capacity to be considered.

Hence, the System Operator has to take the production and consumption position arrived at via trading between participants and refine it to make sure that, throughout the period of delivery of energy, the network is secure.

For example, if they believe that there is insufficient supply to meet demand, they must procure incremental generation. Equally, if they believe the locations of generation and demand are mismatched, they must sell back generation in some locations (the export constrained areas) and procure incremental generation in others (the import constrained areas) – this is known as redispatching.

Ensuring imports and exports are according to schedule

The System Operator needs to ensure that the exports or imports into their control area from neighbouring systems are according to the schedule agreed with the neighbouring System Operators. Failure to do this would essentially “export” physical imbalances to other systems – an interconnected network with multiple System Operators would then be very difficult to control, as no one System Operator would know whether they could rely on the programmed exports or imports from other control areas.

Procuring system reserve

To help achieve these first two objectives, the System Operator needs to ensure that the system is resilient to reasonably probable events. For example, while a good demand forecast may be available, it will inevitably be incorrect. Equally, while there will be a forecast of production, this may also be incorrect. Participants may not produce the exact volume to which they committed – either as a result of inaccuracy in power station control, or more significantly, as a result of plant failure.

To ensure a continued secure supply and cross-border flows, the System Operator must therefore have reserve production available on the system – and given finite network capacity, this reserve may need to be distributed across the system.

This reserve production (or demand reduction) may come in various forms, each with particular physical and economic characteristics. For example, there may be relatively little plant on the system which can respond very quickly to a shortfall or surplus in demand, and what plant there is may be relatively expensive to run. Hence, the price for such short term flexibility may be high. There may be more plant available which can respond over a longer timescale – and this plant may also be cheaper to operate.

Hence, System Operators typically procure a number of different types of reserve – fast reserve to allow them to cope with short term issues, and longer term reserve which can be used to replace more expensive fast reserve once the immediate imbalance has been resolved.

2.2.2 Achieving these objectives: physical services & organisation

To achieve these objectives within the context of a liberalised energy market, System Operators procure a range of services from participants.

The definition of the reserve services which UCTE System Operators procure from participants is set out in Table 1.

Service	Description	Local terminology
Primary control	Automatic reaction of the primary controller of generating sets, involved in primary control, to a frequency deviation caused by a system disturbance or small variations in production and consumption.	UCTE – Primary Control E&W – Primary Response, Secondary Response and High Frequency Response Nordel – Momentary Reserve, comprising Frequency Regulation and Momentary Disturbance
Secondary control	Instructed action of particular generating sets linked to a control loop in a control area, to move the overall system (frequency and interchange) deviation of the control area toward zero following the delivery of primary control in response to a sudden variation in production or consumption.	UCTE – Secondary Control
Reserve & instructed balancing services	Services that are not automatically delivered when required, but are instead instructed by the TSO. They are generally utilised to cater for plant loss and significant demand forecast error	Various – for example, tertiary reserve, Minutes reserve, balancing services etc.

Table 1: Service definitions

Source: ETSO

Secondary control in particular only exists in the UCTE system. The purpose of secondary control is to control both frequency and inter-regional power exchange in a decentralised way: each TSO is responsible for keeping supply and demand plus scheduled export or import in balance within his control area, thereby contributing to ensuring the global system balance.

Equally, to better achieve the objectives, the UCTE control areas are partly organised in a hierarchical way (as shown in Figure 3). The hierarchy defines for which set(s) of border flows each TSO is responsible. This provides some redundancy for balancing, allows for a better control of inter-area flows and is also used for accounting between TSOs. On the other hand, the “fragmentation” of the UCTE system into secondary control areas sets the administrative structure of all slower balancing services. This means that historically, reserve and instructed balancing services (called “minutes reserve” or “tertiary reserve” in the

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UCTE) have been provided individually per control area, and their specific details vary from country to country.

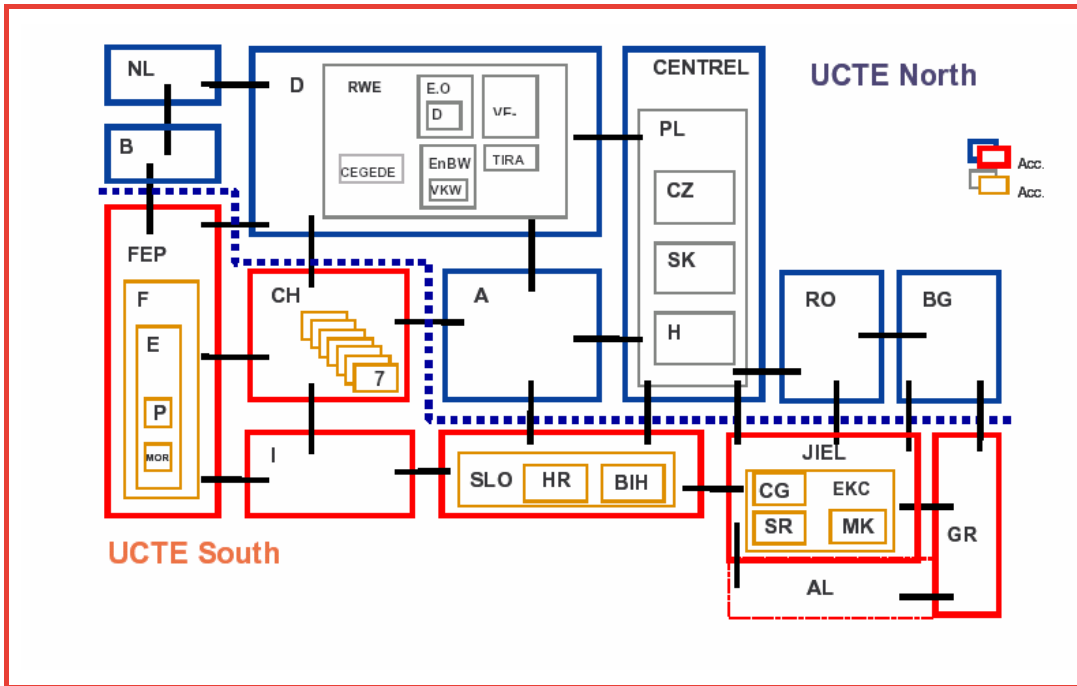


Figure 3: Stylized map of UCTE control blocks

Source: UCTE

2.2.3 Achieving these objectives: commercial balancing arrangements

Commercially, as for market participants, the activities of System Operators to procure these services within their control areas differ across time periods. All of these activities can be referred to as “balancing”. We describe below generic balancing activities in the various timeframes.

Balancing before Gate Closure

Prior to Gate Closure, before production and consumption schedules are known in relation to a particular delivery time, the System Operator has no need (or ability to judge accurately the requirement for) delivery of system services. In this time period, the System Operator therefore undertakes procurement with longer term arrangements to ensure that:

- sufficient system services will be available in relation to delivery periods; and
- where relevant, they are hedged against volatility in the price at which system services (mainly tertiary reserve) are offered.

The System Operator will therefore strike long, medium and short term contracts with participants, under which the participants agree to be available to provide either primary, secondary or tertiary reserve. These contracts typically specify the

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technical characteristics of the service required (e.g. automatic primary reserve, tertiary reserve providing energy within a fixed time period of call off etc.), a required availability to provide the service (e.g. must be available for a certain number of hours, must be available between defined time periods), and a price – either for energy provided only, or for both availability and energy.

In some systems, near to Gate Closure, the System Operator will also undertake limited trading with participants to manage congestion and to start to call off contracts to provide reserve (in anticipation of participants' scheduled production and consumption).

Balancing after Gate Closure

Following Gate Closure, the System Operator is in a position to start to refine the production and consumption schedules submitted by participants to ensure secure supply (by calling off tertiary reserve services), and then to continue to manage the system during the period of delivery (by using all reserve categories).

While some tertiary reserve may be contracted in advance, as described above, within the context of a liberalised energy market, there is typically a mechanism by which participants who have not been contracted to provide tertiary reserve can place short term bids to the System Operator to provide incremental and decremental production at their particular grid location. This mechanism is frequently called the Balancing Mechanism, as it allows participants to submit bids to the System Operator which assist them in balancing overall supply and demand and in managing locational issues (i.e. congestion). This is a limited form of trading, in which the System Operator is always the counterparty.

Therefore, after Gate Closure, to refine participants schedules in advance of the delivery time period, the System Operator may call off tertiary reserve contracts struck in advance or may accept bids to the Balancing Mechanism to increase or decrease production.

The System Operator will typically continue to refine production and consumption schedules from Gate Closure through to the time of delivery. Once delivery commences, all three categories of reserve will be in use – primary reserve to respond automatically to system events, secondary reserve to control boundary flows, and tertiary reserve, instructed manually either through the Balancing Mechanism or through contracts, to replace primary and secondary reserve as required.

Locational element of balancing

In calling off tertiary reserve in balancing timescales, the System Operator is conceptually⁶ at least trying to solve to problems:

⁶ In reality, System Operators are likely to take individual actions which actually address a mixture of issues.

- ensuring overall supply and demand balance – replacing primary and secondary reserve with cheaper resources which are capable of providing power over longer timescales; and
- addressing network congestion.

If the System Operator is to address both issues via a market based balancing mechanism as described above, then participants must be able to submit locational bids (i.e. offers for increments or decrements of energy at a certain location on the grid). Where this is not the case (e.g. in Germany, where participants simply offer increments or decrements of energy from their portfolio as a whole), then the System Operator will need to use alternative methods to resolve congestion.

Where market-based balancing mechanisms are locational, price areas (i.e. areas where the mechanism indicates that energy offered in similar timescales has a common value) will develop. However, while in some countries, control areas are split up into price zones for the purposes of *ex ante* markets, and while those price zones may also be used in balancing timescales, unless the grid within individual zones is very strong (i.e. has significant excess capacity) it is likely that the actual price areas which emerge will have a different footprint from the zones defined *ex ante*.

Suppose a control area is split into three price zones for the purpose of *ex ante* markets, as shown in Figure 4, and that these price zones are imposed on the balancing mechanism.

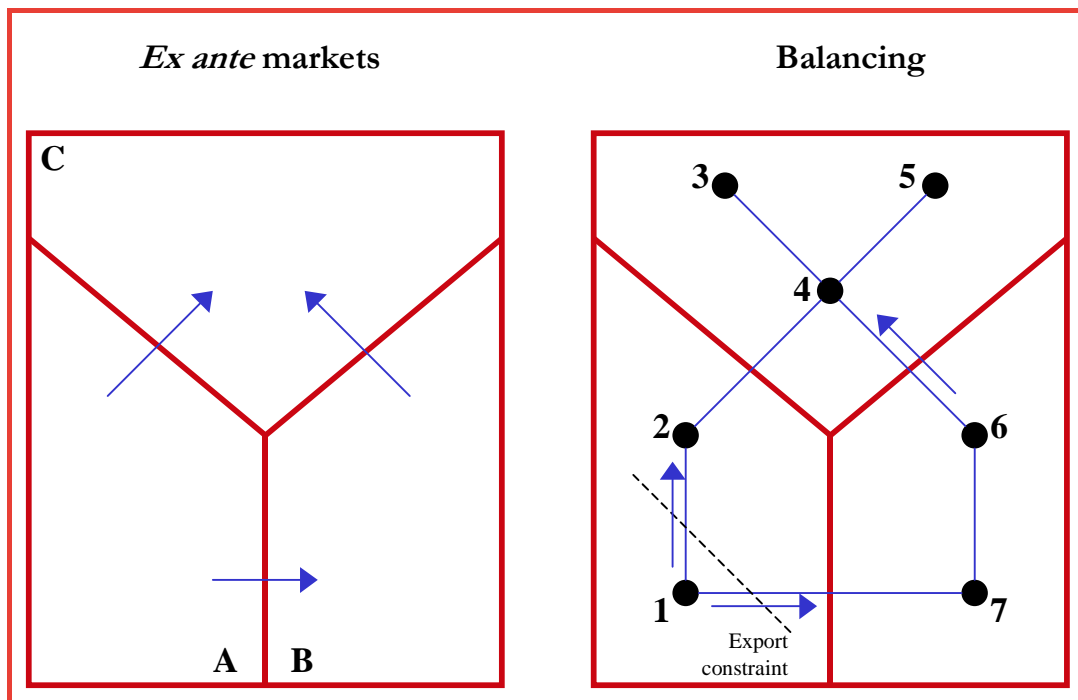


Figure 4: Price zones in *ex ante* markets and in balancing timescales

Source: Frontier Economics

What are intraday trading and balancing?

By allowing the price to vary across zones in *ex ante* markets in response to any zonal surplus of generation over demand (or *vice versa*), congestion between zones can be managed. If there is too much generation relative to zonal demand and export capacity, the zonal price should fall to discourage production.

However, this is not sufficient for balancing purposes. In reality, the actual network will be more complicated than the few potential constraints suggested by the zonal map. At any given time, there could be congestion between nodes within the same zones – this is shown on the example network in Figure 4 in zone A as a constraint on exports from node 1. To resolve this intra-zonal constraint, the System Operator would need to reduce generation at node 1 and increase generation at nodes 2 and 7. In a market context, generation at node 2 would then be more valuable to the system than generation at node 1 – there would ideally be an intra-zonal price differential.

Since balancing relates to the very short term operation of the system, balancing price zones emerge in parallel to the emergence of actual constraints on the network. These may be extremely transient, and will only coincide with *ex ante* defined price zones by chance.

Therefore, where countries have predefined balancing zones, they are more likely to reflect *ex ante* expectations of the location of serious non-transient congestion. To the extent that additional congestion then occurs in real time within such predefined zones, the System Operator will continue to need the flexibility to redispatch within the zone, as a result effectively creating further price differentials within the zones. In this sense, while *ex ante* congestion management arrangements may address the need to allocate the expected volume of scarce transfer capacity, close to real time balancing arrangements will also need to address congestion as it actually occurs, both between and within price zones.

Equally, this implies that balancing should be thought of as a relatively localised activity. Unless there is a very strong grid (and hence little congestion), there will be a limit on the extent to which geographically remote resources can be used to solve balancing issues. Therefore, even if some capacity on interconnectors is reserved for intraday timescales, from an international viewpoint, “transit” of balancing energy across systems is significantly less likely than the exchange of balancing energy between neighbours.

2.3 SIGNIFICANCE OF BALANCING ACTIVITIES

By way of indication of the potential significance of balancing volumes, Figure 5 shows an example of positive and negative balancing energy use in the Nordic area, and Figure 6 shows the contracted secondary and tertiary reserve use in Germany. In the Swedish area, balancing volumes have historically represented 1-2% of annual consumption. RWE’s secondary control and minutes reserve volumes similarly equate to around 1% of the demand they serve.

In terms of the value of balancing, in the England & Wales market, National Grid’s “Incentivised Balancing Costs” (which includes the costs of energy balancing, ancillary services and congestion management) have varied between

What are intraday trading and balancing?

£350m and £380m pa between 2001/2 and 2003/4, or around 3-4% of the value of the market.

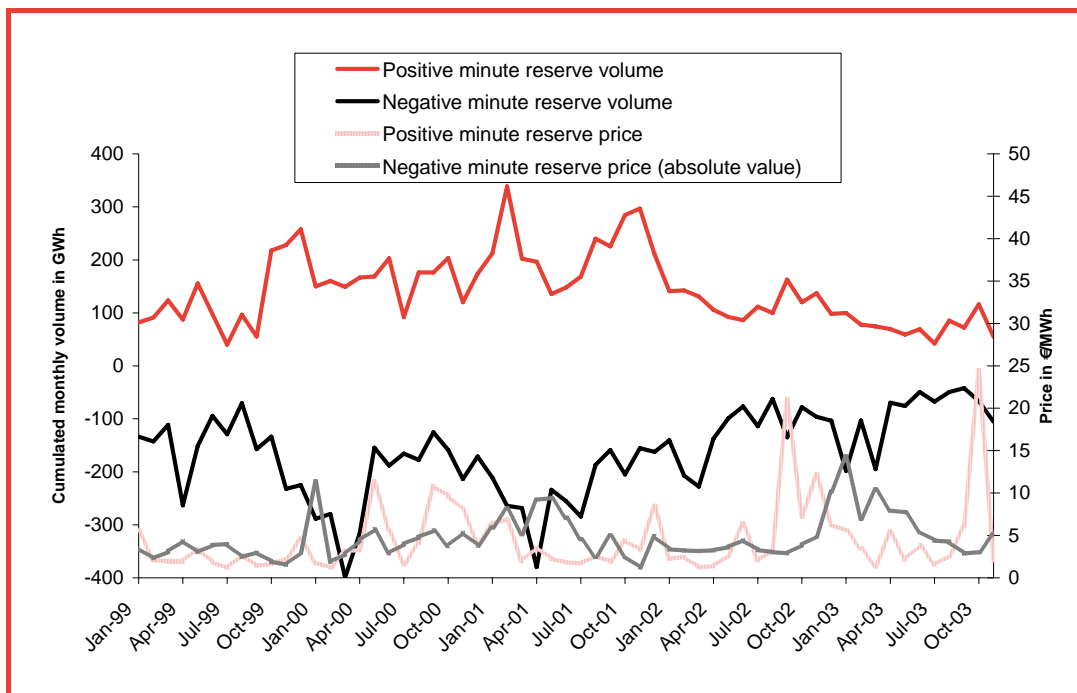


Figure 5: Evolution of balancing energy volumes in Sweden

Source: Frontier Economics / Consentec based on data from Svenska Kraftnät

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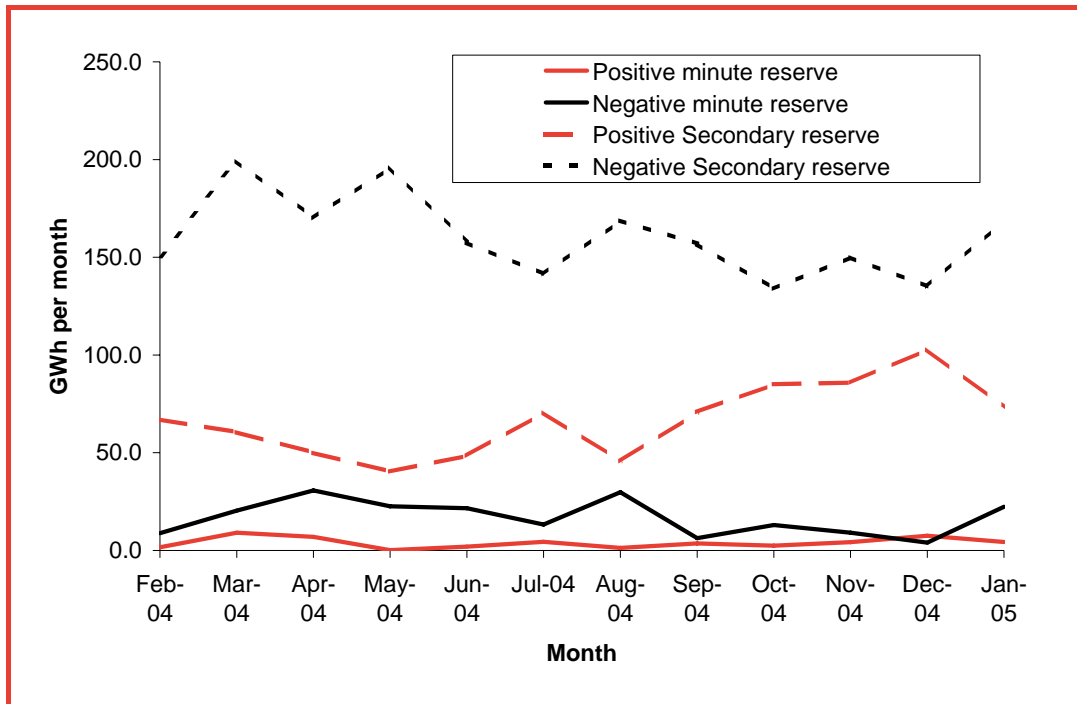


Figure 6: Monthly volumes of contracted secondary and minute reserve in the RWE area

Source: Frontier Economics / Consentec based on RWE Transportnetz Strom GmbH

What are intraday trading and balancing?

3 Potential benefits of co-operation

3.1 INTERNATIONAL LINKAGES IN ELECTRICITY MARKETS

Following the implementation of the first electricity Directive 96/92/EC and the second Directive L 2003/54/EC and the subsequent Cross Border Regulation 1228/2003, there has been a significant number of developments in relation to the international linkages between electricity forward and day ahead markets. For example:

- exchanges, such as NordPool, have expanded their geographic footprint such that participants can trade contracts for future delivery at a number of locations. In some cases, these exchanges are an intrinsic part of the arrangements to manage physical delivery (e.g. they also play a role in interconnector congestion management). In other cases, they are simply marketplaces for trading contracts;
- access to interconnector capacity between countries has, across a number of borders, been contractualised and sold to third parties both on a forward and a day ahead basis;
- capacity at many borders is now allocated via auction; and
- there has been significant progress in developing ways to manage effectively interactions between congestion at multiple borders effectively (e.g. co-ordinated auctions).

One of the issues which has been identified with the use of day-ahead explicit auctions is the sequencing problem in relation to the capacity and energy markets. While relative to implicit auction arrangements, explicit auctions have certain advantages (for example, they do not involve giving an exchange a monopoly over access to international transmission rights), they result in the separation of the activity of procuring access to capacity and procuring electricity to transport across that capacity.

Significantly less thought and development effort has been given to the integration of intraday markets and balancing arrangements. There are a number of entirely justifiable reasons for this prioritisation:

- the volume of energy traded on intraday markets and through balancing arrangements is significantly lower than that traded on forward and day ahead markets (although the expected conditions of shorter term markets may influence behaviour on forward markets). Therefore the potential economic benefits of linking these markets is likely to be lower;
- particularly in relation to balancing arrangements, the products purchased by the System Operator and participants are often not amenable to trading internationally; and
- linking intraday markets and balancing arrangements can bring with it more logistical difficulties than linking forward markets. Nearer to Gate

Closure for a specific delivery period in national electricity markets, facilitating effective trading by participants becomes more challenging, and the arrangements potentially more complex and costly than those required to integrate forward markets (not least because either they have to be tailored to the specific design of national energy markets, or those national designs have to be changed).

In essence, therefore the benefits of international linkages are likely to be lower and the costs higher.

However, this does not imply that there will never be benefit in establishing linkages to allow efficient trade between Member States. Below, we consider:

- the nature of linkages required for intraday markets and balancing arrangements, and how they fit with the design of national electricity markets;
- a qualitative assessment of the potential benefits of linking markets; and
- an indicative quantitative assessment of these benefits across some borders.

3.2 NATURE OF INTERNATIONAL LINKAGES: INTRADAY & BALANCING

There are two key differences between linking intraday markets and balancing arrangements on one hand and forward markets on the other:

- the nature of the products under consideration and the logistical implications of these products for effective international trading; and
- the implications of the sequencing of events in the national electricity markets.

3.2.1 Nature of the products traded

The products traded on intraday markets are, in most ways, similar to the products traded day-ahead or on forward markets (though they are likely to be significantly shorter in duration – for example, electricity delivered over individual hours or groups of hours rather than days, weeks or years).

This is not the case for balancing arrangements, where the products that the System Operator procures are tailored to management of the electricity grid rather than supply of bulk energy to customers

Out of all of the services that the System Operators procure for system management purposes, reserve and instructed balancing services can most meaningfully be traded across borders:

- primary control provision is shared between countries, but the activation of it is automatic and hence the provision of the energy itself, as opposed to the capability, cannot readily be traded;

Potential benefits of co-operation

- secondary control, in addition to the above, requires telecommunication links to be set up, which impedes short-term procurement.

Therefore, in this report, the majority of our attention is focused on reserve and instructed balancing services.

3.2.2 Implications of national electricity market sequencing

The key event in national electricity markets which must be taken into account is that of Gate Closure. Figure 7 illustrates, for any given border, the different timescales in which short term trading could be carried out.

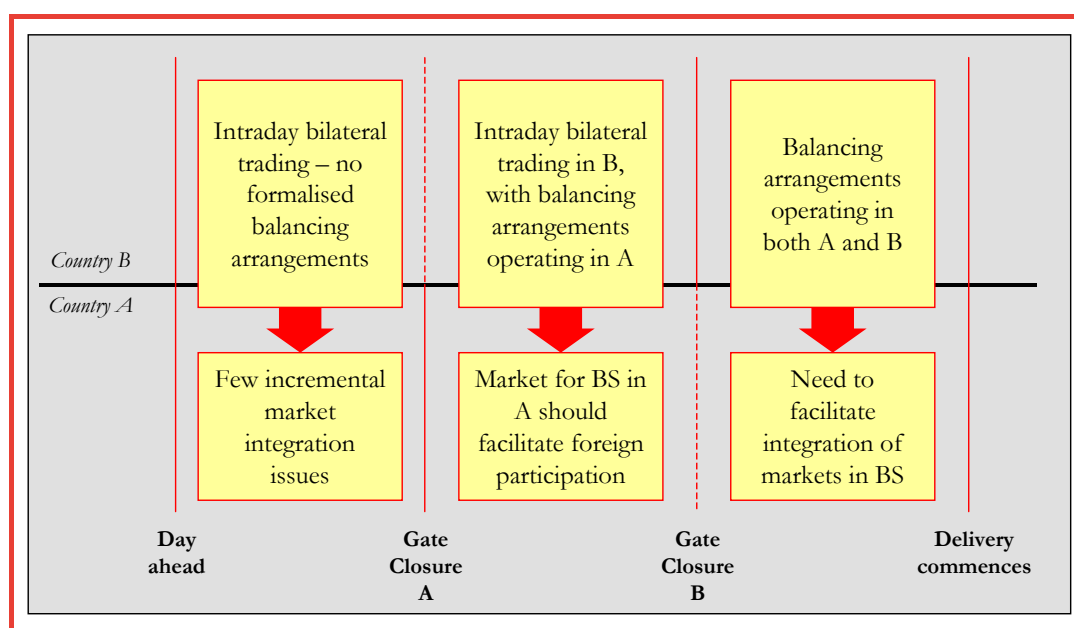


Figure 7: Integration issues vary across intraday and balancing timescales

Source: Frontier Economics

For intraday trading up to the point of the first Gate Closure, the issues in relation to international trading are significantly fewer than after one or two Gate Closures. The key issues for consideration are likely to be that:

- given the shorter timescales involved for trading, the difficulties in securing both capacity to transport energy and the energy itself are likely to be more pronounced; and
- in relation to interconnector capacity, use it or lose it provisions are more difficult to implement in the conventional way (there is no further market into which capacity can be released if it is not used). Alternative arrangements to prevent sterilisation of capacity need to be adopted – such as the release of interruptible capacity where the network operators believe that firm capacity rights held by participants are unlikely to be used.

