European Network of
Transmission System Operators
for Electricity

DEVELOPING BALANCING SYSTEMS TO FACILITATE THE ACHIEVEMENT OF RENEWABLE ENERGY GOALS

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EXECUTIVE SUMMARY

- The balancing of generation and demand is part of the core remit of Europe's transmission system operators (TSOs). Balancing is fundamental to the secure operation of the power system.

- The portfolio of plant connected to the European power system is changing. In particular, the levels of generation for which it is not possible to predict the exact volume of output with certainty and whose output has a legally binding dispatch priority (e.g. wind and solar generators etc.) is becoming more significant. European policies on renewable generation mean that this trend is likely to continue to 2020 and beyond.

- Other things being equal, growing volumes of generation with variable levels of output will increase system balancing requirements and decrease the short-term availability of traditional balancing resources (i.e. flexible centralised power plants). This has implications for the cost efficient integration of renewable energy and therefore for the electricity consumer and requires Europe's TSOs to carefully consider how to put in place mechanisms to achieve this as efficiently and economically as practicable.

- Therefore TSOs need to proactively consider whether markets are designed in an optimal manner, whether the right incentives are being sent to all market participants and whether the right products are being made available.

- TSOs support the creation of non-discriminatory, competitive and liquid markets which provide all parties (irrespective of size or fuel type and including the demand side) with an opportunity to manage their own imbalances and to provide ancillary services (essentially services to help balance supply and demand).

- TSOs consider that the most effective method of minimising balancing costs for Europe's consumers would involve making all parties financially responsible for meeting their own balancing requirements. The key recommendations that are outlined in this paper are as follows:
    - Taking steps to ensure RES generators are 'balance responsible';
    - The development of cross border balancing markets;
    - The development and adaption of market mechanism to reflect the balancing needs required of a system with large volumes of RES; and
    - The development of market designs that allow RES to act as a provider of Balancing Services.

- However, balancing is one part of the vision of a truly pan European electricity market and cannot be viewed in isolation. TSOs are committed to facilitating the achievement of renewable energy and decarbonisation policy goals and are therefore working to promote efficient markets in all timeframes – from the long-term (forward markets) to the very short term (balancing).

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1 PURPOSE AND INTRODUCTION

Europe's energy sector is changing fast. The era in which large, centralised power stations provided the bulk of Europe's energy needs is nearing an end. In its place an era of small, decentralised, renewable generating plant, with output which is difficult to forecast with certainty and an active demand side is emerging. This step change can provide benefits for energy consumers and the environment, but achieving it requires a proactive approach from the Transmission System Operators (TSOs) which manage Europe's energy system and will need a number of significant challenges to be overcome. One of those challenges involves ensuring that TSOs can access the balancing services which are needed to maintain the security of the system and that this can be done at least cost. As such, TSOs need to proactively consider the way in which all aspects of balancing markets are designed. This paper is the first stage in that process.

The paper briefly summarises the role that TSOs play in system balancing, before discussing the operational challenges related to short-term balancing associated with integrating significant volumes of renewable energy into Europe's energy system. In light of these issues, it evaluates a series of options for ensuring the availability of sufficient volumes of balancing services and for minimising the cost (paid by consumers) of those services, before making a series of recommendations.

2 BALANCING

A power system needs to balance the generation and consumption of energy over multiple timeframes from seconds, hours, days and even years ahead. While the TSO has a specific role close to real time, they also have a key role in creating incentives to balance in longer timeframes because of their role in designing the market mechanisms through which balancing services are provided and procured.

Balancing refers to the process through which TSOs manage the physical equilibrium between injections (generation) and withdrawals (consumption) on the grid. This is typically done via a series of legal obligations and/or contracts struck by TSOs for delivery, over different timescales, of two key services:

1. Ahead of real time (i.e. before the gate closure time of the last market in which participants can trade energy), TSOs secure access to power capacity for control purposes in their control area. In this paper, this power capacity (in MW) is referred to as "reserves".

