By EU and UK TSOs:

25 September 2025

Joint report for the Specialised Committee on Energy - Multi-Region Loose Volume Coupling (MRLVC)

Investigating any barriers to the delivery of joint and hybrid offshore projects that may result from existing trading arrangements or MRLVC, and any specific changes needed to existing trading arrangements or specific requirements of the design of MRLVC needed to deliver efficient electricity trading that supports the delivery of joint and hybrid offshore projects.

Executive Summary

Following Recommendation No. 1/2024 of 19 December 2024 issued by the Specialised Committee on Energy (SCE)[1], UK Transmission System Operators (TSOs) and EU TSOs (coordinated by ENTSO-E) were tasked to provide a joint answer on a set of technical questions on Multi-Region Loose Volume Coupling (MRLVC), the trading arrangement introduced by the Trade and Cooperation Agreement (TCA) between UK and EU.

In particular, following the UK's withdrawal from the EU (and consequently the Internal Energy Market (IEM)), Article 312 of the TCA establishes the need for the SCE to implement a specific model to trade over EU-UK interconnectors. Annex 29 of the TCA designates MRLVC as the market coupling arrangements to be implemented.

This report addresses the questions raised in Recommendation No. 1/2024 of the SCE. It is the result of joint work of UK TSOs and those European TSOs directly connected to the UK, with review and approval by all EU TSOs. This report builds on previous work that was mandated by the SCE, that is a Cost Benefit Analysis (CBA) published in 2021[2] and a first set of answers to technical questions published in 2023[3] in response to the SCE Recommendation No. 1/2023 of 7 February 2023[4].

Chapter 2 explores the operational impact of MRLVC on Single Day-Ahead Coupling (SDAC) and the GB Day-Ahead Market (GB DAM) processes. Different operational timelines are presented to show how the introduction of MRLVC would influence the processes in the two markets in a normal day scenario without incidents, and in scenarios with potential decoupling incidents.

Developments in GB and EU markets have not yet changed the design of MRLVC previously presented. However, the summer update (July 2025) on GB's Review of Electricity Market Arrangements (REMA)[5] indicated that shortening GB settlement periods from 30-minutes to 5- or 15-minutes is still being considered as part of the reform package which poses considerations for future computation time needed for MRLVC. In the EU, SDAC is implementing a shift to 15-minute market time units (MTU) that will change the duration of the current processes. New timings and deadlines in SDAC have been taken into account in this report.

The market development in the UK and EU, and the go-live of new point-to-point interconnectors and hybrid interconnectors (with the establishment of new offshore bidding zones), are expected to be translated into an increase of the minimum time needed by the end-to-end MRLVC process. There is a consensus among experts that minimum duration of MRLVC timing shifts to the upper range of the timescales estimated in 2023, from 13 - 42 minutes to a minimum of 30 minutes.

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[1] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202500706

[2] https://consultations.entsoe.eu/markets/cost-benefit-analysis-of-multi-region-loose-volume/supporting_documents/MRLVC_CBA_summary_report_April_2021_final_publication.pdf

[3] https://eepublicdownloads.blob.core.windows.net/public-cdn-container/clean-documents/Network%20codes%20documents/MESC/2024/230710_MRLVC%20report_redactions%20for%20publication%20Feb2024_clean.pdf

[4] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A22023D0425&qid=1678350572355

5 https://www.gov.uk/government/publications/review-of-electricity-market-arrangements-rema-summer-update-2025/review-of-electricity-market-arrangements-rema-summer-update-2025-accessible-webpage

The introduction of MRLVC compared to the current arrangements will increase operational risks in both EU and GB. In the EU market, there are no feasible designs of MRLVC that would allow for reasonable contingency time to avoid increasing the probability of partial decoupling, and the likelihood that it can become a full decoupling. This is particularly acute in relation to the Single Electricity Market (SEM) on the island of Ireland. As a consequence, it was not possible to produce an optimal timeline that can successfully integrate MRLVC with SDAC while maintaining the operational integrity of SDAC.

Operational risks will also affect other timeframes. Regarding the EU intraday market, a specific delay during the finalisation of the Day-Ahead (DA) session leads to the automatic cancelation in advance of the first Single Intraday Coupling (SIDC) intraday auction (IDA) run for the same delivery day. The introduction of any additional mechanisms in the existing timeline, having impacts on SDAC execution, will have indirect impacts on SIDC as well.

The GB Day-Ahead Market (DAM) today has fewer procedural steps and needs a shorter running time than SDAC. However, it has been reviewed that any delay to the GB DAM publication time could lead to impacts on GB's National Energy System Operator's (NESO) control room processes and lead to less efficient operational decisions, i.e. impacts on planning, scheduling and coordination activities, for interconnectors operators.

Chapter 3 presents a draft tender specification for a prototype for a Bordering Bidding Zone (BBZ) Net Position Forecaster (alternatively referred to as “the Forecaster”). The specification includes an overall description as well as a methodology to be employed. Although not explicitly sought, the inputs for the Machine Learning Algorithm (MLA) are included as a separate section. This helps the reader to logically understand what goes into, as well as what comes out, from the model. The specific outputs that are required from the Forecaster are detailed. Tenderers are also asked to deliver an online dashboard to help visualise the net positions.

In order to address future market developments, tenderers are explicitly asked to explain how the prototype would deal with the consequences of bidding zone reconfiguration and the extension of the solution to other known bidding zones. Additionally, the solution needs to be able to accommodate other likely, but not necessarily known, changes such as technological advancements to aid processing time improvements.

The draft specification chapter explains how the outputs from the Forecaster will be inputted into wider MRLVC processes. The assumption is that the MRLVC can use existing Price Coupling of Regions (PCR) IT tools. Some other key requirements are included, such as quality parameters. Tenderers are asked to provide evidence of how testing and validation will be done to ensure accuracy and robustness. A suggested benchmark for the Key Performance Indicator (KPI) is included to help evaluate the performance of the prototype.

An accompanying note to the specification includes important background information. Options around ownership are explained as well as issues relating to Intellectual Property Rights (IPR). A detailed step-by-step breakdown of the anticipated timing of the work is included as well as an estimate of the costs. The report addresses relevant issues related to administrative functions. Annex A includes an illustrated table of contents for a Pre-Qualification Questionnaire (PQQ) which could fit into a potential future tender document.

Finally, Chapter 4 analyses the potential barriers that MRLVC would present in the development of offshore infrastructure in the North Sea, with a particular focus on hybrid projects (see Chapter 4.1

for EU and UK definitions of hybrid assets). For completeness, explicit allocation is also analysed as it is the existing trading arrangement on most of the GB-EU borders.

The analysis considers the preferred market design for offshore hybrid projects which correspond to that of an Offshore Bidding Zone (OBZ) configuration, likely to be implemented both in the EU and GB to efficiently allocate the capacity of the offshore wind and cross-zonal flows of the interconnectors.

Price formation in the OBZ will depend on its imports and exports, which are automatically handled under full price coupling, but must be forecasted under explicit allocation and volume coupling. By construction, MRLVC results in a sub-optimal price formation, as once the UK exited the EU it could not participate in the governance arrangements required to maximise efficiency. In particular, MRLVC uses a volume coupling methodology which delivers inefficient results in OBZs when the line between the OBZ and SDAC is congested. Moreover, the loose characteristic of MRLVC relies upon the use of the BBZ Net Position Forecaster. This represents a challenge with flow-based capacity coupling implemented in SDAC and with advanced hybrid coupling.

Following the analysis on the expected performance of MRLVC, its impact on business cases for offshore transmission and generation is presented. The report concludes MRLVC would lead to lower congestion rents and therefore will reduce the social welfare created for the connected countries. For offshore wind developers MRLVC will cause suboptimal compensation from Contracts for Difference (CfD) and Financial Transmission Rights (FTRs) payments and the increased costs and risks to adjust their position on intraday. EU and UK TSOs conclude that specific changes to MRLVC cannot be identified that improve its compatibility with offshore developments in EU and UK and specifically hybrids.

Taking the analysis into consideration, along with previous work delivered to the SCE, EU and UK TSOs conclude MRLVC is not a trading arrangement that can ensure operational stability in electricity markets and the right certainty for investing in offshore infrastructure.

The 2021 CBA suggested there could be potential welfare gains if MRLVC was implemented successfully. However, this report identifies that the risk to successful implementation is very high. As a result, there is a high risk that hypothesised welfare gains are not realised. A more recent 2024 report[6] commissioned by EirGrid and SONI, suggests that there is no certainty that MRLVC would be an improvement on the status quo arrangements between the Single Electricity Market (SEM) and GB.

The EU and UK TSOs are unable to confirm the validity of the concept of MRLVC based on the work carried out in this, and previous, reports.

Moving from the current trading arrangements to MRLVC does not solve the offshore hybrid project investment challenges as it introduces a significant economic uncertainty. Moreover, a move to MRLVC leads to increased operational risks for both markets jeopardising the stability and efficiency of SDAC. While MRLVC theoretically offers some benefits on the status quo, the work of TSOs across the last 5 years demonstrates that these potential benefits are outweighed by significant risks.

[6] For instance, the 2024 "Beyond borders: Unlocking the power of UK-EU offshore wind coordination" report by Baringa suggests there is no certainty that MRLVC would improve on status quo arrangements between the Single Electricity Market (SEM) and GB.

1. Introduction

1.1. Mandate for this report

Following the meeting of the Specialised Committee on Energy (SCE) of the 7th of November 2024[7], the European Commission (EC) and the UK's Department for Energy Security and Net Zero (DESNZ) (the "Requesting Parties") mandated the European Transmission System Operators (TSOs) (coordinated by ENTSO-E) and the UK TSOs respectively to deliver a joint analysis[8] on Multi-Region Loose Volume Coupling (MRLVC), the electricity trading arrangement agreed to be implemented in the Trade and Cooperation Agreement (TCA) between the European Union and the United Kingdom of Great Britain and Northern Ireland.

EU and UK TSOs delivered two previous reports to evaluate the feasibility of MRLVC including a Cost Benefit Analysis[9] (CBA) in 2021 and a report responding to technical questions[10] in 2023. Both reports identified fundamental design issues with MRLVC which this latest analysis seeks to address in response to the most recent SCE questions.

1.2. Previous Work

2021 Cost Benefit Analysis

The 2021 CBA assessed costs and benefits and discussed the various advantages and challenges faced by the operation and implementation of two different MRLVC design options: Preliminary Order Books (POBs) and Common Order Books (COBs). The analysis further compared these two options with the existing and planned potential arrangements on interconnectors between the UK and the EU (counterfactuals), such as Intraday (ID) implicit allocation (price coupling) as in place for the GB-SEM (Irish Single Electricity Market) border, DA implicit (for the GB-Norway North Sea Link interconnector), and DA explicit (as on all other borders).

The 2021 CBA concluded that MRLVC can potentially provide improved economic welfare compared to existing explicit allocation mechanisms, but this is heavily dependent on the quality of the BBZ forecasting methodology. As a consequence, it is clear that a critical feature of the proposed MRLVC design is the use of a forecast for the net commercial flows to, or from, each of the BBZ to the rest of the IEM – i.e. a forecast of the net position of each BBZ, excluding flows between BBZs and the UK, that will be later computed in SDAC. This BBZ forecast would be calculated by the bordering EU TSOs based on a BBZ methodology to be developed in the implementation phase.

The CBA concluded that MRLVC performance would be highly sensitive to/reliant on the BBZ flow forecast methodology being able to produce a reasonably accurate forecast, and that the BBZ flow forecast largely determines the quality of, and market confidence in, the MRLVC arrangements. There was no certainty a BBZ, in conjunction with MRLVC, will provide better answers to the offshore challenges compared to explicit auctions.

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[7] Specialised Committee on Energy – minutes of the Meeting on 7th November 2024

[8] EUR-Lex Document 22025D0706 Recommendation No 1/2024 of the Specialised Committee on Energy

[9] Cost Benefit Analysis of Multi-Region Loose Volume Coupling (MRLVC) from the EU and UK TSOs MRLVC group, April 2021

[10] Responses from the TSO group to the technical questions on Multi-Region Loose Volume Coupling (MRLVC), July 2023

The 2021 CBA further highlighted that there were several critical implementation challenges to address related to, inter alia, establishing new frameworks, business processes, concepts etc. and that the implementation costs and timeline for an MRLVC solution were dependent on further clarifications and choices. As the CBA was conducted by an independent third-party at the request of EU and UK TSOs, TSOs caveated the independent third-party modelling tool does not capture all the complexities in determining the socio-economic welfare benefits associated with cross-border allocation mechanisms.

2023 Report

The 2023 report was written by EU and UK TSOs after the SCE requested further analysis of MRLVC following the previous evidence provided. The report considered i) the POB MRLVC design; ii) SDAC timings and MRLVC; iii) quality of the BBZ Net Position Forecaster; and iv) MRLVC delivery timeframe and associated costs.

Regarding the POB MRLVC design, the 2021 CBA discussed that it requires the use of a preliminary SDAC order book created at the time of submission of UK order books (OBKs). These OBKs would be used to run MRLVC in advance of SDAC Gate Closure Time (GCT). Answers to the technical questions raised in the 2023 report further emphasise that no adequate solutions were identified that can sufficiently prevent market manipulation if preliminary OBKs are used.

To answer technical questions related to COB and SDAC timings in full, TSOs examined all potential variables that influence and determine how MRLVC could operate alongside the existing SDAC process. A highly technical and detailed breakdown of SDAC operational process and timings was provided with technical owners of this process, with Nominated Electricity Market Operators (NEMOs) and other expert parties contributing and providing unbiased assessment of the feasible introduction of changes to accommodate MRLVC.

The 2023 report concluded that MRLVC is a complex multi-jurisdictional delivery program that will introduce significant changes to existing, stable pan-European and UK electricity marketplaces with trade-offs between system and operations risks and welfare gains. Timeline estimations for the implementation of complex projects, like the implementation of MRLVC, are very difficult, especially for the design phase. The initial estimate of the overall time needed to implement the MRLVC project (for the COB and similarly for the POB designs) benchmarked against similar projects is 4 years and 4 months. Based on that estimated duration, the overall high-level costs for the MRLVC and SDAC streams are estimated at around €27 million, including a 40% contingency – not including the cost of procuring the BBZ Net Position Forecaster, as well as operation costs and local implementation costs.

The key findings of the 2023 report were developed considering the status quo of the EU and GB electricity markets, without making presumptions of further important policy and regulatory developments and operational implementations that were in the making, such as:

a. Implementation of 15-minute market time units (MTU) in SDAC.
b. Future interconnections between EU and GB such as NeuConnect (that will link Germany to GB) and the go-live of Celtic interconnector that will connect the Single Electricity Market (SEM) to SDAC.
c. The Review of Electricity Market Arrangements (REMA) and changes related to a single GB price.
d. EU electricity market reform and amendments to Network Codes and Guidelines.
e. EU bidding zones review process.

f. Relevant offshore developments in the North Sea, such as hybrid interconnectors and Offshore Bidding Zones (OBZs). In particular, the analysis did not take into account the impact of MRLVC on new offshore developments such as:
    - Price formation on OBZs.
    - Capacity utilisation for wind and cross-border volumes.
    - Impact of the business case for investments in future interconnectors and offshore wind farms.

1.3. Approach and methodology for fulfilling the mandate

The answers provided to the given questions are formulated as a joint response from all involved parties. On the EU side, the task to answer the questions has been delegated to the EU TSOs which are directly connected to the UK, namely Eirgrid/SONI, RTE, Elia, TenneT NL, TenneT DE, Energinet and Statnett. On the UK side, the UK TSOs consisting of GB Interconnectors IFA, IFA2, NSL, Viking Link, Nemo Link, BritNed, ElecLink, Moyle, EIDAC, NGV and the GB National Energy System Operator (NESO) worked together.

To provide answers on questions related to the operational impact of MRLVC on the European Day-Ahead Market, EU TSOs also asked for the input of the Market Coupling Steering Committee (MCSC) that governs the implementation of SDAC and has extensive experience and knowledge on operational topics such as market coupling timelines and processes. The MCSC is an initiative of European TSOs and NEMOs (European Power Exchanges) and delegated their contribution to a specific Task Force withing the SDAC Quality Assurance and Release Management (QARM) group. Throughout the report their contribution is indicated by referencing “EU experts”.

To get full insights of the impact of MRLVC on GB DAM operations, GB TSOs similarly engaged with GB Power Exchanges (PXs) to assess if any information from the 2023 report required updating.

EU and UK TSOs have organised the work into three workstreams in which experts from all TSOs collaborated. The workstreams reflect the three questions asked in the mandate from the SCE. The outcomes from the workstreams are reported in the following chapters:

- Chapter 2: Operational timeline.
- Chapter 3: BBZ Net Position Forecaster draft specifications.
- Chapter 4: Compatibility with hybrids.

This report also features references from additional reports produced by TSOs themselves or specialist research companies that have been commissioned by TSOs.

1.4. Assumptions

a. REMA’s outcomes (specifically the shortening of imbalance settlement periods to 5- or 15-minutes) are still to be decided and create uncertainty for the GB DAM. The development of the package of reforms is still ongoing, with any policy changes likely to take several years to be fully implemented.

b. It is assumed that the workload to procure and develop the prototype BBZ Net Position Forecaster will be equally shared between any consortium of EU and UK TSOs who are participating.

c. On the BBZ Net Position Forecaster, historic data needed to train AI machines might not be available and there are obvious limitations to how AI could be applied.

d. It is assumed that MRLVC can use the existing PCR IT tools, e.g., Multi-Protocol Label Switching (MPLS) setup for SDAC, and does not need additional MPLS lines.

e. Due to there being too many assumptions to be considered (final REMA reforms, 15-minute MTU), operational timelines proposed are untested.

f. Similarly, due to the number of assumptions required, no further simulations to compute the efficiency of trading arrangements were feasible. EU and UK TSOs consider the figures from the 2023 report still valid. Moreover, the outcomes of a report commissioned by an EU TSO were included.

g. No numerical simulations to compute the suboptimal results of MRLVC with hybrid offshore assets were taken due to limitations of tools/data/etc.

1.5. Elements out of scope of the analysis presented in this report

For the elements listed below, it is beyond the scope of this report to carry out an assessment of the impact of MRLVC. Detailed assessments would require a level of resources and time that were not available to the EU and UK TSO group:

a. Local changes to systems of MRLVC TSOs, MRLVC NEMOs and Relevant Electricity Market Operators (REMOs) and possibly non-MRLVC NEMOs;
b. Local changes to systems and operational processes of market participants;
c. Modification to the current explicit mechanism to allocate cross-border capacities;
d. Development of information flows to/from BBZ Net Position Forecaster and to/from MRLVC (e.g. subset of OBKs);
e. Changes to existing roles and responsibilities such as shipping systems;
f. Validation processes in local systems;
g. Currency conversion; and
h. System operational risk.

1.6. Conclusions on feasibility of MRLVC

The EU and UK TSOs are unable to confirm the validity of MRLVC concept based on the work carried out in this and previous reports.

With the publication of this report on the feasibility of MRLVC, EU and UK TSOs provide to the SCE all relevant elements to judge its compatibility and efficiency with European and British markets. EU and UK TSOs will provide the necessary presentations on this report to the SCE and national regulators as outlined in the SCE minutes of December 2024.

2. Operational impact of MRLVC on EU and GB Day-Ahead Markets

> *Recommendation No 1/2024 of the Specialised Committee on Energy, Article 2 (a):*
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> *An optimal operational timeline combining the operations of the MRLVC, the EU Single Day-Ahead Coupling, and the Great Britain wholesale electricity market arrangements under a Common Order Book approach, including the optimal validation and fallback arrangements. The optimal operational timeline should promote the robust and efficient use of interconnectors while minimising risks for the secure operation of the EU and UK electricity wholesale markets and taking into account possible market developments up to 2030-35. The operational risks linked to that timeline on both the EU Single Day-Ahead Coupling and the Great Britain wholesale electricity market should be assessed and, to the extent possible, quantified. A range of options for operational timelines should be included in the supporting analysis to support the identification and assessment of the validity of an optimal timeline.*

2.1. Introduction to SDAC and GB Day-Ahead Markets

2.1.1. EU Single Day-Ahead Coupling (SDAC)

Introduction and key concepts for the European Single Day-Ahead Coupling

The Day-Ahead European electricity market is based on the Single Day-Ahead Coupling (SDAC) initiative. This implicitly allocates cross-zonal capacity in the most efficient way by simultaneously coupling Day-Ahead (DA) markets of adhering countries in the same algorithm.

SDAC (together with its intraday counterpart, Single Intraday Coupling (SIDC)) is mandated by the Capacity Allocation and Congestion Management (CACM) Regulation[11] and is a common initiative between TSOs and NEMOs.

NEMOs and TSOs need to be able to provide 'in time' bids and offers from market parties and capacity and constraints from the grid, matching them in a single algorithm (known as EUPHEMIA), to then validate and send outputs such as matched trades, clearing prices and scheduled exchanges. Therefore, SDAC is a complex sequence of procedures that needs to occur in a precise and tight timeline.

Under normal conditions (i.e. no issues with reception of data and running of the algorithm) the so-called normal procedures are followed. If an issue arises, back-up procedures are in place (e.g. sending information via a different means) to overcome such an issue. This allows market coupling to advance through all its steps and prevents a 'fallback' procedure from being triggered.

Fallback procedures occur when the relevant information cannot be produced, or exchanged, by a normal (or back-up) procedure, or if a check fails before the partial/full decoupling deadline. Fallback procedures aim to manage the risk of decoupling but could lead to a partial or full decoupling.

A partial decoupling is a situation in which it is not possible to allocate the cross-zonal capacity, via implicit allocation, for one or several areas or interconnectors before the partial decoupling

[11] Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management

deadline. A full decoupling is a situation in which capacities cannot be implicitly allocated for the entire SDAC area.

Several fallback procedures exist within SDAC, applying either to all borders of a single bidding zone, or specific borders, in order to manage unforeseen situations. Fallback procedures can be stopped if the issue is solved before the partial decoupling/full decoupling deadline, preventing any decoupling from occurring.

