ENTSO-E Position on Offshore Development

Market and Regulatory Issues

15 October 2020

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ENTSO-E Mission Statement

Who we are

ENTSO-E, the European Network of Transmission System Operators for Electricity, is the **association for the cooperation of the European transmission system operators (TSOs)**. The 42 member TSOs, representing 35 countries, are responsible for the **secure and coordinated operation** of Europe's electricity system, the largest interconnected electrical grid in the world. In addition to its core, historical role in technical cooperation, ENTSO-E is also the common voice of TSOs.

ENTSO-E **brings together the unique expertise of TSOs for the benefit of European citizens** by keeping the lights on, enabling the energy transition, and promoting the completion and optimal functioning of the internal electricity market, including via the fulfilment of the mandates given to ENTSO-E based on EU legislation.

Our mission

ENTSO-E and its members, as the European TSO community, fulfil a common mission: Ensuring the **security of the interconnected power system in all time frames at pan-European level** and the **optimal functioning and development of the European interconnected electricity markets**, while enabling the integration of electricity generated from renewable energy sources and of emerging technologies.

Our vision

ENTSO-E plays a central role in enabling Europe to become the first **climate-neutral continent by 2050** by creating a system that is secure, sustainable and affordable, and that integrates the expected amount of renewable energy, thereby offering an essential contribution to the European Green Deal. This endeavour requires **sector integration** and close cooperation among all actors.

Europe is moving towards a sustainable, digitalised, integrated and electrified energy system with a combination of centralised and distributed resources.

ENTSO-E acts to ensure that this energy system **keeps consumers at its centre** and is operated and developed with **climate objectives** and **social welfare** in mind.

ENTSO-E is committed to use its unique expertise and system-wide view – supported by a responsibility to maintain the system's security – to deliver a comprehensive roadmap of how a climate-neutral Europe looks.

Our values

ENTSO-E acts in **solidarity** as a community of TSOs united by a shared **responsibility.**

As the professional association of independent and neutral regulated entities acting under a clear legal mandate, ENTSO-E serves the interests of society by **optimising social welfare** in its dimensions of safety, economy, environment, and performance.

ENTSO-E is committed to working with the highest technical rigour as well as developing sustainable and **innovative responses to prepare for the future** and overcoming the challenges of keeping the power system secure in a climate-neutral Europe. In all its activities, ENTSO-E acts with **transparency** and in a trustworthy dialogue with legislative and regulatory decision makers and stakeholders.

Our contributions

ENTSO-E supports the cooperation among its members at European and regional levels. Over the past decades, TSOs have undertaken initiatives to increase their cooperation in network planning, operation and market integration, thereby successfully contributing to meeting EU climate and energy targets.

To carry out its **legally mandated tasks**, ENTSO-E's key responsibilities include the following:

- Development and implementation of standards, network codes, platforms and tools to ensure secure system and market operation as well as integration of renewable energy;
- Assessment of the adequacy of the system in different timeframes;
- Coordination of the planning and development of infrastructures at the European level (Ten-Year Network Development Plans, TYNDPs);
- Coordination of research, development and innovation activities of TSOs;
- Development of platforms to enable the transparent sharing of data with market participants.

ENTSO-E supports its members in the **implementation and monitoring** of the agreed common rules.

ENTSO-E is the common voice of European TSOs and provides expert contributions and a constructive view to energy debates to support policymakers in making informed decisions.

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Executive Summary

Offshore wind energy is expected to be an important part of the European energy transition and a key contributor to reaching the targets in the EU Green Deal.

The electricity market design should ensure the efficient utilisation of resources by providing efficient price signals (incentives) to generators, consumers, storage and infrastructure operators both for short term operations and for long-term investments. A key issue is how to integrate massive amounts of offshore wind generation to the onshore markets in the most efficient manner.

The offshore market design can be configured in several ways. This paper discusses two main concepts:

- **the Home Market Concept (HM) and**
- **the Offshore Bidding Zone Concept (OBZ).**

The discussion of this paper relates to **future offshore developments**. It is important to ensure that short-and medium-term hybrid projects are neither delayed nor blocked, and they may need to be treated through individual arrangements. ENTSO-E also acknowledges that the regulatory framework might require further development in the future to account for the characteristics of a future integrated power system across onshore and offshore.

In this paper, ENTSO-E advocates for **applying a holistic perspective when choosing the market design concept** to be applied for the offshore HVDC-infrastructure, considering three key perspectives in addition to the perspectives of a wide range of important stakeholders.

The three identified key perspectives include:

- **Market efficiency,**
- **system operation efficiency and**
- **the alignment with policy objectives.**

In what follows, ENTSO-E provides **initial analysis and views on the first two perspectives** and identifies some of the **open questions to be considered** by policy makers.

The Home Market Concept

The HM concept is today commonly used for **radial connections of Offshore Wind Farms (OWFs)** and **offshore wind hubs to shore**. The market design solution for offshore interconnectors is also well established and does not distinguish market-wise if they are built on land or subsea.