Following the first Gate Closure in relation to the markets either side of the international border, the key issue revolves around making sure that foreign

participation in balancing arrangements is possible – that is, a generator in the market where Gate Closure has not occurred should be able to bid to provide balancing services to the System Operator in the market where Gate Closure has happened. The key issues in relation to this are likely to include:

- sequencing – is it possible for a party to acquire interconnector capacity at short notice in preparation for making the bid, or at even shorter notice in the event the bid is actually called by the neighbouring TSO;
- interconnector nominations – in some systems, the timescales for nomination of flow on the interconnector is different from the earlier of the Gate Closure times on the interconnected systems. In this situation, a party making a bid to provide balancing capability would need to be reasonably confident that they would be able to change their interconnector nomination to take into account any call by the System Operator to provide balancing energy. Perhaps even more importantly a system operator would not rely on a party that did not have certain interconnector capacity to meet the call; and
- timing of local Gate Closure – if the local Gate Closure is n hours before delivery commences, then a generator could only submit a bid to the neighbouring System Operator for balancing energy with a minimum of n hours notice period – just in case the call to provide the energy was made once the local market had closed. If n is large, then the difference between call-off and reaction time may be so great as to make the offer unhelpful to the neighbouring TSO (for example, because they will rarely know so far in advance that they require balancing energy, or because there is no scarcity of balancing resource on their national grid with similar cost structures).

After Gate Closure has taken place in both of the interconnected markets, the ideal situation would be to have arrangements which, for a given generator, made it appear as if they were bidding to a single Balancing Mechanism – that is, that the TSOs could all see the same bid and co-ordinate between themselves as to whether they need the balancing energy.

However, unless there is formally one Balancing Mechanism, this is likely to be difficult to achieve. For example, while a bid could be submitted to two (or more) Balancing Mechanisms, once it is accepted in one mechanism it would need to be withdrawn from the others. A rule within the Balancing Mechanisms which made this possible is likely to create difficulties for the TSOs, as they will never have certainty as to the range of balancing options which they have for the system;

Any approach to linking intraday and balancing arrangements internationally needs to take these factors into account.

3.3 QUALITATIVE ASSESSMENT OF LINKAGES

3.3.1 Benefits of greater international linkages

Having considered which products are of greatest relevance to international interaction, and having considered the issues which would need to be addressed in arrangements to facilitate linkage of intraday and balancing arrangements given the design of national energy markets, we now turn to a qualitative assessment of the potential benefits of linking markets.

The benefits from linking intraday markets and balancing arrangements are likely to derive from a combination of factors:

- **More efficient use of flexible resources:** at present, if there are no linkages between intraday markets or balancing arrangements, then low cost flexible generation resources in one country may not be utilised, while more expensive resources are utilised in a neighbouring country either by participants to fine tune their portfolios given latest expectations of their purchase and sale positions, or by the System Operator to balance their supply and demand position or to resolve transmission constraints. Clearly, in this situation, provide there were no binding transmission constraints between the two systems, greater linkage of short term markets should reduce the overall costs of serving demand across the two systems. This effect might be expected to be most pronounced where there exist neighbouring systems with different fuel mixes – for example, a thermal system or a system with significant wind capacity interconnected with a system with a lot of storage hydro or open cycle gas turbine capacity;
- **Reduced exercise of market power:** to the extent that, as a result of barriers to intraday and balancing interaction, generators within national systems are able to exercise market power either as a result of their location or their flexibility, removing barriers may increase the competitive constraints on such plant. These benefits should then be passed on to customers through a combination of retail competition and the regulatory regime applied to the System Operator. Of course, market power issues may remain within individual balancing regimes⁷
- **Allowing parties to create a hedge to imbalance exposure:** it may also be that exposure to volatile imbalance prices is creating a barrier to entry in some markets (e.g. to the market for retail to small customers or to the generation market) in some markets. To the extent that allowing parties

⁷ Approaches to addressing such market power vary from country to country. In some systems such as the UK, general competition law is relied upon. Some regulatory authorities have suggested that, as a result of the difficulties in assessing or demonstrating the extent to which parties have effective market power in very short term markets, further regulation beyond competition law is appropriate. Such regulation could vary from more explicit criteria as to what could and could not be considered as abuse of a dominant position, through to requiring dominant generators to provide balancing power under regulated arrangements, with a maximum price set for the provision of energy. The latter approach is taken in the French system.

with generation in Country A to receive payments related to the provision of balancing services in Country B (the prices for which typically form an input to imbalance prices), then by providing a hedge to imbalance prices, a generator in Country A may perceive a lower risk associated with entry into Country B. Much would depend on the extent of correlation between potential balancing payments and the potential imbalance price exposure – which may be low for a number of reasons⁸. However, even in the absence of a perfect hedge, to the extent that increased international linkages lead to a “deeper” set of balancing options and hence less volatile balancing (and consequently imbalance) price, the barriers to entry may be reduced;

- **Cross-border redispatching:** transmission constraints, especially when these occur close to a border of a TSO’s control area, may be most efficiently resolved by adjusting generation on both sides of the border. This requires a process that allows the TSOs involved to instruct reserve (ideally with respect to its location in the grid) in a coordinated synchronised way, therefore relying on integrated or at least harmonised balancing markets on each side of the border.

The importance of efficient fine tuning of participant positions, and efficient balancing is likely to grow over time – particularly with the continuing trend to increasing renewables capacity (particularly wind generation). A key feature of wind generation is, as noted in the previous chapter, uncertainty regarding the likely output – this is clearly now having an impact on key markets (e.g. Germany) as wind capacity grows in importance.

It is important to note that there would be another potentially significant benefit if, in addition to linkages between Balancing Mechanisms, physical control areas were integrated. As noted in the last chapter, balancing arrangements are the commercial means by which System Operators secure access to balancing resources for their control area. Within the UCTE system, each System Operator must act in their control area to ensure that the exchange between control areas is at the agreed level (that is, the aggregated flow across all interconnectors of each control area is maintained at its programmed rate).

However, as a result of this UCTE requirement, even if balancing arrangements are robustly linked, it is still possible for two control areas which are interconnected to be taking balancing actions in the opposite direction which, within an integrated control area, would not be required. Consider two control areas, A and B:

- Suppose in control area A, there has been a generation outage. The System Operator of control area A has to purchase balancing energy to

⁸ In a system where imbalance prices were calculated from the marginal price paid or received for balancing services, this correlation would obviously be extremely weak. It may be stronger in countries where imbalance prices are based on an average of the prices paid for balancing services – however, even then, given the range of different prices which could be paid in a balancing period, and the potential for inclusion of capacity and energy payments in different ways in the imbalance price calculation, it may be low.

replace the lost generation, to ensure (a) that demand on their system is still served, and (b) that their interconnector export to control area B is maintained at the agreed level;

- Suppose that, at the same time, in control area B, there has been a significant demand reduction (for example, a major load turning down unexpectedly). The System Operator of that area now has to sell balancing energy back to generators to ensure (a) that there is not oversupply on their system, and (b) that their export to control area A is maintained at the agreed level.

Now suppose that the two control areas were integrated. If the size of the load reduction were broadly equivalent to the size of the generation outage, and presuming that there were no significant transmission constraints between the two, then the System Operator for the larger control area would need take no action. The overall cost of balancing to system users would be lower.

However, it is worth noting that this last benefit requires more than simply the integration of balancing arrangements – it requires the integration of control as well. In addition, such integration would mean that the advantage of decentralised frequency control with respect to overall system security would be reduced. The example of the Italian blackout in 2003 has demonstrated that the principle of decentralised system responsibility, implemented by the secondary control mechanism, can help to restrict the impact of such major disturbances to individual control areas. In this respect the secondary control mechanism can be understood as a contributor to social welfare. Hence, the welfare gain through reduced balancing demand, resulting from a larger control area, should not be assessed in isolation from the potentially increased risk of major disturbances.

The benefits of increased options for portfolio fine tuning (through intraday markets) will be passed on to customers provided markets are reasonably competitive. The benefits of increased options for balancing requirements (and, where relevant, reduced balancing volume requirements) will accrue in the first instance to the System Operator. This raises two issues in relation to the regulatory regime that the System Operator faces:

- if they pass through all balancing costs to users directly, they may not face a great incentive to reduce balancing costs. In contrast, if they are incentivised in relation to the cost of balancing, they should actively seek opportunities to reduce total balancing costs, and should hence be supportive of increased international linkages between balancing mechanisms; and
- the extent to which customers receive some part of the benefit of reduced balancing costs will largely be determined by the effectiveness of regulatory oversight of the System Operator's charges.

3.3.2 Costs of greater international linkages

In considering the costs of implementing arrangements to facilitate international linkages between intraday markets and balancing arrangements, there are a number of aspects which it will be important to consider:

- implementation costs – these may involve the upfront negotiation of the arrangements between parties involved, and the implementation costs of new IT systems and new control processes to facilitate the linkages;
- participant costs – to the extent participants have to integrate with different arrangements to submit bids for energy internationally and nationally, then additional costs will be borne eventually by customers;
- security of supply – if international linkages of intraday markets or (more likely) balancing arrangements have any significant effects on security of supply, these should clearly be taken into account; and
- loss of the committed day ahead use of that part of the interconnector's capacity that is reserved for intraday balancing flows⁹.

3.4 QUANTITATIVE ASSESSMENT OF POTENTIAL BENEFITS OF LINKAGES

In order to get a very rough view of the order of magnitude of potential benefits, and given difficulties in accessing data across a large number of borders, we restrict our analysis to consider a particular border using a relatively basic methodology. The objective of the analysis is to give a view of the broad magnitude of potential benefits available – i.e. are they negligible or material – which can be assumed to apply generally, rather than to attempt to estimate the precise extent of potential benefits in the specific cases.

Below we briefly describe the methodology which we have used, before summarising our results.

3.4.1 Methodology

To consider the benefits of exploiting intraday and balancing exchange opportunities across borders, we compare the expected value of the ability to trade between countries on day ahead markets to the expected benefit of being able to trade intraday and in balancing timescales. Essentially, we consider the value of holding interconnector capacity to trade in day ahead markets and then

⁹ In order to ensure that balancing power can be securely transferred across congested interconnectors, this optional exchange needs to compete with scheduled exchange for the limited transmission capacity available. Previous studies have shown that, at least under ideal market conditions, an optimal share of the transmission capacity between scheduled and optional exchanges yields a net gain in economic welfare when compared to an exclusive allocation of transmission capacity to scheduled exchanges. (See for example econcept/Consentec/IAEW, “Windenergie und schweizerischer Wasserkraftpark” [Wind energy and Swiss hydro power plant], study for Swiss Office of Energy [BFE], February 2004 [in German with French abstract])

compare it to an estimate of the value of holding interconnector capacity for trade in shorter term markets.

Interconnector capacity is considered as an option to trade between markets. We then consider the value of that option given expected price levels in the two systems and price volatility at the day ahead stage (taking into account the observed correlation between prices)¹⁰. We then repeat the analysis using expected price levels and price volatility during balancing timescales. Since the prices achieved for balancing energy are, in most systems, difficult to obtain, we use imbalance prices as a proxy – we consider only systems where the imbalance price is based on some form of average of prices paid for balancing energy.

We then calculate the value of being able to trade between the systems in balancing timescales as the difference between the two option valuations.

There are clearly a number of shortcomings of this approach:

- We assume that there are only two opportunities to exercise the interconnector capacity option – at the day ahead stage and in a single shot Balancing Mechanism where prices are proxied by imbalance prices. In reality, the option could be used at any time between the day ahead market and the point of delivery. Indeed it is possible to envisage arrangements allowing multiple use of it during this time. This simplification in our analysis implies that our estimate of the value of greater linkages between intraday markets and balancing arrangements is likely to be conservative.
- There is no single “balancing price”. The price received for balancing activities is likely to depend significantly on the technical capabilities of the service being offered – for example, the value captured for balancing energy available in 30 seconds is likely to be significantly greater than the value captured for balancing energy available within an hour. Hence, our use of imbalance prices as a proxy for the price received for balancing energy assumes that the service being offered is, in some sense, the average service required by the System Operator in each balancing period.
- Imbalance prices are not a perfect proxy for balancing mechanism prices. Equally, depending on their definition they are not always directly related to balancing bids (e.g. in many systems, the price for imbalances which “help” the system – that is, for long imbalances when the system as a whole is short and *vice versa* – is often derived from *ex ante* prices such as a power exchange price or a price from a reliable price reporter, rather than from actual prices paid for balancing energy).
- We assume that, in relation to balancing arrangements, System Operators would place equivalent value on balancing offers from a national and international resource. We note that, in certain circumstances, System Operators may place more value on national resources, as they assume that

¹⁰ We use a simple option valuation methodology based on Monte Carlo analysis using historic data to estimate price distributions, rather than adopting either a closed form option valuation solution such as Black-Scholes, or attempting to model price formulation.

international resources could not be relied on if the international system had its own system issue – that is, national system security would be placed above international commercial commitments.

However, as we noted above, the intention of the methodology is to provide a broad indication as to whether the benefit is material or not, rather than to estimate the benefit accurately.

Finally, we note that the methodology is intended to capture only the first of the qualitative benefits considered above. We do not attempt to model either the benefits in relation to:

- potential reduction of entry barriers; or
- integration of control areas.

3.4.2 Results of quantitative analysis

We applied the above methodology to the border between the UK and France for the period May to September 2003¹¹. This border was selected primarily because a reasonable duration of data was available both for day ahead and imbalance prices.

The difference in the option value of interconnector capacity used in day ahead and shorter term markets can be considered to derive from two factors:

- the difference in the expected *level* of prices across the two timescales; and
- the difference in the expected *volatility* of prices.

Table 2 sets out the results of our analysis.

¹¹ We note this analysis covers only a summer period – as a result of different demand conditions and generation usage, it is possible that different results would be obtained over winter. However, to the extent that, even after taking into account summer maintenance, one might expect short term price volatility to be higher in winter (as the supply margin is lower), this summer analysis could be argued to provide a conservative estimate of value.

	Incremental value due to		Total €/MWh
	Difference in expected price levels €/MWh	Difference in volatility €/MWh	
May 2003	9.50	1.18	10.68
June 2003	16.78	1.27	17.95
July 2003	2.71	9.63	12.35
August 2003	11.02	3.91	14.93
September 2003	15.75	0.67	16.42
Average	11.13	3.33	14.46

Table 2: Additional interconnector value in short term markets

Source: Frontier Economics analysis

The table indicates the potential for material value for connection capacity in short term markets in addition to that which could be captured through day ahead markets.

There is a further consideration which must be made in the interpretation of this result, however. The volume of capacity on which this level of value could be secured through intraday and balancing trading is likely to be relatively low:

- The volume of energy required by participants to fine tune their portfolios and by TSOs for balancing purposes is typically a small proportion of the overall consumption in the system – hence, above a certain level of volume, demand for short term energy would dry up (i.e. there would be no change in price differential across the link).
- If increasing volumes of balancing energy are sourced internationally, then for the same set of balancing requirements, a lower volume will be sourced nationally. Given the nature of balancing resources, a small change in the volume demanded may have a disproportionately large effect on price. Hence, if the volume of balancing energy demanded from national resources is reduced, significantly lower cost resources could be setting the “national” balancing price, making it significantly less profitable for international resources to sell balancing energy.

If we assume that the UK-France interconnector is available 95% of the time, and the above value differential could typically be exploited on no more than 5% of the 2000MW of interconnector capacity, then we arrive at an annual benefit of shorter term markets of up to €12m per annum. If the benefit could be exploited on 10% of the capacity, this benefit would double to €24m per annum.

As noted above, while this analysis was based on data from 2003, as the proportion of installed capacity represented by renewables energy with uncertain

Potential benefits of co-operation

output or availability increases, the volume of energy required for balancing is likely to increase, and hence the benefits from effective integration between arrangements internationally is likely to grow.

3.5 CONCLUSIONS

While, as we note above, this analysis is aimed at providing an insight into the broad order of magnitude of the potential benefits rather than trying to estimate them accurately, it would appear from the results obtained that, if the Anglo-French border is in any way representative of other European borders, there are reasonably material benefits to be gained from intraday and balancing trade.

4 Options for integration of intraday & balancing arrangements

Having identified potential benefits from the integration of intraday market and balancing arrangements, in this chapter we summarise three case studies of borders between TSO areas where some linkages between short term markets exist. The case studies undertaken were:

- Nordpool borders (e.g. Norway-Sweden, Sweden-Finland, Norway-Denmark, Sweden-Denmark);
- England – France; and
- Between TSOs in Germany.

The case studies were selected to provide examples of the range of experience that exists currently around Europe, and also to reflect different approaches to the development of intraday and balancing arrangements. The regime applied to the Anglo-French interconnector was, to a certain extent, a development of a set of existing arrangements associated with the link. This contrasts with the Nordic arrangements, which involved a more fundamental reform of the regime, in the light of operational experience. In both cases, the developments were led by the relevant TSOs. The German arrangements were put in place following requirements set down by the national competition authority as part of a set of remedies for power sector mergers.

Having summarised the arrangements in operation in each of these case studies, we consider possible amendments and improvements to derive some generic models based on the case study arrangements.

4.1 CASE STUDIES

4.1.1 Case study 1: England-France

The England & Wales and French electricity markets are linked by the Anglo-French interconnector. Open access arrangements (via a series of auctions) were introduced on the Anglo-French interconnector from 1 April 2001. Until early 2004, these arrangements allowed trading of energy across the link up to day ahead. From March 2004, arrangements to facilitate intraday trading were introduced.

National market timescales

Figure 8 provides an overview of the timescale of the England & Wales market.

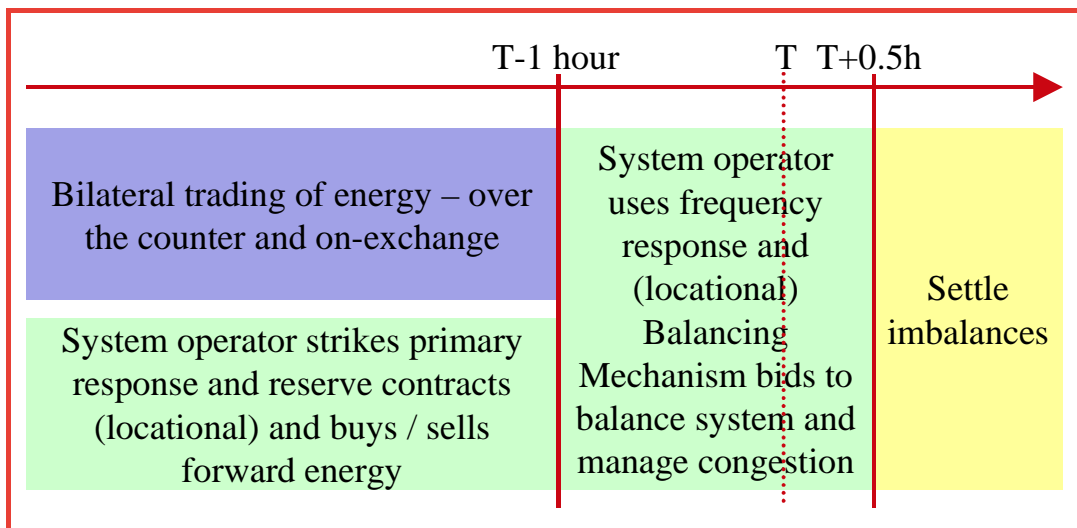


Figure 8: England & Wales market timeline

The key events and timings in the England & Wales market are as follows:

- while participants are required to submit initial notifications of their intended physical production and consumption around the day ahead stage, there is no centrally organized market until an hour ahead of the relevant delivery half hour; and
- Gate Closure is at the hour ahead stage. Participants submit their final intended production and consumption schedules to the System Operator, and the formal Balancing Mechanism opens, allowing participants to submit bids for the provision of balancing energy to the System Operator. It is important to note that the Balancing Mechanism in relation to each half hour opens an hour before the start of *that half hour* – there is a rolling schedule of Balancing Mechanism opening times.

Figure 9 provides an overview of the timescales of the French market. Unlike those in England & Wales, they are not based on a fully rolling Gate Closure, but rather schedules and balancing bids are submitted for the remainder of the day of delivery at a number of gate closures through the day.

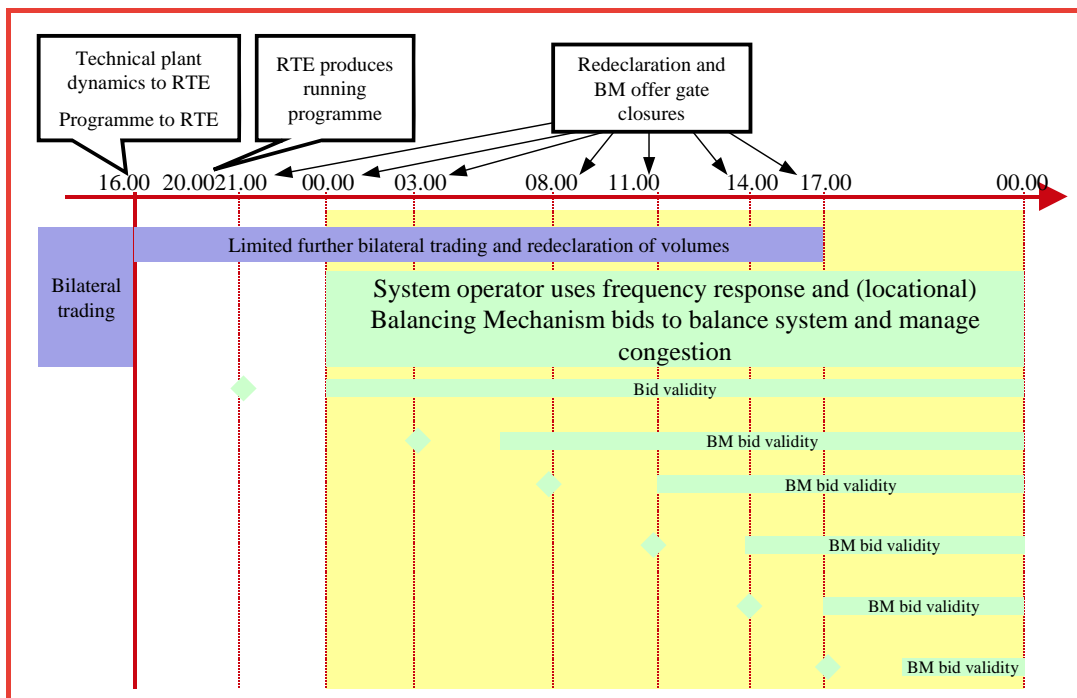


Figure 9: French market timescales

The key events and timings in the French market are as follows:

- participants are required to submit an indicative schedule of their planned output and consumption at around midday day ahead;
- participants are required to submit a final schedule at 16.00 on D-1. At this point in time they submit a schedule for each half hour of the relevant day of delivery. Equally, they are required to submit a range of information on the technical characteristics of their plant. Finally, they also submit their initial offers of balancing energy; and
- however, this is not the end of all bilateral trading in relation to the delivery day. Following this 16.00 nomination and 20.00 schedule publication, there are a number of further chances for participants to redeclare their production and consumption schedules. The redeclarations must be submitted by defined Gate Closures through D-1 and D, and are all subject to a neutralization time (i.e. a redeclarations submitted at 08.00 can only include volume changes applying from 11.00). Participants are also permitted to resubmit balancing offers through the day – with the same timings as for schedule redeclarations.

International interaction: Before gate closure in either system

Having purchased interconnector capacity rights in any of the annual, seasonal, quarterly, monthly, or daily products, interconnector users (IUs) are required to make a “Mid-Channel Nomination” (MCN) indicating their intended interconnector usage at 13.00 on the day ahead. For this nomination, IUs are free to nominate use up to their holding of capacity rights. It is these MCNs which NGC and RTE use to develop their daily operational plan (along with

Options for integration of intraday & balancing arrangements

forecasts and initial submissions as to participants national production and consumption).

Prior to gate closure in either market, participants are still free to trade energy internationally between each other. However, their ability to deliver on these energy trades clearly depends on their ability to adjust their MCNs.

Renominations are possible after the submission of day-ahead MCNs. However, these renominations are not guaranteed to be accepted – in broad terms, they are accepted provided that the change in interconnector flow does not cause a change in the national operational plans (for example, if an operator had, on the basis of MCNs, planned a certain pattern of maintenance, or taken actions to relieve anticipated within-system congestion, a renomination which would materially change their ability to follow this operational plan may not be accommodated). Guidelines are published (on RTE’s website) indicating the likely constraints on renomination.

If more than one request for renomination is submitted but cannot be accommodated, all the requests are scaled back until they are feasible. However, since there is no fixed time for renominations, there can be an element of first-come, first-served in accommodating changes.

Hence, prior to Gate Closure in either system, the main limit on the extent of participants’ international trading is operational.

International interaction: After French gate closure

The submission of MCNs is currently required at 2pm day ahead. Following the first French gate closure, participants in the England & Wales market who have unused capacity on the interconnector have two trading options:

- Bilateral trading, provided they are confident that they will be able to get the interconnector operators to agree to a redeclaration of their MCN and get RTE to agree to a redeclaration of their French schedule – the last opportunity for such trading is set by the time of the last such opportunity for redeclaration (17.00 on the day of delivery); and
- Bidding to the French mécanisme d’ajustement.