SDAC developments

The European electricity market is going through a significant transformation with the shift to a 15-minute MTU from the standard 60-minute MTU in SDAC today. The shift is a requirement set by the Electricity Regulation[12] to harmonise market operations across Europe (from DA to balancing) and will mean that, in SDAC, trading and scheduling of electricity will occur in 15-minute intervals instead of hourly. This will increase flexibility in the market and allow better integration of intermittent Renewable Energy Sources (RES).

The 15-minute MTU will be implemented on all borders and bidding zones in SDAC, with the go-live expected in September 2025. The implementation is a shared effort between NEMOs and TSOs for updating and testing SDAC processes. In order to process the increased number of bids and optimise price formation, the market coupling algorithm EUPHEMIA has been upgraded and is expected to need more time to produce its first outputs. This will have an impact on the operational schedule of SDAC and its fallback procedures. TSOs and NEMOs have been optimising other processes and deadlines in order to minimise the impact of such increased timing in the already tight SDAC schedule.

Inevitably, the introduction of 15-minute MTU will bring some changes to the SDAC operational timeline. The main changes identified by EU experts are as follows (all times used in this document are Central European Time (CET)/Central European Summer Time (CEST) unless stated otherwise):

- EUPHEMIA calculation time will be 30 minutes (instead of 17 minutes previously)
- Preliminary confirmation requires 8 minutes
- New regular publication time will be at 12:55[13] (instead of 12:52 previously)
- Final confirmation requires 10 minutes (firm results confirmed at the regular time of 13:05 instead of 12:57 previously)
- Risk of partial decoupling deadline at 12:35
- Partial decoupling deadline at 13:00 (instead of 13:05 previously)
- Full decoupling deadline stays at 14:20
- After a partial decoupling situation, the Algorithm Time Limit will be reduced to 20 minutes (this also applies to any calculation launched later than 13:30)

[12] Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (recast)

[13] All times in the document are provided in Central European Time (CET/CEST). When relevant, the Greenwich Mean Time (GMT)/ British Summer Time (BST) time applicable in GB is added in brackets.

The new SDAC operational timeline is therefore the following:

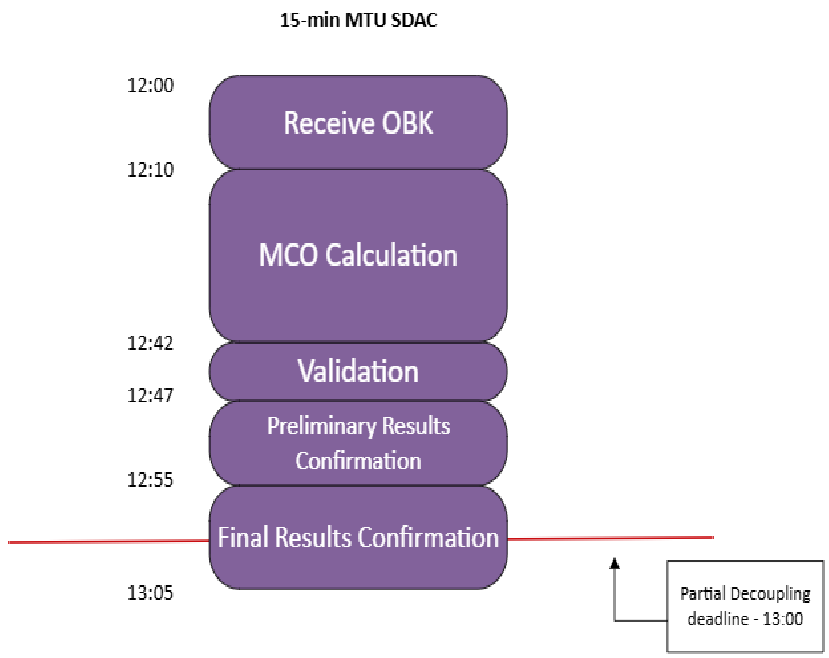

Figure 1 SDAC timeline under 15-minute MTU

Other SDAC aspects

Advanced Hybrid Coupling (AHC) and co-optimisation will be important changes in cross-border allocation.

AHC is a development of a flow-based capacity calculation method that has gone live in the Nordic Capacity Calculation Region in October 2024 and will be implemented in Core Capacity Calculation Region in the coming years. AHC will allow accurate representation of how HVDC interconnectors impact onshore network elements, therefore removing the need to forecast interconnector's flows when determining cross-zonal capacities.

Co-optimisation will allow market parties to bid for cross-border energy capacity and for balancing capacity, in DA, at the same time, with the same bids, so that they are optimised and allocated at the same moment. Co-optimisation, in particular, is still in the research and development stage and is expected to take time to be implemented. Therefore, EU experts advise not to take these elements into account.

2.1.2. GB Day-Ahead Market

Introduction to current market arrangements in GB

The GB DAM is organised by two PXs, the European Power Exchange ("EPEX") and Nord Pool Exchange ("N2EX"), who each perform their separate market clearing, leading to two GB DAM prices per MTU:

- EPEX runs a GB DAM auction with a GCT at 10:20 (9:20 GMT/BST) D-1 with 60-minute products, and subsequently also runs a DAM auction with a GCT at 16:30 (15:30 GMT/BST) D-1 with 30-minute products.
- N2EX runs a GB DAM auction with GCT at 10:50 (9:50 GMT/BST) D-1 and 60-minute products.

In GB, intraday trading takes place in the continuous Intraday Market (IDM), which opens at 01:00 D (00:00 GMT/BST D-1). From one hour before real time, NESO uses the Balancing Mechanism (BM) to balance the GB market. The settlement period used to calculate imbalance charges is 30 minutes.

Currently, there are different cross-border trading arrangements for existing GB interconnectors, depending on the area they connect to:

- Continental Europe (IFA, IFA2, ElecLink, Nemo Link, BritNed, Viking Link): interconnector capacity is sold to the market through explicit auctions which take place before GB's DAM auctions, and before SDAC, allowing nomination after the market results are known. Auction timings differ across individual interconnectors.
- Norway (NSL): The GB DAM is implicitly price-coupled with bidding zone NO2 through the N2EX auction at 10:50 (9:50 GMT/BST) D-1.
- Ireland (EWIC, Moyle, GreenLink): There is no implicit or explicit Day-Ahead trading on SEM-GB interconnectors. The SEM is implicitly price-coupled with GB at the intraday stage under two intraday auctions (IDAs), one running at 18:30 (17:30 GMT/BST) D-1 and another running at 9:00 (8:00 GMT/BST) on day D.

In addition to the wholesale market arrangements described above, there are auctions for ancillary services at Day-Ahead run by NESO. These consist of reserve and frequency response products, aiming at balancing supply and demand and correcting energy imbalances at different timescales. These auctions are open to all assets connected to the network that can meet the technical requirements of the services. For clarity, GB interconnectors do not currently participate in these auctions as service providers.

The timing of NESO's auctions of ancillary services at Day-Ahead is as follows:

- Balancing Reserve at 9:15 (8:15 GMT/BST)
- Static Firm Frequency Response at 12:00 (11:00 GMT/BST)
- Dynamic Frequency Response and Quick Reserve at 15:00 (14:00 GMT/BST)
- (Slow Reserve will be added to this auction from Q3 2025)

Introduction to the potential changes in market arrangements in GB

REMA is a comprehensive initiative by DESNZ, aimed at transforming the UK's electricity market to support a decarbonised, cost-effective, and secure power system by 2035. REMA is considering reforms in different areas including wholesale market pricing, balancing arrangements, access rights, Contracts for Difference (CfD) and capacity mechanisms. The programme was launched in April 2022, with initial consultations starting in July 2022 and a second round in March 2024. In July 2025, in the REMA summer update[14], the UK Government announced its decision on REMA to retain a single national price in GB's wholesale market and introduce a package of reform to improve the efficiency of GB's future power system. Among these reforms, REMA is exploring changes to

[14] Review of electricity market arrangements (REMA): Summer update, 2025 (accessible webpage) - GOV.UK

settlement periods, including shorter intervals (e.g., 5- or 15-minutes) to improve market responsiveness and efficiency. The Reformed National Pricing Delivery Plan, setting out the next steps on design and delivery, is expected to be published by the end of 2025.

Impact of GB market reform on MRLVC

REMA reforms promise to significantly impact the GB DAM. However, this impact is likely to remain uncertain until later in the reform process as decisions are still in progress.

The REMA summer update mentioned above, confirmed that the case for shorter imbalance settlement periods in GB (5- or 15-minute) is still being considered under reformed national pricing.

Shortening GB settlement periods to 5 or 15 minutes, as opposed to the current 30 minutes, would create more granular wholesale market temporal signals. This could lead to greater market participation by smaller and innovative flexible assets, including Demand-Side Response, and potentially reduce overall costs by moving volumes out of the Balancing Mechanism and into the wholesale market.

Any decision on shorter GB settlement periods may have an impact on MTUs utilised by the GB DAM. Currently, the GB DAM MTU is 60-minute, and could be reduced to 30-minute, 15-minute or less.

Any reduction in the GB DAM MTU would increase the amount of information to be considered by the MRLVC algorithm and therefore the computation time. If GB was to implement 15-minute MTUs in its DAM, as is the case with SDAC, it would be a specific design choice to also improve the granularity of MRLVC (today assumed as hourly). However, any additional or more detailed calculation would only increase MRLVC's computation time.

2.2. Update on MRLVC design

COB design of MRLVC

The 2021 CBA[15] identified two different MRLVC designs, a POB and a COB. The POB design would require the use of a preliminary SDAC order book created at the time of submission of GB OBKs. These OBKs would be used to run MRLVC in advance of SDAC GCT, allowing sufficient time to ensure that there are no delays and/or impacts in the SDAC process. The COB design requires that MRLVC would wait for both the GB and SDAC GCT but could imply a delay in further processes of SDAC and GB DAM.

The further analysis of the 2023 report concluded that the POB design was characterised by a high risk of market manipulation, and it was therefore discarded by the SCE in 2024. The same 2023 report characterised the following steps and assumptions for the MRLVC COB design:

1) Calculate forecast BBZ net positions in SDAC
    a. Forecasting BBZ net positions can be done by 12:00 with negligible risk of delay
    b. Running the process as close as possible to GCT would take advantage of the most up-to-date information available

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[15] https://consultations.entsoe.eu/markets/cost-benefit-analysis-of-multi-region-loose-volume/supporting_documents/MRLVC_CBA_summary_report_April_2021_final_publication.pdf

2) Send interconnector technical constraints
    a. The TSOs need to provide the technical constraints data to the MRLVC process (e.g., Available Transfer Capacities; ramping restrictions on some borders)
    b. This can be done any time prior to MRLVC GCT
3) OBK gate closure time
4) Check, adjust currency (if necessary) and submit OBKs
    a. BBZ NEMOs and GB PXs compile and check their OBKs and submit them to the MRLVC Market Coupling Operator (MCO)'s PCR Matcher and Broker (PMB) platform, the communication and data exchange system). This was estimated to take around 3-10 minutes in the 2023 report. GB PXs have confirmed that this timeframe remains accurate for GB[16]
    b. In the case of the GB PX, their OBKs must be converted from GBP to EUR before they are sent to the MRLVC MCO using a common foreign exchange rate
    c. It has been estimated that the MRLVC computation will require 4-7 minutes for checking OBKs. This time allows for later-than-average OBK submission (currently the average time to submit OBKs in SDAC is 3 minutes, with the minimum time being 2 minutes and the maximum time being 10 minutes)
5) Run MRLVC computation
    a. MRLVC algorithm should get acceptable results within 10 minutes (and able to apply a cut-off deadline if necessary)
6) Compute price taking orders (PTOs)
    a. The output from the MRLVC calculation will need to be converted into PTOs that can be submitted to SDAC and the GB DAM. In the case of GB, the PTOs need to be converted back into GBP. The estimated time for this step is 1-2 minutes
7) Validate flows
    a. Interconnector TSOs need to validate MRLVC results to ensure flows are consistent with Net Transfer Capacity (NTC)/technical constraints
    b. If the interconnector TSOs wish to perform the check themselves, this could potentially add 1-10 minutes to the MCO process
8) Transfer PTOs to SDAC and GB price coupling DAM
    a. Once MRLVC has calculated the flows, which are validated, and they have been put into the required PTO format, they need to be sent to the appointed NEMO in each BBZ, who then submits them to the SDAC PMB
    b. The time required for these steps is estimated to be about 2-3 minutes
    c. An equivalent parallel process will be needed for the GB price coupling

[16] But note that revisions to the GB market under REMA may potentially affect this.

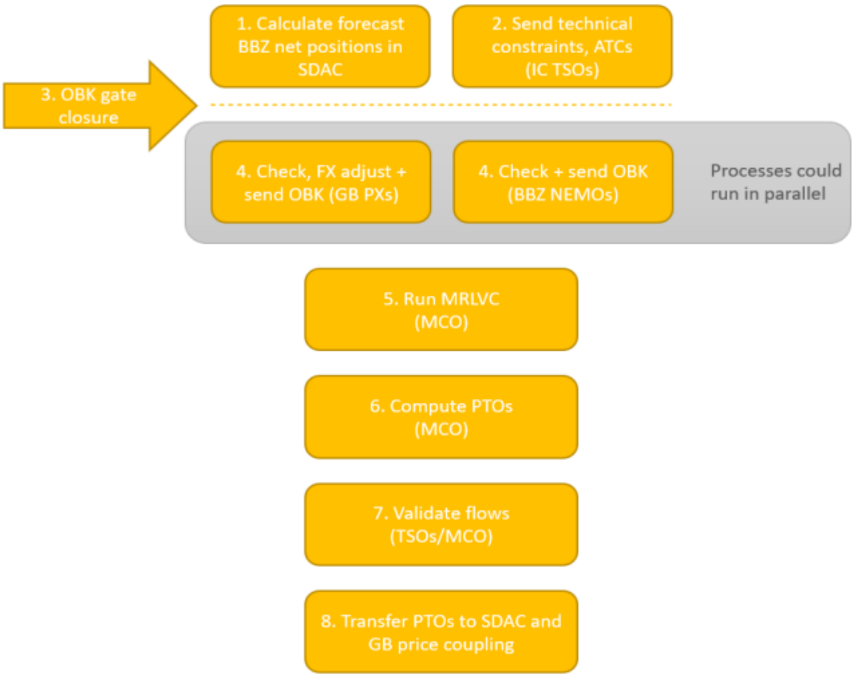


Figure 2. MRLVC process steps identified in 2023 report

Therefore, the assumptions taken for the design of the sub-processes of MRLVC in the 2023 report still hold for EU and GB market experts.

Estimated duration of MRLVC

The 2023 report[17] inferred the duration of MRLVC by comparing other types of implicit options. Considering the whole MCO process, the duration of MRLVC was estimated between 13 and 42 minutes with EU experts highlighting the more realistic range between 30-40 minutes.

[17] https://eepublicdownloads.blob.core.windows.net/public-cdn-container/clean-documents/Network%20codes%20documents/MESC/2024/230710_MRLVC%20report_redactions%20for%20publication%20Feb2024_clean.pdf

Process	Who	Start	Duration
1. Forecast BBZ net import/export position in SDAC and send to MCO	Forecaster	11:00 D-1	2-5 min
2.Send GB-BBZ interconnector capacities and technical constraints (losses, ramp rates, etc) to MCO	IC TSOs	11:00 D-1	2-5 min
3.Order book gate closure	BBZ NEMOs, GB PXs	COB: 12:00 POB: 11:45	
4.Check, convert to EUR at a provided FX rate and send GB PXs' order books to MCO	GB PXs	After Step 3	4-7 min
Check and send BBZ NEMOs' order books to MCO	BBZ NEMOs	After Step 3	4-7 min
5.Run EUPHEMIA and compute interconnector flows	MCO	After Step 4	5-20 min CEPA 10-20 min + EU experts
6.Compute PTOs, convert to GBP	MCO	After Step 5	1-2 min
7.Validate MRLVC flows as compliant with capacities, technical constraints	IC TSOs	After Step 6	1-10 min
8.Transfer PTOs to SDAC via BBZ NEMOs Transfer PTOs to GB price coupling via GB PXs	BBZ NEMOs GB PXs	After Step 7	2-3 min
Total MRLVC computation time (step 4-8)	**All**	**Step 4 to 8**	**13-42 min**

Figure 3. Inferred MRLVC duration in the 2023 Report

The number of bidding zones was used as a factor that would influence the duration of the MRLVC calculation. However, the NeuConnect interconnector between Germany and GB was not considered at that time. Adding new zones, especially from Germany with their high volume of OBK, will only increase the computation time of MRLVC and put its actual duration in the higher range identified in 2023. Moreover, the preferred market design for hybrid projects is OBZs that will also become new BBZs to be considered in MRLVC.

EU experts agree that the introduction of NeuConnect (currently anticipated to be in 2028) will increase the computation time of MRLVC. Without simulations, only a qualitative assessment is possible, starting from the 2023 estimations. Considering that the addition of a new bidding zone in SDAC leads to a change in the algorithm (e.g. in the topology, granularity of some data) and that the change in the calculation time is not linear to the addition of a bidding zone (or its order books), the same projection can be made about MRLVC. In accordance with the findings of the EU experts in 2023, it is believed that the MRLVC algorithm calculation will take between 10-20 minutes to run. However, with the inclusion of NeuConnect and new OBZs, the run time will trend towards the higher limit.

In a similar way, when increasing the number of BBZs and related OBKs, other processes adjacent to the pure calculation will also increase their duration. Therefore, taking the full sequence of processes into consideration, the updated estimation from EU experts for MRLVC's end-to-end duration is now between 30 and 42 minutes.[18]

[18] This is an educated estimation as EU experts were unable to run simulations in the time available due to the complexity and turn-around time required.

EU experts also want to highlight that the proposed design of MRLVC would compute hourly flows. A lower granularity MRLVC would add complexity into the algorithm (as with the SDAC shift to 15-minute MTU) and increase the time needed to compile OBKs. This complexity would be increased if a reduction in the GB DAM MTU is implemented as part of REMA reforms.

2.3. Assessment of operational risks of MRLVC to SDAC, SEM and GB DAM

2.3.1. Normal day scenario in SDAC

This section of the report builds on much of what was already highlighted in the 2023 report. With the introduction of the 15-minute MTU in SDAC expected for September 2025, the new operational timeline of SDAC changes as discussed in Figure 1 in the previous section, 'SDAC developments'.

As per the proposed timeline, SDAC will aim to publish preliminary results by 12:55, with the final confirmation completed by 13:05. This then allows SDAC to use the time between 13:05 and 14:20 for any contingencies required to mitigate against. The process for MRLVC remains unchanged from the 2023 report, but its duration would increase to between 30 and 42 minutes. Under this assumption, the addition of MRLVC into SDAC processes would negatively impact the current partial decoupling deadline within SDAC's market coupling process. This is highlighted in the figures below.

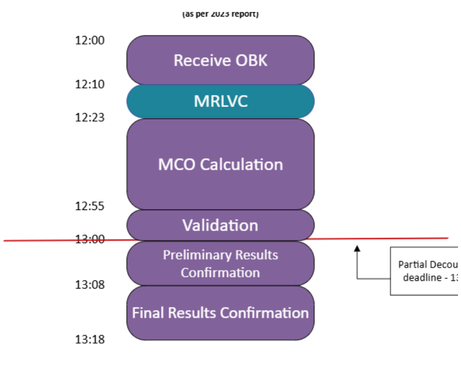


Figure 4 Outline of SDAC process with introduction of 15-min MTU and 13-min MRLVC

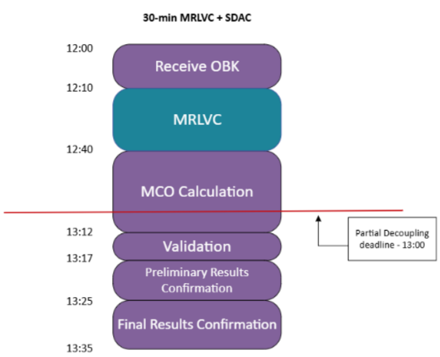


Figure 5 Outline of SDAC process with introduction of 15-min MTU and 30-min MRLVC

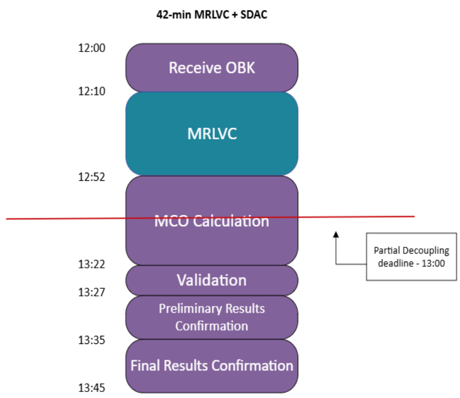


Figure 6 Outline of SDAC process with introduction of 15-min MTU and 42-min MRLVC

Even where the shortest possible timeline for MRLVC is assumed (in 2023 this was 13 minutes), there won't be enough time for SDAC to meet its current partial decoupling deadline before the preliminary results confirmation. Note that the timeline will change due to the introduction of the BBZ.

Moreover, the 13-42 minutes timeline of MRLVC assumes no technical issues or delays within the MRLVC MCO, which of course would further impact SDAC timelines. In short, there is currently no design of MRLVC, if introduced into SDAC, which does not risk the likelihood of a partial decoupling.

Currently, the time dedicated to the SDAC process is 12:00 – 14:20. 12:00 is the OBK gate closure time and is written in CACM. 14:20 is the full decoupling deadline and is derived from the deadline for nomination, which is set at 15.30 in several countries. The time from the partial decoupling deadline (set at 13:00 with the implementation of the 15-minute MTU) and 14:20 is dedicated to contingencies to avoid a full decoupling. Time from 14:20 to 15:30 is dedicated to the actions after full decoupling to respect the 15:30 deadline for nomination of shadow auctions, nomination of local auctions etc. Therefore, the deadline of 14:20 can be considered non-flexible and any contingency would have to respect that timeline.

If MRLVC is included in SDAC processes, the delay introduced by MRLVC (with the realistic range of 30-42 minutes) would reduce any mitigation time for SDAC to avoid partial decoupling as it would push existing processes way over the deadlines set by SDAC for the market coupling procedures. Under certain circumstances there is no time for partial decoupling, meaning that any incident which in the past would have led to a partial decoupling will now lead to full decoupling under the current deadlines.