The discussion of whether to apply the HM or OBZ concept applies to hybrid projects and multi-terminal configurations, where OWFs are connected to infrastructure that connects two or more bidding zones. Both concepts have pros and cons and require further analysis in several respects.

The Offshore Bidding Zone Concept

Based on current insights, the OBZ concept appears to be the **prominent solution when considering the efficiency of markets and system operations**, mainly as the OBZ concept provides a market solution that better reflects physical congestions and physical flows. The OBZ concept does, however, provide less market revenue to OWFs compared to the HM concept. Thus, the OBZ concept could require stronger support mechanisms (e.g. subsidies) to realise investments in socioeconomic efficient hybrid projects. **Policy makers would have to apply a holistic perspective**, considering how to best cater for all three key perspectives of efficiency of markets and system operations while simultaneously realising the political targets of the EU Green Deal.

ENTSO-E now calls on policy makers to consider the market design options and on the energy community to develop more insights into these issues and conduct a thorough discussion to ensure efficient market integration across land and sea for the long-term benefit of EU citizens.

1. Markets that Promote the Green Deal

The deployment of renewable energy sources needs to increase significantly to reach the target of net zero greenhouse gas emissions by 2050 contained in the EU Green Deal. Offshore wind energy is a huge opportunity for Europe, and offshore wind capacity is expected to increase significantly towards 2040.

There are many interlinked challenges related to the offshore renewable power system. In this paper, ENTSO-E addresses the challenge of developing a market design that integrates offshore wind energy efficiently into the European electricity markets onshore. In this document, ENTSO-E examines the future market design solutions for integrating energy from Offshore Wind Farms (OWFs) to the European electricity markets. The role of the market design is to facilitate efficient trading between market participants, promote secure operations and the efficient utilisation of resources, and provide relevant incentives for investments across the power system, including generation, grid infrastructure, storage and consumption.

The perspectives on market design vary between stakeholders. Offshore generators, onshore generators, consumers, hydrogen developers, some NGOs etc., all represent highly legitimate interests, and they all contribute with relevant and valuable insight to the European discussion on how to define the best possible future offshore market design.

The Transmission System Operators (TSOs) aim to optimise socioeconomic welfare, while keeping the system within security limits. However, even within this framework, ENTSO-E has identified three alternative perspectives (figure 1) that may provide dilemmas that require careful consideration and wise management by decision makers. **These three perspectives on market design form the basis for the discussion in this position paper.**

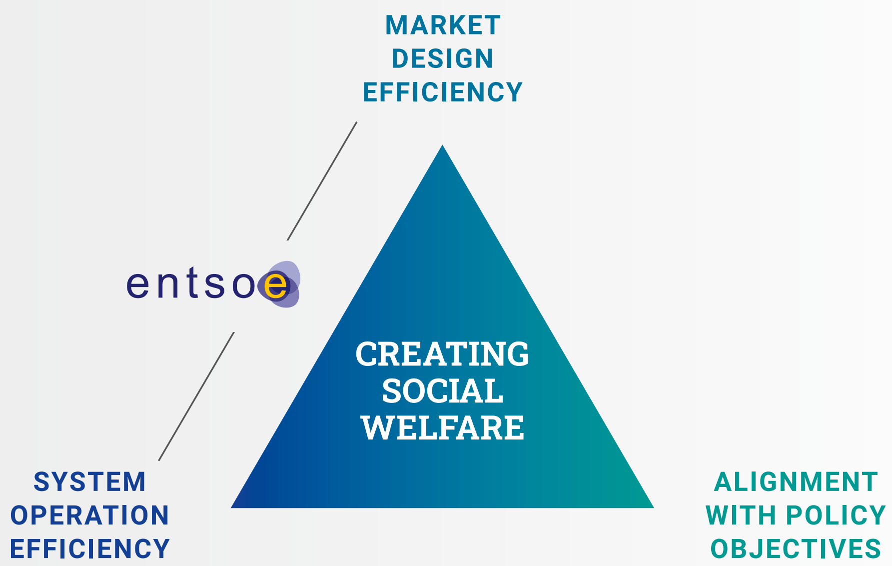

Figure 1: Three key perspectives on market design. The responsibility of TSOs and ENTSO-E relates to the efficiency of markets and system operations (the left axis of the triangle).

1.1 Market Efficiency

First, the perspective of market efficiency **requires price formation to reflect true costs and market outcomes to reflect physical electricity flows** to provide efficient price signals (incentives) for both the short-term day-to-day optimisation for real-time operations and for long-term developments. Within the physical limitations of the power system, efficient competition is encouraged to promote liquidity, system security and cost efficiency.