Participants having submitted their MCN can submit bids to the mécanisme d’ajustement at the D-1 Gate Closure (i.e. the gate closure at 8pm day ahead, for which bids are valid from midnight on the day). In order to avoid the risk of having their bid to the French mechanism called following a rolling Gate Closure for the relevant period in the England & Wales market, the bid to the French mechanism would have to indicate a notice time of more than one hour.

As noted above, changes to MCNs should be accepted by the operators provided they do not cause operational issues.

Following this 8pm Gate Closure, interconnector users are not able to participate further in the mécanisme d’ajustement. RTE told us that this was because offers from IFA users would rarely fit RTE’s balancing needs as a result of the gaps of 3 hours between nomination and provision.

Options for integration of intraday & balancing arrangements

RTE is planning to extend the arrangements in France to incorporate 12 gate closures, implying a shorter time period between nomination and provision. Having done this, they plan to allow nominations into the mécanisme d'ajustement from interconnector participants during the day (rather than day ahead) – NGC and RTE are working on this development.

International interaction: After gate closure in both systems

After gate closure in both systems, there is no direct participation of international resources in national balancing arrangements – all international trading is conducted through System Operator to System Operator trades, under a contract between NGC and RTE.

Around 6 hours before their entry into force, NGC and RTE agree prices for the exchange of balancing energy between them over the interconnector. Recently, NGC and RTE have started to make these prices available to all participants (for example, they are published on the England & Wales Balancing Mechanism Reporting website¹²). At present, one set of prices hold for an entire day.

There is no volume limit on the balancing energy available at this price other than the interconnector capacity. Equally, the only dynamic constraints which apply to the provision of the energy are those constraining the operation of the interconnector itself.

However, the availability of the international balancing resource is constrained by:

- **the volume of residual capacity available on the interconnection:** no capacity is reserved *ex ante* for balancing purposes – the balancing capability is only available to the extent that IUs are not making full use of the interconnector capacity; and
- **conditions on the other system:** provision of balancing energy can be withdrawn by either System Operator at any time. This condition allows the operators to put the system security of their own network above the provision of international balancing resource.

This uncertainty surrounding the availability of the balancing energy resource does impact on the way in which the System Operators consider the resource in their overall reserve planning. For example, while National Grid Company in England & Wales would include a volume of potential balancing resource over the interconnector in longer term reserve (e.g. reserve held at the day ahead stage to cover the potential loss of a unit on the system), they would not typically consider it part of their short term operational reserve held to cover system events near to and during real time.

In contrast, RTE does consider the balancing services contract with NGC as part of their reserve (unless NGC have already declared the service unavailable). The exception to this is when the interconnector is flowing more than 1500MW into

¹² www.bmreports.com

France – in this situation, the extent of reserve assumed to be provided by the interconnector is reduced.

In deriving prices to offer to the counterparty System Operator across the interconnector, two basic principles could be adopted:

- **cost based bids:** estimate the likely cost of providing balancing energy from available resources on the national system (involving taking a view as to plant nationally available, the volume and pricing of reserve held, the likely level of balancing offers from national plant etc.) and provide a bid based on this estimated cost; or
- **value based bids:** estimate the likely level of balancing energy prices from the other System Operator’s national resources (involving taking a view as to the likely “tightness” of their system) and providing a bid which is believed to be competitive with these estimated balancing prices given the dynamic capabilities of the interconnector.

Under the first approach, the value of the international balancing energy accrues to the System Operator calling the energy (they avoid having to take more expensive balancing power from national resources). Under the second approach, the value largely accrues to the System Operator providing the energy from their national resources.

Certainly in NGC’s case, as a result of the incentivisation in relation to balancing costs, there is a short term financial incentive to provide value based bids, as this would allow them to share the value of the international balancing energy with participants.

In RTE’s case, the incentive could be lower, as the rules of the mécanisme d’ajustement leave them financially neutral (through the operation of the “balance operations imbalance management account”).¹³

In reality, it seems likely that the approach adopted across the interconnector by the respective parties is a mixture of these two approaches over time. We understand that National Grid Company make by far the most use of the international balancing capability (i.e. they call for balancing energy across the interconnector much more frequently than RTE).

4.1.2 Case study 2: NordPool area

Up to 2002, while there were common arrangements for *ex ante* trade of electricity through NordPool’s Elspot market, there was little co-ordination of balancing. Once schedules (and resulting programmed transfers between countries) had been determined, the individual TSOs in the synchronous area balanced their systems to the agreed transfers (as is currently the practice in the UCTE area).

¹³ Essentially, if a financial surplus accrues to RTE, the spread between long and short imbalance price is adjusted to pass this surplus back to participants.

The TSOs recognized that this approach frequently resulted in one system utilizing upward regulation while another system required downward regulation. As a result, steps were taken to integrate balancing areas (to capture the benefits of offsetting imbalances across a larger control area) and to integrate commercial balancing mechanisms. Since September 2002, balancing has been integrated across the Nordic area.

National market timescales

While a number of the aspects of the Nordic market arrangements have a common timescale (for example, participation in and timing of the NordPool ElSpot day ahead arrangements), there are differences in the timing of:

- submission of initial notifications to the TSOs of intended production / consumption;
- submission of bids for the provision of balancing energy; and
- submission of final notification of intended production / consumption.

A high level overview of the market timescales across the Nordic countries is provided in Figure 10.

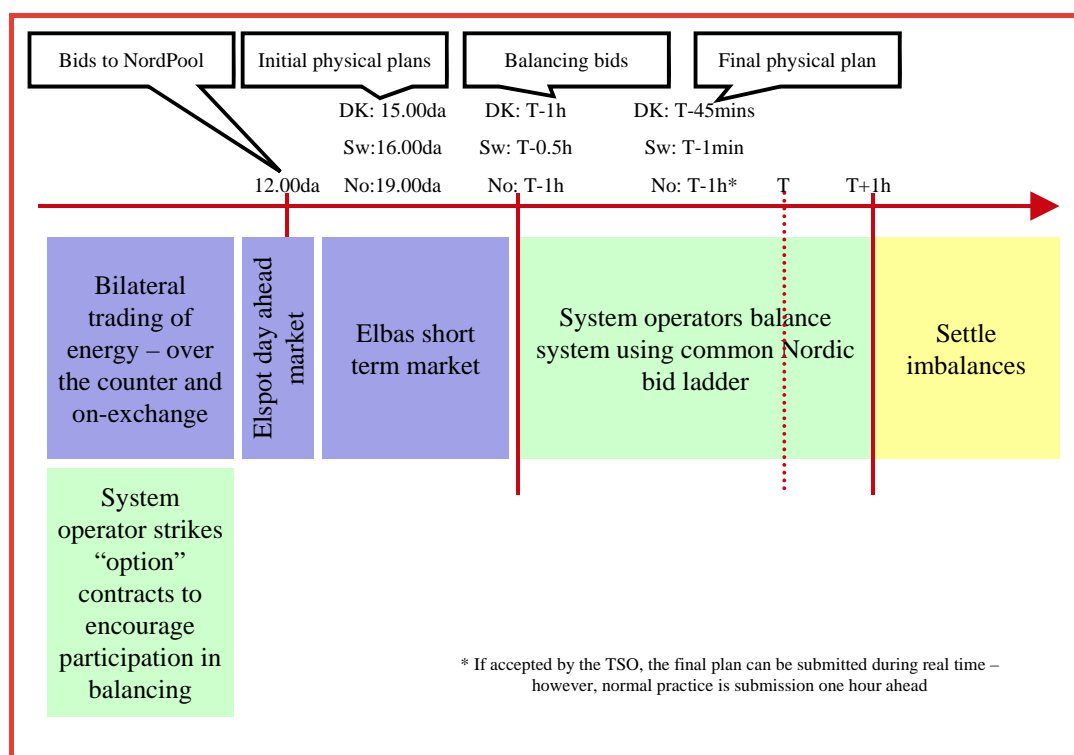


Figure 10: Nordic market timescales

Source: Information from Nordic TSOs

The key events and timings in the national markets are as follows:

- at 12.00 day ahead, participants submit bids to NordPool, which then clears the day ahead market ensuring that prices are set so that interconnection constraints are not breached;

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- subsequently, participants outside Norway¹⁴ can trade on NordPool's short term (Elbas) market. Trading on this market can be both within price zone and between price zones (using any capacity which was not utilized by bids accepted in the Elspot market)¹⁵; and
- at a time which varies by system from an hour ahead of the start of delivery to half an hour ahead, participants submit bids to their local TSO for the provision of balancing energy. Gate Closure takes place at a range of times, from an hour ahead in Norway (based on normal practice) to one minute ahead in Sweden. This means that the System Operators get a gradually emerging picture of the planned production and consumption schedules over the Nordic area, on which to base their balancing actions.

International interaction: Before gate closure in any system

Following the Elspot market, in all countries other than Norway, the continuously traded Elbas market operates. This market allows participants to fine tune positions, both within their own system and (to the extent that there remains unused capacity on the interconnections) between areas.

International interaction: After gate closure in one or more system

Following gate closure in each system, bids for balancing power are submitted to the local TSO. However, these bids are not for exclusive use in that system – the arrangements ensure that, where physically possible, they can be used throughout the Nordic area in real time.

It is to the detail of these arrangements which we now turn.

International interaction: After gate closure in all systems

The Nordic arrangements do not distinguish between “national” and “international” balancing energy provision. The control areas effectively share the balancing resources, and balancing energy is called from the most economically and technically appropriate resource. This is achieved through the concept of a Super TSO who is able to see and call off bids for balancing energy from all balancing resources across the Nordic area.

When the arrangements were first implemented, Statnett and Svenska Kraftnat took turns as Super TSO. However, they now both act as Super TSO, and share a common information system to ensure they have common bid information. The entire synchronous Nordic system (including the Finnish and East Danish TSO areas) is balanced by the Super TSO. The West Danish TSO, as the operator with responsibility for a border with UCTE, is responsible for ensuring

¹⁴ As a result of the predominance of hydro power in Norway, and as a result of the weaker balancing incentives resulting from the single imbalance price, the Elbas market does not operate in Norway (at least at present).

¹⁵ Since Elbas is a continuously traded market, this implies that participants in different locations see different versions of the Elbas trading screen – bids and offers which cannot be accommodated on the transmission system are blocked from view.

that the border transfer with UCTE is at the agreed level – they can use bids from other countries across the direct current link for this purpose, and bids from their generation appear on the common list.

Stattnet and Svenska Kraftnat avoid “co-ordination” problems (e.g. both responding to the same reduction in frequency by calling for incremental generation) by remaining in close contact through their control rooms through the day.

Figure 11 provides an overview of the operation of the arrangements.

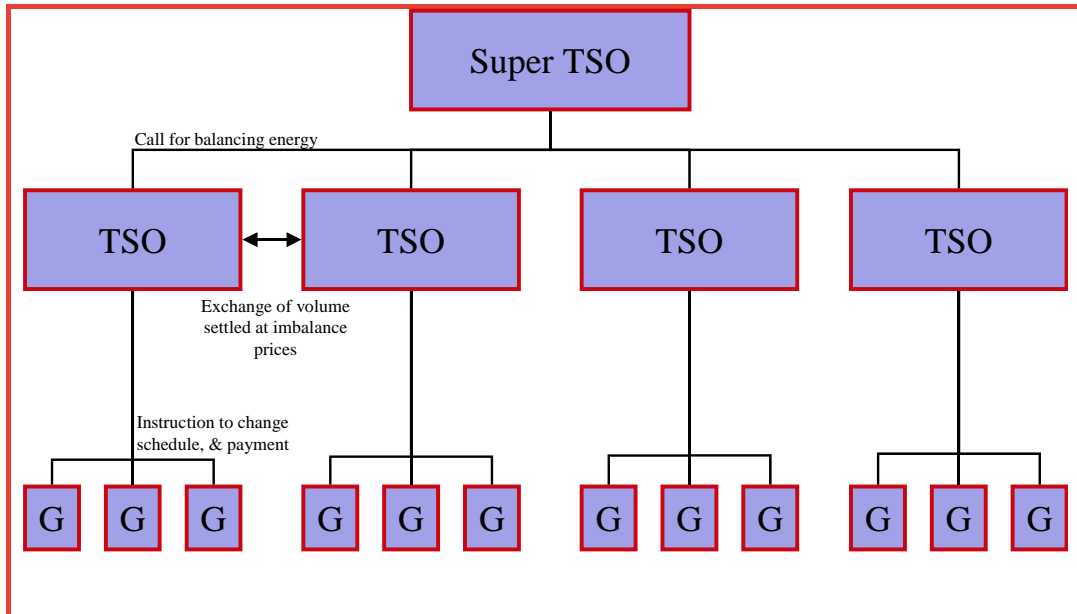


Figure 11: Nordic "Super TSO" arrangements

Source: Frontier Economics / Consentec based on discussions with Nordic TSOs

Suppose there is a need for incremental generation on the synchronous system. The Super TSO recognizes this, and looks at the shared set of balancing bids to find the most appropriate plant from which to purchase this energy. Stattnet and Svenska Kraftnat co-ordinate between themselves to ensure that the resource they choose is technically suitable (e.g. that it can deliver the energy sufficiently quickly given different product definitions and technical plant types, that its utilization is not going to result in incremental congestion issues within the control zones etc.)

There is no reservation of capacity on international interconnections within the Nordic region to provide scope for balancing energy to be exchanged. All capacity is provided to Elspot for use day ahead¹⁶ and then to Elbas – to the extent that some international capacity remains unused after Elspot has cleared

¹⁶ In all countries except Norway, where there is market splitting within the country, the impact of national transmission constraints which would interact with cross-border flows are “reflected” onto the cross-border capacity provided to ElSpot – that is, if international exchange would result in national congestion, the interconnector capacity provided to ElSpot is reduced.

and Elbas has closed, there is scope for international exchange of balancing energy.

The Super TSO ignores differences in balancing pricing between the countries – so a bid from a generator in Denmark (where balancing energy is paid as bid) would be treated equivalently to a similarly priced bid from a generator in Norway (where balancing energy is paid at a market clearing price).

Having selected a suitable bid, the Super TSO communicates the requirement for energy to the TSO to which the resource is connected. This “local” TSO then contacts the resource in question and requests the incremental generation. The payment for the additional output also comes from the local TSO.

Suppose the generation resource selected was actually in the Swedish control area. Then as the incremental output is delivered, the export from the Swedish area to the East Denmark area will increase. In settlement, the Swedish TSO will effectively have a “long” imbalance across its border with East Denmark. This imbalance is settled at a price based on the average of the imbalance prices in the two areas. This is the means by which the Swedish TSO recovers the payment to their local generation. All such payments are handled bilaterally between the TSOs.

If the local generation does not deliver the balancing energy which has been contracted, there is no “guarantee” from the local TSO – the Super TSO has to select the next most appropriate bid and call additional energy. The participant that failed to provide the balancing energy will face an imbalance charge.

The Super TSO does not consider that a bid called from outside the country with the balancing requirement will have any greater risk of not being delivered than a bid from within the country – there is no assumption that national supply security will come before the security of the rest of the synchronous Nordic area.

If the Super TSO runs out of balancing energy options and load shedding is required, the System Operation Agreement between the TSOs requires that the country with the largest national deficit (i.e. the highest national demand relative to national generation) is required to cut load.

4.1.3 Case study 3: Between TSOs in Germany

Procurement of balancing energy by each TSO in Germany is managed through individual auction processes for each area. The implementation of the transparent auction processes was a remedy required by the Bundeskartellamt in relation to the RWE-VEW and VEBA-VIAG mergers¹⁷.

National market timescales

Figure 12 sets out the overall timescale for the German market arrangements.

¹⁷ It is important to note that the arrangements in Germany are currently being reviewed and could therefore be amended in the near future.

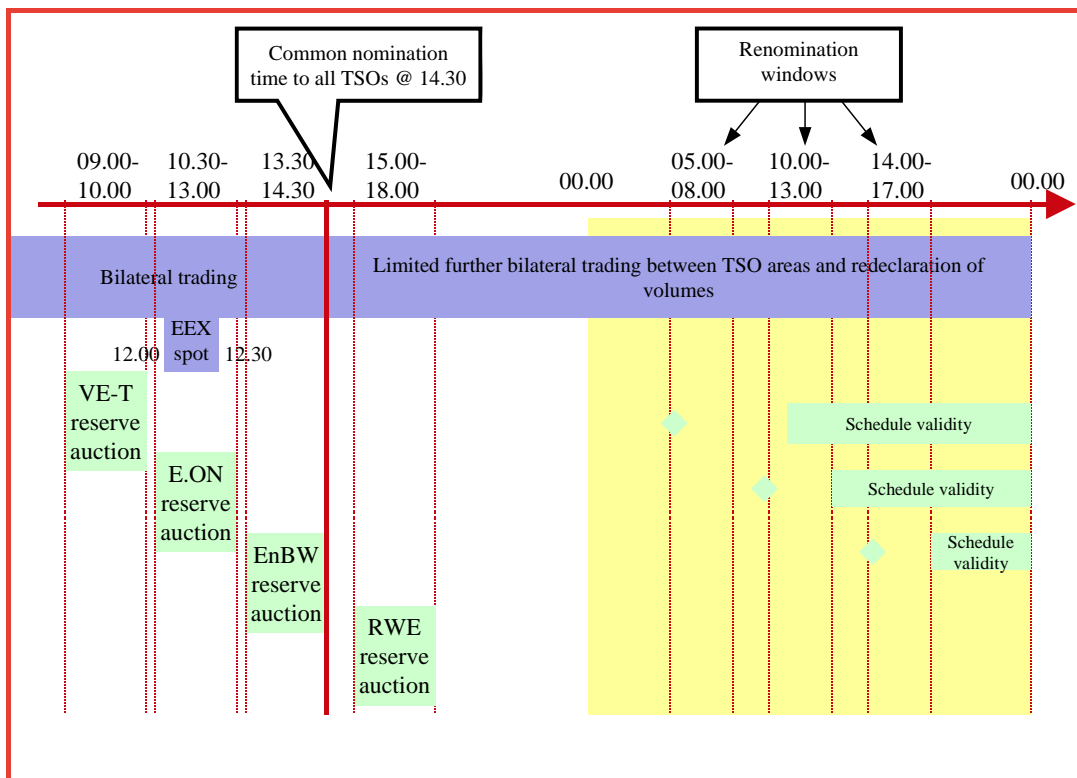


Figure 12: German market timescales

Source: Frontier Economics / Consentec

The key events and timings in the German market are as follows:

- auctions for balancing energy capability (“minute reserve”, equivalent to tertiary reserve) are conducted day-ahead over the internet¹⁸
 - bids to provide minute reserve to Vattenfall have to be submitted at 09.00, with contracts being awarded at 10.00;
 - bids to provide minute reserve to E.ON have to be submitted by 10.30, with successful bidders being informed by E.ON at 11.30, and having to confirm the offers by 1 pm;
 - bids to provide minute reserve to EnBW have to be submitted by 13.30, with contracts being awarded at 14.30;
 - bids to provide minute reserve to RWE have to be submitted by 15.00, with contracts then being awarded by 16.00 and successful bidders having to confirm the offers by 18.00 at the latest;

¹⁸ As a consequence of the entry into force of the new energy law in July 2005, there are currently discussions about a unified common auction for balancing energy across all control areas. The description here refers to the current arrangements.

- the timescales for the nomination of flows are determined in the network access regulation (Stromnetzzugangsverordnung).¹⁹ Balance responsible parties (BRPs) have to nominate their intended production and consumption schedules, and flows between TSO areas at 14.30 one day ahead of delivery; and
- nominations for flows between TSO areas as well as nominations for within area production and consumption can be changed during the day with the TSO being informed three quarters of an hour prior to the new schedule becoming valid (however, the TSO has the right to reject renominations between TSO areas when they may create congestion). Nominations for within area production and consumption can even be updated *ex post* after the day (to allow for trading of imbalances).

Interaction between TSO areas: before common gate closure time

Before gate closure, as noted above, participants in different TSO areas are free to trade – they then simply submit nominations at 14.30 to their TSO in relation to their production and consumption in that area.

Interaction between TSO areas: after the common gate closure time

After the common gate closure, bilateral trading can continue to the extent that participants are confident that – in the cases of inter-TSO area rescheduling – the TSOs will agree to a renomination of their schedules.

In addition, by participating in the balancing energy auction processes of external TSOs, participants can bid to provide balancing energy throughout the day to other areas – hence, the process around these auctions and the process by which TSOs call for balancing energy from successful auction bidders from other areas is of relevance²⁰. Participation in multiple reserve markets is made possible by the markets being organised sequentially – hence, generators can adapt their bids in later markets to the outcome of earlier markets.

Since there is no capacity allocation mechanism procedure for capacity between the German TSOs (as to date congestion has not been a significant issue, other than in relation to wind power) there are few issues relating to securing and reserving capacity to provide balancing power. Wind-related congestion (for example, if VE-T exports significant wind energy to the rest of the Germany system) has typically been dealt with via *ad hoc* rules rather than by the definition and trading of capacity products – when the wind forecast for VE-T is too high, RWE excludes bids from balancing resources on Vattenfall's network from participating in the positive minute reserve auction for the next day²¹.

¹⁹ Download: <http://www.vdn-berlin.de/global/downloads/Publikationen/vv2plus.pdf>

²⁰ Procurement of balancing energy by each TSO is through their own auction process – the implementation of the transparent auction processes was a remedy required by the Bundeskartellamt in relation to the RWE-VEW and VEBA-VIAG mergers

²¹ Following information from RWE Transportnetz Strom.

Where a generator connected to a particular TSO area has contracted with a generator in another TSO area to provide balancing energy and wishes to make use of this resource (i.e. wishes to call for delivery under the contract), the contracting TSO notifies both the generator and the TSO to which they are connected of the requested change to schedule. In addition, the contracting TSO typically contacts the generator by telephone to verify that the balancing energy will be delivered.

Having done this, both TSOs adjust their secondary control equipment. This is necessary as otherwise, following delivery of the balancing energy by the generator in question, resulting in an increase in power exported from the connected TSO's area, the secondary control equipment would act to return the export to the programmed level, negating the effect of the balancing.

Since all bids to the reserve markets are non-locational, the generating company retains the flexibility to choose from which of their plant they deliver the balancing energy.

In the event that the generator fails to deliver the balancing energy themselves, it is the connected TSO that faces the risk. Following such a failure to deliver, the secondary control equipment would automatically adjust the output of other generators to ensure that the (higher) programmed export was actually delivered. The generator in question (or, to be exact, their balance responsible party) would face an imbalance equal to the failure to deliver²².

4.2 GENERIC MODELS DERIVED FROM CASE STUDIES

For a variety of reasons, there are numerous issues in relation to the arrangements for each of the case study borders discussed above which could impact on the efficiency of the market outcomes.

We therefore now consider how generic models could be developed from the three distinct case study arrangements. We consider some generic models for

- linkages of intraday markets (i.e. before either system gate closure);
- linkages of balancing arrangements after one gate closure; and
- linkages of balancing arrangements after both gate closures.

We note that we consider potential improvements for the mechanisms discussed in the case studies in purely theoretical terms. For the TSOs and market participants in each of the relevant markets, there may be perfectly good institutional, regulatory or cost-benefit reasons for remaining with the arrangements as they are currently implemented. We are not attempting to indicate areas where individual countries *should* change their regimes. Rather, we are attempting to indicate areas where regimes could be improved to derive a

²² If the generator informs the contracted TSO in advance that they will be unable to deliver, they are required to repay their capacity payment.

generic *target* set of arrangements for implementation on a more general basis at some point in the future.

4.2.1 Before either gate closure

Prior to either market going through gate closure, the case studies all seem to involve the continuation of the key features of day ahead trading. So for example, in the NordPool area, while the day ahead market is based on an auction process and the intraday market involves continuous (bourse style) trading, the market operator retains a monopoly on international access rights, and trading between countries takes place through one single exchange (Elbas) in which buyers and sellers trade in a similar way to Elspot trading.

Generically then, leaving aside issues relating to a lack of benefit to intraday trading, it is difficult to see why intraday trading need be significantly different in nature to day ahead trading.

There are a number of issues which arise from markets without implicit auction arrangements, which may need to be considered in any generic arrangements aimed at facilitating intraday trading:

- Arrangements which involve an interconnector nomination timescale which is different from the earlier of the two interconnected system gate closures may be unnecessarily restrictive. Once an market participant has made an interconnector nomination, they may be restricted in the extent to which they can change their intended exchange (and hence the extent to which they can undertake intraday trading). However, if this nomination is before gate closure in either of the interconnected markets, national market participants will still be able to change their intended production and consumption. Good reasons would need to be advanced (e.g. in terms of operational necessity) for restricting the time period of interconnector nominations to a greater extent than national participants;
- Where capacity rights are explicitly defined (e.g. through an explicit auction process), sequencing issues arise with intraday trading in the same way as with day ahead trading (although the shorter trading window may exaggerate their effect). To trade electricity intraday over an interconnector with an explicit auction, a participant would also need to trade interconnector capacity rights. Suppose a generator wishes to sell energy to the neighbouring country – they then have to procure interconnector capacity (at a market price) and sell energy (again, at a market price). They can effect these transactions in either order, but in both cases face a number of risks arising from the need to sequence (i.e. the inability to conduct the transactions simultaneously). For example, prices in the second commodity may move following the first transaction, making the overall deal unattractive, and leaving them with stranded interconnector capacity or a need to undo the energy transaction. Equally, liquidity in the second commodity may dry up, with a similar effect; and
- Equally, where capacity rights are explicitly defined and participants are able to hold capacity from the day ahead stage through to intraday markets, it may

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provide increased ability to hoard the capacity (i.e. to purchase it with the deliberate intention of withdrawing it from the market, either to manipulate prices or to frustrate international competition). Use it or lose it arrangements which rely on unused capacity being sold in subsequent markets will not work in intraday markets – because there is no subsequent market. The release of interruptible capacity by the interconnector owners may provide a partial solution to this problem. If the interconnector owners release capacity broadly equal to their estimate of the capacity which will not be used by firm capacity holders, then market participants will have an (albeit less certain) ability to make use of any capacity they themselves expect to be unused. However, introducing such a product adds a further degree of complexity to balancing arrangements.