2. Close to and in real time, energy is activated from these reserves or other available resources (which may be automatically or manually by the TSOs) to maintain the balance within a control area. In this paper, this delivered energy (in MWh) is referred to as "balancing energy".

Ensuring that sufficient volumes of balancing services are available is critical to maintaining the security of the power system.

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Ancillary services are fundamental to the secure operation of the power systems in Europe. The provision of adequate and reliable ancillary services by parties connecting to the system is essential to ensure continued security of supply, particularly in the context of high levels of renewable generation.

3 THE CHANGING EUROPEAN GENERATION PORTFOLIO

The publication of the Renewables Directive[1], which mandates levels of renewable energy use within the European Union, means that the levels of total energy derived from renewables by 2020 will significantly increase. The Directive requires that at least 20% of total energy (on average in Europe) is delivered from renewables by 2020. These new RES installations have to be integrated both operationally into the electricity system and commercially into the electricity markets. The European TSOs play a central role in ensuring the cost effective and successful integration of RES in both these areas.

Of the total target for renewable energy penetration in Europe, a substantial amount will be derived from the use of variable renewable generation to generate electricity (wind and solar plant etc.). This will, in turn increase the system balancing requirements across Europe. Indeed, when the actual output of such plant differs from their forecasts (which is generally the case) and hence do not contribute to meeting the system demand, other resources (necessarily flexible) will have to be used (to change their output, upward if RES sources produce less than expected, and vice-versa) to balance the system.

In real time, the TSOs balance the system using automatic or manually activated reserves[2]. The need for these reserves will increase with higher levels of variable RES generation. Higher levels of imbalances will occur due to the difficulty in accurately predicting weather patterns (recognising that the accuracy of forecasts has increased significantly to date and noting that this trend would be expected to continue – particularly if appropriately encouraged) and, resultant inaccurate predictions for the output from wind and solar RES units. Increasing amounts of RES will thus result in a higher short term balancing requirement. The management of these short term imbalances has an associated cost, which could be reduced if RES producers were properly incentivized to avoid predictable imbalances.

Increasing amounts of variable renewable generation will reduce the availability of traditional balancing resources which tends to increase the cost of maintaining system security. Higher levels of imbalances will occur at increasing levels of renewable generation which will lead to increased short term balancing costs.

[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:en:PDF
[2] These reserves may be precontracted (i.e. they receive a payment for making capacity available) or not.

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4 CREATING MECHANISMS TO MINIMISE THE VOLUME AND COST OF SHORT TERM BALANCING

Adjusting market mechanisms could facilitate a cost minimising integration of RES and support the implementation of the ambitious European de-carbonisation targets. In the following sections, ENTSO-E proposes principles which we consider should be reflected in market design choices in order to minimise short-term balancing costs.

This section will discuss the key areas relating to the short term balancing of the system from a TSO perspective and identify areas in which there is scope to reduce the costs of RES integration by making appropriate changes to relevant market mechanisms. These areas are:

1. Balancing Responsibility for RES
2. Development of cross border balancing markets
3. Adaptation of the market conditions to take into account the balancing needs brought about by RES:
    a. Energy markets should allow negative prices
    b. RES support mechanisms should consider short-term balancing
    c. Flexible Market Products
4. Development of RES as a provider of Balancing Services

4.1 BALANCING RESPONSIBILITY FOR RES

The volume of actions which TSOs need to take to balance the system in real time can be reduced by encouraging market actors to balance (i.e. market actors are held financially responsible for their positions via the so-called Balance Responsible Party (BRP) mechanism, which is the cornerstone of the European electricity market design). This approach incentivises parties to use markets in different timeframes (e.g. long-term, spot, intraday) to balance their portfolio ahead of real-time and to minimise their own imbalance in order to avoid financial exposure or gain a competitive advantage. This substantially reduces the volume of actions which TSOs need to take in real time, enhances overall efficiency and is likely to reduce costs to customers.

This approach means that, broadly speaking, the TSOs' role is to deal with imbalances which cannot be avoided by market parties (i.e. unpredictable factors such as consumption or RES forecast errors and plant failures). To achieve this TSOs must maintain an adequate level of reserves to manage these unexpected events in real time[3].