2.3.2. Impact on suitable SDAC incident scenarios

The term 'incident scenario' includes anything which is abnormal and triggers an incident committee. An incident committee brings together market operators and TSOs to deal with abnormal issues at a short notice within operational timeframes. For example, in SDAC this includes scenarios that may lead to second calculations, partial or full decoupling, reopening order books and/or delay to the publication of results, or to confirm that the issue is resolved. Some other changes to a 'normal day', such as having to delay the start of the calculation due to a technical delay, are usually managed within the normal procedures, where there is some contingency allowed for.

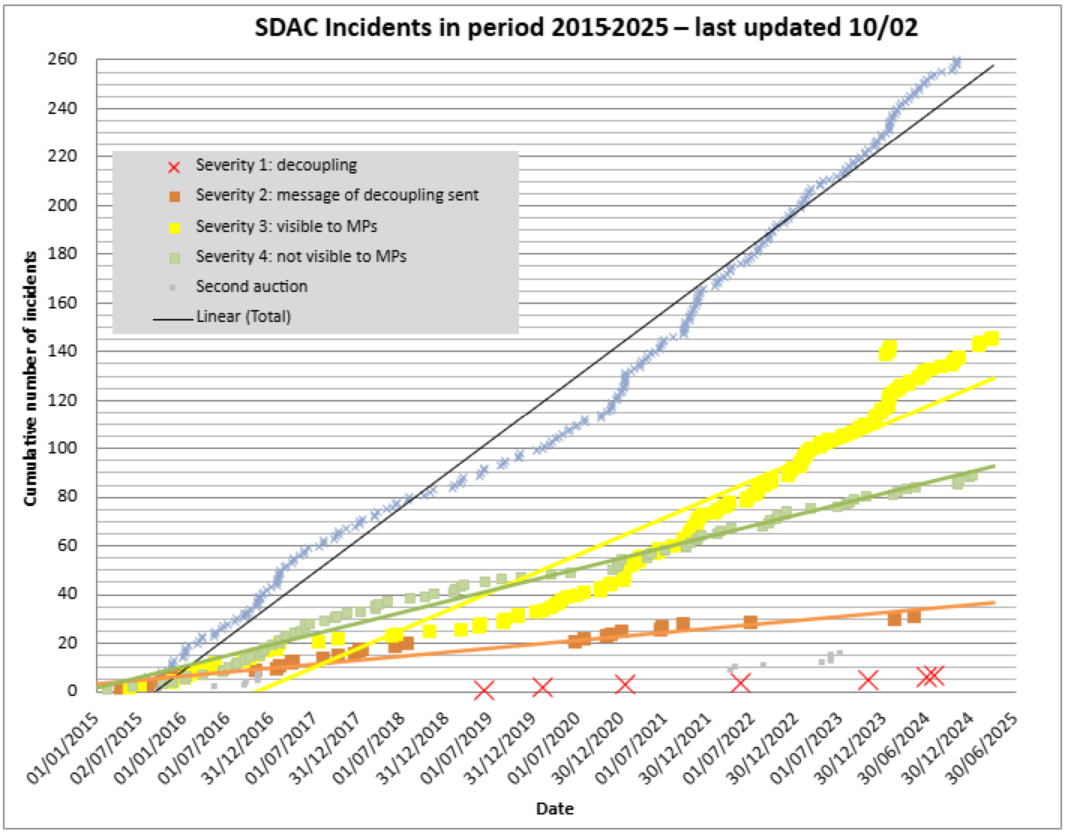


Figure 7 Incident scenario in SDAC (source: EU experts)

The 2023 report detailed the regularity of 'incident scenarios' within SDAC and demonstrated the importance of having sufficient time to resolve even the most minor issues. EU experts have provided Figure 7 above, which illustrates the cumulative total of SDAC incidents from 2015 to the early months of 2025. With over 200 incidents in this timeframe, seven have led to a partial decoupling in the last four years of this timeframe – these are severity 1 issues. Severity 2 issues are serious incidents which were successfully resolved ahead of the partial decoupling deadline, in the last four years of this timeframe, ten of these incidents have occurred. Given that there is no current MRLVC design that does not impact the partial decoupling deadline, it is very likely that these severity 2 incidents may have led to partial decoupling if MRLVC had been included within the SDAC processes. Therefore, the estimation that the inclusion of MRLVC into SDAC increases the likelihood of both severity 1 and 2 incidents, leading to an average of two-yearly full decoupling incidents, remains unchanged.

Each decoupling has a different monetary impact, depending on the borders affected. The impact, computed only for TSOs, consists of i) the difference of the long-term transmission rights compensation to market parties and ii) the congestion rent revenues coming from the Long-Term Auctions and the Shadow Auctions. Below is the estimated monetary impact on TSOs of the latest partial decouplings. It is important to highlight that when losses in social welfare are included, the financial impact of a partial decoupling raised to several millions of euros per incident.

Date of the partial decoupling	Number of borders affected	Monetary impact for TSO only
24 July 2024[19]	8	€ 997 264,72
25 June 2024[20]	10	€ 666 751,00
28 October 2023[21]	4	€ 1 025 943,06
10 May 2022[22]	12	€ 1 916 366,83

Table 1. TSOs financial impacts of partial decouplings

The 2023 report illustrated the impact of example incident scenarios on the SDAC timeline, where possible these have been updated to reflect the inclusion of 15-minute MTUs and MRLVC.

1. Second calculation triggered by an incorrect significant bid

A second calculation can be triggered if at least one NEMO rejects the market results originating in the first calculation by identifying an erroneous order book. After this, the market participant that submitted the wrong bid is allowed to modify the input data without disrupting the entire market process. The SDAC algorithm is then re-run with the corrected data. The second calculation results in a delay in the publication of market results. The second calculation is a distinct process from second auctions, which were decommissioned on 29 January 2025 and are soon to be decommissioned in the Baltics after the 15-minute MTU implementation.

[19] single-day-ahead-market-coupling-(sdac)-report-on-the-partial-decoupling-incident-of-july-24-2024.pdf

[20] single-day-ahead-market-coupling-(sdac)-report-on-the-partial-decoupling-incident-of-june-25-2024.pdf

[21] sdac-report-on-the-partial-decoupling-incident-of-october-28th-2023-.pdf

[22] Microsoft Word - 20220608-SDAC report on the partial decoupling incident of May10th 2022 V1_0

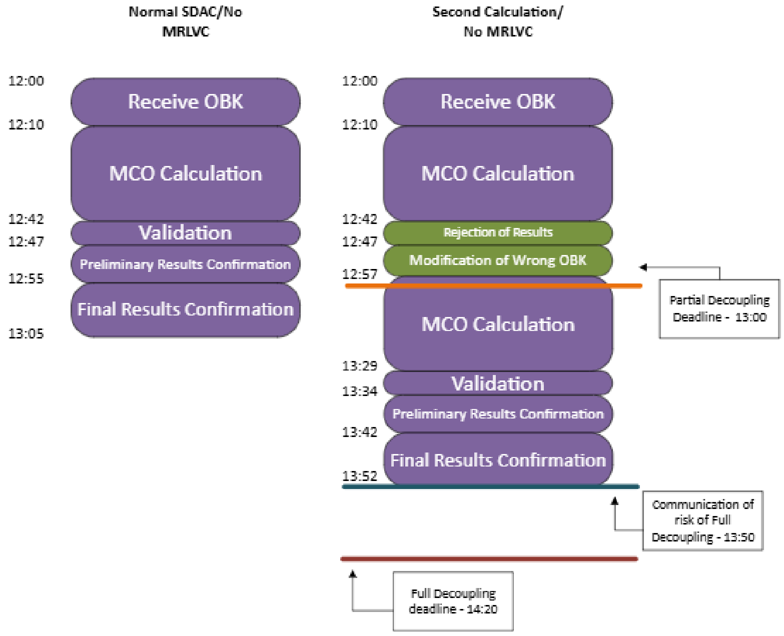


Figure 8 SDAC in a normal run (left) and with second calculation (right) without MRLVC

As visualised in Figure 7 above, in the event of a second calculation, a normal SDAC re-run with updated 15-minute MTU timings could mean a final results confirmation at 13:52, a delay of around an hour, giving a 28-minute contingency window until the full decoupling deadline. This window is needed in case of any further technical issues in addition to running a second calculation[23]. Even without the addition of MRLVC, such a small timeframe means there is already a real risk under 15-minute MTU SDAC arrangements of a full decoupling being called. When MRLVC is included in this

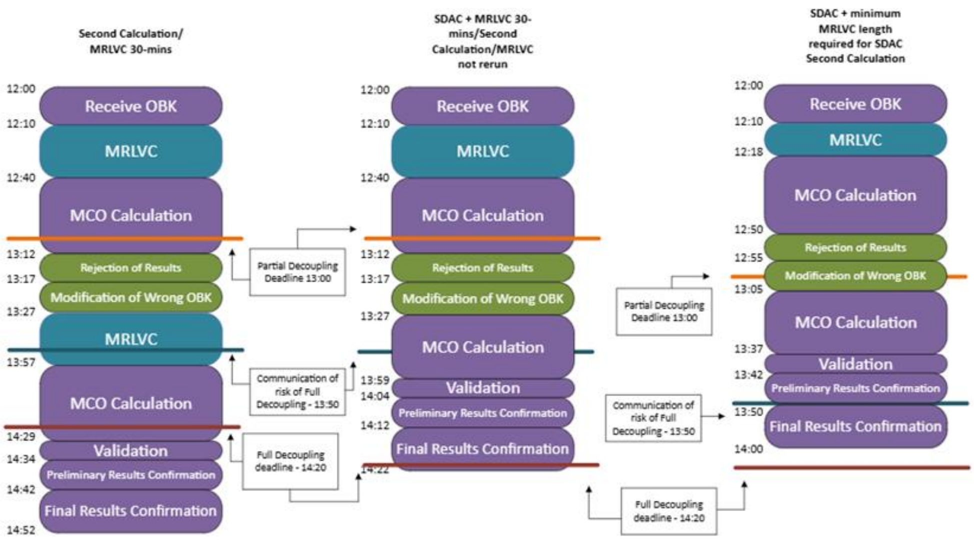


Figure 9 Maximum time of MRLVC to be included in second calculation timeline

[23] The timeline is built with the assumption that NEMO would take indicatively 5 minutes to detect and reject the wrong bid and 10 minutes to align with the market party and modify the erroneous bid.

timeline, as seen below, the full decoupling deadline will not be met. This includes scenarios where MRLVC is not re-run in the second calculation.

In order to include MRLVC in SDAC in a scenario where a second calculation is triggered, the maximum run time for MRLVC would have to be 8 minutes in order to publish results at 14:00.

Considering that a reasonable time for MRLVC is between 30 and 40 minutes, EU and UK TSOs think it would be very difficult to optimise MRLVC in order to gain 25 to 35 minutes in its duration.

2. Partial decoupling triggered by a technical problem in a NEMO

A partial decoupling can be triggered in SDAC if, for example, a country or set of countries are unable to submit compliant OBKs for technical reasons. While rare, partial decouplings do happen, with seven incidents occurring in the last 10 years. The last incident, in 2024, had an estimated impact of almost a million euros on TSOs alone. The overall loss for society can amount to multiple millions.

SDAC builds flexibility into its process to resolve this problem. The deadline for a partial decoupling is currently at 13:00 and the final publication time of confirmed results is at 13:05, giving a contingency time of 5 minutes to complete a partial decoupling.

As previously mentioned, there is currently no design of MRLVC which does not breach the SDAC partial decoupling deadline. MRLVC would have to run perfectly in 5 minutes or less to avoid impacting SDAC's partial decoupling deadline as per Figure 10. Therefore, it is currently not possible to introduce MRLVC into an already tight SDAC process without significantly impacting the contingency time that a 15-minute MTU SDAC process will have. Any issue in one SDAC process can decouple an entire SDAC area, and that scenario must be avoided. This makes the partial decoupling process a mandatory requirement within SDAC.

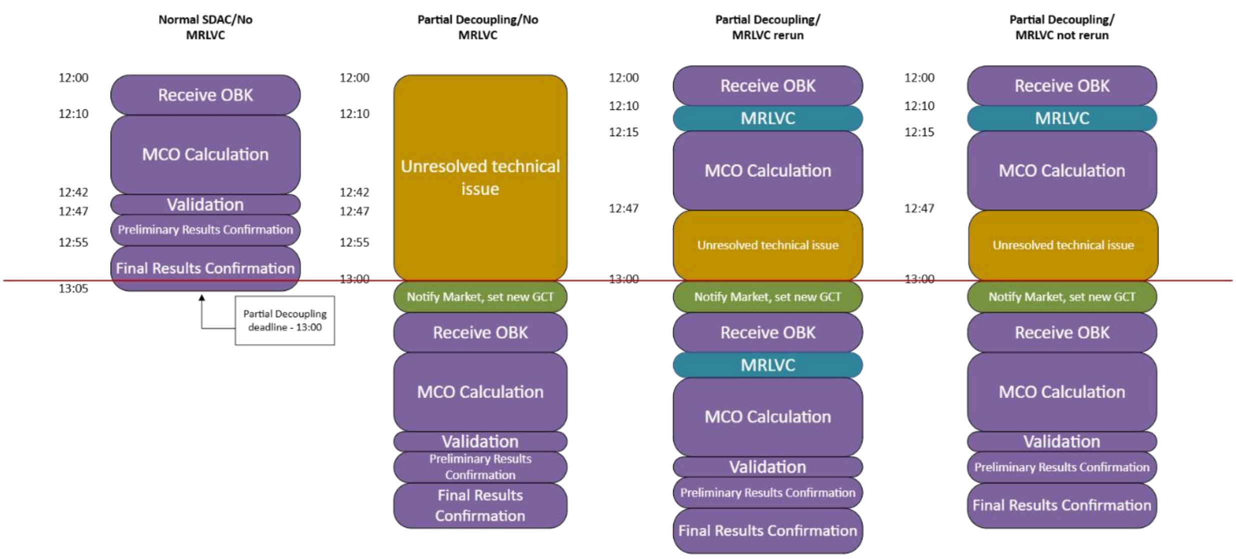


Figure 10 Impact of MRLVC on partial decoupling in SDAC

EU experts still agree with the statements produced in 2023 that MRLVC will increase the risk of partial decoupling and that under certain circumstances would cause a full decoupling. SDAC fallback processes might evolve across 2025 and 2026 (minor to drastic changes are under discussion), therefore MRLVC will remain a key area of concern.

All things considered, there are no feasible designs of MRLVC that would not cause partial decoupling in SDAC.

NEMOs and TSOs have already been optimising the SDAC operational timeline to include new improvements (avoiding repeats of the 2024 decoupling incidents, 15-minute MTUs, Nordic and Core AHC). This leaves no room for further reducing the already tight timeline to include MRLVC.

EU experts do not see any possible changes to the MRLVC concept that would lead to a better integration into SDAC/have less risks for SDAC.

3. Technical problem in the MRLVC MCO

As detailed in the 2023 report, the final example of an incident scenario which could have negative impacts on the SDAC timeline is if there are any technical problems within the MRLVC MCO calculation, e.g. the GB OBKs are delayed.

The 2023 report stated that some flexibility within SDAC procedures to allow for a moderate delay would be possible, and that beyond this, SDAC would need to decide whether to decouple MRLVC or allow more time.

Another option was simply to ignore the MRLVC results, using default flow values in SDAC for the connected interconnectors.[24] This option would minimise the impacts of MRLVC's dysfunction on SDAC operations at the cost of a loss of general welfare and at the risk of disrupting market parties' bid positions.

However, with the introduction of the 15-minute MTU, the SDAC process has now become even more constrained. This is to the extent that the possibility of flexibility within SDAC procedures for any errors within MRLVC is likely no longer an option, particularly when taking into account that there is not a design option for MRLVC that does not currently negatively impact SDAC's partial decoupling deadline.

Therefore, the remaining option (with an MRLVC design of 5 minutes or less) would be to ignore the MRLVC results in the event of a technical issue and to instead use default flow values in the SDAC process. MRLVC will inevitably have an impact on SDAC incident scenarios and complicates the handling of these incidents. Managing the incidents, and the impact the approach has on decoupling risk, orderly markets and delays, is not straightforward. Safeguarding SDAC when MRLVC is failing needs to be a mandatory requirement. SDAC cannot be decoupled for the failure of an external process.

SDAC has already very tight deadlines and it becomes tighter with 15-minute MTU, especially when issues occur in the process. Adding MRLVC adds risks to the process and decreases the available time and therefore is increasing the risk of full decoupling.

[24] Similarly, flows at zero values, equal to long-term nominations or based on historical values could also be used.

2.3.3. Considerations on other possible timelines

EU TSOs and NEMOs are discussing the extension of timings of SDAC to include incident resolution. Any changes in SDAC timing will be done to safeguard its operation and not to fit in it any additional process. Impacted parties will be notified when any change is decided.

It is important to remind the following recommendation from ACER and all National Regulatory Authorities (NRAs) (from the so called 'informal opinion' published in 2023): "*To ensure that the impact on the SDAC operational processes and timings of the failure of the MRLVC are minimized to the maximum possible extent and cannot impact the functioning of the EU Internal Energy Market*".

If MRLVC was implemented into European processes, the start of SDAC processes would have to be further anticipated because European regulation would also mandate extending pre-coupling timings to avoid any risk of decoupling.

2.3.4. Impact of MRLVC on SEM

Special importance must be given to the impacts of MRLVC on SEM, particularly due to its unique characteristics compared to other EU markets linked to GB. The SEM market has a less meshed system, use of HVDC interconnectors and, until the Celtic interconnector becomes operational, is solely interconnected with GB. The current SEM interconnectors (EWIC, Greenlink and Moyle) would be more acutely affected by forecast inaccuracies in net positions of BBZs compared to larger GB-EU interconnectors. This is due to the SEM's smaller system size and tighter balancing margins, which amplify the operational and cost implications of forecast errors.

Unlike larger interconnected EU systems, the SEM has less capacity and fewer redispatch options to manage unexpected flow deviations resulting from MRLVC's loose coupling. Therefore, the TSOs may be forced to resort to more expensive balancing actions, leading to increased market costs and potential reliability concerns during periods of high system stress.

Given that MRLVC is a market solution that has not been tested, it is difficult to ascertain its impacts in the future. Hence, lack of testing provides a particular concern regarding the practice of operationally prioritising capacity allocation on the SEM-GB border in advance of feeding into Celtic. In addition, given the requirements for extensive IT testing likely in the near-term, significant additional resources would likely be needed by SEM market participants, NEMOs and TSOs. Given the already extensive work ongoing in the SEM for EU electricity market integration as part of the Celtic interconnector programme, that availability of resources is likely to be a challenge.

Practical considerations on the timing of MCO processes ahead of the SDAC process are necessary to ensure efficient allocation of cross border flows in terms of direction and magnitude. Proper alignment is critical to preserving market efficiency, minimising arbitrage distortions and ensuring that interconnectors are used optimally to deliver welfare enhancing outcomes.

Additional risks exist around SEM decoupling, which could be created by tight timings and complex interactions between the SDAC processes and those which would be introduced due to MRLVC. While leading to major negative impacts on the SEM, it could also create similar impacts for GB and the wider EU market coupling.

The implementation of MRLVC may have negative impacts on social welfare for SEM customers due to reduced efficiencies of interconnector flows which can lead to suboptimal electricity trading outcomes, higher wholesale prices and limited access to lower-cost generation sources (cheaper renewables). As a result, customers in the SEM could face increased energy costs and reduced market competitiveness.

2.3.5. Impact of MRLVC on the GB market

In contrast with the SDAC process, the GB DAM timeline involves fewer steps and takes less time after the PTOs calculation. From the moment PTOs are calculated by MRLVC the GB DAM is expected to take between 25 and 43 minutes.

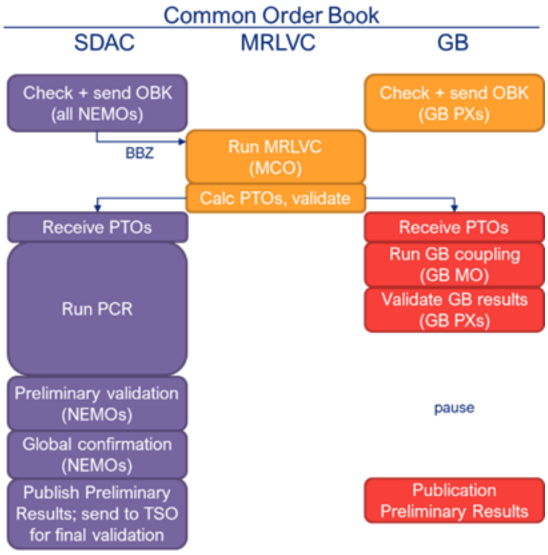


Figure 11 Outline of SDAC and GB DAM processes with MRLVC (from 2023 report)

The detail of the different steps of the GB DAM is as follows:

PTOs:

- Compute PTOs: 1-2 minutes (conversion in GBP is needed in addition, in comparison with equivalent step in the SDAC process)
- Transfer PTOs to PXs in GB: 2-3 minutes

Run GB coupling

- 15 to 25 minutes

Validate GB Results

- 6 to 10 minutes

Publication of Preliminary Results

- 1 to 3 minutes

With the introduction of 15-minute MTU in SDAC, the new regular publication time is expected to be at 12:55 (11:55 GMT/BST) (instead of 12:52 previously).

If GB DAM results are available before that time, there is a choice as to whether they will be published straight away or once SDAC results are available, so that publication is synchronised across EU and GB. It is understood that a synchronisation is not technically needed but is good market practice.

With regards to other GB DA wholesale market auctions, the DA auction run by EPEX at 15:30 GMT/BST is an intra-GB auction that is not coupled to Europe. It is expected that it would not be affected by MRLVC and any change to it would instead be a commercial decision by the PXs operating it.