According to this principle, offshore wind generation should be fully integrated in the Internal Electricity Market (IEM) using the market algorithms employed in the European day-ahead, intraday and balancing markets. These solutions promote the economic and consistent dispatch of demand and supply, rational use of transmission assets and efficient congestion management across offshore and onshore markets. The market solutions must also be able to accommodate future sector integration, including offshore storage and load. **This view is very much a classic socioeconomic perspective** on electricity market design, focusing on the efficient utilisation of resources across borders and market timeframes.

1.2 System Operations Efficiency

Second, the perspective of efficient system operations **addresses the incentives for consumption and generation to have a balanced position and provide flexibility to the markets, to the extent that this is possible and efficient.** Reduced system imbalances will improve the security margins of system operations, which will allow for the faster integration of more renewables in the power system.

Secure electricity supply is the core function of the power system and the core job of the TSOs. To this end, TSOs provide the markets with a framework of physical limitations that the market must respect (i. e. transmission capacities). TSOs are regulated to apply a holistic and integrated perspective on system operations, considering system security, market efficiency and the ability to promote a renewable power system. **This perspective is very much aligned with classic socioeconomic perspectives**, as all commodity markets are designed to respect physical congestions and boundaries.

1.3 Alignment with Policy Objectives

Finally, the alignment with policy perspective relates to the **long-term policy perspective of policymakers**. Policymakers may intervene in the market with new policies that, for example, address market failures. Market failures may exist if markets fail to reflect externalities such as the cost of pollution and climate change. To this end, policy makers implement regulation and mechanisms that may affect markets and competition, such as targeted tariffs, taxes, support schemes and regulation, granting certain players unconstrained access[1] to infrastructure. **This perspective also aligns with classic socioeconomic thinking.** Markets are not perfect, and policymakers intervene on behalf of society. Such policy intervention must, however, be designed carefully to both deliver on its own merits and avoid the possible adverse effects.

This position paper[2] presents the ENTSO-E perspectives on offshore market design, considering the three perspectives identified above. The current most prominent market design concepts, the **Offshore Bidding Zone concept (OBZ)** and the **Home Market concept (HM)**, are described and discussed in more depth. In the future, other market design concepts may become relevant.

The paper rests on three key assumptions. First, existing projects and projects in a far stage of development have all assumed a certain market design setup. ENTSO-E recognises that these developments may need to be treated through individual arrangements and possibly through transitional periods to integrate with a future market design. Second, the discussion in this paper relates to a physical setup with HVDC interconnections. Finally, ENTSO-E recognises that market solutions shall comply with the intent of the European regulations, such as the Clean Energy Package, Capacity Allocation and Congestion Management Guideline as well as other relevant Guidelines. However, ENTSO-E also acknowledges that the regulatory framework might need to be further developed in the future to account for the characteristics of a future integrated power system across onshore and offshore.

1 Unconstrained access is different from priority dispatch. Unconstrained access to infrastructure means that capacity calculation takes into account the expected generation of the players in question thus resulting in lower cross-zonal capacity. Priority dispatch means that the generator is dispatched irrespective of the generation costs, and this is not compliant with the CEP.

2 This position paper builds on the ENTSO-E Position on Offshore Development and will be followed by position papers covering other elements related to the offshore renewable developments, including a paper on the distribution of roles and responsibilities related to system operation, investment and ownership of infrastructure.

2. Two Market Design Concepts

The future offshore grid configurations (figure 2) will be a mix of interconnectors between bidding zones (1), offshore wind connected to nearby shores (2 and 3), hybrid projects connecting offshore wind to interconnectors (4) and multi-terminal offshore hubs connecting multiple platforms and member states (with or without offshore wind being connected) (5). The choice of market design solution is well-established for the first three configurations. This paper, therefore, specifically addresses the market design for configurations 4 and 5.