Taking the above into account, it seems clear that the generic model of intraday trading will depend on the treatment of interconnector capacity – specifically, whether or not there are implicit auctions in place.

Where there are implicit auctions, it is difficult to see why a generic model of intraday trading which is effectively a continuous version of any joint day ahead energy and transmission auction process would not be adopted.

Where there are no implicit auctions, generic intraday arrangements may again be similar to the day ahead arrangements, but may also include:

- interconnector nomination timescales which are aligned with the earlier of the two interconnected system gate closure times;
- the release of some interruptible capacity; and
- any arrangements to facilitate simultaneous trading of energy and capacity (for example, those described in our earlier report on congestion management describing how this can fit in explicit auction framework).

4.2.2 After one gate closure

In the German system, the gate closure time is common to all TSOs – hence this trading window is not applicable. In the Nordic system, since bids submitted to the integrated balancing mechanism can be utilized anywhere in the interconnected area, there is no sense in which there are special arrangements for international participation in the balancing mechanism of each of the systems.

Where there is no common gate closure, a number of issues arise, as can be seen from the England – France case study:

- The timing of local gate closure can limit the flexibility (and hence value) of bids submitted to the neighbouring system. For example, for GB market participants submitting bids to the French market, participants would tend to specify a minimum time of one hour between RTE calling the bid and the energy being delivered – this is to ensure that they are able to adjust their GB nominations to take account of obligations in France. Clearly, the longer the time period between calling of balancing energy bids and the delivery of energy, the less valuable the balancing energy is to the TSO; and

- While, since one system will have gone through gate closure, it would be reasonable to expect interconnector nominations to have been submitted, it is unclear whether these would be a significant constraint on the acceptance of bids for balancing energy by the system which has gone through gate closure. If the TSO of that system calls on balancing energy from the neighbouring country, it is presumably possible for their local system to accept the energy (i.e. the area around the point of connection of the interconnector is not export constrained). Since the other system has not gone through gate closure yet, and hence national market participants could significantly change their proposed production and consumption, there would have to be good reasons for that TSO to place more onerous restrictions on the plans of interconnector users; and
- To be able to offer incremental balancing energy in the neighbouring country, if the interconnector were exporting anyway, some interconnector capacity would have had to have been left unused at the point of interconnector flow nominations (either by the participant providing the energy, or by another participant). However, once trading is solely with the neighbouring TSO for balancing purposes, given that the TSO knows the remaining capacity of the interconnector, it may be that the requirement to accompany balancing bids with interconnector capacity holdings can be relaxed. In the situation of a requirement for incremental balancing energy provision, the TSO will only call a volume over the interconnector which is feasible (i.e. which does not result in overloading of the line). Hence, participants should factor this explicit volume constraint into the price of the bids they offer to the neighbouring TSO, and there should be no discontinuity in pricing between *ex ante* markets and the market for provision of balancing power (provided the TSO makes clear the residual volume of available capacity)²³. However, it would be necessary to ensure that the rent which would have accrued to the interconnector owners in relation to any capacity used for balancing energy in this way continued to accrue – this may involve the purchasing TSO paying the interconnector owner(s)²⁴ an amount equal to the closing interconnector capacity price multiplied by the volume of capacity used for balancing energy purchases. Arrangements structured in this way would reduce the risks around hoarding of interconnector capacity, as provided some participants

²³ Suppose the day ahead price in Market A were €30/MWh, the price in Market B were €31/MWh, and interconnector capacity sold for €1/MW for an hour. Further, suppose the market prices equated broadly to the costs of the marginal generator. The price of interconnector capacity essentially rations the scarce resource in the event of potential congestion (i.e. it prevents parties in market A with generation costs of, say, €30.50/MWh from exporting and causing congestion). Now assume that 1MW of interconnector capacity was unused, and consider bidding for balancing energy without having first to procure interconnector capacity. Ignoring any premium for speed of response, provided there is sufficient competition in Market A, bids will be submitted to the TSO in Market B at just above €30/MWh, as parties with costs just above those of the marginal generator compete to have the TSO in market B call them to generate and fill the remaining 1MW of capacity.

²⁴ While the TSO may also be the interconnector owner, to the extent that interconnector congestion rent is shared between systems, while an explicit payment may not be required, it would still be necessary to ensure revenues were treated appropriately in terms of any share passed to the neighbouring TSO.

had left unused capacity, it could actually be used by any party to provide incremental balancing energy.

Taking the issues above into account, it is possible to conceive of a generic model for trading on borders where the gate closure times are different and where one gate closure has taken place which is similar to that currently in operation between the GB and French markets, but which has the following features:

- a relatively short time between gate closure and delivery in the market with the second gate closure;
- few or no constraints on interconnector volume renominations if balancing energy is called by the neighbouring TSO; and
- no requirement for any interconnector capacity purchase to accompany the provision of balancing energy (i.e. allocation being ‘first come first served’).

If arrangements close to this model were introduced, then the benefits from closer harmonization of gate closures may be relatively low. However, to the extent it proves difficult to implement such measures, then an alternative strategy may be to minimize the time during which one system has gone through gate closure and the other one remains open for trading. However, it is important to note that in taking this approach, a solution would still need to be found for the exchange of balancing energy once gate closure has taken place on both systems.

It is to this issue which we now turn.

4.2.3 Post both gate closures – model 1: System Operator to System Operator trading

The first of the possible generic models that we consider for linking arrangements for balancing energy post gate closure in both systems is based on the GB – France arrangements for System Operator to System Operator trading.

There are a number of potential issues with the arrangements as implemented for the GB-France border which may create concerns in relation to their potential efficiency. These include:

- The arrangements for determining the price at which the System Operators trade are unlikely to result in prices which reflect the evolution of system conditions. At present, one single price for the entire day is determined before delivery commences. From the point of view of economic efficiency, it would be better were pricing more granular (i.e. in the limit, one price agreed between the System Operators for each balancing period), and if the agreement of this price were as close as possible to the time of delivery;
- While the TSOs have indicated to us how they construct the prices at which they exchange energy (i.e. a “cost based” approach), there does not appear to be any constraint on this pricing approach. The similarities between the SO-SO trading model and a single balancing mechanism, across the two systems (as there would be in a single national market) are perhaps greatest when

TSOs pass on bids from their national balancing resources at cost – although there are, as we discuss below, then issues about the route by which benefits are passed back to consumers; and

- Both systems involve some form of *ex ante* contracting – however, the contracts struck in the GB system constrain the price at which balancing energy is provided, which the contracting in France does not. If the costs of the contracts in general are not taken into account appropriately when the TSOs provide each other with balancing bids, a distorted signal as to the cost of balancing energy will be sent to the other TSO who will otherwise not pay any of the contract cost and may receive cheaper balancing energy.

There is a further issue in relation to the GB arrangements in terms of the absence of facility for the TSOs to reserve some capacity from the *ex ante* sales to participants with the explicit intention of utilizing the capacity for the exchange of balancing energy.

If a system under the control of a single TSO is considered, it is perfectly possible to conceive of a scenario in which particular circuits are part loaded in order to allow generation resource behind what would otherwise be an export constrained area to count to system reserve – for example, if these were the only reasonable priced source of balancing resource.

Similarly, then, in certain circumstances, it may be economically efficient for the operators of the interconnector to reserve some capacity from the *ex ante* auctions in order to ensure that incremental balancing energy could be supplied from the neighbouring country (clearly the efficiency of this would depend on the direction of flow of the interconnector, national system conditions and prices etc.)

However, there are potential disadvantages with arrangements which leave TSOs with the discretion to withhold interconnector from the *ex ante* markets. Frequently, TSOs are required to release all capacity to the market in order to ensure that they do not deliberately withhold volume to increase their revenue. Arrangements which provide some discretion on the volume released in relation to what will inevitably be subjective judgements in relation to the potential value of reserve would make it more difficult to prevent TSOs adjusting their *ex ante* volume release to maximize revenue.

Taking the above into account, it is possible to envisage a generic model of System Operator to System Operator trading as currently used across the GB-France border, but with the following variations:

- short term agreement on prices at which electricity is traded, and the facility to specify one price per balancing period; and
- prices specified between TSOs which relate to the cost of procuring balancing from national resources, taking fully into account any capacity or contract payments made by the TSO.

Depending on the national regulatory arrangements, it may also be considered beneficial to allow the TSOs to reserve some interconnector capacity for

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balancing purposes. In any event, however, the exercise of such discretion is likely to require regulatory oversight.

4.2.4 Post both gate closures – model 2: Integrated balancing arrangements

The second of the possible generic models that we consider for linking arrangements for balancing energy post gate closure in both systems is based on the Nordic integrated balancing arrangements.

There are a number of potential issues with the arrangements as implemented for the Nordic area which may create concerns in relation to their potential efficiency. These principally relate to ongoing differences in the national energy market arrangements in the Nordic area. For example:

- Different bases are used for remuneration of balancing bids in the Nordic area. In Norway, Sweden and Finland, the players are paid the equivalent of the highest or the lowest respectively of the bids accepted for the hour concerned – that is, they are paid a market clearing price which may be above their bid. In Denmark, the players are paid as bid. This should, other things being equal, create incentives for the Super TSO to take balancing bids from the Danish system. Since bids from this system are paid as bid, the TSO knows that they will never have to pay more for them - in contrast to taking balancing energy from a resource in the other countries, where having to take further actions later in the settlement period could increase the marginal clearing price and the amount to be paid for both bids. While the TSOs are not directly incentivised financially in relation to the cost of balancing energy (in the same way as NGC is in the UK), they may come under regulatory pressure if the costs of balancing were thought “too high”. That they do not consider these differences in assessing which bids to call is possibly a result of the generally consensual Scandinavian approach to their arrangements. Were the arrangements to be implemented elsewhere in Europe, a greater level of harmonization is likely to be required;
- The cash out regime in Norway is single price whereas in the other areas there are two prices - and as a result the incentives to balance in Norway are likely to be lower, resulting in a potentially greater need for balancing actions. On the other hand, the Norwegian TSO pays some participants to be available and submit (unconstrained price) bids – the benefit of which potentially accrues to customers in all countries. Discussions are ongoing in the Nordic area in relation to harmonising a number of such features – again, the fact that it is possible to operate the shared bid ladder arrangements while the differences exist may be the result of a co-operative Scandinavian attitude. Once again, we are of the view that, were the arrangements to be implemented elsewhere in Europe, a greater level of harmonization is likely to be required;
- The basis for settling balancing energy provided across borders is the average of the imbalance prices of the two systems. Suppose a bid for upward balancing in Norway had been accepted, giving Statnett a “long” imbalance. In a purely commercially driven environment, Statnett may then have an

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incentive to ensure that more expensive bids for balancing energy are then taken in other countries, to increase their imbalance price and hence the rate at which Statnett is paid for the volume of energy delivered. The averaging arrangements, while a simple and pragmatic solution to the problem, may need to be reconsidered were the arrangements rolled out generally.

Again, as we noted with the SO-SO trading generic model, it may also be considered beneficial to provide TSOs with the facility to withhold some interconnector capacity from the *ex ante* markets in order to facilitate system reserve being distributed internationally and to provide the possibility of calling incremental balancing energy across borders.

The considerations which were discussed above in relation to such an approach under the SO-SO trading model also apply in a model with integrated balancing arrangements.

Taking the above into account, it is possible to envisage a generic model of integrated balancing arrangements as currently used in the Nordic area, but with a greater degree of harmonization of the underlying national energy market arrangements.

4.2.5 Post both gate closures – model 3: participant offers to multiple mechanisms

The final possible generic model that we consider for linking arrangements for balancing energy post gate closure in both systems is based on the arrangements used between German TSO areas.

There are a number of potential issues with the arrangements as implemented for Germany which may create concerns in relation to their potential efficiency. These include:

- The timing of the auctions for the procurement of balancing resources in Germany is significantly in advance of the delivery of energy. This means that, at the time that participants are submitting bid prices, they have only limited information in relation to the short term developments of supply and demand – for example, they will not have up to date forecasts of wind (of particular importance in Germany, given the scale of wind generation), demand, or short term plant availability. Hence, they will not be able to fine tune their pricing in response to forecast errors or particular events (e.g. plant trips). Arguably, as a result, the arrangements will tend to undervalue flexible plant;
- The arrangements in Germany address the problem of participants with one resource bidding into two possible markets by arranging the markets in a sequential fashion – that way, once a bid is accepted in an early market, the participant knows that it is not possible to bid the same volume in subsequent markets with the same balancing resource. While this approach is workable, it is unlikely to result in an efficient utilization of balancing resources. Ideally, participants would be able to see the evolution of the prices for balancing resources across the mechanisms, and on this basis decide where to place

their resource. Parallel operation of balancing mechanisms would go some way towards addressing this problem;

- The arrangements implemented in Germany do not take account of scarce capacity between zones. As noted above in relation to linkages between markets when one gate closure has taken place, it may not be necessary to require participants explicitly to purchase interconnector capacity to support bids to provide balancing energy, provided that the TSOs together make clear the volume of remaining spare capacity on the link. However, again as noted above, arrangements would need to be put in place to ensure that the treatment of any interconnector congestion rent relating from transfer of balancing volumes was treated appropriately;
- Under the arrangements in Germany, the bids provided by participants are non-locational in nature – that is, once a certain volume of energy is called, the participant can produce it from any resource in their portfolio. This implies that a call for balancing energy from a neighbouring TSO could cause intra-control area congestion for the local TSO. It may be preferable for the bids to be locational, and for there to be some form of filter by the local TSO of those bids which could, if called by neighbouring TSOs, cause intra-control area congestion.

Again, as we noted with the generic models discussed above, it may also be considered beneficial to provide TSOs with the facility to withhold some interconnector capacity from the *ex ante* markets in order to facilitate system reserve being distributed internationally and to provide the possibility of calling incremental balancing energy across borders.

The considerations which were discussed above in relation to such an approach under the earlier models also apply in a model with these arrangements.

Taking the above into account, it is possible to envisage a generic model in which participants submit balancing offers directly to individual TSOs in a way similar to that currently operated in Germany, but with amendments which might include:

- balancing arrangements which operate closer to the time of delivery than those in Germany;
- balancing arrangements which operate contemporaneously rather than sequentially;
- appropriate account being taken of any congestion rents due on interconnector capacity used for transfer of balancing volumes; and
- balancing arrangements which are locational.

As noted above, the German arrangements are currently being reviewed. While nothing has yet been finalised, we understand that one of the options being considered is a move away from four separate auctions and towards a single mechanism for all systems. This would move the German arrangements closer to those in place in the Nordic area (although they would remain non-locational, and there would be no integration of control areas).

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5 Assessment and recommendations

In this chapter we consider the potential advantages and disadvantages of each of the generic models for linkage of intraday markets and balancing arrangements described in the last chapter.

We assess the models from three broad viewpoints:

- likely achievement of economic efficiency;
- any effects on security of supply; and
- practical implementation issues (i.e. effort to implement).

Equally, since we are considering the possibility of implementing arrangements across a range of potential countries, we consider the ability of the arrangements to deal with countries with multiple borders as well as the simpler case of two countries only interconnected with each other.

5.1 LINKAGES OF INTRADAY MARKETS

The generic model derived from the case studies relating to linkages of intraday markets is relatively close to the actual arrangements in place in the case study countries, and is relatively simple to implement.

The generic model should be capable of addressing countries with multiple borders. None of the features of the generic model (aligning nomination timescales with the earlier of the gate closure times in relation to any individual pair of countries, releasing interruptible capacity or facilitating trading of energy and capacity) are made significantly more difficult in a country with multiple interconnectors.

Hence, we believe it would be reasonable to expect a gradual evolution to arrangements which follow this model.

5.2 LINKAGES OF BALANCING ARRANGEMENTS AFTER ONE GATE CLOSURE

Where the timings of gate closure are not consistent, again, the generic model derived from the case studies would appear relatively simple to implement.

Again, the features of the generic model described above are not made significantly more difficult in a country with multiple interconnectors.

Therefore, where the timing of gate closure is not harmonised, we believe it would be reasonable to expect a gradual evolution to arrangements which follow this model.

5.3 LINKAGES OF BALANCING ARRANGEMENTS AFTER TWO GATE CLOSURES

In relation to linkages between balancing arrangements after two gate closures, the case studies provide different potential generic models. We therefore now turn to an evaluation of these different options.

5.3.1 Assessment of generic model 1: SO to SO trading

Model 1 allows interaction between balancing arrangements with a relatively low implementation effort. By reducing the linkage to an interaction between System Operators, there is relatively little incremental effort required on the part of participants – essentially, participants continue to bid to a single balancing mechanism.

In relation to security of supply, by providing TSOs with additional balancing options, there should be no significant effect. It would be for individual TSOs to assess the risk associated with reliance on international balancing resources for the provision of incremental balancing energy, and to structure their reserve holdings appropriately. In particular, the TSOs would clearly need to take a view of the likely availability in real time of interconnector capacity. They may also take a view of the likely impact on the availability of balancing resources in the event of correlated shocks across systems. Despite the need for such judgements, the TSOs would potentially have in their control a wider set of balancing resources on which to call, and hence security of supply should be at least unchanged and potentially improved.

Greater scope for international balancing interactions may also lead indirectly to an increase in security of supply by increasing communication and collaboration among TSOs, and by making the judgements on the risk associated with particular resources more transparent.

That said, there are a number of key issues with the model as described in the previous chapter:

- **Value accrues to TSO:** the regime involves the TSOs of the interconnected systems trading with each other (albeit reflecting bids from participants) rather than participants trading directly with the TSOs – this has a number of implications:
 - *Fewer opportunities for the exchange of balancing energy may be exploited* – to the extent that TSOs are not fully incentivised in relation to the cost of balancing (and hence do not benefit fully from the value of optimizing the use of balancing resources) they may identify fewer opportunities for exchange of balancing energy than if participants were permitted to bid directly to the relevant TSO; and
 - *Indirect route for benefits to accrue to network users* – TSOs will incur a lower cost to balance the system – the extent to which this benefit is passed back to market participants will depend on the regulatory regime and the robustness of regulatory oversight.

Assessment and recommendations

- **Impact of lack of separation:** where TSOs remain in common ownership with competitive businesses and there is a belief that the extent of management separation between these businesses and the network operation is insufficient, then the fact that bids for the provision of balancing energy have to be passed through the TSO to be utilized internationally (rather than participants being able to bid directly to international TSOs to provide balancing capability) may be perceived to make this generic model unattractive. However, it is unclear why there should be incremental concerns in relation to this aspect of the model, as they have to balance their national network, and regulatory oversight would be required to ensure efficiencies in national balancing were fully passed through to consumers – the model would not appear to create incremental regulatory issues;
- **Operation with multiple borders:** the arrangements are not as effective as a single integrated balancing mechanism in a system with multiple borders. Consider a System Operator in Country A which has borders with countries B and C. The System Operator in A can collect balancing bids from resources within its system – however, for any one of the bids it has available, it would have a decision to make, based on a forecast of system conditions, as to whether to pass the bid through to the System Operator in country B or C. It could pass them through to both B and C – however, once the bid had been accepted in one of these countries, it would have to be withdrawn from the other – the resulting instability of availability of balancing resource may create problems for the System Operators (as they would have an unstable set of bids against which they were trying to optimize balancing activities)²⁵.

5.3.2 Key issues with generic model 2: integrated balancing arrangements

Of the three models, model 2 is the closest to a single set of balancing arrangements operated by a single System Operator. It allows participants to submit a single bid which can, in theory, be used by any of the operators.

The integration of the control area covered by the integrated balancing arrangements is not a prerequisite of the model – it could operate within systems where there remains a programmed interconnector flow. Although, given the degree of co-ordination required by the TSOs in calling off international balancing resources under this model, operation without integrated balancing arrangements would seem unlikely for anything longer than a transition period.

However, within a European context, there are a number of issues with model 2:

- **Requirement for close real time co-operation:** the actual operation of the arrangements hinges on close real time co-operation between System Operators – for example, to ensure that there is clarity as to who is taking

²⁵ It is worth noting that this multilateral problem is an extension of a problem that would exist in a bilateral SO-SO relationship – namely that both SOs may be contemplating utilising balancing energy from the same resource at the same time. However, in the bilateral arrangement, at least both parties are aware of this risk, which may not be the case in a multilateral situation.

balancing actions and when, so that there are no co-ordination issues (e.g. an over-reaction to a balancing requirement because more than one operator took a corrective action). This co-operation is also required in order to understand different plant dynamics, internalise different balancing product definitions, select appropriate resources, manage internal country constraints etc. It is via real time co-operation on these issues (i.e. frequent sharing of information and telephone communication between operators) that the arrangements function effectively without formal merger of the System Operators. Co-operation on this level is achievable in the Nordic area – however, whether it would be generally achievable elsewhere in Europe is more questionable;

- **Time and cost to implement:** the integration of the balancing arrangements is likely to be relatively costly to implement in terms of commercial arrangements, IT systems etc (certainly relative to model 1). In addition, the generic model requires harmonization of a number of aspects of national market design which would have a cost in relation to negotiation and implementation.

In terms of operation within countries with multiple control areas, since this model approximates to a single balancing mechanism (albeit with multiple TSOs responsible for calling energy), there should not be any issues.

In terms of security of supply, without integration of control areas, as this model should (as with model 1) result in an unambiguous increase in the options available to the System Operators, there should be no detrimental impact on security of supply.

With integration of control areas, the total of reserve that would be held for the unified control area may be lower than that which would be held were the control areas separate. However, that said, through close co-ordination, the System Operators in the unified area fix the reserve level at one which they believe is appropriate – hence, there would remain the flexibility to retain a fixed level of reserve

Finally, we note that, as a result of the cost to implement and the requirement for close co-ordination of System Operators, it is unlikely that this model would be applicable across Europe, and at the boundaries of any area in which model 2 was implemented, one of the other models would be required to ensure integration with other areas.

5.3.3 Key issues with generic model 3: participant bids to multiple balancing arrangements

Relative to model 1, the key benefit of model 3 is that participants bid directly to the System Operators of neighbouring countries, rather than the bids being directed to the national balancing mechanism. This allows participants to reflect their perceptions of the value of their energy to the System Operator in question in their bids, and ensures the value of any balancing energy exchange flows directly to those providing it.

There are a number of issues with the implementation of this approach:

- the implementation of arrangements with the parallel operation of balancing mechanisms is likely to require a relatively high level of co-ordination of national energy market arrangements – and hence, where arrangements are not co-ordinated at present, would require implementation cost to harmonise. Failure to harmonise would reduce the efficiency of operation of the arrangements, as noted in relation to the German case study;
- in addition, even given harmonised balancing arrangements in the national markets, this model would imply implementation costs – for example, in linking the balancing arrangements, a process would be required by which bids to neighbouring System Operators were filtered to ensure that, in the event they were called, they did not cause congestion issues in the national system. At present, in the German system, if this is the case, it would appear that the cost is simply borne by the local TSO – however, this is not an efficient outcome, as it implies that the neighbouring TSO has taken a decision based on a price which was not fully reflective of the economic costs of calling the resource to provide balancing energy;
- similar issues arise in this model with its operation in countries with multiple borders as were noted in relation to model 1. Any given participant would need to make a decision (based only on a forecast of market conditions in each system) of the System Operator to which each resource was offered; and
- in addition, since it would imply bidding to more than one balancing system (and hence, potentially, being able to interface with more than one set of balancing arrangements and more than one IT system) this approach would result in a greater cost to market participants than either model 1 or 2.

In relation to security of supply, again as for any individual System Operator, there would be more potential sources of balancing energy available, with the option to “risk adjust” the value placed on each. Therefore, it seems to us that there is unlikely to be a detrimental impact on security of supply with this model.

5.3.4 Conclusions of assessment

Having reviewed the key advantages and disadvantages of each of the generic models described in the previous chapter, it is possible to draw a number of conclusions in relation to the appropriate way forward in Europe:

- any of the models considered above could be implemented in relation to a border or series of borders;
- while model 2 is closest to the operation of a single TSO and a single balancing mechanism, it is also likely to have the most significant implementation costs and require the greatest degree of co-operation between the parties involved. This implies that it is unlikely to be applicable in all situations. Given this, for countries neighbouring any area which has decided to adopt model 2, one of the other models would in any case be required;

- in a choice between models 1 and 3, it would appear that, provided the regulatory issues around passing bids through the System Operator can be appropriately resolved, model 1 is probably both quicker and cheaper to implement than model 3 both in terms of any “central” arrangements and for participants in the regime. Therefore model 1 may be an appropriate solution either as part of transitional arrangements, or as an enduring arrangement if there are borders where there is a perception that the benefits of intraday or balancing trade are low (or a perception that arranging significant co-operation between institutions would be difficult).

To the extent that groups of countries are moving towards a more integrated regional approach to *ex ante* arrangements (e.g. for day ahead markets, congestion management etc.) then it may be reasonable to suppose that there would be a greater likelihood that these blocks would be able to achieve the degree of co-operation required for the implementation of model 2. This could then be accompanied by interaction with neighbouring countries or blocks using a regime more akin to model 1.

Equally given that in many cases model 1 may be capable of implementation relatively quickly, a phased approach to the development of final arrangements using model 1 as a transitional step within regional blocks may be worthy of consideration. Such a phased approach may have the advantage that, under model 1, harmonisation between balancing regimes is less important – a number of differences can be internalised by the TSOs. As noted in the discussion of the Nordic area arrangements above, while lack of harmonisation under model 2 need not necessarily prevent greater integration, it is more likely to lead to gaming and inefficient outcomes.

Annexe 1: Anglo-French Interconnector

GENERAL BACKGROUND

The England & Wales and French electricity markets are linked by the Anglo-French interconnector. The interconnector is a direct current subsea link, with a technical capacity of 2000MW. It was jointly built by the Central Electricity Generating Board (CEGB) in the UK and Electricité de France (EDF). It is now jointly owned by National Grid Company (NGC) and Réseau de Transport d'Electricité (RTE), the TSOs in England & Wales and France respectively.