In cases where RES generators are not balance responsible parties, TSOs assume responsibility for balancing their entire output in real time (as opposed to solely unexpected deviations). This substantially increases the volume of actions which need to be taken and the level of operational reserves which need to contracted, increasing cost to all market players and decreasing efficiency. As such, ENTSO-E considers that incentivising all

[3] Note, that the reserves can be either precontracted (i.e they make a payment for making capacity available) or not. The TSO must ensure sufficient reserves of either kind.

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generators, including RES, to balance their own output (by, for example, selling it on the markets to counterparties or using it to supply load) can provide very significant savings.

The principle that RES units should be made responsible for balancing their output does not necessarily mean that every small RES unit has to access the market and balance its own output. RES units could participate with existing Balance Responsible Parties who have complementary assets (e.g. pumped hydro), or bigger market agents can be facilitated by aggregating several RES units to enable economies of scale.

By making parties financially responsible for their own imbalances, incentives can be created which reduce the volume of reserves which need to held by the TSO and the associated cost for the consumer.

4.2 The Development of Cross-Border Balancing Markets

Within balancing markets, TSOs are single buyers and rely on resources supplied by all units (both renewable and non renewable) and consumers to carry out short term balancing. Increased liquidity of the short term balancing market (i.e. the number of participants and balancing volumes that are available) will tend to lower the balancing costs. The presence of cross-border balancing mechanisms can provide the TSOs with greater choice in terms of procurement of short term balancing services and may lower costs to the electricity consumer. This will help to support the integration of variable renewable energy into the European electricity system.

With sufficient cross border network capacity and the appropriate cross border trading mechanisms in place, system imbalances in wind power and other power production, consumption and external exchange could in some circumstances be smoothened out by TSOs using the greater range of balancing resources available (over a larger area).

ENTSO-E has developed target models for the design of markets for cross-border exchanges of balancing energy and reserves (see a recent ENTSO-E Position Paper[4] for more details).

Implementation of the target models for cross border trade of balancing energy and reserves respectively will assist in the cost effective integration of renewables in Europe.

Effective cross-border balancing markets in addition to day ahead and intraday energy markets provide the tools to facilitate the cost effective procurement of short term balancing services. This can potentially reduce the system balancing costs and facilitate the integration of variable RES units into the electricity system.

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https://www.entsoe.eu/fileadmin/user_upload/_library/position_papers/110531_AS_TOP_08_XBBalancing_Consolidated_Final.pdf

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4.3 ADAPTING MARKET MECHANISMS

4.3.1 ENERGY AND BALANCING MARKETS SHOULD ALLOW NEGATIVE PRICES

Market prices should reflect the supply-demand equilibrium on the power system at a given time. In certain scenarios (e.g. high RES generation) it is appropriate to allow negative prices in order that all participants are given the opportunity to offer all their available flexibility (which may mean in some cases participants offering negative prices for a given period of time). By allowing this on all market timeframes (long-term, spot, intraday), and on balancing offers made by market participants, there are benefits in terms of social welfare. Such negative price phenomena within markets in Europe have been rare up to now. However, it is important that price signals on markets are able to reflect this particular scenario, i.e., that energy prices are not artificially distorted due to a floor at 0 €/MWh on a market.

Market prices should fairly reflect the supply-demand balance, taking variable RES into account. Negative prices can be a consequence of market design choices and should not be explicitly disallowed[1]

4.3.2 RES SUPPORT MECHANISMS SHOULD CONSIDER SHORT-TERM BALANCING

Some existing support mechanisms generate effectively constant revenue for RES producers, notwithstanding the impact of the RES output on the supply-demand equilibrium of the system. Thus, for example, if the RES output is so high that negative prices appear on the energy markets (*see previous point*), RES producers will still be paid for their output. Hence under such schemes, there is no incentive for RES producers to improve their forecasts and/or to use mechanisms (e.g. storage capacities) to adapt their output to demand. While the very principle of a support mechanism is obviously to provide actors with financial guarantees, it is important that the mechanisms take into account the supply-demand equilibrium, particularly in mature markets where the contribution of variable RES is significant.