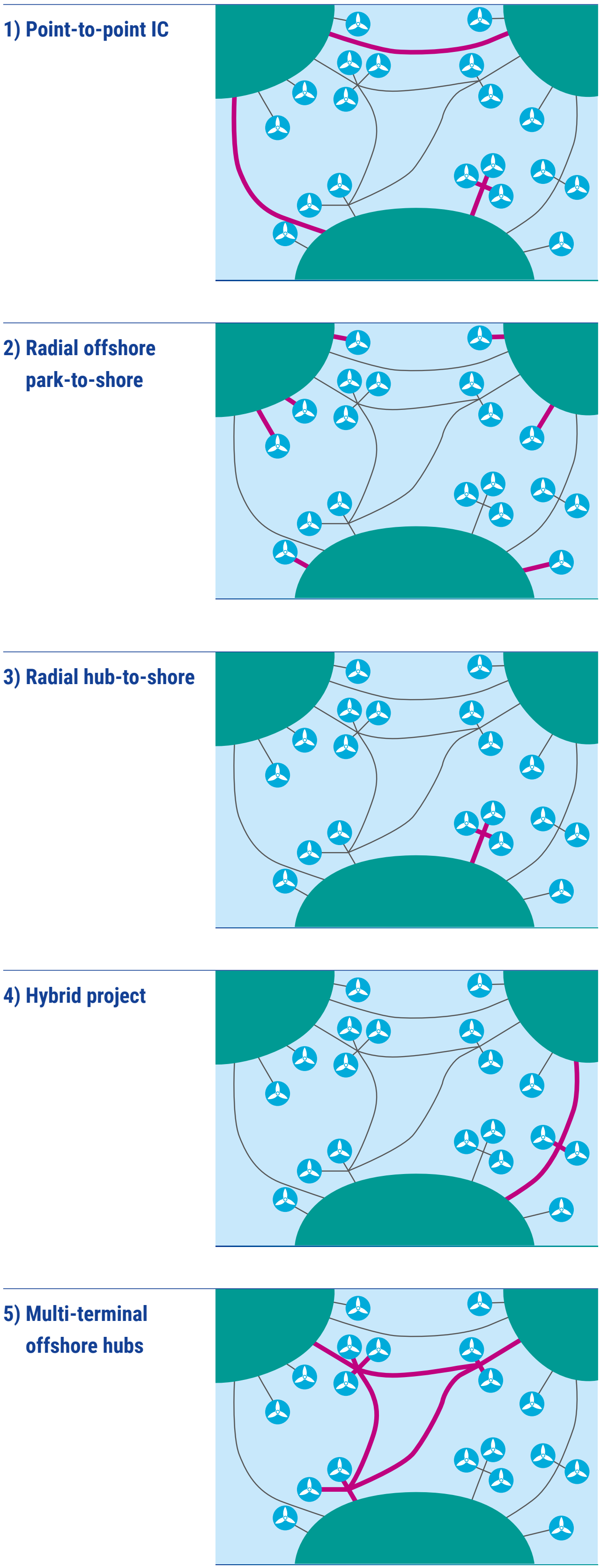

Figure 2: Alternative offshore grid configurations. c.f. NSCOGI study 2012

2.1 Configurations

Configuration 1 is a "regular" interconnector, connecting two bidding zones, without any flow influence of offshore wind farms. The flow is optimised by market algorithms in the European market coupling. In general, the flow is from the area with low price (surplus area) to the area with high price (deficit area). All generators in the low-price exporting area get the lower price in that bidding zone, and the TSOs earn and share a congestion rent on behalf of the tariff customers who have paid for the interconnector.

In configurations 2 and 3, offshore wind is connected to only one bidding zone (home market). The OWF earns the price of the home market and operates as if it was located on shore in that bidding zone.

Configuration 4 is a technical setup that combines configuration 1 with configuration 2 or 3 and is therefore called a hybrid asset. This technical setup differs significantly from configurations 1, 2 and 3, because it enables competition for capacity between the exporting side of the interconnector and the connected offshore wind farm(s). Offshore wind power can, marketwise, be treated in several ways. Two concepts are discussed: the OBZ or the HM concept.

2.2. Applying Concepts

The rationale for applying one of the currently most prominent concepts could be the following:

OBZ[3]:

OWFs compete with market players in the onshore bidding zone for access to interconnection capacity. Hence, the price of the offshore bidding zone and the dispatch of the OWF depends on the neighbouring onshore bidding zones. The offshore price will, in general, be equal to the price of the bidding zone to which there is no congestion (the surplus bidding zone that is exporting).

OWFs (hubs) form one or multiple separate offshore bidding zones, in which the offshore wind farms submit bids and are dispatched. The number and sizing of the potential offshore bidding zones would need to be investigated further, as they have to reflect the physical setup. In the day-ahead timeframe, the market coupling algorithms will match offshore generation with onshore and/or offshore demand, calculate the electricity price in the offshore bidding zone equal to the onshore connected bidding zone with the lowest price[4] and determine the dispatch of the offshore wind farms. The utilisation of the grid connections will be a result of the day-ahead market coupling optimisation. The offshore windfarms will be exposed to their own imbalance price.

HM Concept:

The offshore connection is marketwise split into two parts – a connection between the offshore power plant and the onshore grid (its HM) and an interconnection between the power plant and the foreign market. The power plant is part of the HM and will always bid and dispatch into one existing, onshore bidding zone (its HM) and will thus always receive the electricity price of this bidding zone, irrespective of the direction of the flow. To reduce the need for countertrading, the import capacity towards the HM from other bidding zones will most likely be reduced depending on the expected generation of the OWF. OWFs will, as part of the HM, also be exposed to the imbalance settlement price of the HM.

2.3. Applying Algorithms

The algorithms applied in the European market coupling will be used to optimise the flows and prices for both concepts. The optimisation may lead to the same market outcomes (prices and flows) for the two market design concepts; however, the market outcomes may also differ, as discussed in the next section.