Nevertheless, the MRLVC process could impact the timings of other auctions or processes taking place at DA in the GB market. Assuming GB DAM publication time is aligned with SDAC publication time, no impact to the submission time of interconnector reference programmes is expected. However, any delays to SDAC/GB DAM publication time could impact when NESO receives the interconnectors' DA reference programmes which contain details of flows and ramping for the next operational day. This would have an impact on NESO's strategy planning and decision making, with possible impacts to the analysis of DA margins and assessments for code-mandated system warnings. If a delay causes this to be after 14:00 (13:00 GMT/BST), then NESO control room processes would be impacted. This would impact the strategy analysis for the next operational day, which uses the data from the reference programmes as an input to areas including trading requirements and Net Transfer Capacity/Intraday Transfer Limit restrictions. It could lead to less efficient operational decisions if not all information is available when required, and having reduced time to complete analysis before submission deadlines.

Delayed SDAC/GB DAM publication times could also potentially impact the timing of GB frequency response and reserve auctions which run after the interconnector positions are known, at 15:00 (14:00 GMT/BST).

2.3.6. MRLVC fallbacks on GB Interconnectors

The final consideration is how any technical problems within either MRLVC or SDAC may impact GB-EU interconnectors. Fallback processes are needed to address operational incidents in either sequence, and a key question is what fallback processes will be used to allocate capacity on GB interconnectors in the event of MRLVC that is forced to decouple. Examples of how this could be done are as follows:

- **Day-Ahead Shadow Auctions** – an explicit auction where market parties are able to leave standing bids for capacity. Following a decision to trigger a shadow auction, market parties are given very limited time to submit or amend existing orders. Following the results of a shadow auction, market parties can submit orders on SDAC. Shadow auctions are a standard fallback process in most of Europe, understood by market parties, and all capacity tends to be allocated (as rights). However, clearing prices for capacity tends to be very low and the timings for this option limits fallback options within SDAC.
- **Intraday Explicit Auctions** – a standard explicit auction for a trading day ('D') where market parties have reasonable time to submit bids following completion of SDAC, e.g. afternoon of D-1. This gives an opportunity to trade out positions in intraday markets. This option has minimal impact on SDAC and allows potential for reasonably efficient prices and utilisation of capacity. However, participation and timing may be low if this is not a normal intraday process, additionally the timing will depend on when SDAC completes, which could be late in the case of a severe incident within SDAC.

- **Intraday Implicit Auctions** – an implicit auction for a trading day ('D') where market parties have reasonable time to submit bids following completion of SDAC, e.g. afternoon of D-1. This implies a standard intraday coupling process (regional). This option has minimal impact on SDAC and allows potential for efficient prices and utilisation of capacity. However, it requires an intraday market coupling process so is therefore only suitable for specific regional markets.

GB interconnectors were asked to rank and provide feedback from the above options. The answers are as follows:

	IC 1	IC 2	IC 3	IC 4	IC 5	IC 6	Comments
DA Shadow Explicit Auction	1			2	1	1	• Preference for an automated solution • Would be a means to retain a DA allocation, particularly important for situations of 'planned' fallbacks (i.e. problems within MRLVC are known in advance).
ID Explicit Auction					2		
ID Implicit Auction		1	1				• Regional ID implicit coupling already working relatively well as an enduring fallback solution, no rationale at this point in time to change this. Currently no regional explicit auctions so any introduction would be complex.
Other				1			• Another option could be to use forecasted flows as an input in the case of MRLVC decoupling as it will still use the prices of SDAC and the GB market positions would still be included.

Table 2 Preferred fallbacks from GB IC questionnaire (conducted in 2025)

As per the table above, preferences vary amongst different parties, driven mostly by regional market differences. However, it is not currently seen as a significant issue to have different fallback options amongst different interconnectors.

2.3.7. Impact of MRLVC on Intraday markets

The TCA mandates MRLVC as a coupling arrangement only for the DAM. On the GB interconnectors, the intraday market would still be coupled through existing arrangements (explicit auctions between GB and EU, implicit auctions between GB and SEM). However, the additional process will impact the normal timeline of EU Intraday Markets at 15:00 D- 1.

It is the opinion of EU experts that the scope of the DA and intraday markets and their organisational structures (defined as cascade) are relevant to consider when designing a mechanism foreseeing the cross-border allocation of capacities/volumes, even if based on a loosely coupled approach. Considering the current operational markets (Pan-European and not) that affect the same parties from both EU and GB/SEM sides, any discussion on the implementation of a process for DA shall not exclude the impact it could have on the intraday timeframe.

Also, the current operational timelines of SDAC and SIDC are factually interlinked in the definition of fallback processes as well. If a specific delay during the finalisation of the DA session occurred, it would lead to the automatic cancelation (in advance) of the first SIDC IDA run for the same delivery day. The introduction of any additional mechanisms in the existing timeline, having impact on SDAC execution, will have indirect impacts on SIDC as well.

Considering the timings of the current GB intraday auctions, there is not expected to be any significant impacts on the GB intraday auction following the inclusion of the MRLVC process into the GB DAM.

2.4. Conclusions

- **Developments in EU and GB DAM**
    - New bordering bidding zones will be added into MRLVC as a consequence of new interconnectors between SDAC and GB going live (i.e. GB-Germany), the establishment of new OBZs both in EU and GB waters and any potential future changes in the configuration of market zones in GB or EU neighbouring countries.
    - The shift to 15-minute MTUs in SDAC's borders and bidding zones will allow a more precise alignment between generation and consumption and improve the reliability of the grid. The market coupling algorithm EUPHEMIA will increase its computation time as it will have to process an increased quantity of data. European NEMOs and TSOs have therefore optimised the operational timeline of SDAC to limit the impact of such increased calculation time. This change means that the time SDAC has to resolve incidents is further constrained.
    - REMA is considering a key change to reduce the duration of GB settlement periods that could potentially impact the amount of information to be processed by the MRLVC algorithm.

- **MRLVC design and duration:**
    - Developments in SDAC and the GB DAM have not changed the design of MRLVC previously presented in 2023.
    - However, known market developments in EU and UK (e.g. new interconnection, new borders) are expected to result in an increase in the minimum time needed by the end-to-end MRLVC process. There is a consensus among the experts that MRLVC end-to-end process timing will be moving to the upper range of the scale estimated in 2023, from 13 - 42 minutes to a minimum of 30 minutes.
    - The updated estimated duration of MRLVC will fall between 30 and 42 minutes. However, as the minimum time to complete MRLVC is now 30 minutes (previously 13 minutes), the interaction between MRLVC and SDAC is even greater as MRLVC will always negatively impact the partial decoupling deadline of SDAC, increasing the likelihood that a partial decoupling event will lead to a full decoupling.

- **Possible fallbacks:**

  On the EU Market:

- With the updated timing (30 to 42 min), there is no design option of MRLVC which does not breach the partial decoupling deadline of SDAC. While the options listed in 2023 (MRLVC decoupling, default values, ignoring MRLVC results) are still valid, these options cannot be implemented successfully with the current estimation times of the MRLVC timing. Safeguarding SDAC when MRLVC is failing is a mandatory requirement as SDAC cannot be decoupled for the failure of an external process.
- For these reasons, it is therefore not possible to produce an optimal timeline that can successfully integrate MRLVC with SDAC while maintaining the operational integrity of SDAC.

On the GB Market:

- There are different potential fallback solutions for the allocation of cross-border capacity (e.g. shadow auctions, capacity goes to intraday, explicit auction and others). There is no preferred solution across the GB interconnector community, with each TSO selecting the optimal solution for their business.

- **Operational risks of MRLVC on existing markets:**

On the EU side:

- As was concluded in the 2023 report, MRLVC will always negatively impact the partial decoupling deadline of SDAC, increasing the likelihood that a partial decoupling event will lead to a full decoupling.
- The assessment done in 2025, which increases the time needed for the MRLVC timing, makes the impact of MRLVC on SDAC even greater as it reduces the contingency time to solve any incident. Therefore, MRLVC will increase the probability of a partial decoupling. Due to a tighter timeline, it is also more probable that a partial decoupling will lead to a full decoupling.
- The implementation of MRLVC in the SEM will introduce significant operational and market risks including heightened forecast errors, increased balancing costs, reduced social welfare for SEM consumers and potential misalignment with SDAC.
- Operational risks will also affect other timeframes. Regarding the EU intraday market, a specific delay during the finalisation of the DA session leads to the automatic cancelation in advance of the first SIDC IDA run for the same delivery day. The introduction of any additional mechanisms in the existing timeline, having impacts on SDAC execution, will have indirect impacts on SIDC as well.

On the GB market:

- Following a potential calculation of PTOs by MRLVC, the GB DAM process involves a series of defined steps that typically span between 25 and 43 minutes. While results can be published as soon as they are available, the timing of publication may influence downstream processes. Delays could affect when NESO receives interconnector DA reference programmes, which are essential for planning trading strategies and operational decisions impacting NESO control room activities (e.g., analysis of DA margins and assessing needs for code-mandated system warnings).

Outcomes on the market developments:

- Developments in SDAC and the GB DAM have not changed the design of MRLVC previously presented in 2023.
- However, the upcoming market developments in the EU and UK are expected to be translated into an increase of the minimum time needed by the MRLVC algorithm (due mainly to new interconnectors, borders or changes in BZ, etc). There is a consensus among the experts that MRLVC timing will be moving to the upper range of the scale estimated in 2023, from 13 - 42 minutes to a minimum of 30 minutes.
- All things considered, the introduction of MRLVC compared to the current arrangements will increase the operational risks in both EU and UK market. This is especially the case in the EU market as there are no feasible designs of MRLVC that would allow for a reasonable contingency time to avoid a partial decoupling, with the increased risk that it can become a full decoupling.

3. Draft Tender Specification

3.1. Overall Description

Recommendation No 1/2024 of the Specialised Committee on Energy, Article 2 (b)(i):

A draft tender specification for a prototype for a BBZ net position forecaster which should:

- (i)Include a detailed description of requirements, including:

· The methodology (e.g., statistical and/or deterministic) to be employed;

·Specific outputs that would be required from the forecaster;

·How the forecaster will incorporate future market developments, including the future introduction of new bidding zones whether onshore or offshore;

·How outputs from the forecaster will be inputted into wider MRLVC processes;

·Any other key requirements identified through the work set out under subparagraph (a) and Article 3.

The BBZ forecast is essential to determine the correct flows on the EU-UK interconnectors. In an MRLVC solution the flow on the interconnectors shall be determined based on the full OBKs in the GB and EU connected bidding zones, thus realised bids from market parties. The bid/ask curves shall however be offset to either the right (towards exports) or left (towards imports) based on the sum of exchanges with neighbouring areas as shown in Figure 12.

The adjustment, Sum (Import + Export) which is equal to the Net Position, is the BBZ forecast for a given bidding zone. The need for a forecast arises because the actual interaction of BBZs with other bidding zones is only determined during the allocation phase of the market (see Figure 13 below), which is *after* what is necessary in the MRLVC process, but *prior* to the allocation phases in GB and EU respectively.

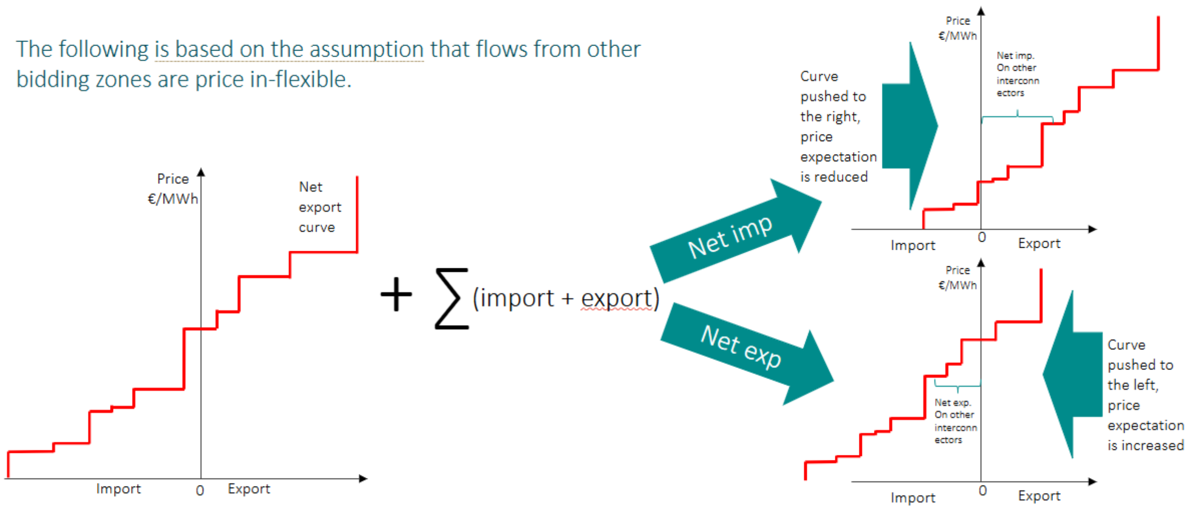


Figure 12 The Net export curve of the bidding zones is adjusted with the sum of imports and exports into a bidding zone to obtain the adjusted Net export curve which is to be used for the MRLVC calculation.

The topology of the market could change over time, thus the BBZ Net Position Forecaster will need to be future proofed to adjust to this possibility. It is highly likely that eventually there will be OBZs to forecast. If that were to be the case, the BBZ Net Position Forecaster would need to consider the flows between the GB zones connected to Europe through interconnectors and the non-connected GB zones. The Forecaster shall also consider exchanges between zones with both GB and EU interconnectors, for example, France and Belgium have both EU-GB interconnectors and EU-EU interconnectors.

3.2. Methodology to be employed for BBZ

Based on methodologies available in scientific literature the following high-level methodology or a combination of them is to be used:

- The primary approach is to use a machine learning algorithm. Evidence of accuracy shall be provided to the TSOs.
- A secondary and complementary approach would be to apply statistical models and utilisation of other relevant data from other representative areas, and/or parallel runs when no historical data is available, for example, when a new bidding zone is introduced in the system. Evidence of accuracy shall also be provided to the TSOs for this approach.
- The model shall ensure transparency through compliance with the EU transparency regulation (Commission Regulation (EU) No 543/2013 of 14 June 2013 on submission and publication of data in electricity markets) while also complying with REGULATION (EU) 2024/1689 which lays down harmonised rules on artificial intelligence, Article 13(3)(b)(iv) on transparency, for example by use of Shapley Values or similar.
- The approach chosen shall ensure repeatability when given the same input. Again, the tenderer shall provide evidence for this feature.

3.3. Inputs for machine learning algorithm

It is imperative that the algorithm is retrained at regular intervals and that due consideration is given to how the oldest historic data is used versus newest data. The tenderers shall report on choices made, the criteria for choosing to retrain the model, the consequence of these and recommendations for any future enduring BBZ solution. The relevance of all data sources shall be documented to TSOs and the data source must be reliable to be part of an operational environment, which the tenderer shall provide evidence for.

The following are the minimum datasets required. The tenderer must document why it might be necessary to make any changes to this list:

- Load forecasts and historic data
- Temperature forecasts and historic data
- RES forecasts and historic data
- Generation assets of different technologies in each bidding zone
- Generation availability forecasts and historic data
- Gas, coal, wood product price forecasts and historic data
- CO_2 emission forecasts and historic data
- Maximum and minimum Net Positions (NP) in bidding zones
- Historic NPs in bidding zones
- Capacities in the grid, cross border or internally in bidding zones where relevant and determined by the tenderers and historic data for these limitations
- Ramping restrictions

Primary and potential alternative data sources should be clearly identified and documented.

3.4. Specific Outputs that would be required from BBZ Net Position Forecaster

The following outputs shall be published to the ENTSO-E transparency platform, a transparency platform in GB (unknown as of now), as well as submitted to the MCO which will run the MRLVC process.

The detailed outputs are:

- Net positions in MWh/h per bidding zone per MTU of the next day
- Transparency metrics per bidding zone per MTU, for example Shapley values

In addition, the tenderers shall deliver:

- An online dashboard to visualise the net positions and the transparency metrics for current and historic data, available for the procuring TSOs

3.5. How outputs from the BBZ Net Position Forecaster will be inputted into wider MRLVC processes

The output from the BBZ Net Position Forecaster becomes a direct input into the MRLVC algorithm (see Figure 13). The impact of this input (Net Position MWh/h) is illustrated in Figure 12.

It is assumed that MRLVC can use the existing PCR IT tools, e.g. MPLS setup for SDAC, and does not need additional MPLS lines. However, MRLVC TSOs need to connect to the MRLVC systems via a new MPLS connection – which could be a connection between BBZ Net Position Forecaster and the MRLVC PMB directly or through MRLVC NEMO systems.

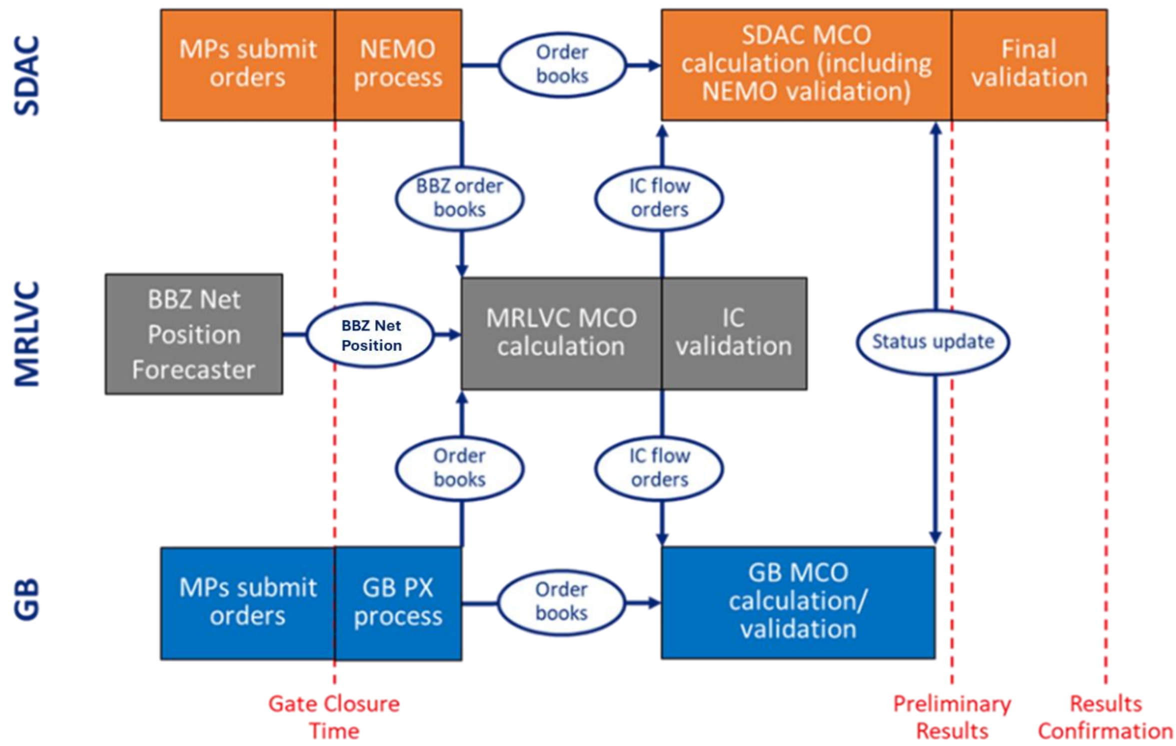


Figure 13 How outputs from forecaster are linked to wider MLRVC processes. Source: Cost Benefit Analysis of Multi Region Loose Volume Coupling 2021.

3.6. How the BBZ Net Position Forecaster will incorporate future market developments

While it is impossible to predict what may happen in the future there are a few known scenarios that a tenderer should consider when responding to the procurement:

1. Reconfiguration of bidding zones
   - It is possible that there may be a reconfiguration of the BBZs at some time in the future. This may have implications for the data requirements and operation of any algorithms. The tenderer will be asked to consider how potential changes may impact the performance of the solution and how this could be demonstrated.

2. Extension of the solution beyond the current list of BBZs
   - Linked to 1) above, this envisages additional countries/zones being added as opposed to the current zones being reconfigured.
3. Change in MTU

   - Future changes in the MTU may necessitate changes to the timing intervals in data.

4. Advances in markets to reduce processing timeframes

   - Future changes in technology e.g. quantum computing advances need to be considered especially where there is a known potential for performance improvements e.g. faster processing time. The tenderer will need to demonstrate how any solution would be future proofed to a reasonable degree.

- The extent of the future market developments that need to be accommodated may be better known at a later stage, especially after the outcome of REMA is known. This should be revisited closer to the actual procurement.

3.7. Other key requirements (quality parameters)

- The BBZ forecasts of the net positions shall be based on at least 12 months' worth of data.
- The tenderers shall provide evidence on how testing and validation will be done to ensure accuracy and robustness.
- The forecasts produced by the BBZ Net Position Forecaster shall focus on root mean squared error as one quality parameter. The tenderers shall propose additional relevant quality parameters to be utilised to showcase the accuracy of the forecasts.
- It will be of crucial importance to agree the KPIs in order to evaluate the prototype. Here it might be required to not only consider KPIs which evaluate the accuracy on volumes, but also the impact of this volume accuracy on welfare. A suggested benchmark for output quality is that the NPs shall not diverge more than 20% from the realised NPs for more than 80% of the hours[25]. This is an indicative target and is expected to be discussed with tenderers to finalise an acceptable and realistic threshold based on their prototype design and operational requirements.
- The forecaster must address the timing and computational constraints of SDAC and provide robust fallback functionality to ensure timely publication of market results.
- As the BBZ forecast is a key part of a larger process it is important to have a consistent, stable and robust calculation process to ensure process stability. Therefore, the tenderers shall provide a timeframe for calculation of the net positions and shall show this to be complied with 99.9% of the time.

3.8. Accompanying Information

Recommendation No 1/2024 of the Specialised Committee on Energy, Article 2 (b) (ii):

(ii)The draft tender specification should be accompanied by:

·Information on how the tender would be issued and governed, including consideration of ownership and intellectual property rights;

·A detailed breakdown of anticipated timings and costs;

·Any relevant issue related to administrative functions required to address UK and EU system interdependencies in the implementation of an MRLVC solution.

The following sections offer considerations and illustrative options for exploring the questions of ownership, governance, costs and timings etc. However, the content is not intended to be definitive nor to contain exhaustive recommendations or instructions. More formal negotiations between the

[25] Based on experience from the Nordic RCC forecasting and a Master Thesis on ML improvements on the NP and flow forecasting at NRCC, this would be an ambitious target for the forecasting.

final/agreed TSO parties involved, with agreement from the respective authorities, would be required to define these areas for any future procurement process.