Open access arrangements (via a series of auctions) were introduced on the Anglo-French interconnector from 1 April 2001. Until early 2004, these arrangements allowed trading of energy across the link up to day ahead. From March 2004, arrangements to facilitate intraday trading were introduced.

GENERATION PARK

The make-up of the generation park in England & Wales and in France is depicted in Figure 13:

- While more than 50% of France's generation capacity is provided by inflexible nuclear power plants, it also has around 13% of flexible reservoir and pumped storage capacities.
- While England & Wales has a lower proportion of nuclear capacity (around 16%), it also has only 2 pumped storage sites (accounting for a around 3% of generation capacity) and limited OCGT capacity.

Other things being equal, one might assume that there would be scope for the provision of balancing energy from France to England & Wales, as the French system has more immediately flexible hydro generation capability.

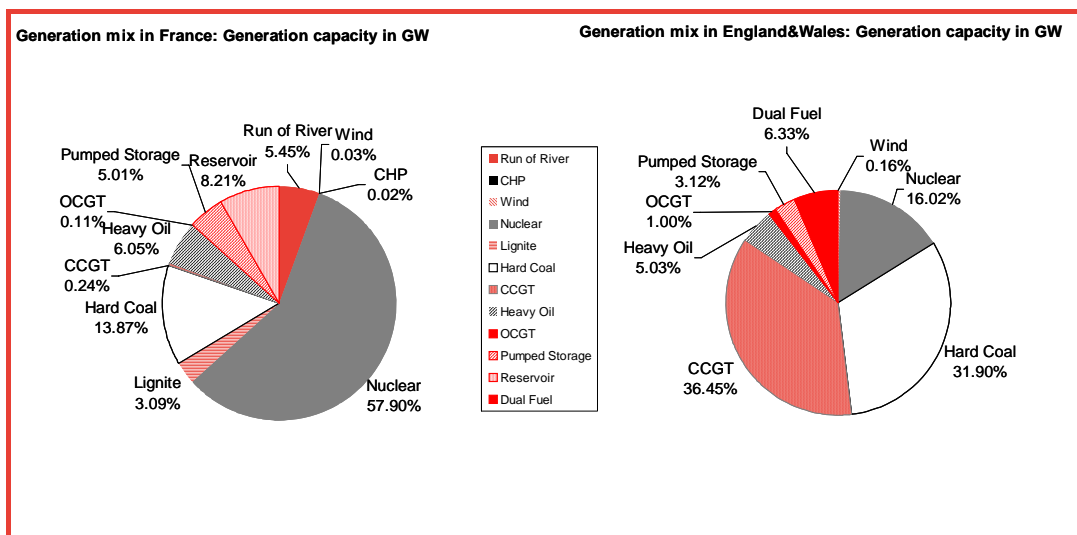


Figure 13: Generation in England & Wales and France

Source: Frontier Economics / Consentec and National Grid Transco Seven Year Statement

SUMMARY OF NATIONAL ARRANGEMENTS

England & Wales

Timescales

Figure 14 provides an overview of the timescale of the England & Wales market.

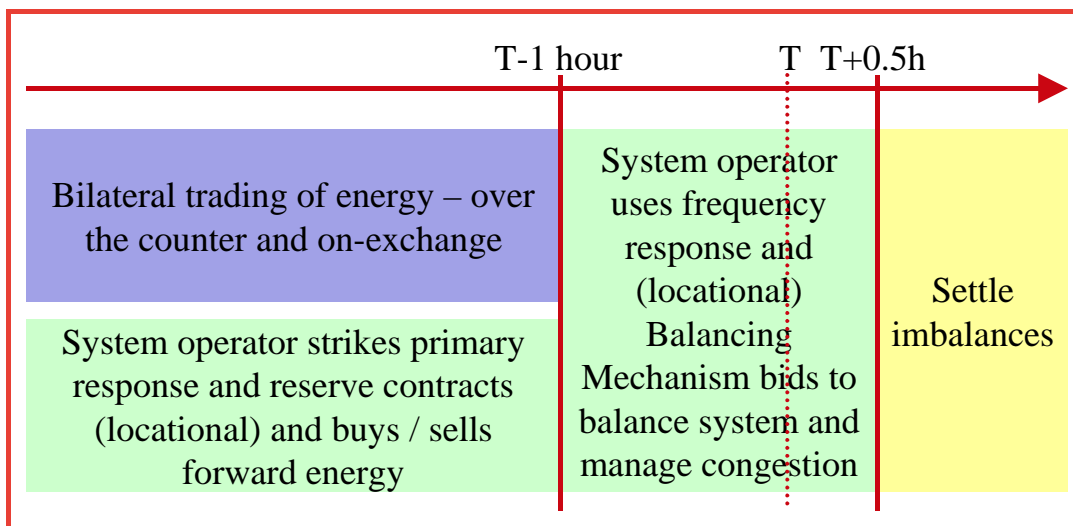


Figure 14: England & Wales market timescale

While participants are required to submit initial notifications of their intended physical production and consumption around the day ahead stage, there are no centrally organized market until an hour ahead of the relevant delivery half hour. Prior to this hour ahead stage:

- Participants trade with each other to balance their intended production and consumption; and
- The System Operator trades with participants for a range of reasons, including:
 - contracting for non-mandatory frequency response;
 - contracting for reserve – while reserve can be contracted for in the Balancing Mechanism at the hour ahead stage, *ex ante* reserve contracts allow the System Operator to gain greater certainty over the price at which reserve will be available²⁶ and to ensure that sufficient plant is available to provide reserve²⁷; and
 - managing congestion – by buying and selling locational energy.

²⁶ The contracts typically involve an “availability” payment and a “strike price” at which participants are required to make energy available through the balancing mechanism

²⁷ “Warming” contracts involve a payment to plant to warm up in preparation for production of energy provided that no energy is actually then produced. If energy is produced, revenue to cover the cost of warming is assumed to be factored in to the bids to provide that energy.

At the hour ahead stage, participants submit their final intended production and consumption schedules to the System Operator, and the formal Balancing Mechanism opens, allowing participants to submit bids for the provision of balancing energy to the System Operator. It is important to note that the Balancing Mechanism in relation to each half hour opens an hour before the start of that half hour – there is a rolling schedule of Balancing Mechanism opening times.

The System Operator then calls on participants' bids (along with primary reserve and other ancillary service contracts – for example, relating to the provision of reactive power) to balance the system.

Nature of market

The *ex ante* procurement of services required by the System Operator is typically conducted through open tenders organised by National Grid as required. The tenders are open to all generators and consumption units technically capable of providing the services required – participation is voluntary. The broad framework for the approach to tenders (rather than the detailed tender rules and process) is set out in the “Procurement Guidelines” which are subject to regulatory approval.

The Balancing Mechanism is a more formal market, with rules and procedures set out in a code which is approved by the regulator. Participation in the Balancing Mechanism is voluntary, and is open to both generators and retailers.

The regulatory arrangements incentivise the System Operator to balance the system in the most cost-efficient way possible (e.g. using the most efficient combination of *ex ante* trades and Balancing Mechanism offers).

Product definition

Participants make offers to deviate from their submitted schedules either upwards or downwards. Participants can also constrain their offers to the System Operator according to a range of dynamic parameters:

- ramp up and ramp down rates;
- notice time required to deviate from zero production;
- notice to deliver full bid volume;
- minimum time at zero / non-zero production;
- stable export / import limit; and
- maximum delivery and period.

The pricing of participants' balancing bids may be constrained by bilateral contracts with the System Operator.

Payment terms

The detailed payment terms of *ex ante* trades vary according to the service in question – for example:

- firm energy trades involve an energy price only;
- contracts to provide reserve might involve both an availability payment and a strike price for the provision of energy if required; and
- warming contracts provide a price to “warm up” which is paid if no energy is then subsequently called from the station – if energy is called, no warming payment is made.

However, all payments are pay as bid.

The payments in the Balancing Mechanism are also paid as bid. The volume of energy used to calculate the payments made is derived from the profile of the deviation from schedule which the System Operator instructs (as shown in Figure 15).

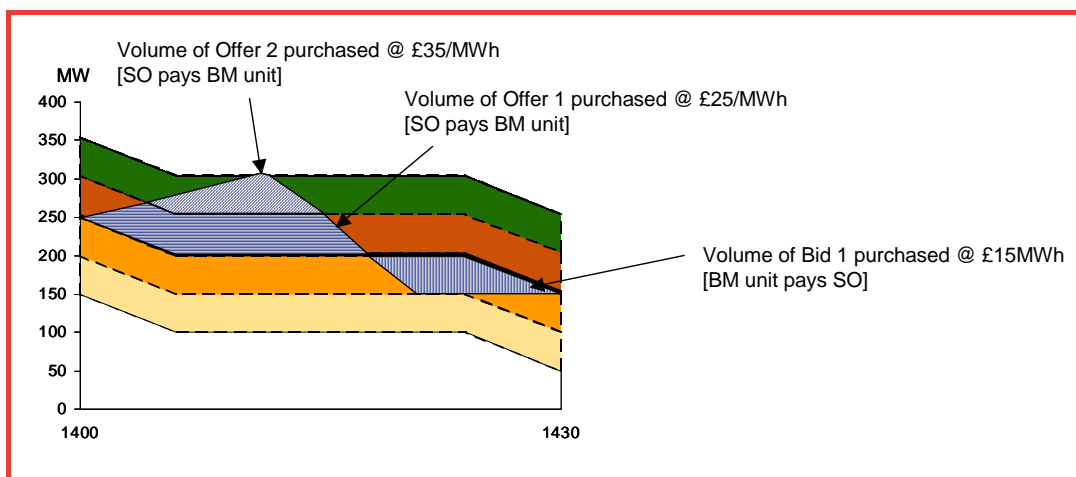


Figure 15: Balancing mechanism payment calculations

All balancing costs are recovered from all market participants through NGC's Balancing Services Use of System (BSUoS) charges (regardless of balance). In addition to this Elexon uses the costs of some of NGC's balancing actions to derive imbalance prices which are levied on participants that are out of balance.

Information availability

For the England & Wales Balancing Market, detailed information provided to the public.²⁸ This includes data on

- Liquidity of the Balancing Market - This covers up to date live information on market depth, including Offer Volume, Bid Volume, Accepted Offer Volume (AOV), Accepted Bid Volume (ABV) on a quarter hourly basis across all BM Units.
- Market Activity – Data on actual bids from individual BM units and details of accepted bids, with the length of period for which they were used.

²⁸ See www.bmreports.com.

- Expected demand - Demand forecasts from same day and day ahead up to 52 weeks ahead. The day-ahead values are also available with a differentiation by demand zone.
- Scarcity – Data on the margin between maximum power exports from BM units and the National demand forecast by NGC, and on expected imbalance, both up to day-ahead (the day-ahead values are also available with a differentiation by demand zone).
- Demand outcomes – Initial Demand Outturn in MW on a quarter hourly basis (in MW), released 15 min after the settlement of the period in question.
- Price outcomes – Historical data on system buy prices and the system sell prices on a quarter-hourly basis (in £/MWh).
- Balancing adjustment data - This includes detailed data on adjustments to system buy prices and system sell prices to take into account, among other things, the cost of *ex ante* trades by the System Operator, balancing actions taken for congestion reasons etc.. Only the cost of energy balancing trades are used in setting imbalance prices. The costs of congestion related forward trades for example would not feature (although the volumes do affect the net imbalance volume).

The market outcomes of NGC's reserve tenders are documented in detail in a market report. For example, the latest report for the tender for 2004/5 sets out:

- all price bids received during the tender, with the availability price (in £/MW/h) and the utilisation price (in £/MWh), on an anonymised basis;
- information given about the overall MW standing reserve contracted, with a breakdown availability by season and by indicating, whether the bids have been accepted by a BM or non BM unit; and
- a breakdown of cost for standing reserve utilisation and capacity for the previous year (here: 2003-04) by month, with the number of the total calls and the average amount called per standing reserve call.

France

Timescales

Figure 9 provides an overview of the timescales of the French market and balancing arrangements. Unlike those in England & Wales, they are not based on a fully rolling Gate Closure, but rather schedules and balancing bids are submitted for the remainder of the day of delivery at a number of gate closures through the day.

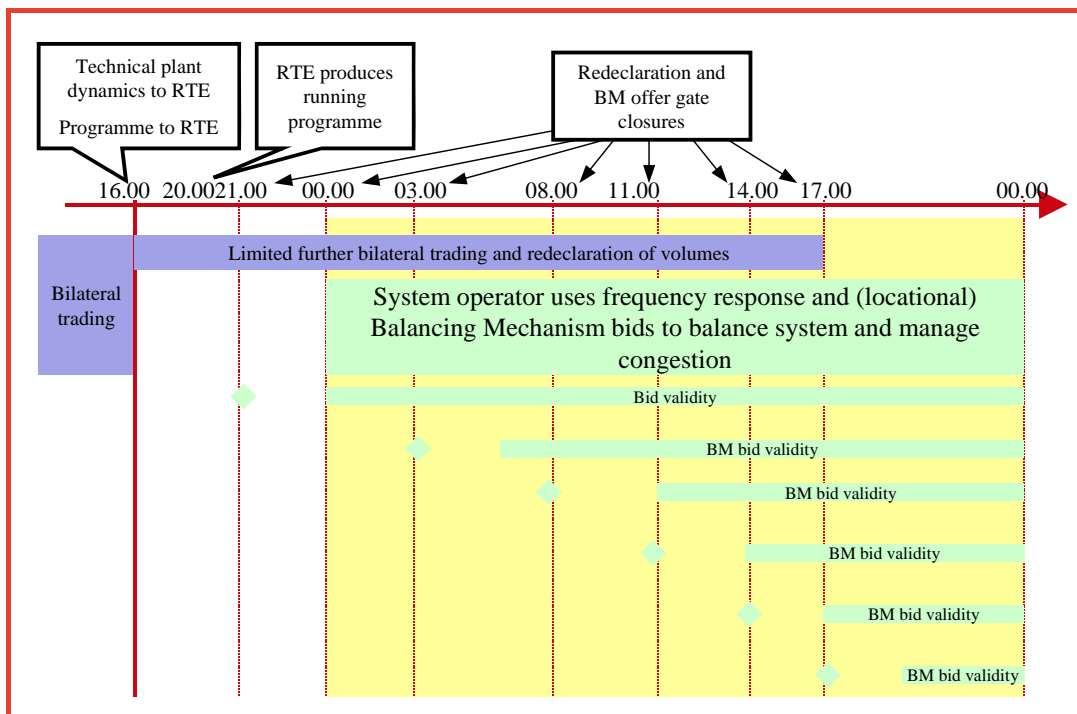


Figure 16: French market timescales

As in England & Wales, there is full over-the-counter and on exchange bilateral trading ahead of the day. Participants are required to submit an indicative schedule of their planned output and consumption at around midday day ahead, and are required to submit a final schedule at 16.00 on D-1. At this point in time they submit a schedule for each half hour of the relevant day of delivery.

Equally, they are required to submit a range of information on the technical characteristics of their plant – for example, they are required to submit information on availability for primary and secondary regulation, start-up and shutdown times, hydrological constraints (where relevant), notice required to synchronise etc. Again, this information is intended to be valid for the whole day.

Finally, they also submit their initial offers of balancing energy.

Based on the submitted schedules and the balancing offers of all participants, RTE calculates a feasible set of schedules for all participants (again for the whole of D). This schedule is published to participants at 20.00 on D-1.

However, this is not the end of all bilateral trading in relation to the delivery day. Following this 16.00 nomination and 20.00 schedule publication, there are a number of further chances for participants to redeclare their production and consumption schedules. The redeclarations must be submitted by defined Gate Closures through D-1 and D, and are all subject to a neutralization time (i.e. a redeclaration submitted at 08.00 can only include volume changes applying from 11.00).

However, the nature of the redeclarations is constrained – for example:

- participants are limited in the number of times they can redeclare in respect of any given day, and in the absolute volumetric change which can be made in a redeclaration;
- participants' redeclarations must always be consistent with the technical plant dynamic constraints notified to RTE on D-1; and
- participants must not, in the redeclarations, countermand balancing actions taken by RTE.

If a redeclaration breaches one of the constraints set down in the market rules, then the acceptance of the redeclaration is at RTE's discretion.

As a result of these constraints, bilateral trading after the 16.00 D-1 nomination is essentially limited to "fine tuning" of positions.

Participants are also permitted to resubmit balancing offers through the day – with the same timings as for schedule redeclarations.

RTE also have contracts for the provision of balancing energy outside this formal mechanism. They have a (regulated) bilateral contract with EDF under which they agree a volume of energy which will be made available within the balancing mechanism on a 15 and 30 minute lead time (1000MW and 500MW respectively). There is no constraint on the price at which this volume of energy is made available through the mechanism²⁹. The payment to EDF under this contract is recovered from balance responsible entities.

The intention is that in due course, this contract will be put out to formal tender.

Primary and secondary reserve are provided under mandatory requirements in connection contracts – remuneration of these service is broadly cost-reflective.

Nature of market

The Balancing Mechanism (mécanisme d'ajustement) is a formal market, with rules and procedures set out in a code overseen by the regulator. It allows participants to make offers to the System Operator to deviate from their submitted schedules either upwards or downwards. Participants can also constrain their offers to the System Operator according to a range of dynamic parameters (described further below). Participation in the Balancing Mechanism is voluntary, and open to both generation and load.

Product definition

Balancing mechanism bids have a variety of technical parameters associated with them in addition to the technical constraints for production or consumption sources submitted at D-1. For example, for a generation resource, bids may indicate:

²⁹ Although there is scope for an enquiry into pricing for any bid of higher than €150/MWh.

- maximum available power;
- technical minimum power;
- usage period of balancing offers (maximum usage for hydro resource, minimum usage for thermal); and
- lead time for provision of balancing.

Balancing offers across interconnections may also indicate limitations to their offers, including similar factors:

- minimum and maximum usage period;
- minimum and maximum power offered; and
- maximum number of activations.

The balancing mechanism is locational – therefore, balancing mechanism offers can be used for a range of purposes:

- ensuring overall system balance (“P=C” actions);
- managing congestion; and
- reconstituting reserve.

Payment terms

As in the England & Wales balancing mechanism, participants are usually paid as bid. There are exceptions to this – for example, where the system operator utilizes resources above their specified maximum energy constraint, in which case the payment includes both an element of bid price and marginal price.

The rules of the mécanisme d’ajustement ensure that RTE is financially neutral in relation to imbalances and the procurement of balancing energy.

Information availability

The rules which set out how the balancing mechanism will operate also define the information which is required to be made public in relation to balancing activity. This list is set out in Table 3

No.	Public indicator	Publication
1	Required Reserve and forecast reserve at peaks, calculated on D-1 on the basis of Offers Submitted	On D-1
2	Balancing Trend (Upward, Downward or zero) per Half-Hourly Period	On D (provisional) On D+3 worked (for invoicing)
3	Highest price (in Euros/MWh) of Upward	On D (provisional)

No.	Public indicator	Publication
	Balancing Offers Activated for balancing the electrical system per Half-Hourly Period	On D+3 worked (for invoicing)
4	Average Weighted Price (in Euros/MWh) of Upward Balancing Offers Activated per Half-Hourly Period	On D (provisional) On D+3 worked (for invoicing)
5	Lowest price (in Euros/MWh) of Downward Balancing Offers Activated for balancing the electrical system per Half-Hourly Period	On D (provisional) On D+3 worked (for invoicing)
6	Average Weighted Price (in Euros/MWh) of Downward Balancing Offers Activated per Half-Hourly Period	On D (provisional) On D+3 worked (for invoicing)
7	Volume of upward energy Activated (in MWh) for balancing the electrical system between each Gate Closure	On D (provisional) On D+3 worked (for invoicing)
8	Volume of downward energy Activated (in MWh) for balancing the electrical system between each Gate Closure	On D (provisional) On D+3 worked (for invoicing)
9	Total volume of upward energy Activated for the entire day (in MWh) for balancing the electrical system	On D+1 (provisional) On D+3 worked (for invoicing)
10	Total volume of downward energy Activated for the entire day (in MWh) for balancing the electrical system	On D+1 (provisional) On D+3 worked (for invoicing)
11	Volume of upward energy Activated (in MWh) for Congestion between each Gate Closure	On D (provisional) On D+3 worked (for invoicing)
12	Volume of downward energy Activated (in MWh) for Congestion between each Gate Closure	On D (provisional) On D+3 worked (for invoicing)
13	Volume of upward energy Activated (in MWh) for reconstituting system services between each Gate Closure	On D (provisional) On D+3 worked (for invoicing)

No.	Public indicator	Publication
14	Volume of downward energy Activated (in MWh) for reconstituting system services between each Gate Closure	On D (provisional) On D+3 worked (for invoicing)
15	Volume of upward energy Activated (in MWh) for reconstituting reserves between each Gate Closure	On D (provisional) On D+3 worked (for invoicing)
16	Volume of downward energy Activated (in MWh) for reconstituting reserves between each Gate Closure	On D (provisional) On D+3 worked (for invoicing)
17	Price of negative Imbalances per Half-Hourly Period On D (provisional)	On D+3 worked (for invoicing)
18	Price of positive Imbalances per Half-Hourly Period On D (provisional)	On D+3 worked (for invoicing)
19	Price/volume curve for Upward Offers with Mobilisation Leadtime <2 Hours received by RTE for each of the 2 consumption peaks on Day D	On D

Table 3: Public indicators in relation to French balancing mechanism

Source: RTE

INTERNATIONAL INTERACTION

Historically, the interconnector transfer on the Anglo-French interconnector was stable in the France to England direction. As the arrangements have opened to third party access and as the fundamental supply and demand position in each market has evolved, the transfer has become more volatile – this is shown in Figure 17. As a result, the interconnector is no longer consistently fully loaded and it is now more suited to accommodating balancing transfers in either direction.

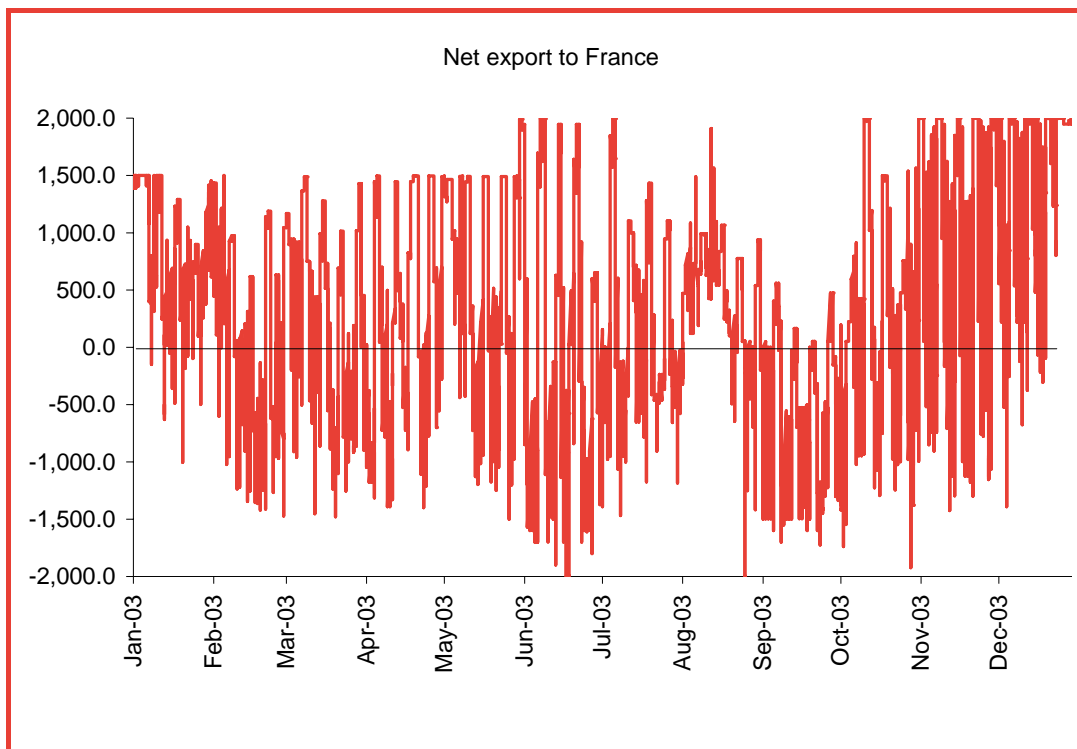


Figure 17: Anglo-French interconnector exports

Source: Frontier Economics / Consentec

Before gate closure in either system

Having purchased interconnector capacity rights in any of the annual, seasonal, quarterly, monthly, or daily products, interconnector users (IUs) are required to make a “Mid-Channel Nomination” (MCN) indicating their intended interconnector usage at 13.00 on the day ahead. For this nomination, IUs are free to nominate use up to their holding of capacity rights. It is these MCNs which NGC and RTE use to develop their daily operational plan (along with forecasts and initial submissions as to participants national production and consumption).

Prior to gate closure in either market, participants are still free to trade energy internationally between each other. However, their ability to deliver on these energy trades clearly depends on their ability to adjust their MCNs.

Renominations are possible after the submission of day-ahead MCNs. However, these renominations are not guaranteed to be accepted – in broad terms, they are accepted provided that the change in interconnector flow does not cause a change in the national operational plans (for example, if an operator had, on the basis of MCNs, planned a certain pattern of maintenance, or taken actions to relieve anticipated within-system congestion, a renomination which would materially change their ability to follow this operational plan may not be accommodated). Guidelines are published (on RTE’s website) indicating the likely constraints on renomination.

If more than one request for renomination is submitted but cannot be accommodated, all the requests are scaled back until they are feasible. However, since there is no fixed time for renominations, there can be an element of first-come, first-served in accommodating changes.

Hence, in the period prior to Gate Closure in either system, the main limit on the extent of participants' international trading is operational, i.e. the TSOs' need to maintain security of their respective networks..

After French gate closure

The submission of MCNs is currently required at 2pm CET day ahead. Following the first French gate closure, participants in the England & Wales market who have unused capacity on the interconnector have two trading options:

- Bilateral trading, provided they are confident that they will be able to get the interconnector operators to agree to a redeclaration of their MCN and get RTE to agree to a redeclaration of their French schedule – the last opportunity for such trading is set by the time of the last such opportunity for redeclaration (17.00 on the day of delivery); and
- Bidding to the French mécanisme d'ajustement.