Configuration 5, the multi-terminal offshore hub, is in principle several hybrid projects (configuration 4) combined into a meshed grid. The sizing of the offshore hubs needs to be investigated, given that this is important for the topics discussed in this paper. Although the situation is more complex than in the previous case, the discussion of the OBZ and HM concepts for hybrid configurations is also relevant for configuration 5. Algorithms in the European market coupling will also, in this case, promote efficiency for both concepts.

The following sections discuss the pros and cons of the two alternative concepts considering the three perspectives defined earlier in this paper – the perspectives of market design efficiency, system operation efficiency and alignment with policy objectives.

The hybrid project (configuration 4) is considered as it illustrates both configurations 4 and 5, whereby offshore capacity is exposed to competition across sea and land.

In configurations 1, 2 and 3, well-established solutions will continue to be applied.

3 The example illustrates price and dispatch effects in a region applying coordinated NTC-approach. For regions applying the flow-based approach, these effects are more complicated depending on onshore congestions, though following a similar logic

4 It may, however, deviate from a flow-based methodology

3. The Market Efficiency Perspective

The choice for the HM or OBZ design has a distributional effect on welfare. The reason for this is that in the HM design, the OWF has unconstrained access to the onshore bidding zone (its home market), whereas this is not necessarily the case for the OBZ design. ENTSO-E does not have a political view on the distributional effects, and the issue is dealt with in a later section of this paper.

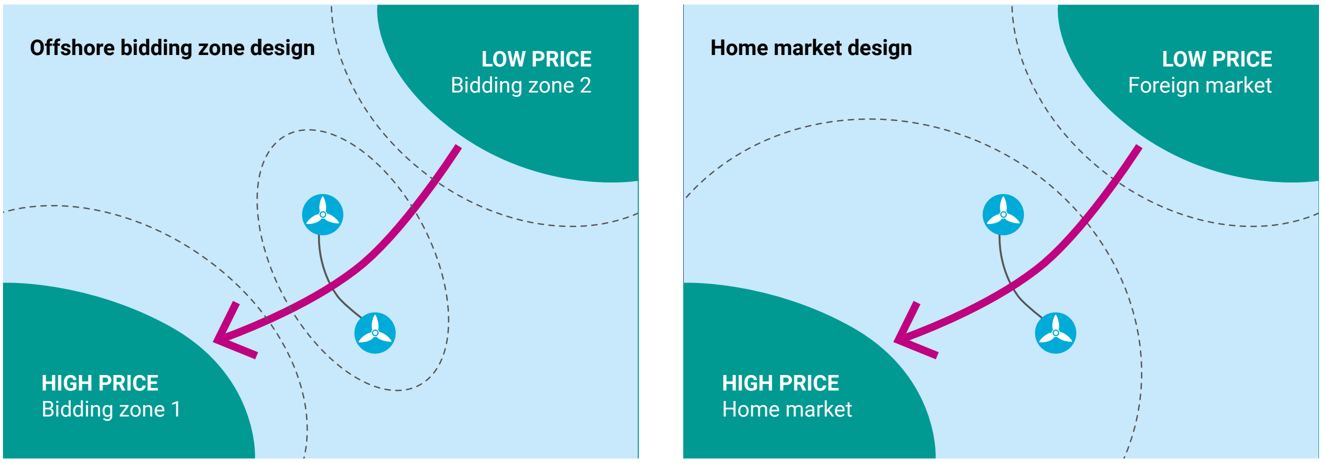

Figure 3: A comparison of the OBZ and HM market design when the market flow is towards bidding zone 1 or the home market

The simple example in figure 3 illustrates the case with imports to the home market or bidding zone 1 in a hybrid configuration.

- In the OBZ concept, the OWF will be part of the exporting side of the market (in line with physics, as congestion is between the OWF and bidding zone 1), and the price in the OBZ will be equal to the low price in the exporting zone.
- In the HM solution, the OWF will be part of the bidding zone of the home market and hence receives its (potentially) higher price. This means that there is no capacity constraint between the OWF and the home market bidding zone from the perspective of the OWF. The remaining transmission capacity of the hybrid configuration that is allocated to the market is reduced (or increased, depending on the direction) with the forecasted offshore wind infeed.

The day-ahead dispatch is, in this case, likely to be the same with both concepts[5].

In the case where the market flow is in the opposite direction, as in the case of Figure 3, the OBZ and HM concepts will result in the same dispatch and the same market price to the OWFs (the market flow from bidding zone 1 or the HM towards the bidding zone 2 or the foreign market). This is because bidding zone 1 or the HM is exporting and the congestion is then moved to be between the OWF and bidding zone 2 or the foreign market.

In short, the day-ahead dispatch is likely to be the same for both market solutions. The market outcomes will only differ when the marginal price of the OWF is higher than the price of one or more of the connected bidding zones, and in such cases the dispatch of the OBZ concept is more efficient. However, even if the dispatch is the same in the two market solutions, the market price for the OWF may differ, depending on the direction of the market flow.