3.8.1. Information on how the tender will be issued and governed including consideration of ownership and intellectual property rights

The tender must be compliant with tender categories admitted under Chapter VI of the TCA. The EU - UK TSOs group will propose the methodology, based around a machine learning algorithm, while enabling the providers to find the best option under the value-for-money principles of EU and UK sustainable procurement. However, the form of the tender is beyond the scope of this report. Consideration of both EU and UK legislation will have to be made when the tender process decision is taken . The draft tender will be the instrument for contractors to deliver a prototype BBZ Net Position Forecaster that could perform the tasks underlined in the SCE letter of November 28th, 2024.

The tender will be issued by a consortium of interested EU and UK TSOs. Any consortium will need to be subject to a legal agreement to prevent disputes at a later stage. [redacted]

The European Commission (EC) and DESNZ will have a governance role. This means that the two institutions will be involved in approving any prototype. As a result, 8 months has been included in the timeline to allow for this. There will also be a role for regulatory authorities with regard to certain aspects including cost recovery. It is likely that individual TSOs will have to work directly with national regulatory authorities to address issues such as cost recovery.

3.8.2. Ownership

[redacted]

Option A	Option B
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	

Table 3: Options to outline the different options for ownership

3.8.3. Intellectual Property Rights

Any Intellectual Property (IP) created would be subject to a clear agreement between all TSOs on management and ownership, and this agreement must be in place before the tendering process begins. The agreement should use EU and UK legal instruments for IP ownership, licensing and cost sharing arrangements to be governed by the respective EU and UK laws. In addition, the protection and enforcement of the IP are to be considered where possible under the unitary system or single authority. As such, the terms of this agreement are outside the scope of this document.

Before the beginning of the procurement process, in addition to the IP agreements among TSOs, IP arrangements must be agreed between consortium and vendor, whether it be assignment or licencing of the IP. [redacted]

It is envisioned that a nominated TSO be selected from among the interested TSOs to lead the procurement and engagement with vendor. Public procurement for research services must comply with EU and UK procurements rules. Public funding of research must respect EU State Aid rules and respective UK rules. This is especially true if IP ends up with private partners. Selection processes must be transparent and competitive to reduce the risk of illegal state aid.

3.9. A detailed breakdown of anticipated timings and costs

Timelines and procedures for publication may be subject to a consortium agreement which would also address exploitation/ application of IP.

3.9.1. Timing

The initial proposal is a duration of 29 months which would be the minimum time expected to complete the work, and this may be prolonged if further testing is required. An initial outline (for illustrative purposes) is as follows:

a. 6 months for an approval process validation phase.

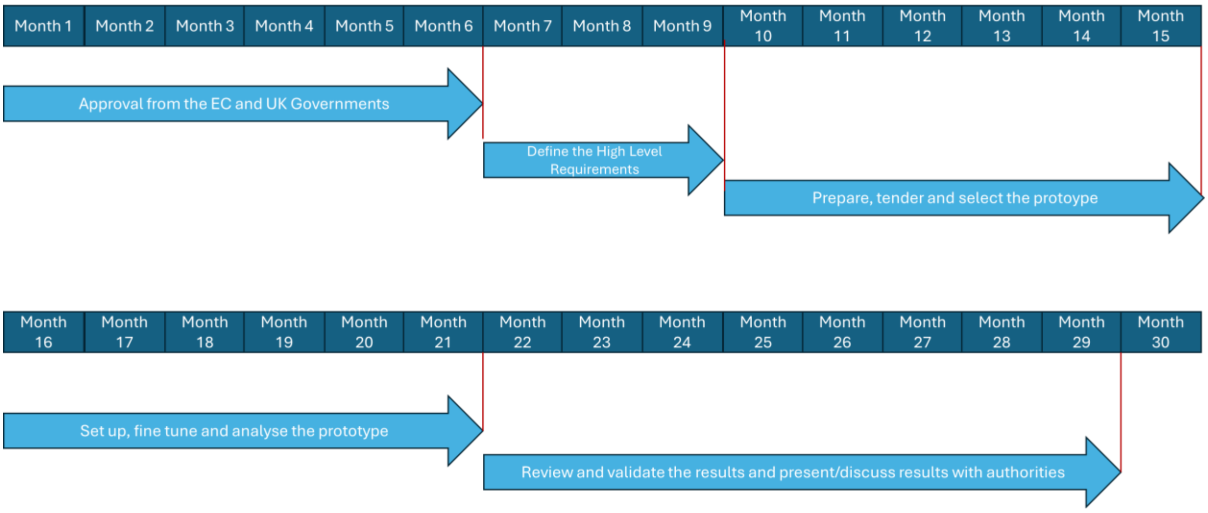
b. 3 months to define the high-level set of requirements for the prototype of the BBZ Net Position Forecaster.

c. 6 months to prepare, tender and select the prototype.

d. 6 months to setup, fine-tune and analyse the prototype including running MRLVC simulations (preparations to be done before these 6 months start).

e. 8 months to review and validate the results and present/discuss results with authorities.

Figure 14 Timeline for delivery of work



Approval Process – Validation Phase

Given the importance of the design concept, TSOs consider it necessary to have an approval phase from the EC and UK government on the designed solution before the prototype tender is live. During the prototype tender phase, evolutions of the designed solution may happen, and a process will have to be in place to address them.

Tender and NRA Approval

The estimate cost range of the prototype and supporting services may go beyond the EU or UK threshold for which specific procurement procedures and timelines may have to be followed.

Furthermore, given that the costs of the prototype could be significant, TSOs, as regulated entities, will have to get support and assurances from their respective NRAs to ensure that the costs are considered reasonable, acceptable and are recoverable by the TSOs. This aspect must be included in the tendering and approval process.

3.9.2. Anticipated Costs

The first consideration given to costs is to how they should be shared among the TSOs. While a limited number of options are presented, these are not to be considered exhaustive and more may be considered at a later stage. It must be noted that no one TSO should be the sole bearer of costs. There should be consideration of TCA Annex 29 Part 1 Paragraph 6 stating: "*The costs of developing and implementing the technical procedures shall be equally shared between the relevant United Kingdom transmission system operators or other entities, on the one side, and relevant Union transmission system operators or other entities, on the other side, unless the Specialised Committee on Energy decides otherwise*".

[redacted]

[redacted]

Option A	Option B	
[redacted]		
[redacted]		
[redacted]	[redacted]	[redacted]
[redacted]	[redacted] [redacted] [redacted]	[redacted]
[redacted] [redacted]	[redacted] [redacted]	[redacted] [redacted]
[redacted] [redacted]	[redacted]	[redacted]

Table 4: Options to outline the different options for cost sharing

[redacted]

Item	Lower Estimate/€	Upper Estimate/€
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

Table 5: Outline of detailed cost estimates

Assumptions for the table above:

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

3.10. Any relevant issue related to administrative functions required to address UK and EU system interdependencies in the implementation of an MRLVC solution

There are a number of relevant issues that would need to be addressed in order to successfully implement the proposed solution including:

1. **Regulatory Alignment**

It is vital that there is a degree of compatibility between the regulatory frameworks in the UK (mainly GB) and EU. While terms like "dynamic alignment" have been used elsewhere it is not within the scope of this document to identify the specific measures that would need to take place in order to address the regulatory risks that are evident from having two parallel regulatory systems in place.

2. Technical Coordination

There will be a need for greater technical coordination between EU and UK TSOs around areas such as capacity calculation. In addition, there will be a need for greater cooperation between other key actors including market operators, NEMOs etc to ensure that their respective roles are both understood and honoured. While some of these entities are heavily regulated others are not.

At present, while there is practical coordination on a daily basis, it is not necessarily consistent across all organisations. At a higher-level, administrative structures may need to be reviewed to ensure that there are sufficient resources and procedures in place to enable the concept of MRLVC to be both successfully implemented and smoothly operated.

3.11. Illustrated tender Solution

The table of contents for a sample Pre-Qualification Questionnaire (PQQ) in the Annex is an illustrative example of how the technical specifications for a BBZ Net Position Forecaster would typically fit into an initial procurement documentation. This is not binding for either of the parties at this point and the final version would include annexes featuring more detailed technical specifications negotiated amongst the final TSO parties involved.

Critical considerations for developing any tender documentation for this purpose, which are not confirmed at this point, would be:

- Determination of the issuing body, jurisdiction and governance of the tender
- Confirmation of the prototype's ownership, including intellectual property rights
- Contract value
- Clarification of the awarding criteria
- Full technical requirements compliant with Articles 2 (a) and Article 3 [of *Recommendation No 1/2024 of the Specialised Committee on Energy*] considering administrative functions for EU and UK operational systems

3.12. Conclusions

- The prototype for a BBZ Net Position Forecaster shall be based on a machine learning algorithmic approach. Its accuracy and robustness will have to be demonstrated during the prototyping phase.
- The extent of the future market developments that need to be accommodated may be better known at a later stage, including reforms linked to the REMA programme in GB. This should be revisited closer to the actual procurement.
- The timescales of tender through to testing completion will have a duration of minimum 23 months, which may be prolonged if further testing is required, and shall include an 8-month approval process by EC and UK government and NRAs assurance on the cost recovery by TSOs. [redacted]
- [redacted]
- Given the novelty of the concept, it is highly likely that both known and unknown risks may impact both costs and the delivery schedule for any prototype being developed.

- There are also key issues related to administrative functions that would need to be addressed before any solution could be implemented. These key dependencies include regulatory alignment and technical coordination. To address the high level of uncertainty, an extensive risk register is included in the annex. The main risks identified are the following:
    - AI learning may be impacted by the fact that there is no legacy data on the internet requiring alternative measures. Different UK and EU administrative functions (e.g. governance and approval) lead to a lack of oversight and potential delays in decision making.
    - Where the NP forecast is inaccurate the results are not useable and influence the MRLVC solution to the extent that explicit trading is preferable.
    - Difficulties in assigning specific aspects of EU and UK legislation to the tender lead to non-compliance with EU and/or UK laws.

4. Challenges facing the delivery of joint and hybrid offshore projects from existing trading arrangements or MRLVC

Recommendation No 1/2024 of the Specialised Committee on Energy, Article 3:

The Specialised Committee recommends that the Parties request that their respective TSOs for electricity and, for the Union, the ENTSO-E facilitating the work of EU TSOs produce a joint report for the Specialised Committee investigating any barriers to the delivery of joint and hybrid offshore projects that may result from existing trading arrangements or MRLVC, and any specific changes needed to existing trading arrangements or specific requirements of the design of MRLVC needed to deliver efficient electricity trading that supports the delivery of joint and hybrid offshore projects.

The TSOs joint report should:

(a) investigate the impact of both existing trading arrangements and an MRLVC solution on joint and hybrid projects, over the medium term (2030-2035 horizon), with a particular focus on:

i. the scope of the application of the trading modalities, and whether and how the performance of capacity allocation may be affected;

ii. how these trading arrangements could operate with different market designs, in particular offshore bidding zones; and

iii. whether there may be sufficient clarity in the business case for infrastructure investment,

(b) take into consideration:

i. the nature and scale of possible offshore renewable energy infrastructure developments across the North Seas in the medium term, including possible hybrid interconnectors, energy islands, meshed grids and offshore electrolysers;

ii. possible mechanisms of price formation;

iii. the complementary role of forward and intraday trading arrangements;

iv. impact on the accuracy of bordering bidding zone forecasts; and

v. any specific adjustments that may be required in the design features of these trading modalities, within their general confines, to help address any identified barriers and or requirements in the development and operation of joint and hybrid offshore projects to deliver efficient trading arrangements,

4.1. Definition of Offshore Hybrid Assets (OHA)

Here are some first key definitions for clarity on the terminology used.

GB perspective – OHA

OHA refers to the integration of interconnection with offshore wind. The complexities and ambitions of these asset types vary in scale between countries, from a singular platform to energy hubs to meshed grids.

From a GB perspective, Ofgem put forward a recommendation to categorise OHAs into two groups, to progress policy development on the licensing arrangements:

1) Non-standard interconnector (NSI) – OHAs connected to an offshore generator in the connecting jurisdiction, but not in GB, which will conduct interconnection activities in GB and the connecting jurisdiction as well as offshore transmission activities (only in the connecting state). These asset types will be eligible for a standard electricity license, as they will not perform the dual activity of the interconnection and offshore transmission in GB (although they will conduct offshore transmission activities in the connecting jurisdiction), and their characteristics in GB will be those of an electricity interconnector, as defined in the Electricity Act.[26]
2) Multi-purpose interconnector – OHAs connected to an offshore generator in GB, which will conduct interconnection activities in GB and the connecting state as well as offshore transmission activities in GB (and optionally in the connecting state). These asset types will be eligible for an MPI license, as they will perform the dual activity of the interconnection and offshore transmission in GB.[27]

EU perspective - Hybrid Projects

In the EU, hybrid interconnectors are referred to in European official publications as "*hybrid projects*" that are "*transnational, coordinated offshore energy generation projects. Typically, hybrid projects combine transmission assets across maritime boundaries*".[28]

From an ENTSO-E perspective, the term hybrid asset is not used as "*an asset is either transmission or generation, and that combining the two functions challenges the EU unbundling principle*".[29]

ENTSO-E considers that an offshore hybrid project refers specifically to the transmission assets (comprising the offshore hub, the offshore cable and onshore substations), while the offshore RES itself that is connected to the offshore hybrid project is treated separately as any other generation asset in the EU electricity system. The figure below visualises ENTSO-E definition:

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[26] Consultation on the Regulatory Framework for Offshore Hybrid Assets: Multi-Purpose Interconnectors and Non-Standard Interconnectors

[27] Consultation on the Regulatory Framework for Offshore Hybrid Assets: Multi-Purpose Interconnectors and Non-Standard Interconnectors

[28] Hybrid projects - Publications Office of the EU

[29] Deliverable-D1.6-Report-on-regulatory-barriers-FINAL.pdf

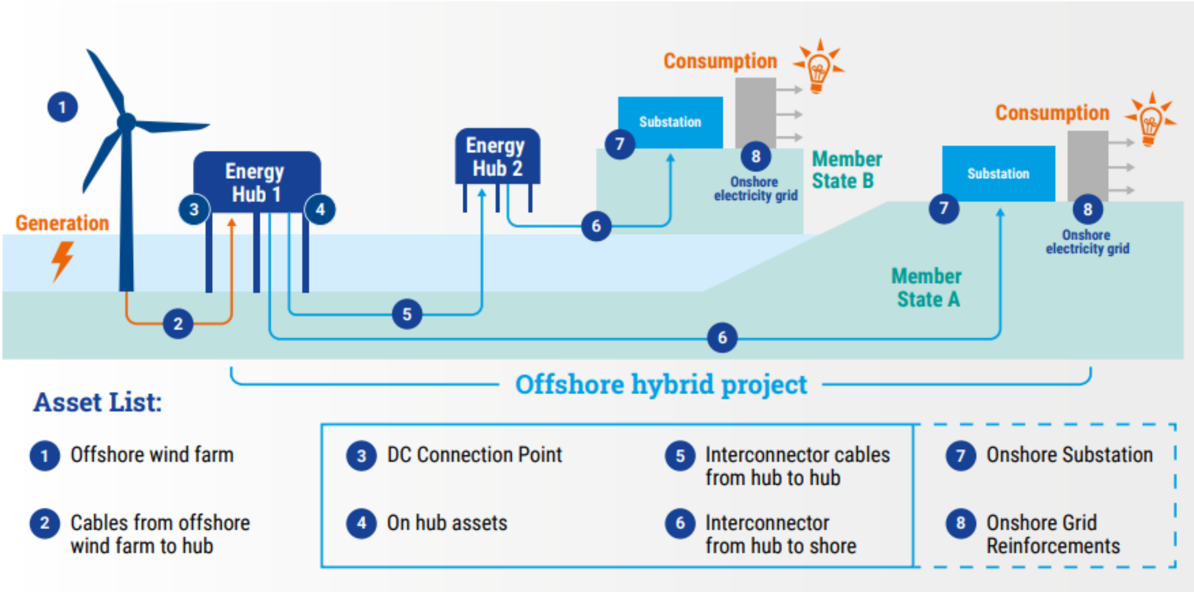

Figure 15 ENTSO-E view on the distinction between transmission and generation assets[30]

In the North Sea, hybrid projects' development is strategic for the deployment of offshore generation and to increase the asset utilisation when compared to a radially connected wind farm. Cross-border collaboration between Member States is key for hybrid projects. In this regard, the revised Trans-European Networks for Energy (TEN-E) regulation mandates the development of collaborative frameworks to identify, plan and share the costs of such large-scale projects[31]. The result was the EU Commission's Guidance on collaborative investment frameworks for offshore energy projects and the creation of Offshore Network Development Plans (ONDP) from ENTSO-E, in which hybrid projects are collected and identified.

In the 2024 ONDP, ENTSO-E also made a distinction between several types of offshore projects[32]:

- Dual purpose: combine the functionality of the connection to shore of offshore RES and the interconnection between multiple bidding zones.
- Multi-purpose: integrate energy sectors by including, for example, hydrogen production.

Offshore Bidding Zone versus Home Market

An OBZ refers to a new zone where the local price establishment and volume allocation is made separately to either connected market. In this zone, there is often no or barely any local demand and therefore, those within the OBZ are in direct competition with imports and exports from neighbouring bidding zones for the capacity of the interconnector that is connected to the OBZ[33].

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30 ENTSO-E Position Paper on Offshore Development: Assessment of Roles and Responsibilities for Future Offshore Systems

31 eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023DC0668

32 ENTSO-E TYNDP 2024 Offshore Network Development Plans – Tranmission Infrastructure Needs

33 elia-group-x-orsted-making-hybrids-happen.pdf

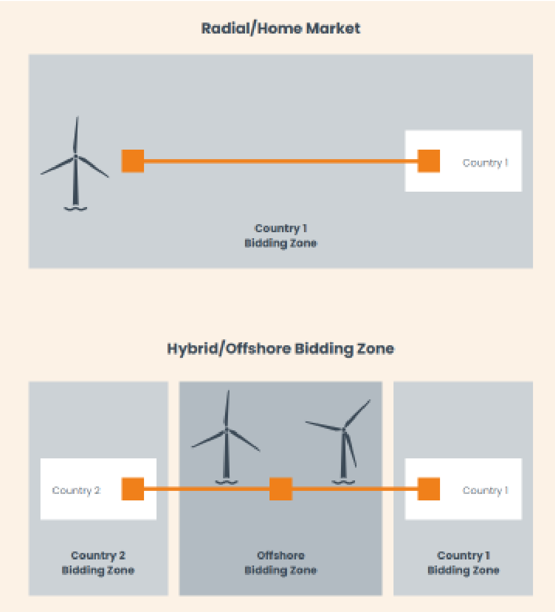

Figure 16 Home market and offshore bidding zone models for hybrid interconnectors[34]

OBZs are identified by the EC[35], ACER, the Council of European Energy Regulators (CEER)[36] and ENTSO-E[37] as the most efficient way to integrate large scale offshore renewables through hybrid projects.

The current design used for radial connections of Offshore Wind Farms (OWF), the Home Market design, is widely seen as not suited for hybrid projects. In such a model, the OWF connected to the hybrid project will be considered in the bidding zone of the Exclusive Economic Zone (EEZ) in which it is in and will be priced accordingly. Therefore, it would inject all its electricity in the onshore bidding zone without consideration of the technical limits of the offshore infrastructure. Because of this, depending on OWF forecasts, either the OWF will be curtailed and redispatched or the offshore hybrid transmission will be underutilised.

Alternatively, forming an OBZ will reflect the structural congestion happening in the hybrid interconnector. OWF submit their bids in an OBZ, and they are efficiently dispatched following the optimisation of the market algorithm. Therefore, the arbitration for the scarce capacity of the interconnector between the OWF and cross-zonal flows is internalised in the EU market algorithm. Extending the bidding zone definition given in the recast of the Electricity Regulation 2019/943, an (offshore) bidding zone is "*the largest geographical area within which market participants are able to exchange energy without capacity allocation*"[38].

[34] elia-group-x-orsted-making-hybrids-happen.pdf

[35] eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020SC0273

[36] ACER-CEER Reflection on EU offshore strategy

[37] ENTSO-E Position on Offshore Development: Market and Regulatory Issues

[38] REGULATION (EU) 2019/ 943 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL - of 5 June 2019 - on the internal market for electricity

The Commission also clarifies that OBZs are not limited to the offshore hubs but can also include near-shore onshore areas. This is in line with the principle of determination of bidding zones that are based on where the structural congestion occurs[39].

In GB, the concept of an OBZ will be applied in the same way for MPI project types, therefore establishing its own price against the GB and connected market to obtain capacity on the interconnector. The GB OBZ would need to access the relevant markets in the same way as the GB wholesale market to be able to operate as intended.

4.2. Offshore developments in the North Sea

Joint and hybrid offshore projects in the medium term (2030–2035)

The North Sea is becoming a critical region for offshore renewable energy, with several countries setting ambitious targets for offshore wind and hybrid energy projects. However, the proposed MRLVC solution and the current trading arrangements may have significant implications for these projects, particularly in the context of offshore wind targets, interconnector development, and the EU and UK's renewable energy goals. This overview examines how these factors could influence the region's joint and hybrid offshore projects in the medium term (2030–2035).

EU and GB are already deeply interconnected, with around 10.3 GW of point-to-point interconnectors already installed. An additional 1.4 GW link between GB and Germany, is currently under construction, to be commissioned in 2028. Ofgem, the energy regulator for GB has approved a regulatory regime for three additional P2P interconnectors and two hybrid interconnectors to be developed, noted below.

Name	Type
LirIC	P2P Interconnector
MaresConnect	P2P Interconnector
Tarchon	P2P Interconnector
LionLink	Hybrid Interconnector
Nautilus	Hybrid Interconnector

Offshore Wind Targets of North Sea Countries

North Sea countries, namely the UK, Germany, the Netherlands, Denmark, Ireland, Norway and Belgium, have set ambitious North Sea offshore wind targets for the coming decades. For example, the UK aims to generate 70% of its electricity from renewables by 2030, with offshore wind playing a central role. Similarly, Germany and the Netherlands are expanding their offshore wind capacity to help meet their climate targets.