Participants having submitted their MCN can submit bids to the mécanisme d'ajustement at the D-1 Gate Closure (i.e. the gate closure at 8pm day ahead, for which bids are valid from midnight on the day). In order to avoid the risk of having their bid to the French mechanism called following a rolling Gate Closure for the relevant period in the England & Wales market, the bid to the French mechanism would have to indicate a notice time of more than one hour.

As noted above, changes to MCNs should be accepted by the operators provided they do not cause operational issues.

Following this 8pm Gate Closure, interconnector users are not able to participate further in the mécanisme d'ajustement. RTE told us that this was because offers from IFA users would rarely fit RTE's balancing needs as a result of the gaps of 3 hours between nomination and provision.

RTE are planning to extent the arrangements in France to incorporate 12 gate closures, implying a shorter time period between nomination and provision. Having done this, they plan to allow nominations into the mécanisme d'ajustement from interconnector participants during the day (rather than day ahead) – NGC and RTE are working on this development.

After gate closure in both systems

After gate closure in both systems, there is no direct participation of international resources in national balancing arrangements – all international trading is conducted through System Operator to System Operator trades, under a contract between NGC and RTE.

Contracts have existed between the two System Operators since the commissioning of the link in 1986. However, until 2003, their use was restricted to allowing programmed interconnector energy exchanges to be amended:

- to assist under emergency conditions; and
- to resolve national congestion issues.

After 2003, the arrangements were amended to allow the exchange to be amended for energy balancing reasons in either system. The arrangements in this area have evolved gradually since 2003.

Below we consider:

- operational detail of SO-SO arrangements; and
- pricing and commercial issues.

Operational arrangements

Around 6 hours before their entry into force, NGC and RTE agree prices for the exchange of balancing energy between them over the interconnector. Recently, NGC and RTE have started to make these prices available to all participants (for example, they are published on the England & Wales Balancing Mechanism Reporting website³⁰). At present, one set of prices holds for an entire day.

There is no specific volume limit on the balancing energy available at this price, just the remaining capacity of the interconnector and any operational constraints. There are potentially dynamic constraints which apply to the provision of balancing energy, which can arise both from the operation of the interconnector itself and also from wider system conditions..

However, as noted the availability of the international balancing resource is constrained by:

- **the volume of residual capacity available on the interconnection:** no capacity is reserved *ex ante* for balancing purposes – the balancing capability is only available to the extent that IUs are not making full use of the interconnector capacity; and
- **conditions on the other system:** provision of balancing energy can be withdrawn by either System Operator at any time. This condition allows the operators to put the system security of their own network above the provision of international balancing resource.

This uncertainty surrounding the availability of the balancing energy resource does impact on the way in which the System Operators consider the resource in their overall reserve planning. For example, while National Grid Company in England & Wales would include a volume of potential balancing resource over the interconnector in longer term reserve (e.g. reserve held at the day ahead stage to cover the potential loss of a unit on the system), they would not typically

³⁰ www.bmreports.com

consider it part of their short term operational reserve held to cover system events near to and during real time.

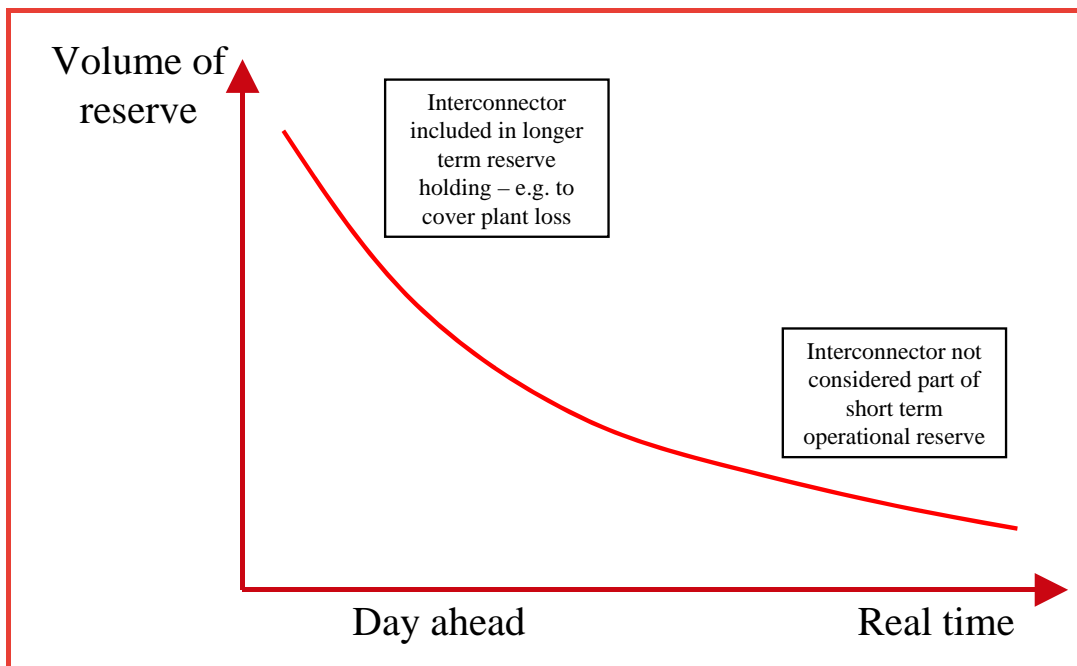


Figure 18: Illustrative use of interconnector in reserve holding

Source: Frontier Economics / Consentec

In contrast, RTE do consider the balancing services contract with NGC as part of their reserve (unless NGC have already declared the service unavailable). The exception to this is when the interconnector is flowing more than 1500MW into France – in this situation, the extent of reserve assumed to be provided by the interconnector is reduced.

Pricing and commercial issues

In deriving prices to offer to the counterparty System Operator across the interconnector, two basic principles could be adopted:

- **cost based bids:** estimate the likely cost of providing balancing energy from available resources on the national system (involving taking a view as to plant nationally available, the volume and pricing of reserve held, the likely level of balancing offers from national plant etc.) and provide a bid based on this estimated cost; or
- **value based bids:** estimate the likely level of balancing energy prices from the other System Operator's national resources (involving taking a view as to the likely "tightness" of their system) and providing a bid which is believe to be competitive with these estimated balancing prices given the dynamic capabilities of the interconnector.

Under the first approach, the value of the international balancing energy accrues to the System Operator calling the energy (they avoid having to take more expensive balancing power from national resources). Under the second

approach, the value largely accrues to the System Operator providing the energy from their national resources.

Certainly in NGC's case, as a result of the incentivisation in relation to balancing costs, there is a short term financial incentive to provide value based bids, as this would allow them to share the value of the international balancing energy with participants. However, this would change the nature of the original relationship with RTE potentially adverse consequences.

In RTE's case, the incentive could be lower, as the rules of the mécanisme d'ajustement leave them financially neutral (through the operation of the "balance operations imbalance management account").³¹

In reality, it seems likely that the approach adopted across the interconnector by the respective parties is a mixture of these two approaches over time. Other things being equal, if both parties are to share the benefits of the ability to exchange balancing energy on broadly equal terms, one might therefore expect RTE's bids to be closer to value based and NGC's bids to be closer to cost based.

HISTORICAL INFORMATION ON PRICES AND VOLUMES

Bid and offer prices under the contract between the two System Operators have only been made public recently. However, in both systems, the day ahead market price determines one of the system sell and buy prices, with the other being set by a function based on the weighted average of balancing actions³². Hence, imbalance prices can be used as an (albeit imperfect) proxy for energy balancing costs.

Figure 19 shows the development of imbalance settlement prices in France and England & Wales.

System Buy Prices in England & Wales and France appear to be more closely related from early 2004 onwards – this is consistent with the implementation of improved intraday arrangements for trading over the interconnector (March 2004). However, we note that prior to 2004, it would appear that the French SBP was higher than that in E&W, implying an advantage to RTE in calling on E&W balancing resource – this is not the direction in which we understand the majority of balancing actions have been.

In contrast to the System Buy Price, the System Sell price in France has, since early 2004, been persistently below that in E&W. This would imply it would be beneficial for NGC to call on RTE for downward balancing (as they should pay less to RTE than to national generators). However, we note that RTE appears to submit a bid price of zero to NGC, making such a trade unattractive.

³¹ Essentially, if a financial surplus accrues to RTE, the spread between long and short imbalance price is adjusted to pass this surplus back to participants.

³² If the system is overall short (requiring upward balancing), it is the system sell price that is relatively benign and set by the day ahead market, with the system buy price being set by some form of average of balancing actions.

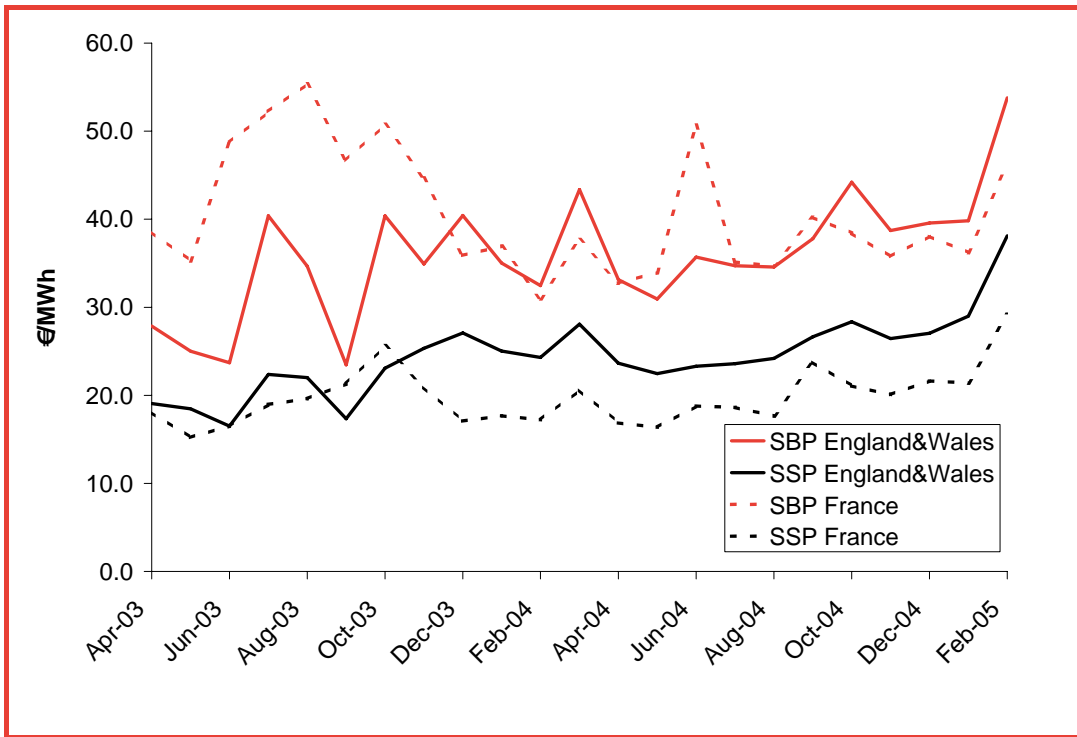


Figure 19: Monthly average imbalance prices England & Wales vs. France

Source: Frontier Economics / Consentec based on RTE and Elexon data

The monthly averages in Figure 19 mask a seemingly persistent hourly relationship.

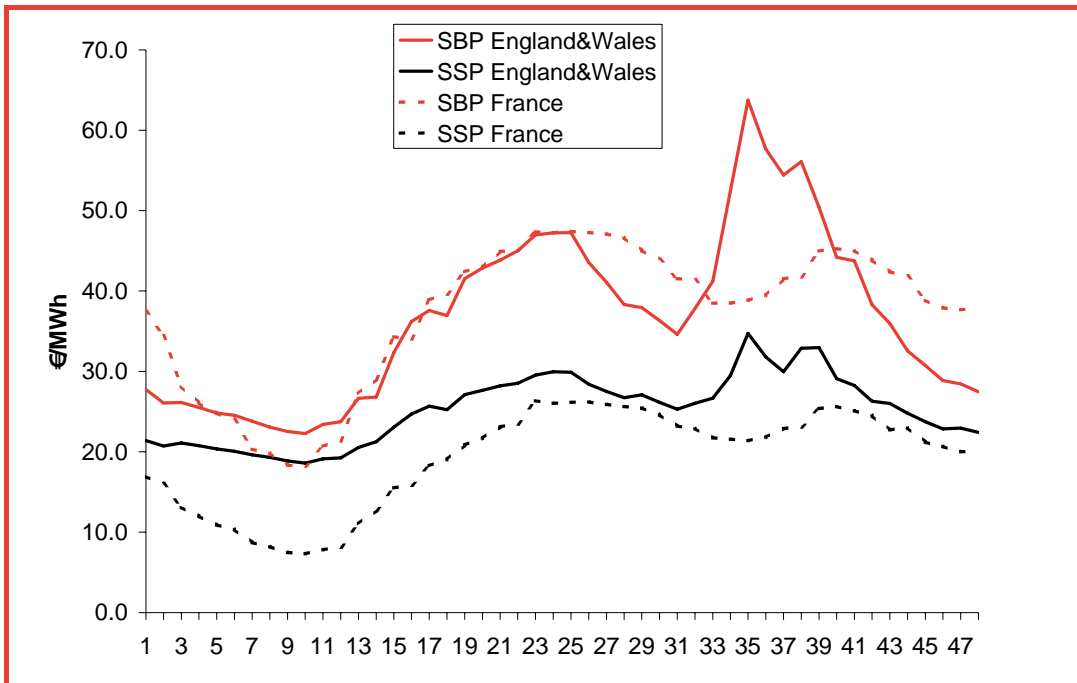


Figure 20: Average half hourly imbalance prices England & Wales vs. France, 2004

Source: Frontier Economics / Consentec based on RTE and Elexon data

Annexe 1: Anglo-French Interconnector

While for the majority of the day the System Buy Prices seem to track each other closely, it appears that the E&W price is greater than the French price early in the morning and in the early to mid evening. This would imply a benefit to within day price differentiation in the System Operator to System Operator contract. As noted above, however, prices are currently set on a daily granularity.

Table 4 provides details of the bid and offer prices under the balancing contract between the two operators for a sample number of days recently. During these days, both systems experienced some cold weather, and on the England & Wales system, on 28th February and then again on 2nd March, NGC issued “Notifications of Insufficient Margin” (NISMs) which were still in force at the time interconnector prices were published. The NISM in respect of 3rd March indicated a significant margin shortfall of 2200MW.

Date of price validity	RTE bids and offers (£/MWh)		NGC bids and offers (£/MWh)	
	Offer	Bid	Offer	Bid
25 Feb 2005	87.83	0.00	89.03	26.92
26 Feb 2005	70.04	0.00	56.75	22.82
27 Feb 2005	71.31	0.00	53.12	23.53
28 Feb 2005	112.19	0.00	111.72	26.94
1 Mar 2005	113.09	0.00	126.21	28.25
2 Mar 2005	113.71	0.00	131.28	34.09
3 Mar 2005	151.84	0.00	172.19	35.90

Table 4: Sample bid and offer prices

Source: Elexon

Figure 21 compares this bid data to imbalance prices for the days in question (as a loose proxy for the cost of balancing energy from national resources). The RTE offer price tracks the French System Buy Price closely, whereas on the day of the first NISM, the NGC offer price increased significantly relative to the outturn track of England & Wales System Buy Prices (perhaps indicating an expectation on the part of NGC that the system would be tighter than it turned out to be).

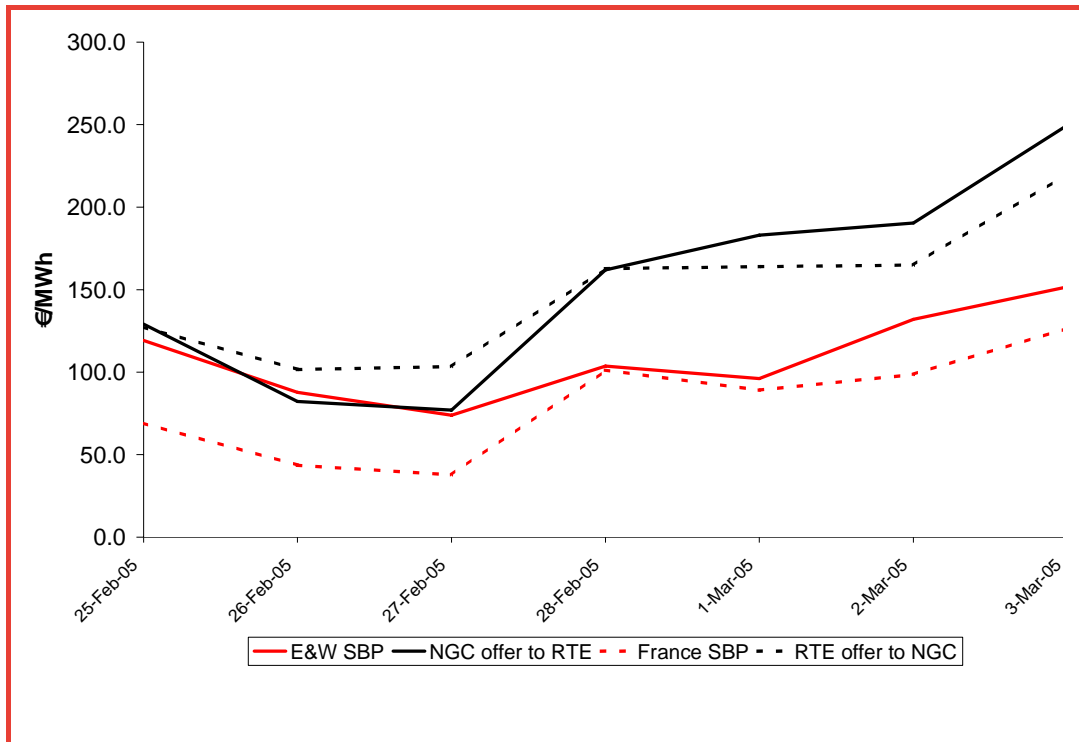


Figure 21: Comparison of bid/offer prices to imbalance prices

Source: Frontier Economics / Consentec based on data from Elexon

Annexe 2: Nordic common balancing arrangements

GENERAL BACKGROUND

The Nordic countries (here we consider specifically Norway, Sweden, Finland and Denmark) are interconnected in various ways:

- Norway, Sweden, Finland and East Denmark are synchronously connected with alternating current transmission lines;
- A number of direct current lines connect:
 - Sweden and Finland (in addition to the AC links);
 - Sweden and Poland;
 - Sweden and Germany;
 - East Denmark and Germany;
 - Sweden and West Denmark; and
 - Norway and West Denmark.

The synchronous part of the Nordic system is connected to the UCTE system via the direct current links to West Denmark.

A detailed map of the full Nordic system and its neighbours is shown in Figure 22.

Up to 2002, while there were common arrangements for *ex ante* trade of electricity through NordPool's Elspot market, there was limited but growing co-ordination of balancing. Once schedules (and resulting programmed transfers between countries) had been determined, the individual TSOs in the synchronous area balanced their systems to the agreed transfers (as is currently the practice in the UCTE area). The system with the largest transfer error was required to regulate to return the transfer to programme. Although in some cases different arrangements were agreed between TSOs when these were beneficial.

The TSOs recognized that this approach frequently resulted in one system utilizing upward regulation while another system required downward regulation. As a result, steps were taken to integrate balancing areas (to capture the benefits of offsetting imbalances across a larger control area) and to integrate commercial balancing mechanisms. Since September 2002, balancing has been integrated across the synchronous part of the Nordic area.

It is important to note that, while the arrangements have been integrated, this did not involve harmonizing all of the national balancing arrangements. Significant differences remain.



Figure 22: Nordic network map

GENERATION PARK

The breakdown of installed capacity by fuel type in each of the Nordic countries is set out in Table 5.

Fuel type	Denmark	Finland	Norway	Sweden
Total installed capacity (MW)	12,830	16,893	28,081	33,361
Hydro	11	2,978	27,676	16,143
Nuclear	0	2,640	0	9,441
Other thermal power	9,704	11,225	305	7,378
Condensing power	0	3,852	73	2,108
CHP district heating	8,978	3,665	12	2,572
CHP industry	456	2,830	185	979
Gas, others	270	878	35	1,719
Wind	3,115	50	100	399

Table 5: Installed capacity in Nordic countries as of Dec. 2003

Source: Nordel annual statistics 2003

The fuel mix in Norway is almost entirely hydro based (99% of installed capacity). Diversity is also limited in Denmark – 94% of capacity is provided by a mixture of CHP district heating and wind power. The mix in Sweden and Finland (shown graphically in Figure 23) is more diverse – however, both countries still have significant hydro resource.

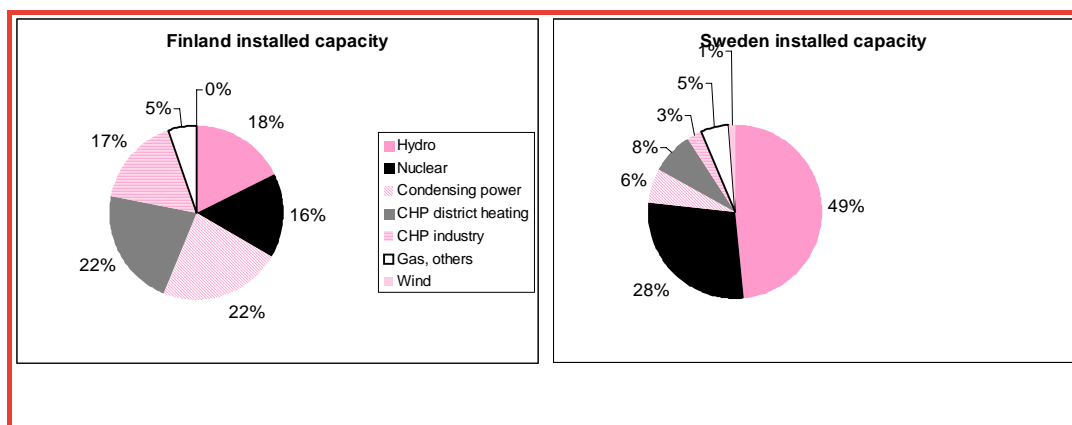


Figure 23: Plant mix in Sweden and Finland

Source: Nordel

Other things being equal, the generation mix of the Nordic area would imply a significant benefit to the hydro capability within Norway and Sweden being shared more widely, particularly with Denmark where there is a lot of inflexible CHP capacity.

SUMMARY OF NATIONAL ARRANGEMENTS

Timescales

While a number of the aspects of the Nordic market arrangements have a common timescale (for example, participation in and timing of the NordPool ElSpot day ahead arrangements), there are differences in the timing of:

- submission of initial notifications to the TSOs of intended production / consumption;
- submission of bids for the provision of balancing energy; and
- submission of final notification of intended production / consumption.

A high level overview of the market timescales across the Nordic countries is provided in Figure 10.

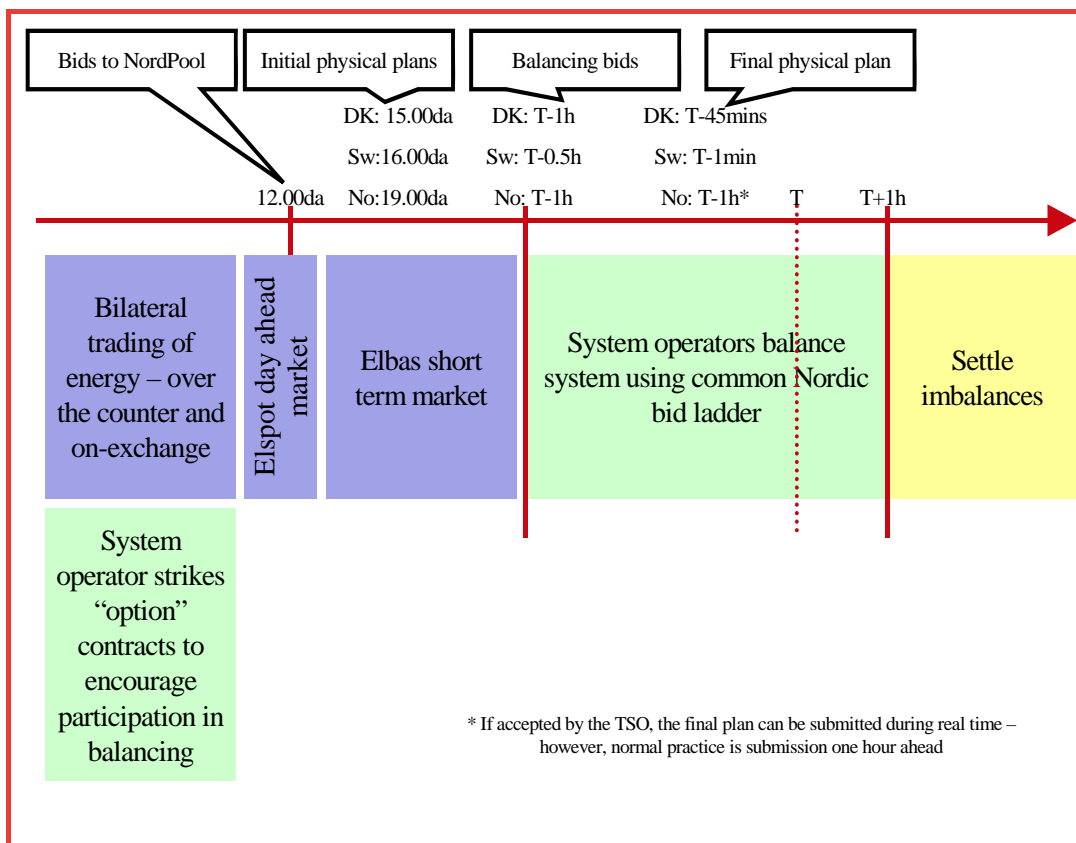


Figure 24: Nordic market timescales

Source: Information from Nordic TSOs

Prior to day ahead, participants trade with each other bilaterally, or on NordPool's forward market (Eltermin).