Finally, it is difficult to anticipate the effects that the HM concept will have on the market dispatch in a more complex meshed structure, with connections to several bidding zones and with several OWFs located in waters of different states.

5 The dispatch will differ if the market price in the foreign market is lower than the marginal cost of the offshore wind (e. g. when prices abroad are negative).

Thus, from a market efficiency perspective, the OBZ concept seems to provide a more efficient solution. The OBZ concept reflects physics (congestions) and costs and facilitates open competition across onshore and offshore. OWFs will experience lower market revenues, which is a policy issue revisited in a later section.

A second finding is that the OBZ concept is compatible with implementing flow-based methodology in the market algorithms, whereas it is questionable whether this is possible with the HM concept. Both concepts seem to be compatible with the Net Transfer Capacity (NTC) approach.

Furthermore, the market design concept must be scalable given the expected expansion of offshore wind developments. Further analysis is required to build understanding in this field. However, the OBZ concept will benefit from reflecting physical congestions and from being a transparent and pure market optimisation solution. Nevertheless, given the potentially lower market prices for OWF in the OBZ design, increased support schemes may be necessary. The impact on the different algorithms and systems used in capacity calculation and allocation needs to be assessed, in particular with regards to the implementation of new bidding zones.

Finally, in the HM solution the TSOs will become accountable for wind forecasts, as part of their responsibility for capacity calculation. The wind forecasts have a significant impact on the capacity calculations in the HM solution. In the OBZ concept, the role of TSOs is separated more clearly and transparently from the role of the OWF developer, addressing the issue of forecasting errors.

The OBZ concept seems to be the preferred solution from a pure market efficiency perspective as it leads to equal or, in some circumstances, more efficient price formation, better reflects physical congestions and flows, and improves competition for capacity. The HM concept grants unconstrained access for the OWF to the home market, and this is the single feature that separates the two market design concepts from each other. This unconstrained access could create market inefficiencies for the HM concept.

4. The System Operation Efficiency Perspective

The system operation efficiency perspective addresses how the OBZ and HM concepts affect the efficiency of the balancing markets. As seen in the simple case of a single hybrid connection (figure 3), the market dispatch will, in most cases, be the same. However, as real time approaches and actual OWF generation differs from day-ahead forecasts, the consequences of the two market designs become more significant even in such a simple case. In the following key features, the two alternative market design concepts are discussed.

4.1 Discussion of the OBZ Concept

The OBZ concept is generally in line with the existing European balancing practices. This means that the OWF operator is responsible[6] for any imbalances that they impose on the system, assuming it to be a Balance Responsible Party (BRP). The TSO responsible for the respective balancing area resolves the remaining imbalances[7].

The main difference is that both the OWF operator and the TSO will have to use resources in other bidding zones for their balancing (SIDC for the OWF and/or MARI/PICASSO for the TSO). The question of who will ensure the availability of those balancing resources and how they are coordinated requires agreements on a supra-national level.

The export capacity from the OBZ limits the incentives to generate in the OBZ. Generators have no incentive to generate more than what can be transported to shore. In the case of less than 100 % generation in the OBZ, the market uses the interconnection capacity for transit between the low-price and high-price bidding zones. As such, there is available export capacity from the OBZ towards the low-price market in the event of a positive imbalance. In the event of a negative imbalance, the OBZ can be balanced from both connected markets, as either the flow towards the high price market can be reduced or the flow from the low-price market can be increased. This available capacity will allow both the BRP to balance its perimeter or the TSO to balance its imbalance area in the OBZ. Given that the OBZ is an offshore imbalance price area, the OWF will have the financial incentive to react to the imbalance price of the offshore bidding zone.

As such, with an OBZ there will always be sufficient transmission capacity available to allow generation, which has an economic value.

4.2 Discussion of the HM Concept

As for the OBZ concept discussed above, the HM concept is also generally in line with the existing European balancing practices. However, the HM solution implies greater TSO intervention. In the HM concept, the TSO gives firm cross-zonal capacity to the market, accounting for the forecasted generation from the OWF. If actual offshore generation exceeds the expectation, more energy will all-else-equal need to flow towards the home market than can be allowed physically (still assuming the case in Figure 3 where the HM is the high price area). For the OWF operator, however, this is irrelevant, as they are part of the home market[8] and belong to the same imbalance price area. As such, they are free to sell any positive imbalance in the intraday market either in the home market or through the home market to a buyer in a connected market.

As the transmission capacity might be insufficient to let the additional offshore generation flow to the home market, the

6 An OBZ is an offshore imbalance price area

7 Most likely, an already existing onshore TSO will be the TSO for the offshore bidding zone. Exactly which TSO will need to be determined on a case-by-case basis.