[39] eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020SC0273

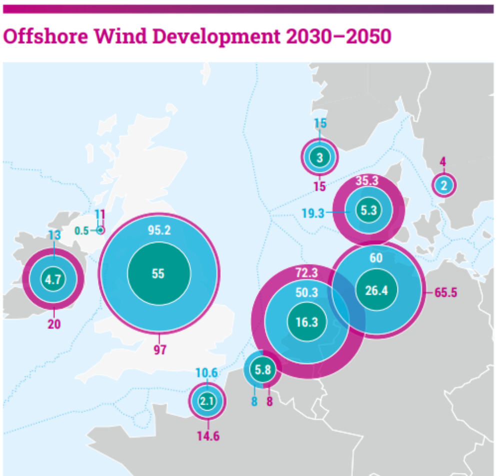

Figure 17 Offshore wind capacities 2030, 2040, 2050[40]

Interconnectors and Identified Corridors

More point-to-point interconnectors and hybrid interconnectors will be developed in the next decades to better distribute the benefits of the RES installed. A more integrated sea basin will allow transportation of electricity to the demand centres, increase energy security from offshore RES due to the redundancy of the interconnection and connecting areas with different wind profiles.

The ONDP developed by ENTSO-E in 2024 is a component of the Ten-Year Network Development Plan (TYNDP) and translates the EU Member States' individual non-binding offshore targets into offshore transmission corridors.

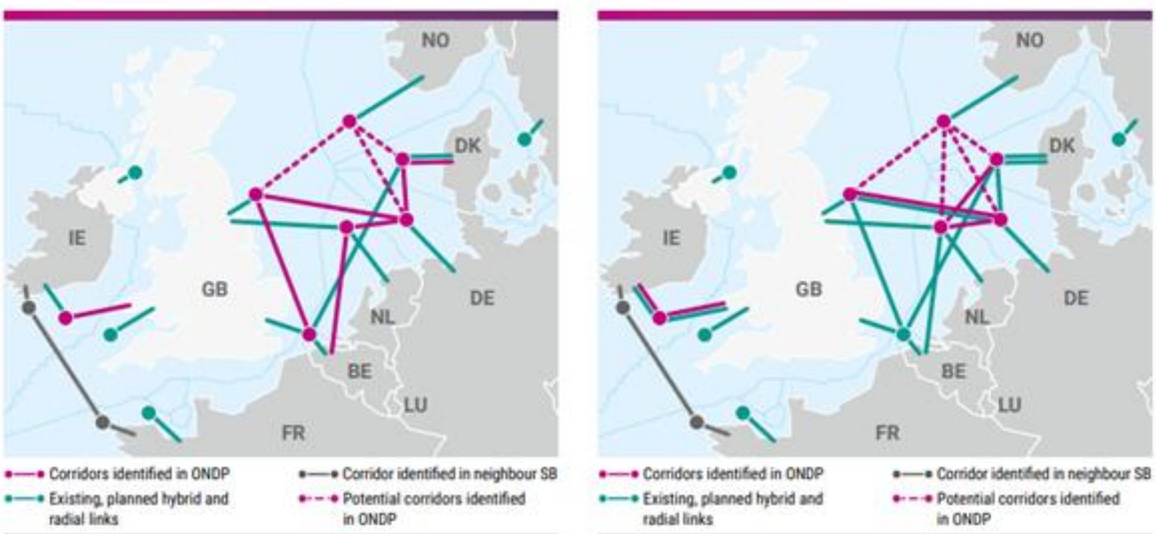

Figure 18 Integrated offshore network in the North Sea in 2040 and 2050[41]

[40] ENTSO-E TYNDP 2024 Sea-Basin ONDP Report – Northern Seas Offshore Grids

[41] ENTSO-E TYNDP 2024 Sea-Basin ONDP Report – Northern Seas Offshore Grids

The ONDP shows that after initial radial interconnections of OWF, in order to optimise their construction and operation, the first energy islands and hybrid interconnectors will start to be developed.

Another interesting snapshot of the North Seas' interconnections comes from the Grid Map developed by the Offshore TSO Collaboration (OTC) presented in the Expert Paper of April 2025[42] (see Figure 18). The Grid Map developed by OTC is a first example of joint regional planning, in which the North Seas TSOs have presented a set of projects whose collective benefit outperforms the individual one.

The final result shows an increased level of interconnections with GB around 2040, in which hybrid interconnectors, included in the blue shaded circular area, play a central role.

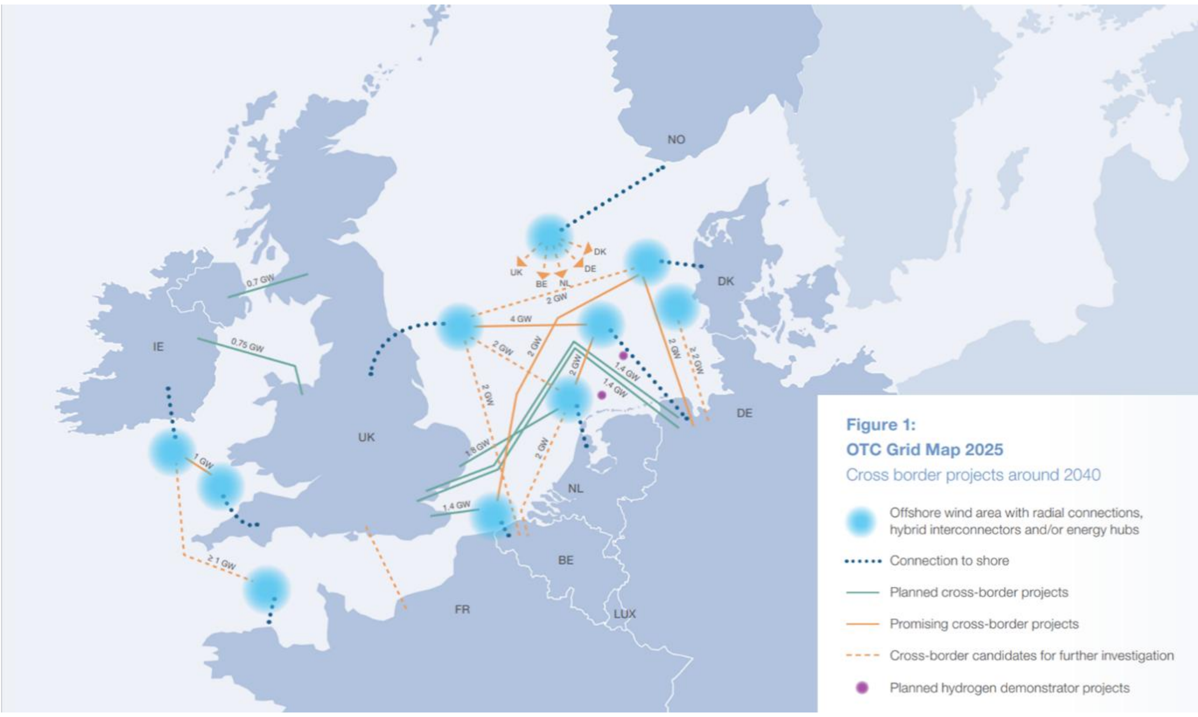

Figure 19 OTC grid map for cross-border offshore projects[43]

Hydrogen development in the North Sea

In Europe, only three countries have submitted in the ONDP non-binding goals at a stage where multi-purpose projects (i.e. OWF generation and electrolysers) are identified in the North Sea. The Netherlands, Denmark and Ireland plan to install a total capacity of 34 GW of electrolyser capacity by 2050.

Electrolysers have the potential to create a certain level of load in OBZs and therefore participate in the OBZ price formation process. However, due to the long-term timeframe and the uncertainty associated with these projects, in the analysis below, OBZs will be considered with no load.

[42] Joint Planning in Europe's Northern Seas by Elia Group - Issuu

[43] Joint Planning in Europe's Northern Seas by Elia Group - Issuu

4.3. UK Renewable Energy Targets and Increased Exports

The UK has committed to a significant increase in renewable energy generation, with offshore wind playing a central role in achieving its renewable targets.[44] In line with these targets, GB plans to increase its reliance on renewable energy, complemented by cross-border flows with neighbouring countries, as part of its strategy to diversify its energy sources and secure a stable supply of clean energy.

NESO's Clean Power 2030 report[45] outlines GB's targets for offshore wind and interconnectors, along with the challenges associated with achieving these targets.

GB aims to significantly expand its offshore wind capacity to achieve clean power by 2030. The target is to contract as much offshore wind capacity in the next one to two years as in the last six combined. This involves increasing offshore wind capacity by building an additional 28-35 GW, reaching a total of 43-50 GW by 2030. The deployment of offshore wind must happen at an unprecedented pace, far exceeding previous records. This includes contracting around 4-10 GW from each of the allocation rounds in 2025 and 2026. Offshore wind relies on substantial onshore infrastructure, including substations, transmission lines, and grid connection points, to integrate generated electricity into the national grid.

However, there are several challenges associated with these targets. The rapid scale-up in offshore wind deployment will stretch supply chains and require accelerated decision-making in planning, permitting, and awarding contracts. Key decisions on funding, awarding contracts, consenting, and policy are needed within the next year to ensure construction on key projects starts as soon as possible.

Interconnectors play a crucial role in GB's clean power strategy by allowing the country to benefit from different supply mixes, generation patterns, and demand patterns in neighbouring markets. The target is to increase interconnector capacity from 8 GW in 2023 to 12 GW by 2030. GB aims to become a net exporter of electricity across the year, switching from the current situation where it is a large net importer.

Looking further ahead and complementing the view of Clean Power 2030, The Future Energy Scenarios Pathways to Net Zero 2025 (FES)[46] developed by NESO, provides a detailed roadmap for achieving net zero emissions by 2050, highlighting the importance of strategic planning, consumer engagement, and integration of various energy sources and technologies.

It focuses on four pathways, meeting net zero targets in three of them:

- Holistic Transition: A balanced mix of electrification and hydrogen, with high levels of renewable energy and significant infrastructure investment.
- Electric Engagement: Primarily focuses on electrification with high consumer engagement and adoption of smart technologies.
- Hydrogen Evolution: Emphasizing in hydrogen for decarbonizing industry and heat.
- Falling Behind: scenario that does not meet the net zero target.

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[44] Northern Ireland (NI) and GB have separate renewable energy targets. The Climate Change Act (NI) 2022 established a target for NI of at least 80% of electricity consumption to be from renewable sources by 2030.

[45] Clean Power 2030 | National Energy System Operator

[46] Future Energy Scenarios (FES) | National Energy System Operator

The FES 2025 report also includes a Ten-Year Forecast which is a short-term projection based on current policies and project pipelines. Each pathway forecasts a different level of interconnector reflecting the needs of the system.

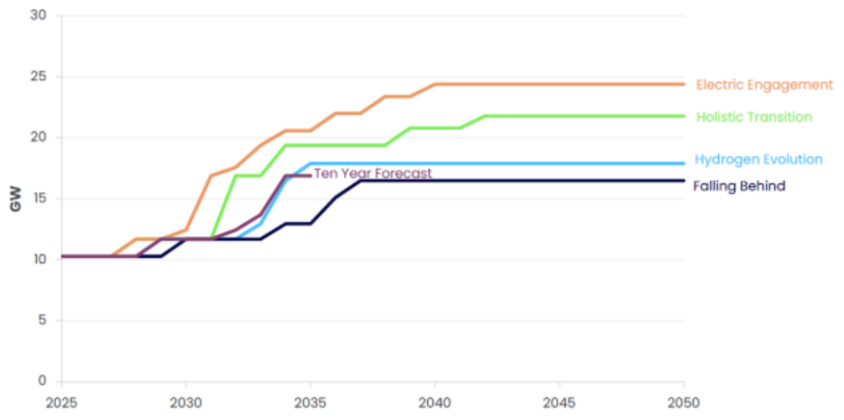

Figure 20 Interconnector Capacity

Three of the pathways outlined in the Ten-Year Forecast indicate that GB will become a net exporter of electricity beyond 2030, while the Hydrogen Evolution pathway results in a potential more balanced net flow. Elevated levels of renewable generation, particularly from offshore wind, suggest that electricity supply will frequently exceed domestic demand, resulting in exports to continental Europe. This typically occurs during periods of low consumer demand or when internal network constraints limit transmission capacity within GB.

Although the net export position is expected to decline slightly after 2040, GB remains a net exporter in three out of the four pathways.

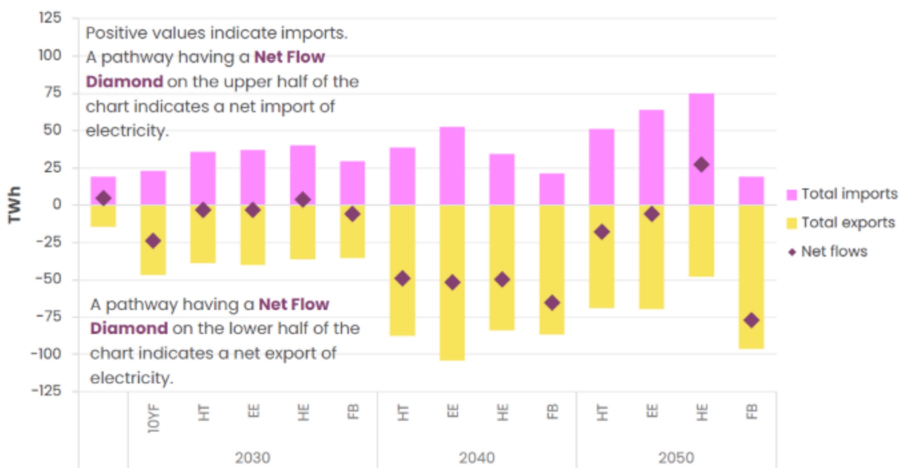

Figure 21 Interconnector Imports, Exports and net annual flows

There are also challenges associated with interconnectors. Careful consideration is required around the market arrangements for interconnector flows, especially where these could introduce inefficiencies that incentivise gas-fired generation in GB to run for export across interconnectors. It is crucial that interactions between the future market design and the future market arrangements are aligned to foster the optimal deployment of cross-border assets.

4.4. Relevant market design elements discussed in this report

Flow-based market coupling

The flow-based market coupling model is a method to compute and allocate the capacity that is traded across borders within a Capacity Calculation Region. Instead of setting fixed capacity limits per border (in the so-called Net Transfer Capacity, NTC, model), the flow-based model simulates the actual physical constraints of the grid. It does this by assessing the available margins on critical network elements and using power transfer distribution factors (PTDFs), which quantify how changes in a bidding zone's imports or exports affect the power flow on each critical branch within the Capacity Calculation Region.

The flow-based model is more sophisticated and complex than the NTC model, but it allows to be less conservative as it better reflects real network conditions. Because of this, more cross-border capacity can be traded, increasing European social welfare.

The flow-based method is required by Article 20 of the CACM Regulation[47] and it has been implemented in the Day-Ahead timeframe in the Core Capacity Calculation Region in 2022 and in the Nordic Capacity Calculation Region in 2024.

Advanced Hybrid Coupling

Advanced Hybrid Coupling (AHC) is IEM's target model to take into account the effect of the interconnector flows from connected Capacity Calculation Regions (CCRs) on their internal grid.

Today Standard Hybrid Coupling is applied. This is where a forecast value from the TSO is reserved prior to capacity calculation to then assess the impact of interconnector flows on a CCR's critical network elements.

In Advanced Hybrid Coupling, the flow on the interconnectors has a direct impact on the physical capacity of the network elements during the allocation phase. Therefore, no forecasts are needed anymore and the use of network elements becomes a market decision, maximising socio-economic welfare. In order to do that in the flow-based algorithm, a Virtual Hub (VH) is introduced in the model on each CCR border with interconnectors. VH is a virtual bidding zone without any buy and sell orders, used to represent the imports and exports on an AHC border.

4.5. Compatibility with market design and barriers

Questions addressed in this section:

- What are the barriers posed by existing trading arrangements or the MRLVC design to the delivery of joint and hybrid offshore projects?
- How can these trading arrangements operate under different market designs? What specific challenges arise in the context of offshore bidding zones?

[47] Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management

Explicit shortcomings with offshore hybrids (Price Formation and Cross-Zonal Capacity Calculation)

In explicit allocation, cross-zonal capacity and electricity are traded separately. This can lead to inefficient price formation and utilisation of an interconnector.

- **Price formation with OBZs**:

Explicit allocation defies the goal of OBZs, which is to avoid forecasts inefficiencies. As a matter of fact, the capacity on the side GB-OBZ and SDAC-OBZ would have to be split based on forecasted volume of offshore wind.

Secondly, forecasts errors will distort price formation in OBZs. OBZs do not contain liquidity. There is only wind generation and normally no local demand, which means that the OBZ cannot set meaningful prices on its own. Exporting power is needed to import prices.

The supply/demand equilibrium of an OBZ can only be reached through exports, something which would be automatically considered from BBZs under full price coupling, but under explicit allocation it can only be reached via forecasting.

In explicit auctions, market parties in the OBZ (therefore OWF operators) need to obtain cross-zonal capacity between the OBZ and GB. After that, the OWF will place orders in the OBZ market (i.e. SDAC) and in the GB market. This split in liquidity is based on the OWF forecasts of the price difference between the OBZ and SDAC and will inevitably influence the price of an OBZ as calculated by SDAC. Therefore, the OBZ price will be influenced by decisions of market participants.

- **Timings for explicit auctions on existing EU-GB interconnectors:**

The explicit auctions performed today on UK interconnectors are only partially harmonised in terms of timings and access rules.

The deadline for clearing the DA explicit auction to secure capacity and the deadline for nominating such capacity in DA auctions are far from aligned. This adds an additional degree of complexity to market participants in performing correct predictions (as it is spread among several interconnectors).

Bidding Zone Border	Interconnector	DA Explicit Auction Cleared at	DA Nominations Due by
BE-GB	Nemo Link	09:30	14:00
NL-GB	BritNed	09:10	13:50
FR-GB	IFA1 / IFA2	10:00	14:00
DK-GB	Viking Link	09:55	13:30
FR-GB	ElecLink	09:50	14:00

Table 6 Day-Ahead auction clearance and nomination timings for bordering bidding zones

- **Economic inefficiencies:**

  Since explicit allocation relies on forecasts, it is possible that the netted schedule over the interconnector does not exploit the full cross-zonal capacity in the market favourable direction. These inefficiencies can be seen in the frequency of the "flows against price difference" that occurs in explicitly allocated interconnectors with GB. In 2024 a technical paper from Elia reported that for these interconnectors bordering with GB, the percentage of market time units in which scheduled commercial exchanges went against market direction was around 20%. The occurrence of such inefficiencies is reported on Figure 22 below.

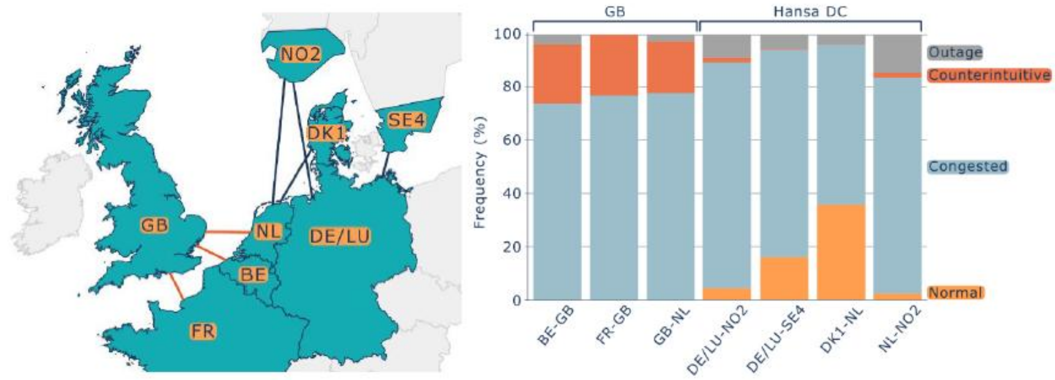

Figure 5: Illustration of considered interconnectors

Figure 6: Frequency of schedules leading to uncongested, congested or counterintuituve market outcomes incl. outages

Figure 22 Frequency of scheduled leading to uncongested, congested or counterintuitive market outcomes including outages [48]

  Another efficiency indicator is the utilisation rate of the interconnector capacity. GB interconnectors' rate is between 71% and 78% while for Hansa interconnectors it reaches 90%.

- **Incompatibility with AHC:**

  Explicit allocation on GB IC prevents the use of AHC as interconnector capacity is computed at a different time to the European flow-based area. For AHC to perform fully, the bidding zone border needs to be in a flow-based area, meaning that capacity is computed through a flow-based model, and it is allocated implicitly. As a matter of fact, AHC will be limited to bidding zone borders that are fully within SDAC such as between Core, Nordic and Hansa.

4.6. MRLVC shortcomings with offshore hybrids

For the purpose of our assessments, the OBZ concept will be used in the analysis of future developments in electricity market design, in the context of MRLVC implementation. This includes the introduction of AHC in the EU. Here, we will look to focus on assessment factors including

[48] https://www.eliagroup.eu/-/media/project/elia/shared/documents/elia-group/publications/20241014_elia-technical-study-on-need-for-electricity-market-price-coupling-with-uk.pdf

(Analysis based on data from ENTSO-E transparency platform and RTE eco2mix platform).

feasibility and compatibility, price formation, efficient use of interconnectors, capacity valuation and commercial utilisation.

European Target Internal Market

The sections below will describe the impact of MRLVC on some market design evolution and features that will be key for the development of offshore infrastructure in the North Sea.

Barriers posed by MRLVC

MRLVC poses major challenges, allocatively and in terms of forecast dependency, which introduces a number of risks.

- Volume coupling can lead to inefficient price signals:
    - The premise of MRLVC is that it is developed as a volume coupling mechanism. The difference between this and price coupling is that it only determines cross-zonal flows without calculating prices. Price coupling calculates both cross-zonal flow and prices.

- Forecasting errors can even further reduce the efficiency of the loose coupling:
    - Loose coupling depends on flow forecasts between BBZ and non-BBZ SDAC markets. This creates a high risk of forecasting errors, which will ultimately lead to inefficient use of interconnectors, reduced congestion revenue and decreased socio-economic welfare. The efficiency of MRLVC will depend on the accuracy of the BBZ Net Position Forecaster, that is a methodology that will need to be developed from scratch.