In Norway, Sweden and Denmark, the TSOs may also contract for participation in the market for balancing power in Norway and Sweden in winter months and in Denmark for the whole year. All of the TSOs contract *ex ante* for primary response (we return to this below).

Annexe 2: Nordic common balancing arrangements

At 9.30 day ahead, the TSOs provide NordPool with information on the interconnection capacity they expect to be available. Then at 12.00 day ahead, participants submit bids to NordPool, which then clears the day ahead market ensuring that prices are set to ensure interconnection constraints are not breached.

Subsequently, participants outside Norway³³ and Western Denmark can trade on NordPool's short term (Elbas) market. Trading on this market can be both within price zone and between price zones (using any capacity which was not utilized by bids accepted in the Elspot market)³⁴

At a time which varies by system from 26 hours ahead of the start of delivery to half an hour ahead, participants submit bids to their local TSO for the provision of balancing energy. They submit their final physical production and consumption plans again at a range of times, from an hour ahead in Norway (based on normal practice) to one minute ahead in Sweden.

This means that the System Operators get a gradually emerging picture of the planned production and consumption schedules over the Nordic area, on which to base their balancing actions.

Nature of market

Unless option contracts have been entered into, the market for balancing energy is voluntary in all countries. Bids are submitted by generation and demand to the local TSO.

In Norway and Denmark, as noted above, *ex ante* contracts are struck to encourage participation in balancing. In Norway the TSO strikes so-called "option" contracts. However, these contracts are not standard options, since they do not require the counterparty to offer power at a specific price level in the market for balancing services. Rather, they simply involve a payment to the counterparty for their participation in the balancing market³⁵ – the price at which energy is provided is left up to the counterparty.

In all countries, primary response is procured under contracts with both an availability and utilization price. In Norway, this service is in addition to mandatory requirements – and also in addition to provision through the market for balancing power in summer. In Sweden and Finland, the TSOs also own some gas turbine capacity used for tertiary regulation.

The cost of procuring balancing energy is recovered in different ways across the systems. For example, revenue from imbalance settlement charges finances some

³³ As a result of the predominance of hydro power in Norway, and as a result of the cheaper imbalance prices resulting from the single imbalance price, the Elbas market does not operate in Norway (at least at present).

³⁴ Since Elbas is a continuously traded market, this implies that participants in different locations see different versions of the Elbas trading screen – bids and offers which cannot be accommodated on the transmission system are blocked from view.

³⁵ The TSOs have the right to check that the participant is available to provide balancing energy once they have signed a contract.

components of reserve in the Swedish system, whereas the one price nature of imbalance settlement in Norway means that no contribution to reserve costs is made.

In Norway, Sweden and Finland, the TSOs have at their disposal an alternative to using the formal balancing arrangements – they can instruct parties to bring forward or put back changes to their production or consumption schedules by quarter of an hour (the settlement period is one hour). A fixed price is paid for this service.

Product definition

Dynamic information is not provided by participants as part of the bid for balancing energy. Plant which is instructed through the balancing market is subject to differing requirements in relation to the time to provide energy across countries:

- **Norway:** technically, regulating power is required to be available within 15 minutes of notification by the TSO. However, in practice, as a result of the substantial hydro capacity, in most situations the power is available in much shorter timescales;
- **Sweden:** regulating power is required to be available within 5 to 10 minutes of notification by the TSO;
- **Finland:** regulating power is required to be available within 5 to 10 minutes of notification by the TSO; and
- **Denmark:** regulating power is generally required to be available within 15 minutes although some bids are subject to longer notice.

Payment terms

Provision of primary response is remunerated under bilateral contracts – these are paid as bid.

There are differences between the countries as to the payment terms for provision of balancing energy through the formal market mechanisms. In Norway, Sweden and Finland, the players are paid the equivalent of the highest or the lowest respectively of the bids accepted for the hour concerned – that is, they are paid a market clearing price which may be above their bid. In Denmark, the players are paid as bid.

There are also differences as to the payment terms for primary response. In Denmark, there are bilateral contracts – these are pay-as-bid. In Sweden, there are arrangements for weekly and hourly bids (pay-as-bid) and in Norway there is a mix of yearly payments and a weekly market (marginal price).

Information availability

Ex post, imbalance pricing and imbalance volume data are available from the TSOs. The TSOs use NordPool as the information distributor.

The TSOs provide a range of data on the current power flows across interconnections in the Nordic area, and where there are projected demand and supply mismatches.

INTERNATIONAL INTERACTION

Before gate closure in any system

Following the Elspot market, in all regions other than Norway and West Denmark, the continuously traded Elbas market operates. This market allows participants to fine tune positions, both within their own system and (to the extent that there remains unused capacity on the interconnections) between areas.

After gate closure in one or more system

Following gate closure in each system, bids for balancing power are submitted to the local TSO. However, these bids are not for exclusive use in that system – the arrangements ensure that, where physically possible, they can be used throughout the Nordic area in real time.

It is to the detail of these arrangements which we now turn.

After gate closure in all systems

The Nordic arrangements do not distinguish between “national” and “international” balancing energy provision. The control areas effectively share the balancing resources, and balancing energy is called from the most economically and technically appropriate resource. This is achieved through the concept of a Super TSO who is able to see and call off bids for balancing energy from all balancing resources across the Nordic area.

When the arrangements were first implemented, Statnett and Svenska Kraftnät took turns as Super TSO. However, they now both act as Super TSO, and share a common information system to ensure they have common bid information. The entire synchronous Nordic system (including the Finnish and East Danish TSO areas) is balanced by the Super TSO. The West Danish TSO, as the operator with responsibility for a border with UCTE, is responsible for ensuring that the border transfer with UCTE is at the agreed level – they can use bids from other countries across the direct current link for this purpose, and bids from their generation appear on the common list.

Statnett and Svenska Kraftnät avoid “co-ordination” problems (e.g. both responding to the same reduction in frequency by calling for incremental generation) by remaining in close contact through their control rooms through the day.

Figure 11 provides an overview of the operation of the arrangements.

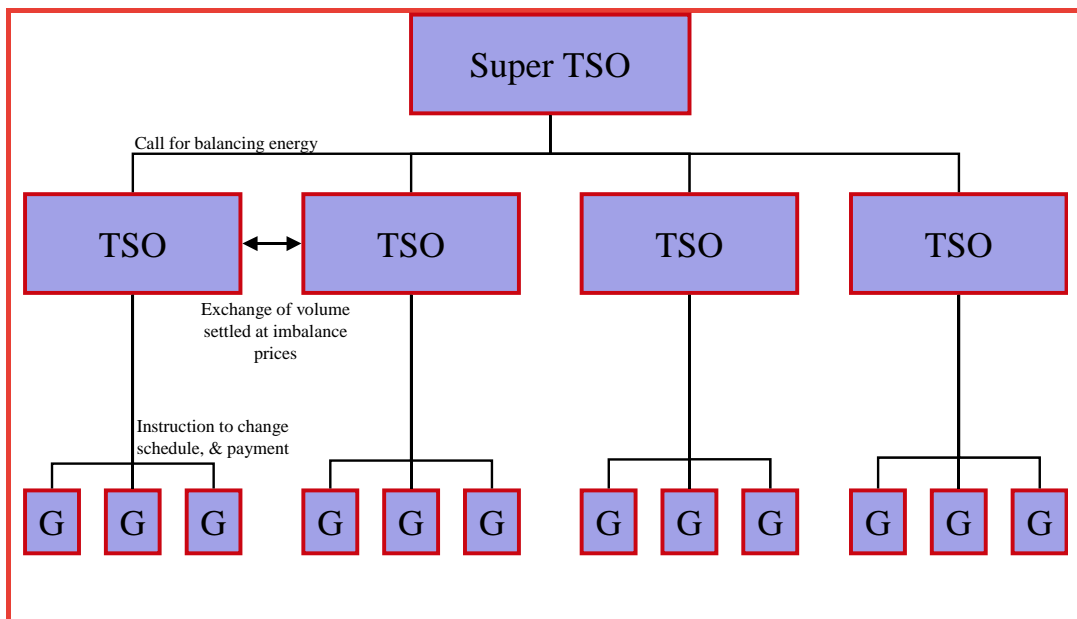


Figure 25: Nordic "Super TSO" arrangements

Source: Frontier Economics / Consentec based on discussions with Nordic TSOs

Suppose there is a need for incremental generation on the synchronous system. The Super TSO recognizes this, and looks at the shared set of balancing bids to find the most appropriate plant from which to purchase this energy. Normally, the next unit in the merit order list is chosen. Statnett and Svenska Kraftnät coordinate between themselves to ensure that the resource they choose is technically suitable (e.g. that it can deliver the energy sufficiently quickly given different product definitions and technical plant types, that its utilization is not going to result in incremental congestion issues within the control zones etc.)

There is no reservation of capacity on international interconnections within the Nordic region to provide scope for balancing energy to be exchanged. All capacity is provided to Elspot for use day ahead³⁶ and then to Elbas – to the extent that some international capacity remains unused after Elspot has cleared and Elbas has closed, there is scope for international exchange of balancing energy.

The Super TSO ignores differences in balancing pricing between the countries – so a bid from a generator in Denmark (where balancing energy is paid as bid) would be treated equivalently to a similarly priced bid from a generator in Norway (where balancing energy is paid at a market clearing price). There is, however, the intention to institute the marginal price basis uniformly across the systems.

³⁶ In all countries except Norway, where there is market splitting within the country, the impact of national transmission constraints which would interact with cross-border flows are “reflected” onto the cross-border capacity provided to ElSpot – that is, if international exchange would result in national congestion, the interconnector capacity provided to ElSpot is reduced.

Having selected a suitable bid, the Super TSO communicates the requirement for energy to the TSO to which the resource is connected. This “local” TSO then contacts the resource in question and requests the incremental generation. The payment for the additional output also comes from the local TSO.

Suppose the deficit was in East Denmark and the generation resource selected was actually in the Swedish control area. Then as the incremental output is delivered, the export from the Swedish area to the East Denmark area will increase. In settlement, the Swedish TSO will effectively have a “long” imbalance across its border with East Denmark. This imbalance at the border is settled at a price based on the average of the marginal imbalance prices in the two areas. All such payments are handled bilaterally between the TSOs.

If the local generation does not deliver the balancing energy which has been contracted, there is no “guarantee” from the local TSO – the Super TSO has to select the next most appropriate bid and call additional energy. The participant that failed to provide the balancing energy will face an imbalance charge.

The Super TSO does not consider that a bid called from outside the country with the balancing requirement will have any greater risk of not being delivered than a bid from within the country – there is no assumption that national supply security will come before the security of the rest of the synchronous Nordic area.

If the Super TSO were to run out of balancing energy options and load shedding was required, the System Operation Agreement between the TSOs requires that the country with the largest national deficit (i.e. the highest national demand relative to national generation) is required to cut load.

HISTORICAL INFORMATION ON PRICES AND VOLUMES

Figure 5 shows the evolution of the volume of balancing energy called and the prices for balancing energy in Sweden and, from late 2002, across the Nordic area. It would appear that the volume of balancing energy called in either direction has become less volatile since the adoption of the common bid ladder arrangements. This is consistent with TSOs co-ordinating responses to balancing requirements, rather than neighbouring TSOs calling for balancing in opposing directions in order to maintain a particular border transfer.

The graph does not seem to indicate a significant change in price volatility or levels. However this does not imply that, relative to the counterfactual of no integration having taken place, price development has not changed.

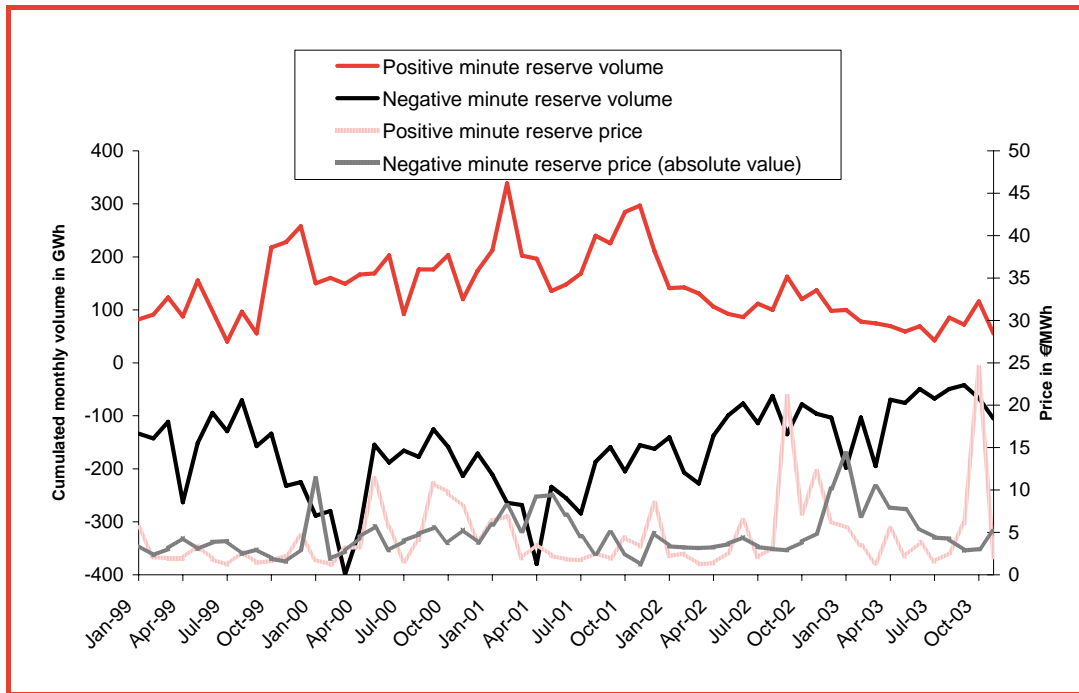


Figure 26: Evolution of balancing energy volumes

Source: Frontier Economics / Consentec based on data from Svenska Kraftnät

Annexe 3: Germany inter TSO arrangements

GENERAL BACKGROUND

The German high-voltage transmission grid is split into 4 control areas, which are operated separately, by each single TSO (RWE Transportnetz Strom GmbH, Vattenfall Europe Transmission GmbH, E.ON Netz GmbH and EnBW Transportnetze AG respectively), as illustrated in Figure 27.

All German TSO's are 100% subsidiaries of the large energy companies RWE AG, E.ON AG, EnBW AG and Vattenfall Europe AG, all of which also have considerable generation capacities. (The TSOs are, however, obliged to act independently and in a non-discriminatory manner according to EU unbundling requirements and related national legislation.)

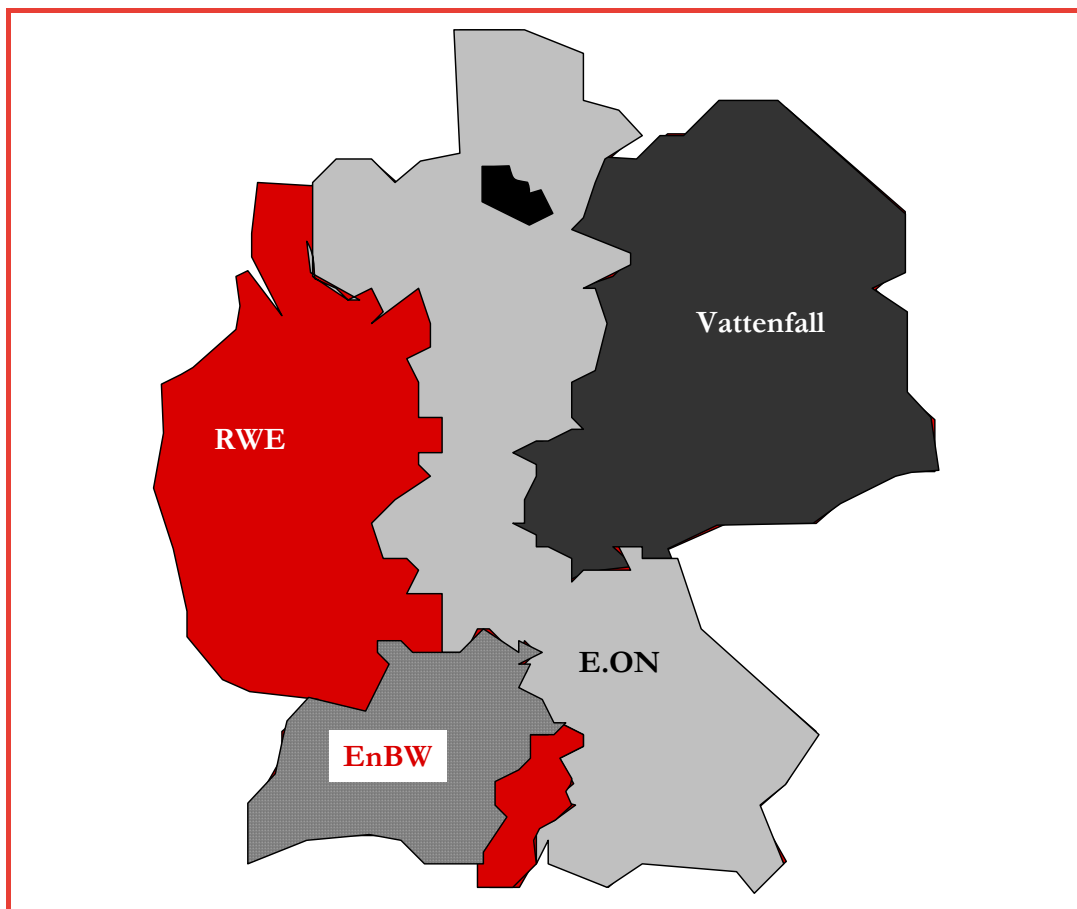


Figure 27: The TSO areas in Germany

Source: Frontier Economics / Consentec

GENERATION PARK

The generation park in Germany is relatively diverse, as illustrated in Table 6. There is substantial baseload capacity (nuclear, lignite, run of river hydro) and also (as a result of incentives to invest) significant wind capacity³⁷. This wind capacity has been the subject of intense discussion in relation to the cost of balancing energy in Germany – this specific issue is discussed in more detail in Annex 1.

However, there is also some flexible generation, not least from substantial pumped storage capability.

	Installed capacity 2003 (in GW)	By Fuel type
Nuclear	20.6	17.7%
Lignite	19.7	17.0%
Hard coal	25.1	21.6%
Gas	16.0	13.8%
Oil	6.0	5.2%
Other fuel (e.g. Waste)	3.5	3.0%
Water - Run of River	2.9	2.5%
Water - Pumped storage	6.5	5.6%
Wind	14.5	12.5%
Other renewables (Biomass, solar)	1.3	1.1%
Total	116	100.0%

Table 6: Generation and capacity mix in Germany

Source: VDEW, German Ministry of Environmental Affairs

³⁷ Germany has the highest capacity of installed wind generating capacity worldwide.

SUMMARY OF NATIONAL ARRANGEMENTS

Timescales

Figure 28 sets out the overall timescale for the German market arrangements.

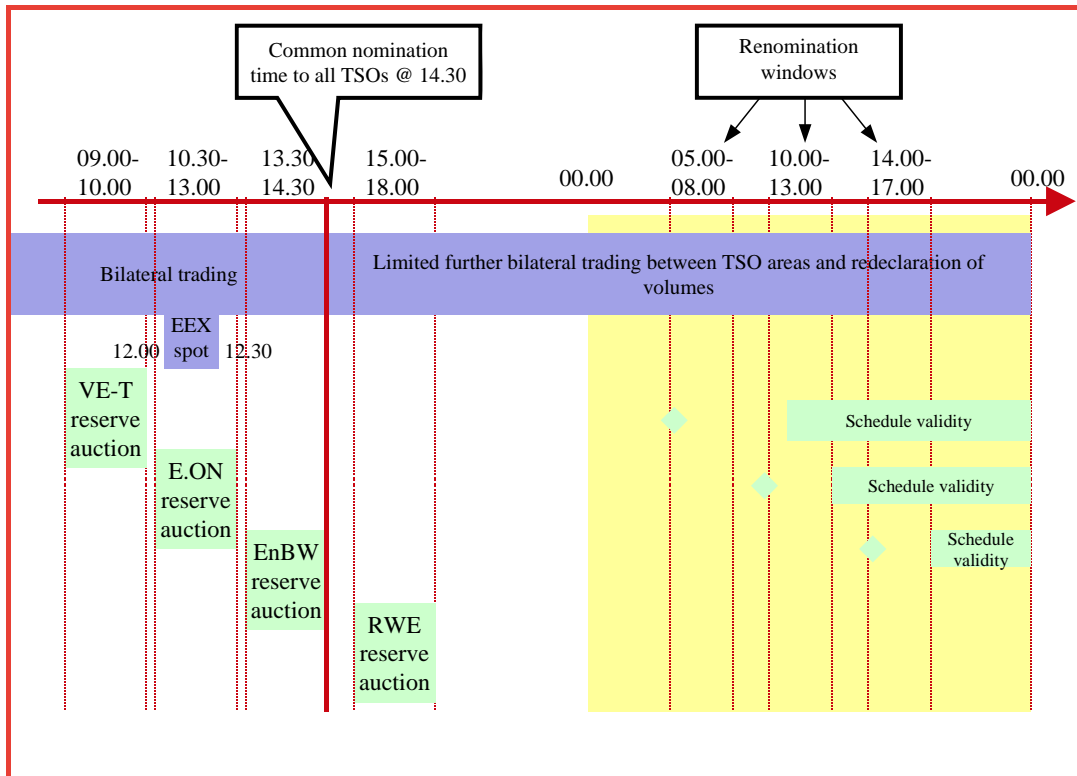


Figure 28: German market timescales

Source: Frontier Economics / Consentec

Auctions for primary and secondary reserve are conducted semi-annually, with a conventional sealed bid tender. Normally, bids are accepted up to one month ahead of delivery. The contract start dates differ among TSOs, whereas the procedure is the same in each control area.

Bilateral trading takes place up to the point of nomination of flows to the TSOs. This includes trading via the EEX spot market.

Auctions for balancing energy capability (“minute reserve”, equivalent to tertiary reserve) are conducted day-ahead by each TSO over an electronic platform³⁸. Prior to the auction, the necessary amount of positive and negative minute reserve is announced in MW, and bids are invited from (prequalified) eligible bidders. For all balancing services, the MW amounts required by each TSO are relatively stable. The precise timescales for the placement of bids varies by TSO:

³⁸ As a consequence of the entry into force of the new energy law in July 2005, there are currently discussions about a unified common auction for balancing energy across all control areas. The description here refers to the current arrangements.

- bids to provide minute reserve to Vattenfall have to be submitted at 09.00, with contracts being awarded at 10.00;
- bids to provide minute reserve to E.ON have to be submitted by 10.30, with successful bidders being informed by E.ON at 11.30, and having to confirm the offers by 1 pm;
- bids to provide minute reserve to EnBW have to be submitted by 13.30, with contracts being awarded at 14.30; and
- bids to provide minute reserve to RWE have to be submitted by 15.00, with contracts then being awarded by 16.00 and successful bidders having to confirm the offers by 18.00 at the latest.

The timescales for the nomination of flows are determined in the network access regulation (Stromnetzzugangsverordnung).³⁹ Balance responsible parties (BRPs) have to nominate their intended production and consumption schedules, and flows between TSO areas at 14.30 one day ahead of delivery.

Nominations for flows between TSO areas can be changed during the day of delivery as follows:

- in case of a generator outage (≥ 5 MW) or re-start: with 15 minutes notice
- in case of load reduction or cancellation of load reduction (≥ 5 MW): with 60 minutes notice
- without specific cause: at three times during the day, with the TSO being informed three hours prior to the new schedule becoming valid.

However, each TSO has the right to reject renominations between TSO areas when they may create congestion.

A different process applies to nominations for within area production and consumption – effectively, the TSO can be updated during the day of delivery and even *ex post* after the day (to allow for trading of imbalances).

Nature of market

All participants in the auctions must fulfil specified prequalification criteria, which are harmonised among TSOs. Bids for primary, secondary and minute reserve are locational or are provided from a corporate portfolio of generation assets.

Bids for primary reserve indicate only capacity to be provided and a price, whereas those for secondary and minute reserve comprise both a price and volume for each of capacity and energy.

Full details of the exact auction mechanism and the criteria for selecting bids (e.g. trade-off between high capacity and energy prices) are not published. For RWE

³⁹ Download: <http://www.vdn-berlin.de/global/downloads/Publikationen/vv2plus.pdf>

and E.ON, there are no publicly available terms for the tender⁴⁰. For Vattenfall and EnBW, excerpts of the tender terms are publicly available⁴¹.

Product definition

As noted above, minute reserve is not only a locational product – it may be provided from a portfolio of generation plant.

A call to deliver energy must be made fully 7.5 minutes ahead of the next 15 minute time interval. For example, a call to provide 90 MW of upward balancing for the interval 11.00-11.15 must be called by 10.52:30 at the latest, and the full 90 MW must be being provided by the generator within 15 minutes. The energy must be called by the TSO for at least 15 minutes, and the minimum volume called by the TSO is 30 MW.

Payment terms

For all TSOs, the capacity element of balancing power is remunerated on a pay as bid basis. However, the remuneration for the energy component varies – some TSOs pay as bid, and some operate marginal clearing price systems.

The cost of balancing energy in Germany amounts to approximately €1bn per year.⁴² Costs for balancing energy are partly recovered via transmission use of system charges from all users, and partly via Imbalance prices from balance responsible parties.⁴³ In particular:

- The cost of power provision (MW, capacity) for primary and secondary balancing energy and for minute reserve are recovered through transmission tariffs;
- The cost for actual usage (energy, MWh) of secondary and minute reserve are recovered through imbalance prices and are charged to balance responsible parties.

It is estimated that with this regime, around 70% of cost for balancing power is passed through to network tariffs, while 30% of cost for balancing power procurement is charged to the balancing groups responsible for the deviation between notified and actual flows.

⁴⁰ According to E.ON Netz, they are however available upon request.