Support mechanisms should take the supply-demand equilibrium into account and preserve exposure to market prices

4.3.3 FLEXIBLE MARKET PRODUCTS

Generally, RES units should have access to the spot and intraday markets and these markets should be developed in a way that supports the needs of RES units. Allowing RES units access to appropriately designed markets close to real time, provided that RES units are incentivized to do so by being made responsible for their imbalances (see section 4.1), will ensure that the role of the TSOs is focussed on managing unexpected system events

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and any residual forecast error created by RES generation (rather than predictable imbalances).[5]

The ongoing coupling of day-ahead and intraday markets will increase liquidity and competition on these markets due to more participants in the markets. This increased liquidity will stimulate trade, and it is foreseeable that the RES producers will have more opportunities to adjust their position before the balancing market, reducing their imbalances and, in this manner, facilitating the integration of RES.

Two important aspects of the market design have an influence on the RES generators' ability to forecast and balance positions:

(1) Gate closure times and

(2) Time resolution

Moving the *gate closure* time closer to real time operation will allow more accurate wind forecasts and, hence, more accurate bids into the market by RES units. It is, however, important, that enough time is left for the TSO to balance the system and solve any technical restrictions that may occur due to the trades established in the intraday market.[6]

Moreover, with increasing volumes of variable RES energy, hourly products traded on the intraday market might not be precise enough, especially when power delivery time comes closer and generation forecasts become more accurate. Consequently, it should be assessed if it would be beneficial to give market players the possibility to react on the gradients of wind power on the market and moreover fine-tune such deviations on short notice. In Germany, there are ongoing discussions on how to address this issue.[7]

Whereas deviations between long-term and short-term wind forecasts and ramps in RES generation could be addressed better by such a measure, the liquidity of such "shorter" products have to be examined before they can be implemented. The impacts on the time left to TSOs to balance the system in real-time which will also have to be assessed carefully.

Markets have to be flexible in order to allow for short term balancing of deviations. The development of intraday markets with gate closure times which are close to real time are an important aspects in facilitating the participation of RES in markets.

[5] The case of Germany is particular: besides their responsibility in balancing the system in real time, the TSOs are also responsible for selling the entire output from RES generators.

[6] Another important issue is the harmonization of the gate closure times across Europe in order to allow the coupling of the several markets which is an essential aspect for the accomplishment of the coupling of day-ahead, intraday (and balancing) markets.

[7] One possibility currently investigated could be splitting hourly contracts on the intraday market one hour before delivery into shorter contracts, like half-hourly contracts or quarter-hourly contracts. This means that with today's lead time of 45 minutes (this lead-time applies on the German market?) the hourly block x would be split into e.g. quarter-hourly blocks 75 minutes prior to hour x. Market participants would then have the possibility to trade the first quarter-hourly block until 45 minutes prior to the hour, the second quarter-hourly product until 30 minutes prior to the hour of delivery, and so on.

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4.4 The Development of RES as a provider of Balancing Services

It is essential that, as the levels of renewable generation continue to increase on the power system in Europe, renewable generation is encouraged playing a role in the provision of balancing services.

Not all balancing services can be provided by renewable generation due to the inherently different technical characteristics of the units. Nevertheless RES units should have the opportunity and be encouraged to participate in the Balancing Services market, even if they have a support mechanism in place.

Wind generation could for example participate and deliver negative control energy on days with high wind levels. However, the impact of this on any RES support mechanism would have to be considered.

The participation of RES in balancing markets should be encouraged

5 Conclusions and Recommendations

This paper has proposed recommendations on effective market mechanisms for managing short term balancing in order to minimise costs to the electricity consumer. The main recommendations are as follows:

1. Creating balancing responsibility for RES
2. Further developing cross border balancing markets
3. Proactively adapting the design of markets to take into account the balancing needs brought about by RES
4. The development of RES as a provider of Balancing Services.

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