Inefficiencies in price formation in OBZ

- As stated in the previous sections, OBZs contain assets with no intrinsic marginal costs, which makes price formation difficult. An efficient price coupling mechanism would be required to determine clearing prices. Allocation and price formation inefficiencies could lead to flows against price differences, which leads to a decrease in welfare via negative DA congestion revenues.
- Assuming perfect forecasts and considering the case (that will occur recurrently in the future) of imports from GB to BBZ, it is likely that the OBZ-BBZ leg of the interconnector will be congested as imports from GB will be complemented by the wind in the OBZ.
    - Following the price coupling algorithm rules, the OBZ price would have to be the same as GB (wind value as much as imports), while OBZ price would have to be lower than BBZ price (since there is an import)
    - However, due to the impossibility of sharing prices, MRLVC would not be able to provide GB prices. Therefore, the OBZ price formation is not influenced by GB.
    - Because of this missing price, the SDAC algorithm will apply a “price indeterminacy rule” that will cause OBZ price to be the same as the BBZ.

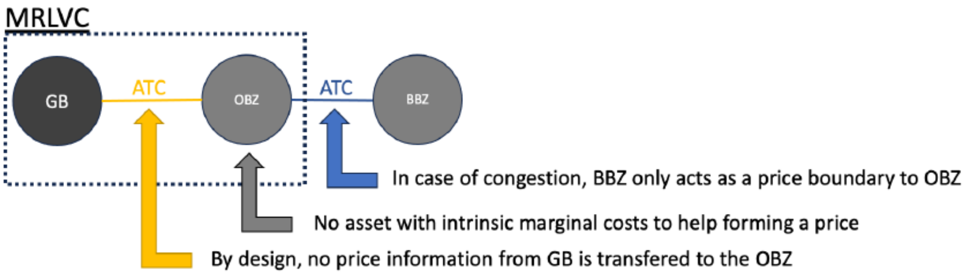

Figure 23 MRLVC does not provide sufficient information for price formation in case of congestion[49]

- Inefficient price formation in OBZ only comes from the volume coupling of MRLVC as price information is not available. Therefore, the same issue would occur in case of other volume coupling solutions e.g. tight volume coupling (i.e. where there is no forecasting element).

Issues with flow-based areas

Flow-based allocation is an inherent part of the European target market model, so MRLVC needs to be designed to work with this in mind. However, the "loose" characteristic of MRLVC entails that the process can only receive information (i.e. order books and scheduled flows) from BBZ. To compute actual flows on the interconnectors, the flows of BBZ with non-BBZ will have to be forecasted. Risk of forecasting errors are heightened and will have a higher degree of consequence, leading to unintended congestion and an impact on DA prices in GB, SEM and SDAC.

If flow-based would not be applied, the Available Transmission Capacity (ATC) model will be used. In this scenario, the BBZ Net Position Forecaster only needs to focus on the net position of each BBZ against other bordering SDAC non-BBZ (ATC between two BBZ would be provided).

However, in flow-based, the net position of each bidding zone is interlinked with the rest of SDAC through flow-based parameters. Therefore, it is not possible to provide MRLVC with the available capacity between BBZ.

MRLVC considers GB to be connected to a radial network of separated BBZs. They are treated independently from each other, individually connecting to GB. This is a barrier as each BBZ would be efficiently interlinked through flow-based allocation. For this reason, MRLVC cannot direct imports/exports of the flow-based area into one or another interconnector when there are multiple routes for efficient flows.

[49] https://www.eliagroup.eu/en/press/2024/10/20241014_eu-uk-price-coupling

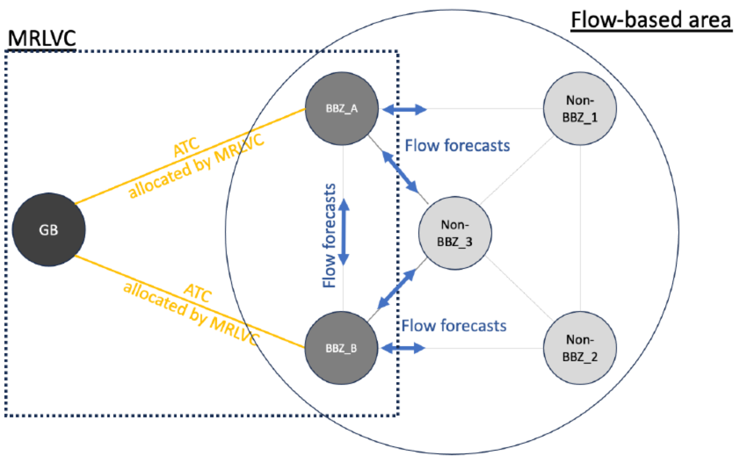

Figure 24 Schematical representation of MRLVC (flow-based model)[50]

Issues with Advanced Hybrid Coupling

Under AHC, a virtual onshore bidding zone needs to have its net position forecasted. This is because TCA requirements states that non-BBZ market data cannot be input into MRLVC. The forecasted flow between the virtual hub and flow-based areas is then input into MRLVC.

Flows between the OBZ and the flow-based area are fixed prior to any MRLVC calculations by the BBZ Net Position Forecaster because MRLVC must flow from/to the virtual bidding zone exactly equal to its forecasted net position. The forecasted net position will set the flow over the OBZ-BBZ interconnector and fix the OBZ supply that flows to GB.

Since MRLVC will set ex-ante the OBZ flows towards GB and SDAC, this becomes a self-fulfilling prophecy as the forecasted position will always become allocated flow, ignoring any other data/calculations and its market efficiency.

Therefore, AHC modelled interconnectors will not be able to allocate their capacity through a market-based mechanism, but only through a forecasting methodology.

The compatibility with AHC is not only an issue of hybrid interconnectors, but of traditional ones as well, as the interconnector will still be modelled through a virtual hub (and its position forecasted and univocally set).

[50] https://www.eliagroup.eu/en/press/2024/10/20241014_eu-uk-price-coupling

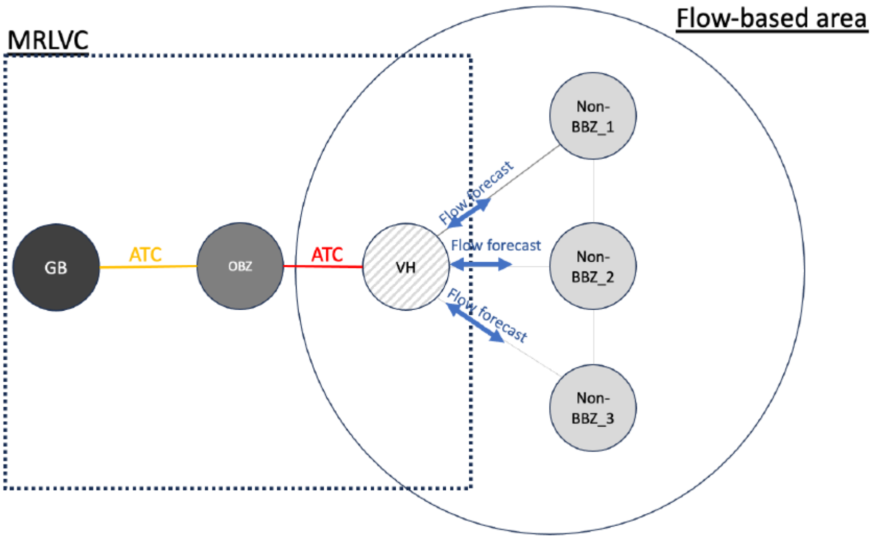

Figure 25 Advanced Hybrid Coupling (and Virtual Hubs) applied with MRLVC[51]

European Bidding Zone Review

European TSOs are undertaking a Bidding Zone Review. As part of this review, they are considering alternative configurations for bidding zones, such as the potential division of the Netherlands and Germany into multiple distinct bidding zones.

Only bids and offers from connected zones are used in the MRLVC algorithm. Therefore, any adjustments to connected zones' bidding areas will impact the data shared with MRLVC. Modifying European bidding zones may affect the computational complexity and effectiveness of MRLVC.

Dividing European bidding zones could result in more EU BBZs connecting to GB. This may lead to additional EU BBZ borders to optimize within the MRLVC algorithm or more borders between EU BBZs and other EU zones not connected to GB, necessitating flow forecasts. The former would increase computational complexity resulting longer computational run times, while the latter could decrease MRLVC's efficiency due to the unavoidable forecasting error.

4.7. Performance of capacity allocation

Questions addressed in this sub-chapter:

- What is the scope for application of existing trading modalities for joint and hybrid projects?
- How do these trading modalities impact the performance of capacity allocation?

Analysis of efficiency of explicit auctions from 2023 report

This analysis of the performance of explicit auctions covers the following metrics (between January 2021 and April 2023):

- Percentage of hourly intervals in which there were Flows Against Price Differences (FAPDs) for each of the existing interconnectors between GB and Continental Europe; and

[51] https://www.eliagroup.eu/en/press/2024/10/20241014_eu-uk-price-coupling

- Aggregate welfare loss from inefficient flows on existing interconnectors between GB and Continental Europe.
- Table 7 shows the percentage of hourly intervals in which there were FAPDs for each of the existing interconnectors between GB and Continental Europe. This analysis is shown by calendar year as well as for the period of May 2022 until April 2023 for comparison with the analysis of BBZ net position forecasts.

IC	2021	2022	2023 YTD	May 2022 – April 2023 (provisional)
Nemo Link	11%	20%	20%	18%
IFA2	11%	17%	19%	15%
IFA	11%	16%	19%	13%
BritNed	12%	21%	16%	18%
ElecLink	N/A	14%	20%	14%

Table 7 Percentage of hourly intervals in which there were Flows Against Price Differences (FAPDs) for each of the existing interconnectors between GB and Continental Europe[52]

Some FAPDs could be associated with baseload day trades which are logical in aggregate even if they appear 'out of the money' for individual intervals. Trades could also have been undertaken at prices which differ from those used for this analysis (i.e., 'over the counter' trades). Such trades can be carried out to utilise the flexibility of interconnector capacity for consumer benefit. Otherwise, in principle, FAPDs can represent a lost welfare opportunity.

The second metric is the aggregate welfare loss from inefficient flows on existing interconnectors between GB and Continental Europe, as shown in Table 8 below. These values include both intervals with FAPDs as well as intervals in which flows are in the correct direction (i.e., from the higher priced region to a lower priced region) but flow is less than 100% such that the interconnector is underutilised. Similarly, this metric is reported for each calendar year and the period of May 2022 until April 2023.

	2021	2022	2023 YTD	May 2022 – April 2023
GB-BE	€ 9.8	€ 36.0	€ 3.2	€ 28.9
GB-FR	€ 23.4	€ 98.0	€ 19.7	€ 95.6
GB-NL	€ 10.9	€ 50.5	€ 4.3	€ 40.0
Total welfare losses	€ 44.1	€ 184.5	€ 27.2	€ 164.5

Table 8 Aggregate welfare loss in millions for explicit auctions from inefficient flows on existing interconnectors between GB and Continental Europe. (This table is from the 2023 MRLVC Report. Source: Analysis of data from ENTSO-E Transparency Platform; Low Carbon Contracts Company; Bloomberg)

[52] *This table is from the 2023 MRLVC Report. Source: Analysis of data from ENTSO-E Transparency Platform; Low Carbon Contracts Company; Bloomberg)*

Analysis of MRLVC efficiency from 2023 report

The 2023 report compared FAPD over GB interconnectors using explicit auction and MRLVC. For MRLVC, a commercial forecaster has been used to simulate the BBZ Net Position Forecaster.

IC	MRLVC	Explicit Auctions	Difference (Explicit-MRLVC)
Nemo Link	€14.4m	€28.9m	€14.5m
IFA1/2, ElecLink	€10.5m	€95.6m	€ 85.1m
BritNed	€3.6 m	€40.0m	€36.4m

Table 9 Simulated MRLVC using commercial forecasts[53]

This shows that the simple MRLVC simulation using the BBZ net position forecasts from the commercial forecaster outperforms explicit auctions on this measure in France, Belgium and the Netherlands. The outperformance is largest for the Netherlands while the smallest improvement is observed for Belgium. It however must be noted that this comparison does not consider the size of the flow deviations and at which price spread level they occur; both are expected to be different under explicit compared to MRLVC.

Analysis including information from the 2024 Baringa Report for EirGrid and SONI (focused on SEM-GB trading arrangements, including MRLVC)[54]

Analysis conducted by consultants Baringa on behalf of EirGrid and SONI in 2024 shows that MRLVC may produce an increase in efficiency compared to explicit auctions. This however does not bring the same benefits as full market coupling, and some inefficiencies in interconnector flows are expected be present under MRLVC. The scale of these inefficiencies will ultimately depend on the detailed design and implementation of MRLVC, including the accuracy of forecasted interactions with external bidding zones.

The implementation costs and timeline for MRLVC could be significant and there is no guarantee that MRLVC will be an improvement on existing arrangements on the SEM-GB border.

MRLVC is expected to improve DA trading efficiency and overall interconnector utilisation relative to explicit auctions. As the SEM-GB border is implicit in the intraday timeframe, it may not experience these benefits, so impact is likely to be lower.

If the MRLVC external BBZ Net Position Forecaster provides a high degree of accuracy in its predictions, MRLVC could be more efficient than the current explicit arrangements on GB-continental borders. However, allowing for some inaccuracies in the forecasting process, the analysis conducted shows that MRLVC may not improve upon the trading inefficiencies observed on GB-continental borders since 2021.

[53] *This table is from the 2023 MRLVC Report*

[54] Further information on this 2024 Baringa Report can be obtained from EirGrid and SONI

As previously mentioned, SEM currently has an uncoupled DA market with bilateral coupling with GB in the intraday timeframe. MRLVC would enable DA trading on SEM-GB interconnectors. In the intraday timeline the existing implicit allocation via coupled intraday markets would remain.

As the SEM-GB border is already coupled in the intraday market, any potential benefits of MRLVC are reduced compared to the continental borders. The modelling conducted by Baringa on behalf of EirGrid and SONI projects that the application of MRLVC to SEM-GB interconnectors may not lead to more efficient trading outcomes than the current Intraday coupling arrangements, as observed over the 2021-2023 period.

The analysis conducted by consultants Baringa on behalf of EirGrid and SONI on the SEM-GB border show the relative efficiency of SDAC compared to explicit-only allocation. This is a helpful guide for EirGrid and SONI, and the SEM, to assess the merit of explicit allocation and the potential costs/benefits of implementing this mechanism on the SEM-GB border in the future.

The DA schedule scatterplots for 2020 exhibit the classic 'S curve' observed for full market coupling, with interconnectors appearing to be fully utilised in the economic flow direction in the majority of periods. The scatterplots for 2021 to 2023 exhibit significant deviations in interconnector trading outcomes. The plots are much more dispersed, with inefficient schedules in the wrong direction notable in some periods.

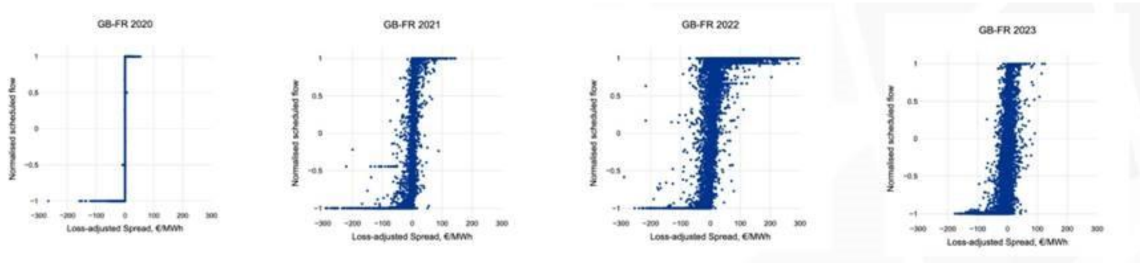

Figure 27 Loss Adjusted Spreads for the Day-Ahead schedules on the GB-FR border 2020-2023. Source: Baringa report for EirGrid and SONI, 2024

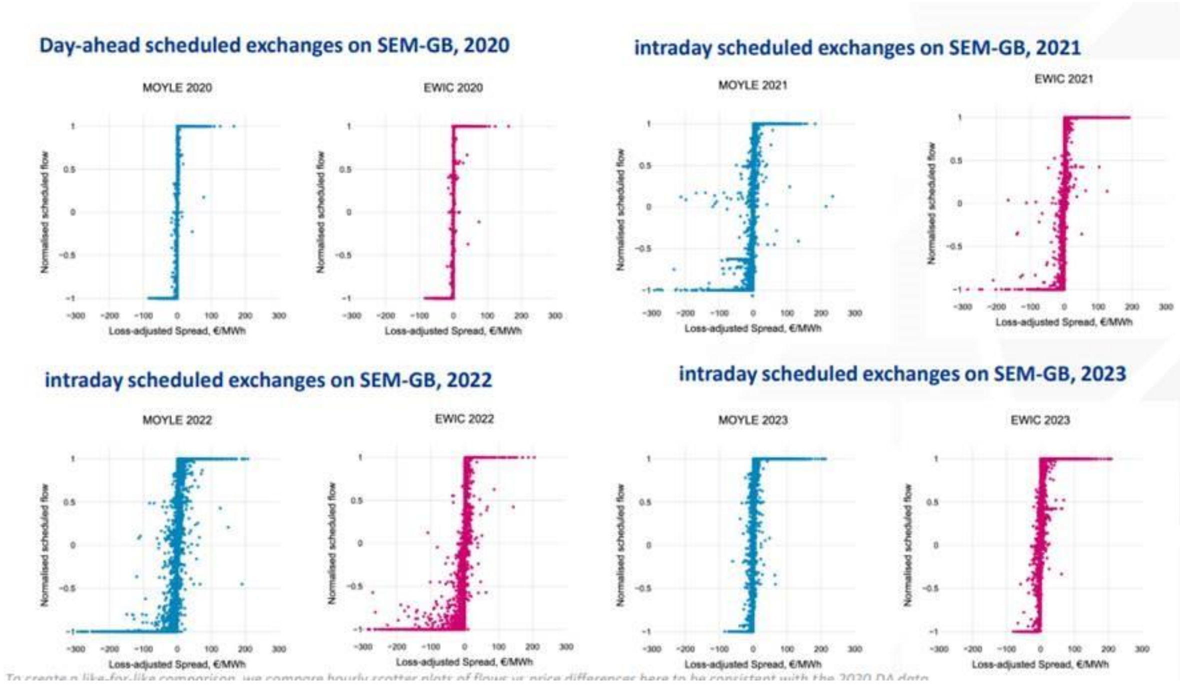

Figure 28 Day-Ahead and Intraday scheduled exchanges between GB and Moyle/EWIC, 2020-2023. Source: Baringa report for EirGrid and SONI, 2024

For the continental borders, the inefficiencies increase dramatically under explicit nominations in 2021-2023. Moyle and EWIC remain coupled, albeit with only the ID1 auction from 2021, but still show a reduction in efficiencies. FAPD is unaffected by traded volumes, so we attribute this increase to more frequent price change.

The Price-Weighted Inefficient Interconnector Utilisation (PWIIU – a trading efficiency metric) remains low compared with FAPD in 2020 for the continental borders, showing that FAPD generally occur at relatively low-price differences. Again, for the continental borders, the inefficiencies increase dramatically under explicit nominations in 2021-2023. As with FAPD, Moyle and EWIC also show reduced efficiencies despite their coupled status. MRLVC represents the possibility of an increase in efficiency however there are multiple market conditions which could impact SEM-GB flows and the implementation of cross border trading arrangements.

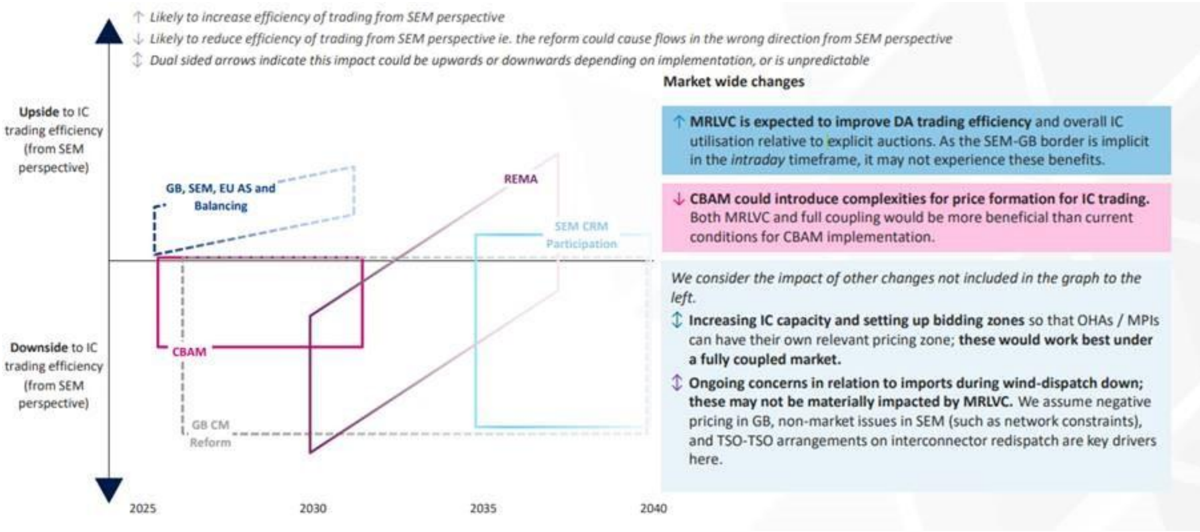

Figure 29 Market conditions which could impact GB/SEM flows and the implementation of cross border trading arrangements. Source: Baringa report for EirGrid and SONI, 2024

The modelling has compared perfect market coupling against MRLVC, and shown full market coupling, would enable the most efficient interconnector utilisation.