8 As the physical congestion is not visible in the market solution

TSO could face a congestion management problem. As such, the TSO would need to curtail or export the additional offshore generation and increase onshore generation accordingly; this could increase overall system costs. Alternatively, the imbalance could be pushed to the other onshore bidding zone, creating unintended deviations between the two onshore hubs. Therefore, the home market design implicitly shifts parts of the imbalance responsibility from the OWF operator (BRP) to the TSO of the home market.

The OBZ concept seems to also be the preferred solution from a system operation perspective. The OBZ concept leads to less TSO intervention in the market.

The table below summarises the discussion of the two concepts from a system operation perspective.

Offshore Bidding Zone Design	Home Market Design
› Offshore grid constraints are fully considered in the market design in these timeframes	› Offshore grid constraints are only partially considered in the market design in these timeframes
› Offshore imbalances and intraday trades don't have a major impact on TSO costs/risk	› Positive day-ahead imbalances might trigger additional redispatch- and countertrading measures
› Imbalance settlement reflects true balancing costs (balancing energy prices in the offshore bidding zone)	› Additional congestion management costs imposed on TSO
› Sufficient cross-border capacity to allow (self-) balancing is always available.	› Some risk of FRR-usage exists in case intraday trade happens just before gate-closure time.
	› Sufficient cross-border capacity to allow (self-) balancing is always available

Table 1: Comparing market design concepts from the perspective of system operations.

5. The Alignment with Policy Objectives Perspective

In the two previous chapters, market design concepts were discussed from the perspectives of efficient markets and system operations. These two perspectives work to enhance overall resource efficiency, a core element of the EU Green Deal. Indeed, efficient markets and system operations promote the efficient use of investments and resources in the electricity system.

The markets are, however, not perfect, and policymakers may, to various degrees, decide to intervene in the design of markets to address market inefficiencies and counter undesired effects from externalities. As described in the previous section, neither of the two discussed market concepts are without issues. In the following, some political dilemmas are addressed.

Market integration.

A political dilemma relates to the combined political request for development of OWFs and for more integration of markets, cross-border trading and competition. To promote cross border integration and trading, there is a policy in place to ensure that 70 % of cross-border capacities are made available to the market coupling day-ahead. However, it is not possible to combine this policy with one of granting OWFs with unconstrained access in hybrid and meshed configurations. Thus, the HM concept comes with a political dilemma, as it is not compatible with the 70 % requirement. There is no such dilemma with the OBZ concept. If the HM concept is applied, exemptions from the 70 % requirements will most likely have to be granted to hybrid and multi-terminal configurations in order to limit redispatching and countertrading needs.

Allocation of CO_2 credits.

Another political dilemma, which is valid for both concepts, relates to the allocation of CO_2 credits in the event of multi-national generation setups. According to the Renewable Energy Directives I and II [9], Member states (MS) can collaborate on the exploitation of renewable energy sources. This means that one MS can potentially realise cheaper RES projects at a lower cost through access to RES in another MS. So far, there have been few examples to learn from, thus a methodology or guideline of how to allocate the credits to the MSs has not yet been established. This is currently more or less based on negotiations between the countries involved. In contrast, the allocation of costs and benefits for interconnections is clearly defined in the TEN-E regulation[10] for projects of common interest (PCI), and is based on extensive and detailed simulations according to the EU's Cost–Benefit Analysis (CBA) methodology, which is applied in ENTSO-E's Ten-Year Network Development Plan (TYNDP). Among the calculated indicators are savings of CO_2, both as part of the socioeconomic value in M€ and in tons. In the case of hybrid projects, generation and transmission assets are combined. Based on the above differences between assessment methodologies of transmission and generation, it looks difficult to combine the CO_2 benefits originating from both components of the hybrid project.

9 Directive 2009/28/EC and Directive (EU) 2018/2001.

10 Regulation (EU) 347/2013 – which has recently been opened for revision


Financial support for wind generation and realisation of RES targets.

Policymakers have shown a willingness to provide financial support for the development of OWFs. The choice of market design concept also affects the market revenues of OWFs. The OBZ concept is attractive from the perspective of market efficiency and system operation, as it efficiently reflects congestions and promotes competition, whereas the HM concept grants wind generators unconstrained access to the HM and higher overall expected market revenues. Lower revenues to OWFs under the OBZ concept may make radial connections more attractive to OWFs. Thus, stronger support mechanisms (e. g. subsidies) may be required to realise investments in hybrid projects and the related RES targets. This raises the question of which Member State will fund such support mechanisms to OWFs connected to several Member States. The complexity of this question also depends on the sizing of the OBZs. However, the trend of falling costs of wind technology could also counter these effects by limiting the need for financial subsidies in the future. From a political perspective, the OBZ concept may be viewed as more controversial, as, to a greater extent, it touches upon the discussion of cross-border RES support.

ENTSO-E does not have a political view on the scoping and dimensioning of political measures such as support schemes for OWFs. However, ENTSO-E would ideally prefer policies that accommodate all three key perspectives simultaneously.