⁴¹ For example, some generic information in relation to acceptance criteria has been made public by ETSO, and the blocks of energy for which tenders can be submitted are publicly known – for example, in Vattenfall's case, 30 MW or multiples of 10MW above this with bids being accepted for 6 blocks of 4 hours, and with partial acceptance of bid volume being possible.

⁴² German Monopoly Commission (2004), paragraph 253.

⁴³ Source: Monitoring Report of the German Ministry of Economic Affairs (2003), page 29 ff. download: <http://www.bmwa.bund.de/Redaktion/Inhalte/Pdf/monitoring-bericht.property=pdf.pdf>.

Information availability

Information availability regarding the outcome of the minute reserve tenders is limited. TSOs provide some summary figures on prices and volumes tendered, setting out the average capacity price in €/MW (differentiated between positive and negative energy provision), and the maximum and minimum accepted bids in the tenders (in €/kWh).

However, at the moment no information is made public on how many bids have been accepted, who participates in the auction for balancing services, which bids are actually called etc. According to the upcoming Energy Industry Act amendment German TSOs will have to publish the results of invitations to tender anonymously after two weeks.

Imbalance volumes and the imbalance prices charged to BRPs are published by all TSOs.

Participation

Bidders in the auction for primary and secondary reserve as well as minute reserve have to conform with certain pre-qualification criteria. These technical preconditions are described in Appendix D to the German Transmission Code 2003.⁴⁴

The final formulation of criteria and the inspection of whether the criteria are fulfilled are at the discretion of the respective TSO. In the E.ON area, in February 2004, 4 bidders were qualified for the primary and secondary reserve market, and 11 for the minute reserve market.

INTERACTION BETWEEN TSO AREAS IN GERMANY

In the preceding case studies, we have considered the possibility for trading in three timescales. Given the slightly different arrangements, in the German system these three periods need to be interpreted slightly differently:

- Before the common gate closure time; and
- After the common gate closure time.

Before the common gate closure time

Before gate closure, as noted above, participants in different TSO areas are free to trade – they then simply submit nominations at 14.30 (according to Transmission Code 2003) to their TSO in relation to their production and consumption in that area.

After the common gate closure time

After the common gate closure, bilateral trading can continue to the extent that participants are confident that the TSOs will agree to a renomination of their

⁴⁴ Download: http://www.vdn-berlin.de/global/downloads/englisch/service/TransmissionCode2003_Appendices_englisch.pdf.

schedules. The last opportunity for such trading is set by the time of the last gate closure (17.00 on the day of delivery).

In addition, by participating in the balancing energy auction processes of external TSOs, participants can bid to provide balancing energy throughout the day to other areas – hence, the process around these auctions and the process by which TSOs call for balancing energy from successful auction bidders from other areas is of relevance⁴⁵.

We understand from discussions with industry representatives that TSOs frequently use balancing resources which are connected in another TSO area⁴⁶. However, as the identity of bidders in the balancing markets is not revealed by the TSO's in Germany, there is little concrete evidence relating to this bidding activity.

We note this view is not shared by the German Monopolies Commission. In their latest annual survey⁴⁷, they devote a substantial section to balancing – they state that “*no competitive actions of a TSO in the zone of another TSO takes place*”. The Monopolies Commission report suggests that given the joint ownership of generation capacity and networks by the large German energy groups, and the strict prequalification criteria for the provision of balancing energy, competition between generators outside the TSO area to which they are connected is unlikely.

That said, it is logistically possible for such competition to take place. According to German TSO representatives, many prequalified bidders who take part in the balancing service market, especially for minute reserve, are connected to other TSOs' areas.

The rules for the exploitation of resources between TSO areas are harmonised throughout Germany. The participation of prequalified bidders in tenders outside the control area to which they are connected is facilitated by the fact that a “certificate of compliance” with prequalification criteria from the local TSO is accepted as qualifying the bidder to participate in the tenders of other TSOs.

Equally, since there is no capacity allocation mechanism procedure for capacity between the German TSOs (as to date congestion has not been a significant issue, other than in relation to wind power) there are few issues relating to securing and reserving capacity to provide balancing power. Wind-related congestion (for example, if VE-T exports significant wind energy to the rest of the Germany system) has typically been dealt with via *ad hoc* rules rather than by the definition and trading of capacity products – there has, for example, been a case where VE-T, as a consequence of transmission line maintenance, declared a

⁴⁵ Procurement of balancing energy by each TSO is through their own auction process – the implementation of the transparent auction processes was a remedy required by the Bundeskartellamt in relation to the RWE-VEW and VEBA-VIAG mergers

⁴⁶ The set of participating control areas comprises the four German ones plus the control areas of the Austrian TSOs TIRAG and VKW-UNG, who are members of the German control block.

⁴⁷ Monopoly Commission (2004) 15th Annual Expert Report, paragraph 242 ff.

congestion, such that minute reserve bids from the VE-T control area could not be considered by the other TSOs⁴⁸.

Finally, participation in multiple reserve markets is made possible by the markets being organised sequentially – hence, generators can adapt their bids in later markets to the outcome of earlier markets. That said, there are obvious informational issues resulting from such sequencing – we discuss these further below.

Process of calling out-of-area balancing resource

Where a TSO has contracted a generator in another TSO area to provide balancing energy and wishes to make use of this resource (i.e. wishes to call for delivery under the contract), the contracting TSO notifies both the generator and the TSO to which they are connected of the requested change to schedule. In addition, the contracting TSO typically contacts the generator by telephone to verify that the balancing energy will be delivered.

Having done this, both TSOs adjust their secondary control equipment. This is necessary as otherwise, following delivery of the balancing energy by the generator in question, resulting in an increase in power exported from the connected TSO's area, the secondary control equipment would act to return the export to the programmed level, negating the effect of the balancing.

Since all bids to the reserve markets are non-locational, the generating company retains the flexibility to choose from which of their plant they deliver the balancing energy up to 17.00. At that time they must give the message to readiness.

In the event that the generator fails to deliver the balancing energy themselves, it is the connected TSO that faces the risk. Following such a failure to deliver, the secondary control equipment would automatically adjust the output of other generators to ensure that the (higher) programmed export was actually delivered. The generator in question (or, to be exact, their balance responsible party) would face an imbalance equal to the failure to deliver⁴⁹.

HISTORICAL INFORMATION ON PRICES AND VOLUMES

Table 7 presents the contracted volumes of secondary and minute reserve. These volumes have been determined using a common stochastic approach, but reflecting the individual TSO areas' generation park characteristics (e.g. wind generation volatility).

⁴⁸ Following information from RWE Transportnetz Strom.

⁴⁹ If the generator informs the contracted TSO in advance that they will be unable to deliver, they are required to repay their capacity payment.

TSO	Contract period	Positive secondary reserve (MW)	Negative secondary reserve (MW)	Positive minute reserve (MW)	Negative minute reserve (MW)
E.ON	1. Dec 04 - 31. May 05	800	-400	1100	-400
EnBW	1. Feb 05 - 31. Jul 05	720	-390	510	-330
RWE	1. Feb 05 - 31. Jul 05	1230	-1230	1030	-760
Vattenfall	1. Mar 05 - 31. Aug 05	580	-508	730	-530
Total		3330	-2528	3370	-2020

Table 7: Contracted volumes of secondary and minute reserve

Figure 29 illustrates usage in GWh of secondary and minute reserve for the RWE area⁵⁰. It is apparent that, again perhaps surprisingly, the amount of minute reserve used is consistently lower than the usage of secondary reserve.

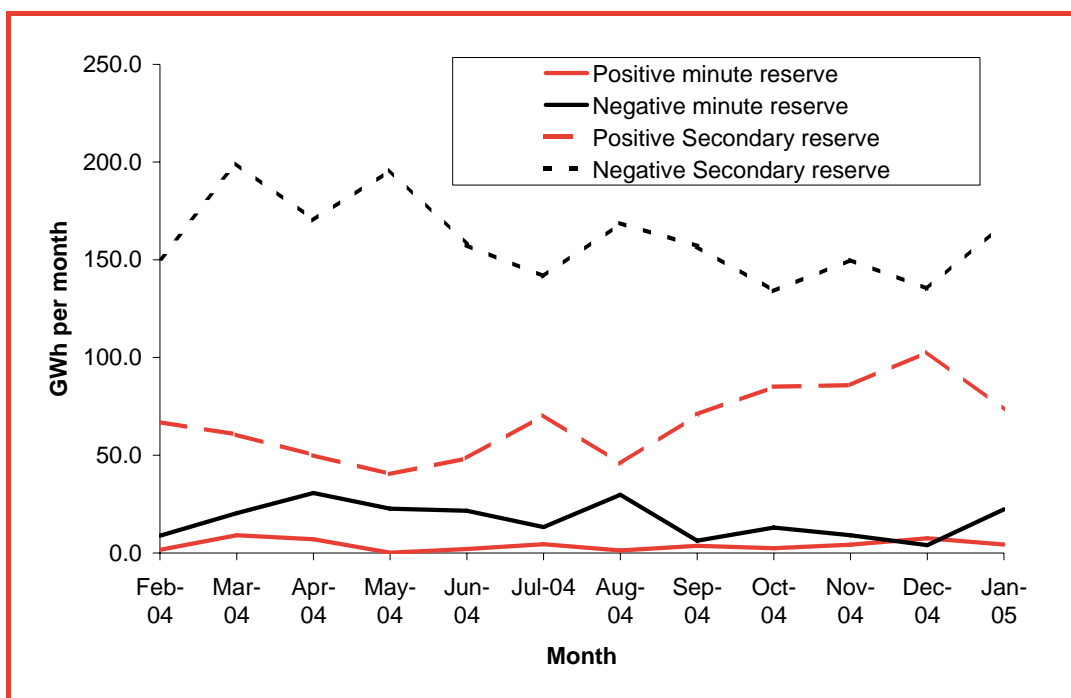


Figure 29: Monthly volumes of contracted secondary and minute reserve in the RWE area

Source: Frontier Economics / Consentec based on RWE Transportnetz Strom GmbH

⁵⁰ Other TSO's do not publish historical volumes by type of balancing services

The above table and figure would appear to indicate that the system operator is relying on secondary reserve as the primary tool for ensuring balance, and intervening with manually instructed minute reserve when secondary reserve capacity is close to full utilisation.

We understand that the choice of reserve follows a merit order and secondary reserve tends to have lower energy prices though significantly higher capacity prices. We are unclear as to how the TSOs choose the appropriate trade-off between secondary and minute reserve and hence how they choose the right quantum of secondary reserve to contract.

Assessing the relative price of the two categories of reserve is difficult given the data available.

Figure 30 shows the evolution of capacity prices for primary and secondary reserve across TSO areas from February 2001 up the latest tender (including power prices up to July 2005).⁵¹

Price levels for primary reserve appear to have converged over time. Such convergence is at least consistent with some degree of trading and sharing of primary reserve holding. Convergence is less evident in relation to secondary reserve – however, the price shown in the figure only relates to secondary reserve capacity – no average pricing information is published in relation to energy delivered under secondary reserve contracts.

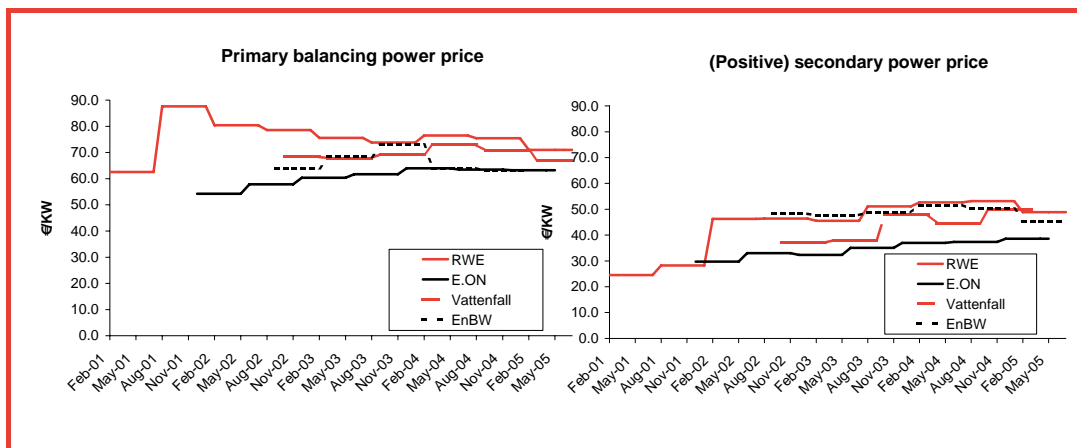


Figure 30: Average primary and positive secondary balancing power prices (€/KW) per TSO area

Source: Frontier Economics / Consentec

When the capacity prices for minute reserve are considered, there is also a high degree of correlation – this is illustrated for RWE, E.ON and EnBW in Figure 31⁵².

⁵¹ The prices represent the average accepted bids from the semiannual tenders.

⁵² Over the whole time year, the correlation coefficient between RWE and E.ON, RWE and EnBW and E.ON and EnBW is 92.1%, 95.5% and 97.7%, respectively.

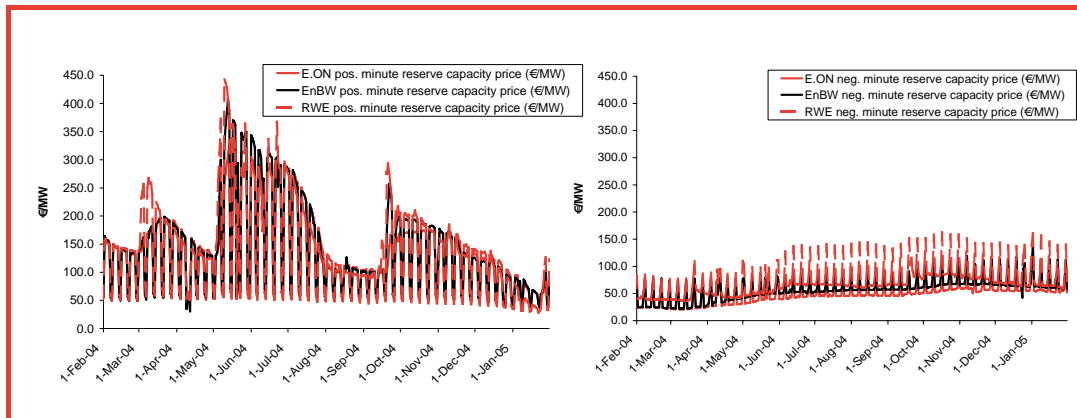


Figure 31: Average daily positive and negative minute reserve power prices (€/MW)

Source: Frontier Economics / Consentec based on TSO data

Again, no average pricing information is published in relation to energy delivered under minute reserve contracts. TSOs publish only minimum and maximum accepted price. The data shows little by way of clear pattern in terms of price evolution – in terms of level, as might be expected, the minimum secondary balancing energy price in all TSO areas lies significantly above the monthly average wholesale price for peak energy⁵³, and the same is by and large true for minute reserve energy. Again, as would be expected, the daily minute reserve price data exhibits considerable volatility.

It is possible to infer to some extent the energy cost of minute reserve procurement from imbalance prices.

Figure 32 shows the development of imbalance prices across the TSO's in Germany over the last year. From this graph, it would appear that minute reserve energy costs are on average broadly in the range of day ahead electricity wholesale prices (while the Vattenfall and the EnBW imbalance price fluctuate around the wholesale level, the E.ON and the RWE imbalance price are slightly lower than the EEX level).

However, it would also appear that there are quite significant differences in the imbalance prices – this is true both on a monthly average basis as well as on a hourly and quarter hourly basis. This is consistent with unexploited scope for further trading between TSO areas in relation to balancing energy.

⁵³ Represented by the monthly average peak price on the EEX spot market

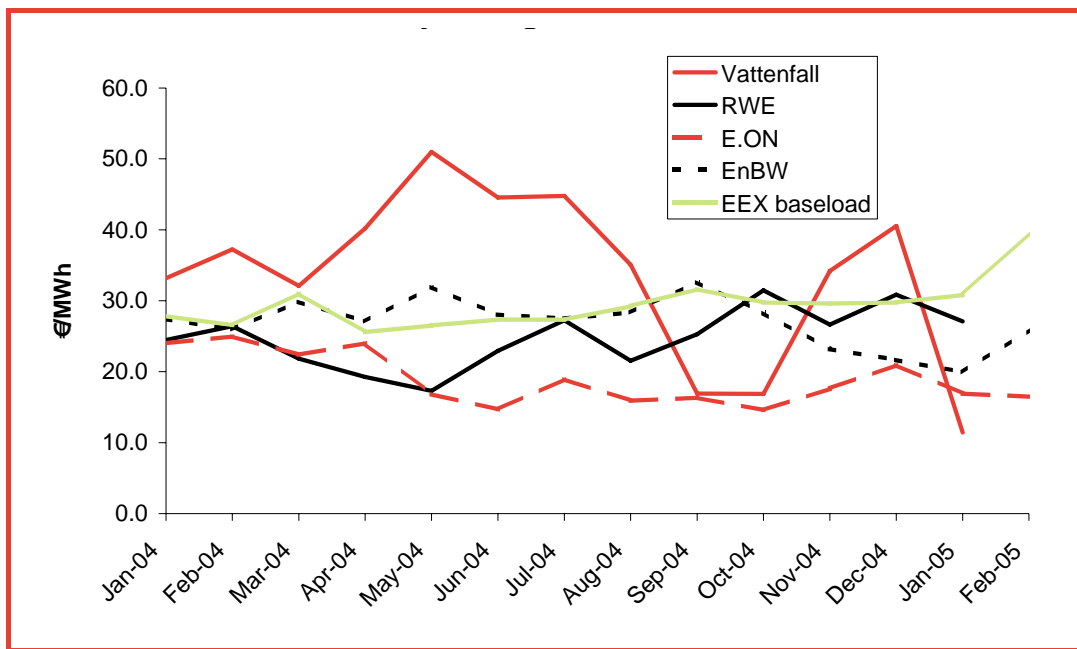


Figure 32: Monthly average imbalance prices by TSO area

Source: Frontier Economics / Consentec

Attachment: Impact of wind energy on balancing in Germany

At present, there is an intense debate in Germany about the impact of growing wind energy capacity on balancing costs. The Renewable Energy Law (Erneuerbare Energien Gesetz EEG) enacted in 2000 and updated in 2004 promotes renewables by guaranteeing generators above market prices for many years ahead. As a result, Germany now has the largest installed wind generating capacity worldwide – and further expansion is expected.

In recent months, network operators have announced their intention to increase network tariffs, in part as a result of having to bear increased balancing costs due to the expansion of wind capacity.⁵⁴ For their part, wind generators deny that wind energy has a significant impact on balancing cost.

Therefore, the German Energy Agency⁵⁵ has commissioned a study that investigates the actual impact of wind energy network cost.

The first part of the study was released end of February 2005.⁵⁶ However, this report focused on the cost of building additional networks to connect new wind plants (particularly those located offshore). A second study that investigates more directly the impact of wind capacity on balancing cost is now planned.

There are only a few other studies around on the impact of wind capacity on balancing volumes. Dany/Bouillon (2002) conducted a simulation of balancing cost for a network model that was calibrated to closely reflect a 20 GW German high-voltage network, with power and energy prices taken from actual minute reserve tenders in the E.ON area for March/April 2002.

The cost of balancing the network (both power and energy) has been estimated by varying the assumed proportion of wind capacity from zero (no wind capacities, balancing only for unexpected load deviations, plant shut-downs etc) to the full 20 GW (only wind capacity installed in the TSO area). The authors find that

- the necessary balancing power rises from around 1 GW for zero installed wind capacity to around 5 GW for the extreme case of 20 GW wind capacity;

⁵⁴ See for example press release of EnBW dated 23.Sept 2004 http://www.enbw.com/content/de/presse/pressemitteilungen/2004/09/pm_20040923_reg_04/index.php. The press release is available in German language only, we therefore give an unofficial translation: "The reason for the increase in network tariffs at the high-voltage level is the EEG-compensation mechanism for wind energy in particular which is in place since August 2004. EnBW has now to take up the wind energy that corresponds to the Baden-Wuerttemberg area, and has to pay for the balancing of that energy. The amount of wind-energy EnBW has to pay for with the introduction of the new mechanism rises by the factor 10, from 200 MW up to 2000 MW. The network tariffs at the high voltage level therefore increase with the effect of January 1st by 9.5%".

⁵⁵ www.deutsche-energie-agentur.de

⁵⁶ Download: <http://www.deutsche-energie-agentur.de/page/index.php?dena>.

- the combined cost for balancing energy and power rises at around €50-60 million per year for each additional GW installed wind capacity.

Another study conducted by the Institut für Solare Energieversorgungstechnik⁵⁷ (ISET 2002) of the University of Kassel underlines the difficulty of conducting wind power forecasts. The study quantifies how the forecast error rises both with duration of the forecast and the location of the wind generators, as illustrated in Figure 33.

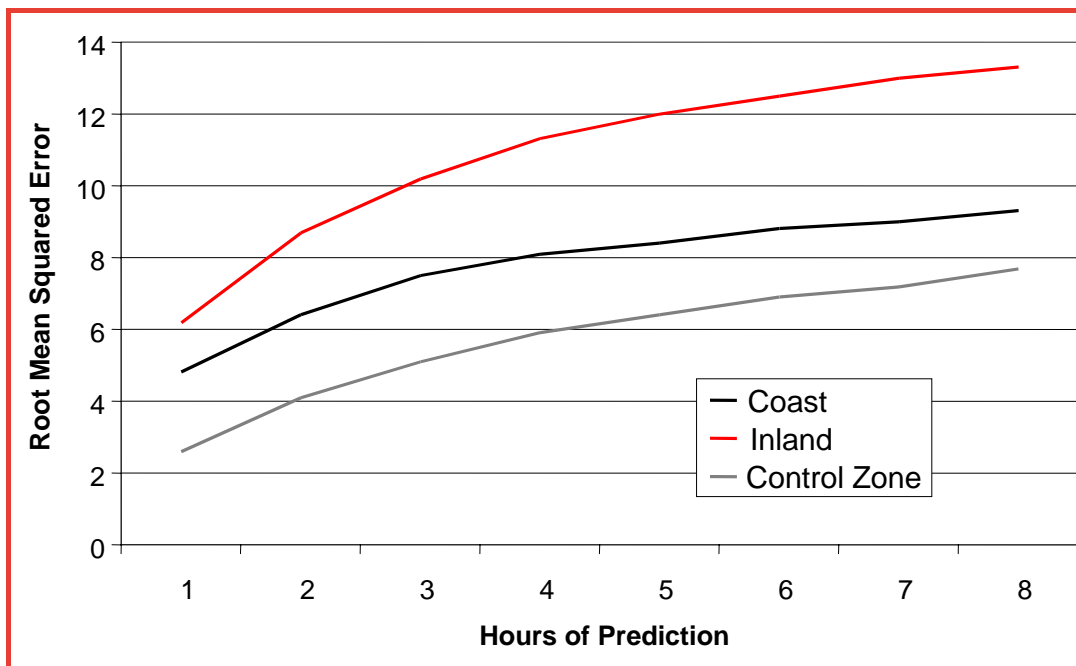


Figure 33: Forecast errors for wind generation in relation to length of forecast and location

Source: Based on ISET (2002)

Quite obviously, the forecast error increases significantly with an increase of the duration of the forecast. This is an important effect in view of the way in which wind power is integrated in the German market and balancing arrangements.

According to the EEG, each TSO has the obligation to take up any energy from renewable sources defined in the law, including wind. The energy is then passed on as follows:

- Based on the expected value of renewables infeed, each TSO calculates a profile of the ratio of energy from renewables and total energy delivered to end consumers in his control area. Each supplier is then obliged to take up a fixed profile of renewable energy calculated from the energy he supplies to end consumers and the above ratio. This mechanism, along with ex post reconciliation of deviations between expected and actual infeed, ensures that all **energy** from renewables is passed on to suppliers.

⁵⁷ ISET develops tools for wind power forecast systems and is market leader for these products in Germany

- By contrast, the responsibility to deal with the difference between momentary **power infeed** from renewable sources and the expected mean value lies with the TSOs. Given the average utilization of wind generators of about 20 %, the difference in power can be up to 80 % of installed capacity. In order to avoid having to procure that amount of negative reserve power, the TSOs take a two-step approach:
 - On the day before operation, they contract a profile for the next day that equals the difference between the day-ahead renewables generation forecast and the fixed renewables profile previously assigned to the suppliers. In other words, the TSOs sell energy to the spot market⁵⁸ if they expect high wind infeed and buy energy if the infeed forecast is low.
 - During the day of operation, TSOs are facing the difference between the day-ahead renewables infeed forecast and the actual momentary infeed. This imbalance is managed by means of minute and secondary reserve.

In order to distribute the reserve demand evenly among the TSOs (whereas the installed wind capacity, being the main contributor to infeed forecast inaccuracy, is concentrated in the North of the country), the 2004 amendment of the EEG has introduced a mechanism by which the current wind power infeed is distributed on-line among the TSOs. To achieve this, each TSO firstly estimates the momentary wind power infeed into his control area on the basis of representative measurements (i.e. power infeed is measured online for a small number of wind parks and scaled up). Secondly, the amount of wind power to be taken up by each TSO is computed from the total infeed (i.e. the sum of the individual estimates) and a share according to the load of the control areas. Thirdly, for each TSO the difference between estimated infeed and amount to be taken up is used to shift the setpoint of his secondary controller. The sum of these shifts is always zero, hence leading to a balance neutral distribution of wind power infeed.

Despite these efforts, the deviation between day-ahead wind power forecast and actual infeed remains a major source for the demand of balancing power.

Considering the significant decrease of the wind forecast error for shorter forecast durations (Figure 33), there could be a notable potential for a reduction of wind-related balancing cost if the TSOs had an opportunity to buy or sell (at least part of) the difference between the fixed suppliers profiles and the wind forecast on an intraday basis instead of the day-ahead market.

⁵⁸ To our knowledge this day ahead trade is not performed via the power exchange (although EEX prices may be affected indirectly by the wind forecast). It is not transparent which market place is used by the TSOs.

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