Across GB interconnectors where explicit auctions are currently used, MRLVC is expected to improve conditions by providing a mechanism for loosely coupled Day-Ahead trading which will increase overall interconnector efficiency. Trading on the SEM-GB border is implicitly coupled in the intraday timeframe; therefore, the relative benefits of MRLVC are unclear. This relative improvement is also dependent on how MRLVC is implemented and how bidding zones are set out, for example, modelling showed that MRLVC with stochastic errors, is no better than the existing mechanism for SEM/GB interconnector efficiency.

Analysis of the costs of implementation of MRLVC versus full market coupling would enable a clear cost benefit analysis of coupling options but it would be difficult to aggregate costs and benefits between parties.

Current arrangements on SEM-GB border involve implicit auctions and it is currently unclear as to whether MRLVC will bring net benefit compared to status quo.

Other considerations

- GB is setting up bidding zones so that OHAs/MPIs, can have their own relevant pricing zone which will likely make prices harder to predict (which will impact current explicit arrangements).
- More IC, OHA and bidding zones will increase cross border capacity, inefficiencies in the market are multiplied by increasing capacity.
- More SEM interconnectors mean more risk of divergence from GB DA markets under explicit conditions, which could reduce efficiency
- OBZs work best under a fully coupled market where they could trade most efficiently, so under MRLVC, bidding zones will see less benefit than they would under a fully coupled market.
- Interconnector growth increases inefficiencies of MRLVC and interconnector growth is best supported under full coupling. MRLVC helps solve some of the challenges of divergence

between SEM/GB DA prices (because there is currently no DA trading SEM/GB), but similarly to above, this would be most efficient under full coupling.

In making a direct comparison between explicit auctions and MRLVC, the view can be taken that MRLVC may represent an improvement over explicit auctions. However, such a comparison must consider other factors that would see its advantages reduced. Any advantages presented by MLRVC are reliant on the effectiveness of the BBZ Net Position Forecasters algorithm (which remain an unknown quantity) and a swift implementation. These drawbacks have the effect of nullifying the advantages.

4.8. Infrastructure investment

The question addressed in this sub-chapter:

- Is there sufficient clarity in the business case for infrastructure investment to support joint and hybrid offshore projects?

Business case for offshore transmission

Comparatively with onshore infrastructure, the variable cost of offshore infrastructure leads to an elevated level of uncertainty and capital expenditure for offshore infrastructure and hybrid interconnectors.

When TSOs have to make major investment decisions, they use a CBA to assess the expected socio-economic welfare of projects versus the investment costs. The same CBA is also used by regulators or governments to approve such projects.

It is a common methodology to simulate the benefits from cross-zonal capacity exchange through full price coupling. Then, a less efficient allocation regime could be added, that would lead to a reduction of such benefits. However, determining such a reduction means modelling the inefficient functioning of the market through a lot of assumptions, leading to additional complexity for the model algorithm and uncertainty for the final results.

With such a level of uncertainty, both TSOs and regulators will not be inclined to positively support investments in offshore grids. Moving away from modelling, and considering purely operational challenges, the uncertainties on the allocation regime used on bidding zone borders between GB and the EU contribute to increased investment risks.

As explained throughout the report, MRLVC brings additional uncertainty to the market and to the TSO:

- MRLVC is a novel methodology that has never been applied before. Examples of (tight) volume coupling were used for past interconnectors in Germany and Denmark, but they have been all discarded for efficiency and operational reasons.
- MRLVC efficiency relies on a BBZ Net Position Forecaster whose design is proved to be challenging and not existing yet. This also hinders the possibility to reliably simulate any MRLVC performance and the related SEW of its implementation.
- Allocation regimes other than price coupling do not provide certainty on congestion income collected on hybrid interconnectors. If the cash flow from congestion incomes is less certain, investments are becoming more difficult to finance.

- The incompatibility of MRLVC with OBZ, and its inefficient price formation when the leg between the OBZ and BBZ is congested, will lead to zero congestion revenue for TSOs (the two prices will be the same. Please refer to Chapter 4.6 earlier in this document and the "price indeterminacy rule").

Business case for offshore generation

If TSOs see uncertainty in financing their offshore infrastructure, a domino effect could be seen for offshore wind developers. As indicated in summary responses from a 2023 Ofgem Consultation on MPI Market Arrangements[55] and in other developers' reports[56], developers see increased risks for offshore wind farms related to the choice of trading arrangement and the development of the offshore grid. CfDs are used as a support scheme to mitigate OWF risks and promote the construction of offshore generation. However, significant distributional effects are seen in case OBZ-EU BZ is congested, for either the OBZ asset owners or for the entity backing a support mechanism (e.g. CfD). This is due to limited price-setting assets in the OBZs which creates a price formation risk. A flawed clearing price in DA auctions will lead to sub-optimal compensation for OWF.

Compatibility with other timeframes:

- On forward markets, long-term transmission rights are used by market participants and OWF operators for hedging purposes. On the GB interconnector, physical transmission rights are used that might take out cross-zonal capacity from the allocation in DA and intraday. On the other hand, financial transmission rights (that are generally used in coupled Europe) would provide the same hedging purpose without ex-ante allocating capacity before DA. However, since FTRs holders are compensated with the price spread over the interconnector created in DA, the suboptimal flows that could result from MRLVC could lead to material differences between FTRs payouts and DA congestion revenues received by TSOs. Therefore, MRLVC would lead to suboptimal compensation coming from FTRs.
- The intraday market is essential for OWF to adjust their position based on the latest wind forecasts. With the current arrangements, adjusting position through explicit auctions (instead of implicit auctions or continuous trading) is more costly and risky as capacity needs to be obtained ex-ante. Currently, there is no agreement on evolving intraday auctions away from explicit or applying MLRVC in intraday. The inability to efficiently adjust position in intraday increases the risk for OWF operators and makes investment in offshore wind less attractive.
- Finally, MRLVC does not provide a consistent methodology to allocate cross-zonal capacity across time frames (from long-term, to DA, intraday and balancing).

4.9. Conclusions

- General market design background
    - North Sea countries aim to install 300 GW of offshore wind by 2050. Interconnections, traditional and hybrid, will be essential to integrate new OWF and benefit from different supply mixes, generation patterns, and demand patterns of both European and British markets.
    - OBZs are the optimal market design for offshore hybrids.

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[55] Summary of Responses on Market Arrangements for Multi-Purpose Interconnectors

[56] elia-group-x-orsted-making-hybrids-happen.pdf

- Careful consideration is required around the market arrangements for interconnector flows, especially where these could introduce inefficiencies.

- Challenges of Explicit Allocation in OHAs connecting the EU and GB
    - Economic inefficiencies arise from explicit allocation on current interconnectors with GB, especially when compared to similar interconnectors that use implicit allocation in the Single Day-Ahead Coupling (SDAC).
    - The combination of explicit allocation and OBZ is inefficient and distortive. Capacity on the GB-OBZ and SDAC-OBZ would be allocated based on wind forecasts and not through the market. This makes useless the formation of an OBZ whose goal is to avoid forecasts inefficiencies. Secondly forecasts errors from market parties will distort the price formation in OBZ.
    - Explicit allocation obstructs the use of AHC, thus hindering optimal utilisation of grid infrastructure, both on land and at sea.
    - While explicit auctions do not directly affect SDAC and SIDC, they do fragment market liquidity and create opportunities for arbitrage and gaming.

- Issues with MRLVC in OHAs connecting the EU and GB
    - MRLVC is unsuitable for OBZs, as it can lead to suboptimal pricing during congestion between the OBZ and SDAC. This issue could also arise for GB OBZs.
    - The BBZ Net Position Forecaster does not fit well with flow-based capacity calculations used in SDAC, and potentially in GB if zones are split.
    - MRLVC does not effectively utilize the available transmission capacity information in SDAC.
    - Additionally, MRLVC conflicts with AHC flow-based modelling. When MRLVC is applied alongside AHC, its forecasting methods precisely define flow patterns, thus changing it from a market order-based allocation to a forecasting-based regime.

- Inefficiencies of MRLVC at GB-SEM borders
    - Theoretically, MRLVC would appear to have increased efficiencies over current arrangements but further analysis by Baringa on behalf of EirGrid and SONI in 2024 (*SEM-GB cross border arrangements post-Brexit including an examination of MRVLC)* showed that costs associated with implementation and operation could negate any efficiencies gained.
    - Additionally, the 2024 Baringa report (commissioned by EirGrid and SONI) highlighted potential inefficiencies on the SEM-GB border (when applying MRLVC) and combined with the fact that MRLVC remains in a concept validation phase, the report casts a negative light on the implementation of MRLVC.
    - Any efficiencies are also contingent on effectiveness of the BBZ Position Forecaster and the compressed times not causing an increase in frequency in full/partial de-coupling events. Historically SEM-GB flows have been hard to forecast as price variability between both market regions have been greater than elsewhere. As a result, it is likely that SEM-GB would be particularly impacted by risks associated with forecasting error.

- MRLVC increases risks for investments in offshore transmission

    - The development of offshore infrastructure will require massive investments from North Sea Countries. The uncertainty of an efficient allocation mechanism becomes an additional risk factor that can threaten the finance ability of such projects.
    - MRLVC introduces higher risk levels into the CBAs used by TSOs and regulators to compare projects, resulting in higher capital cost estimates and reduced economic welfare.
    - Allocation regimes other than price coupling do not provide certainty on congestion income collected on Hybrid Interconnectors. The incompatibility of MRLVC with OBZ and its inefficient price formation when the leg between the OBZ and BBZ is congested, will lead to zero congestion revenue for TSOs.

- MRLVC increases risks for investments in offshore generation

    - If TSOs see uncertainty in financing their offshore infrastructure, a domino effect will be seen for offshore wind developers. A flawed clearing price in DA will lead to a suboptimal compensation and support scheme for OWF's.
    - MRLVC increases risks for RES build out and impacts the feasibility of energy import/export strategies for example for the UK, which it is set to become a net exporter in the next years.

- MRLVC is not compatible with other timeframes/not suitable to enable efficient allocation of cross-zonal capacity across other time frames

    - MRLVC is not an efficient mechanism for hedging in forward markets. If FTRs are applied, MRLVC would lead to sub-optimal compensation to OWF operators.
    - There is no agreement on evolving intraday auctions away from explicit or to apply MLRVC in intraday auctions. The inability to efficiently adjust position in intraday auctions increases the risk for OWF operators.

Outcomes on the offshore development impact:

- EU and UK TSOs conclude that they cannot identify specific changes to MRLVC that improve its compatibility with offshore developments in EU and UK and specifically hybrids:

    - The "volume" element of the design only determines cross-border flow and not prices, producing sub optimal results, particularly when applied to OBZs.
    - The "loose" element of the design gives heavy dependence on flow forecasts between the BBZ and non-BBZ SDAC markets.

Glossary

ACER	European Union Agency for the Cooperation of Energy Regulators
AHC	Advanced Hybrid Coupling
AI	Artificial Intelligence
ATC	Available Transfer Capacity
BZ	Bidding Zone
BBZ	Bordering Bidding Zone
BM	Balancing Mechanism
BST	British Summer Time
BZ	Bidding Zone
CACM	Capacity Allocation and Congestion Management
CBA	Cost Benefit Analysis
CCR	Capacity Calculation Region
CEER	Council of European Energy Regulators
CEST	Central European Summer Time
CET	Central European Time
CfD	Contracts for Difference
COB	Common Order Book
DESNZ	Department for Energy Security and Net Zero (UK)
DA/DAM	Day-Ahead/Day-Ahead Market
EC	European Commission
EEZ	Exclusive Economic Zone
ENTSO-E	European Network of Transmission System Operators for Electricity
EU	European Union
FAPD	Flows Against Price Difference
FD	Full Decoupling
FES	Future Energy Scenarios Pathway to Net Zero Report
FTR	Financial Transmission Rights
GB	Great Britain
GBP	Great British Pound
GCT	Gate Closure Time
GMT	Greenwich Mean Time
HM	Home Market
IC	Interconnectors
ID/IDA/ IDM	Intraday/Intraday Auction/Intraday Market
KPI	Key Performance Indicator
MCO	Market Coupling Operator
MCSC	Market Coupling Steering Committee
MPI	Multi-Purpose Interconnectors
MPLS	Multi-Protocol Label Switching
MRLVC	Multi-Region Loose Volume Coupling
MS	Member State

MTU	Market Time Unit
NEMO	Nominated Electricity Market Operator
NESO	National Energy System Operator
NP	Net Position
NSI	Non-standard Interconnectors
NTC	Net Transfer Capacity
NRA	National Regulatory Authorities
OBK	Order books
OBZ	Offshore Bidding Zone
OHA	Offshore Hybrid Assets
ONDP	Offshore Network Development Plans
OTC	Offshore TSO Collaboration
OWF	Offshore Wind Farm
POB	Preliminary Order Book
PCR	Price Coupling of Regions
PMB	PCR Matcher and Broker
PTDF	Power Transfer Distribution Factors
PTO	Price Taking Order
PX	Power Exchange
PWIIU	Price-Weighted Inefficient Interconnector Utilisation
REMA	Review of Electricity Market Arrangements (UK)
RES	Renewable Energy Source(s)
SEM	Single Energy Market
TEN-E	Trans-European Networks for Energy
TSO	Transmission System Operators
TYNDP	Ten-Year Network Development Plan

Annex A: Table Of Contents for Sample Tender Document

(Illustration of how Requirements are accommodated in a Standard Tender Doc)

3.2 Turnover

FORM 4 - Health & Safety, Environment and Employment

FORM 5 - Cyber Security Assurance

FORM 6 – Candidate Capacity

1. Overview of Instructions to Candidates

2. Organisations in the EU and UK TSO Consortium Group

3. Candidates

4. Joint Submissions

5. Completion of Questionnaire

6. Compliance

7. Amendments to the PQQ Documents and/or Process

8. Verification of Information

9. Clarifications

10. Currency

11. Preparation Costs

12. Forwarding of Documents

13. European Communities (Access to Information on the Environment) Regulations 2007-2014.

14. Data Protection

15. Conflicts of Interest

16. Interference or Canvassing

17. Collusion

18. Compliance with Laws

19. Financial Viability

20. Copyright and Intellectual Property

21. Conditions Precedent

22. Notification of Outcome

Annex B: Risk Register

RISK #	RISK NAME	DESCRIPTION	LIKELIHOOD	IMPACT	TOTAL
R1	Tender Risk No legacy data	There is a risk that no legacy electronic data in circulation (i.e., on the internet or from TSOs) which will mean that AI machine learning will not take place, reducing the usefulness and accuracy of the BBZ Net Position Forecaster.	H	M	H
		Mitigation: The tenderers to propose solutions. Options may be to use data from simulations in other tools or parallel/test runs or make fundamental modelling and use data from there.	M	M	
R2	Tender Risk Specification Approval	There is a risk that where TSOs do not engage in discussing the tender typology before issuing and publishing the call for tenders that there will be delays and sub-optimal procurement outcomes.	M	M	M
		Mitigation: Ensure early alignment and approval process with all TSOs to avoid delays in tender issuance**.** Specifications should be accompanied by information on how the tender would be issued. PQQ, and accompanying documents/annexes, must comply with the laws of the parties mentioned in the tender example, subject to approval by the rest of the TSOs.	L	M	
R3	Tender Risk Tender Ownership and Intellectual Property	There is a risk that, without clear definition around ownership of intellectual property early in the process, disputes will occur later.	M	M	M
		Mitigation: Clearly define the type of ownership and type of intellectual property rights early in the process to avoid conflicts later on. Ensure suppliers are well-informed about intellectual property expectations and potential transfer requirements.	L	M	

R4	EU-UK System Interdependencies	There is a risk that issues related to administrative functions (e.g. governance and approval) lead to a lack of oversight and potential delays in decision making.	M	H	H
		Mitigation: Any procurement documentation must ensure that the administrative procedures are clear with documented reporting and approval structures between EU and UK.	L	M	
R5	Tender Risk Methodology Verification	There is a risk that insufficient optioneering takes place when writing the specification resulting in e.g. machine learning as the sole approach available before proceeding with the design phase of the requirements.	M	M	M
		Mitigation: Ensure that the review by wider TSOs, NRAs and SCE is comprehensive and consider any feedback that might identify better alternatives.	L	M	
R6	Tender Risk Forecaster Output Integration	There is a need to clarify which specific outputs are required from the Forecaster and to explain how these integrate into the draft tender later with justification. Without this it will not be clear what role the Forecaster plays in the wider MRVLC concept.	L	L	L
		Mitigation: Specify outputs clearly in the document; integrate into draft tender with reasons.	L	L	
R7	Tender Risk Market Developments Incorporation	There is a risk that without considering future market developments, e.g. the introduction of new bidding zones/OBZs, that the proposed approach will become obsolete.	M	M	M
		Mitigation: A future market developments section is included in this document which mentions known future scenarios that may occur. However, this is not exhaustive as it is impossible to predict what may happen in the future.	L	L	

<table>
<tr><td rowspan="2">R8</td><td rowspan="2">Tender Risk

Key Specifications Requirements</td><td>There is a risk that without linking elements of the draft tender specification to requirements, that parts may be left out leading to a solution being delivered that is not fit for purpose.</td><td>M</td><td>M</td><td rowspan="2">M</td></tr>
<tr><td>Mitigation: Ensure compliance with key requirements; reference relevant articles and subparagraphs e.g. Identify any other key requirements under subparagraph 2. (a) and article (3) of Annex 29</td><td>L</td><td>L</td></tr>
<tr><td rowspan="2">R9</td><td rowspan="2">Fallback Process Notification</td><td>There is a risk that where processes fail that publish calculated net energy positions are not published following validation and verification, leading to a lack of transparency.</td><td>M</td><td>M</td><td rowspan="2">M</td></tr>
<tr><td>Mitigation: Implement a robust fallback process; with timely notification to market participants. Notify market participants if the fallback process applies.</td><td>L</td><td>M</td></tr>
<tr><td rowspan="2">R10</td><td rowspan="2">Tender Risk

Quality of BBZ forecast</td><td>There is a significant risk that the NP forecast is inaccurate that the results are not useable and influence the MRLVC solution to the extent that explicit trading is preferable.</td><td>H</td><td>H</td><td rowspan="2">H</td></tr>
<tr><td>Mitigation: None, revert to explicit trading or another trading solution to be defined.</td><td>H</td><td>H</td></tr>
<tr><td rowspan="2">R11</td><td rowspan="2">Tender Risk

Tender Governance</td><td>There is a risk that without clear consortium roles and responsibilities, disputes may arise between TSOs leading to potential later misalignment.</td><td>M</td><td>M</td><td rowspan="2">M</td></tr>
<tr><td>Mitigation: Establish a clear consortium agreement early in the process and ensure all parties are well-informed of their roles and responsibilities to facilitate a smooth and compliant tender process.</td><td>L</td><td>M</td></tr>
</table>

R12	Flow based allocation compatibility	GB is considered to be connected to a radial network of separate BBZs under MRLVC. They are treated independently from each other even though each BBZ would be efficiently interlinked via flow-based allocation. MRLVC is unable to direct imports/exports of the flow-based area into one or another interconnector when there are multiple routes for efficient flows.	H	H	H
		Mitigation: None. It is not possible to mitigate this as it is a feature of MRLVC.	H	H	
R13	Tender Risk Zonal Pricing / European Bidding Zone Review	Should the EU decide on alternate configurations for bidding zones, the scale of information needed by the BBZ algorithm may increase significantly. This could lead to higher risk of forecast error and longer computational time.	M	M	M
		Mitigation: A future market developments section is included in this document which mentions known future scenarios that may occur. However, this is not exhaustive as it is impossible to predict what may happen in the future.	L	M	
R14	MRLVC compatibility with other timeframes	If Financial Transmission Rights (FTRs) are used for hedging purposes, where holders are compensated with the DA market spread, sub-optimal flows could lead to material differences between FTR payouts and DA congestion revenues received by TSOs.	M	M	M
		Mitigation: Market Participants with an OWF may need to adjust their position in the ID market. As MRLVC is only looking at the DA timeframe, positions would need to be adjusted via explicit auctions or an alternative arrangement, which are more costly and risky as capacity needs to be obtained ex-ante. This could make investment in offshore wind less attractive.	M	M	
R15	MRLVC impact on SDAC	If MRLVC is included in SDAC processes, the delay introduced by MRLVC (with the realistic range of 30-42 minutes) would reduce any mitigation time for SDAC to avoid partial decoupling as it would push existing process	H	H	H

		run times beyond the deadlines set by SDAC for the market coupling procedures. Under certain circumstances there would be no time for the partial decoupling process, meaning that any incident which in the past would have led to a partial decoupling will now lead to full decoupling under the current deadlines.			
		Mitigation: MRLVC should drastically reduce its duration. However, following the TSO assessment, it would not be possible to produce an MRLVC design that would allow it.	L	H	
R16	MRLVC impact on GB DAM	Any delay to GB DAM publication time due to MRLVC could lead to an impact on NESO's Control Room processes and lead to less efficient operational decisions (e.g., analysis of DA margins and assessing needs for code-mandated system warnings).	M	M	M
		Mitigation: Publish GB DAM results ahead of SDAC if the timeline of the GB DAM process allows it.	M	M	
R17	MRLVC impact on SEM	SEM has less capacity and fewer redispatch options to manage unexpected flow deviations resulting from MRLVC's loose coupling. Therefore, the Transmission System Operators (TSOs) may be forced to resort to more expensive balancing actions, leading to increased market costs and potential reliability concerns during periods of high system stress.	M	H	H
		Mitigation: Further integration of SEM into SDAC (through Celtic or further interconnections) could make it more resilient.	M	M	
R18	MRLVC impact on SIDC	A specific delay during the finalization of the DA session leads to the automatic cancelation in advance of the first SIDC IDA run for the same delivery day. The introduction of any additional mechanisms in the existing timeline, having impact on SDAC execution, will have indirect impacts on SIDC as well.	H	H	H

		Mitigation: MRLVC should drastically reduce its duration. However, following the TSO assessment, it would not be possible to produce an MRLVC design that would allow it.	M	H	
R19	Tender risk	There is a risk that difficulties in assigning specific aspects of EU and UK legislation to the tender lead to non-compliance with EU and/or UK laws.	M	H	H
	Compatibility between UK and EU regulations	**Mitigation:** Legal review to take place as early as possible in the process regarding the legislation and regulation involved on EU and UK sides, with early agreement on the necessary compliance required to avoid future disputes.	L	H	