ENTSO-E calls on policymakers to account for and balance all the different developments and perspectives, consider their costs and benefits, decide on a market concept and create a stable investment environment that can both attract investors, ensure overall resource efficiency and provide secure system operations.

6. Tentative Conclusions

ENTSO-E wants a market design that accommodates social welfare and resource efficiency through efficient markets and system operations that also deliver on the policy objectives of the EU Green Deal.

The table below is a summary of the above discussion of the two market design concepts. From the current perspective, the OBZ concept seems to be a promising concept for future offshore hybrid projects and meshed HVDC projects, when considering the efficiency of markets and system operations. However, the OBZ solution is expected to reduce revenues for offshore wind farms (compared to the HM concept) when the market flow is towards the home market. Thus, the willingness of wind farms to participate in hybrid solutions could suffer. The need for transitional arrangements and/or targeted support schemes would have to be investigated for hybrid and multi-terminal configurations to ensure the future expansion of offshore wind in line with RES targets.

The conclusion has the label "tentative", as further analysis is required in several areas. There are still some open questions related to the implementation of the currently promising OBZ concept. Areas for further investigation include the effects on responsibilities, balancing and intraday market rules, various political aspects and the method of efficiently integrating offshore and onshore markets.

The combined set of regulations across the power system will affect the willingness to invest in both OWFs and offshore infrastructure, and it should therefore ensure the most efficient and coherent investments from the perspective of society at large. Together with the entire community of energy companies, offshore developers, governments, regulators, NGOs and academia, ENTSO-E wants to discuss new insights and ideas for how to develop an offshore power market design that integrates well into the onshore power system. The overall target is to provide Europeans with clean, secure and affordable energy.

	Issues	Offshore Bidding Zone Concept (OBZ)	Homemarket Concept (HM)	Tentative Conclusions & Further Work	
SYSTEM OPERATION EFFICIENCY	**Demand for TSO intervention**	Less redispatch and counter trading than for HM	More redispatch and countertrading than for OBZ	**OBZ provides the more efficient solution as it requires less TSO redispatch and counter-trading.** **Further analysis is required.**	**Tasks for TSOs**
MARKET DESIGN EFFICIENCY	**Distribution of roles and responsibilities between TSOs and OWF developers**	Clear and transparent. No additional need for TSOs to forecast wind generation for capacity calculation	Mixed TSO role. Need for TSOs to forecast wind generation for capacity calculation	**OBZ seems to provide the more efficient solution.** **Some Issues require further analysis.**	
	Scalability to meshed offshore system	Theoretically, transparent and no major increase in complexity, thus scalable. No major impact on capacity calculation expected. Impact on market coupling algorithm runtimes needs to be investigated.	Theoretically, complex and potentially intransparent. Major impact on capacity calculation expected. However, no major impact on market coupling algorithm runtimes expected.		
	CEP 70 % requirement	Full compatibility. 100% capacity allocted to the market.	Not compatible. < 70 % allocated to the market during significant wind infeed		
	Flow-based compatibility (Advanced Hybrid Coupling)	Full compatibility.	Hardly compatible (not yet analysed in depth)		
	Competition and equal market access to capacity	Full competition across onshore and offshore, also when flow towards “home market”. Markets reflect physics and costs.	Unconstrained access to offshore wind limits competition across onshore and offshore when flow towards home market. Markets don’t fully reflect physics and costs.		
ALIGNMENT WITH POLICY OBJECTIVES	**Market Revenues to OWF**	Lower market revenues than in HM when energy flows towards “home market” (else equal)	Higher market revenues than in OBZ when flow towards home market (else equal)	**Policymakers to consider policy options (e. g. subsidy schemes for OWFs (who pays?) and allocation of CO_2 credits to be clarified in the GREEN DEAL context). Related impacts on efficiency of market and system operations to be considered as well.**	**Tasks for Politicians**
	Allocation of CO_2 credits	Allocation of credits unclear for multi-national setups.	Allocation of credits unclear for multi-national setups.		

Table 2: Overview of discussion of OBZ and HM concepts for hybrid and multi-terminal configurations

Abbreviations

Acronym	Meaning
ENTSO-E	European Network of Transmission System Operators for Electricity
AC	Alternating Current
BRP	Balance Responsible Party
CBA	Cost-Benefit Analysis
CEP	Clean Energy Package
DC	Direct Current
HM	Home Market concept
HVDC	High-Voltage Direct-Current
MS	Member State
NRA	National Regulatory Authorities
OBZ	Offshore Bidding Zone concept
OWF	Offshore Wind Farm
TSO	Transmission System Operator
TYNDP	Ten-Year Network Development Plan

Way forward

ENTSO-E is prepared to contribute to offshore development and to be involved in upcoming debates about how this can best be organised. This position paper, which contains the ENTSO-E position on offshore development market and regulatory Issues, will be followed in the upcoming months by further publications.

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