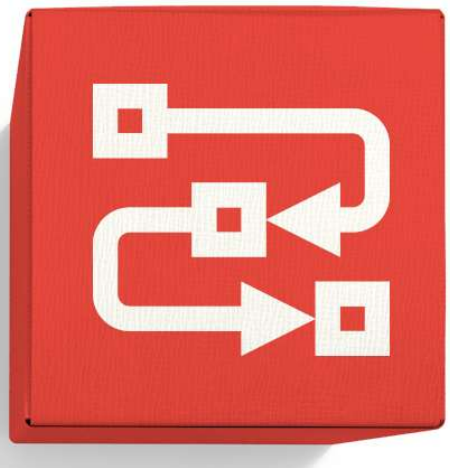
Cost Benefit Analysis of Multi-Region Loose Volume Coupling (MRLVC)

The EU and UK TSOs MRLVC group

April 2021



FINAL REPORT FOR PUBLICATION

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Contents

1. INTRODUCTION

1.1. CONTEXT

Following the UK's exit from the EU, Great Britain (GB) is no longer part of the Single Day Ahead Coupling (SDAC). Therefore, there are no arrangements in place for the implicit day-ahead (DA) allocation of transmission capacity between GB and neighbouring bidding zones.

On the SEM-GB border, currently there is no market-based allocation of cross-zonal transmission capacity until the intraday (ID) auctions used to implicitly allocate capacity at 1730 D-1. For the NSL link, scheduled to begin operation later in 2021, capacity will be allocated implicitly on the morning of D-1 through a stand-alone price coupling. On all other borders, explicit auctions of capacity have been (re)introduced for the day-ahead time frame.

There have been long-standing concerns about the relative inefficiency of explicit auctions of cross-zonal capacity – these concerns were behind the move to market coupling arrangements in the first place. Compared to implicit auctions, explicit auctioning can result in a sub-optimal allocation of capacity. Explicit auctions may also increase complexity for transmission rights holders as they attempt to manage three legs to the trade: cross-zonal transmission capacity, and energy in each of the two markets. There are also challenges with the efficiency of stand-alone implicit auctions, notably concerning fragmentation of liquidity in the energy markets at either end of the interconnector.

Given a desire to maximise the benefits of trade, the EU-UK Trade and Cooperation Agreement (TCA) introduces the concept of **multi-region loose volume coupling (MRLVC)** to apply between the UK and the bidding zones directly connected to the UK. Volume coupling is an implicit allocation mechanism; but unlike price coupling it only determines cross-border flows, with prices determined in a subsequent step.

Experience of volume coupling has been limited – with notable examples being the Interim Tight Volume Coupling (ITVC) between CWE and Nordic regions (2010 – 2014); the BritNed solution, a volume coupling between CWE and GB operated by APX (2011 – 2014); and the Kontek cable between Germany and Denmark (2009 – 2010). All these solutions were regarded as 'tight' volume coupling and there has been no experience of a 'loose' volume coupling where not all relevant data is used in the computation.

Volume coupling is now generally seen as inferior to price coupling. There have been negative experiences – the Kontek coupling was stopped after 10 days, and the issues of 'flows against price differences' (FAPDs) undermined confidence in the ITVC. Nonetheless, volume coupling can in theory still achieve most of the benefits of price coupling.

There is, however, uncertainty about how well the proposed MRLVC arrangements would operate. This uncertainty relates to

- how the MRLVC would be implemented in detail as 'loose volume coupling' can cover a range of different arrangements;
- the restrictions set out in the TCA; and
- a lack of experience of successful operation of directly comparable arrangements, particularly in relation to the size and complexity of MRLVC and SDAC.

In addition, there are concerns about the challenges involved in implementing MRLVC arrangements, including the impact on existing market processes, particularly those of SDAC.

1.2. OBJECTIVES OF THIS REPORT

Under the TCA, the relevant EU and UK TSOs are jointly tasked with developing the MRLVC solution to allocate capacity on the interconnectors to GB at the DA market timeframe.

The first major milestone set out in Annex 4 of the TCA is to prepare a Cost Benefit Analysis (CBA) and outline proposals for the technical procedures of the MRLVC, and the GB and European TSOs have established a working group to progress this.

This report sets out the main findings of the study carried out by the consultants advising the TSO MRLVC working group on this CBA. This study has been carried out by a team involving experts from 4 organisations – CEPA, Ignis Markets, Smart Vision, and THEMA Consulting.

There are two objectives for this study:

- to support the development of a high-level design for MRLVC trading arrangements between GB and SDAC, consistent with the requirements of the TCA; and
- to support the delivery of a CBA of the high-level design compared to the existing arrangements.

A key feature of the proposed MRLVC is the use of a forecast for the net commercial flows to or from each of the bordering bidding zones (BBZs) to the rest of the IEM – i.e., a forecast of the net position that will be later computed in SDAC. The method and accuracy of this BBZ flow forecast is not yet known; and while it will be a critical feature of the MRLVC it is the responsibility of EU TSOs and outside the scope of the study. Possible alternative volume coupling solutions are inconsistent with the Annex 4 of the TCA.

Given that this BBZ flow forecast methodology is not yet available to test, it is unrealistic that the CBA can fulfil the standard role of a CBA in regulatory processes – namely the evaluation of a well-developed solution prior to approval. Instead, this CBA assesses the implications of differing levels of accuracy of the BBZ flow forecast, helping to establish the conditions for a beneficial MRLVC solution.

There are four final deliverables to this study:

- **This short written report summarising the main findings of the CBA, and providing the context for the analytical results.**
- Slidepack containing the main analytical results. Relevant slides are referenced in this written report in square brackets [..].
- Slidepack containing results from wholesale market simulations using the SDAC Simulation Facility (SF).
- Slidepack containing results from wholesale market simulations using the TheMA European power market model.

2. HIGH-LEVEL MRLVC DESIGNS

Annex ENER-4 to the TCA sets out the requirements and limitations on the MRLVC solution, and the timetable to implement it.[1] Furthermore, the UK Department for Business, Energy and Industrial Strategy (BEIS) has published guidance on the required solution from the perspective of the electricity market in GB.[2]

Despite the requirements for a MRLVC solution set out in the TCA, there remains uncertainty about how the MRLVC would be implemented in detail as the term 'loose volume coupling' can cover a range of different arrangements. Therefore, as part of this study, we have developed high-level designs of the MRLVC informed by our experience, a literature review, preliminary qualitative assessment, as well as insight from quantitative analysis.

A minimum requirement for the high level MRLVC designs assessed in this study is compliance with the following constraints set out in the TCA annex:[3]

- **Data restrictions**. MRLVC only has access to order book data for the UK and for the bidding zones directly connected to the UK. It is required to use a forecast for expected commercial flows between bordering bidding zone (BBZs – i.e. connected to the UK) and the rest of the IEM.
- **MRLVC should be a specific process/algorithm and distinct from SDAC**. This rules out operationally integrating the MRLVC and SDAC matching processes. Our understanding is that this does not prohibit the use of Euphemia software in MRLVC.

In designing the high level MRLVC options, we have focused on the most important choices/trade-offs for whether and how to proceed with MRLVC implementation. This has been informed by our preliminary assessment and the initial feedback from the TSO working group - in particular, regarding concerns about the possible impact on SDAC. Consequently, two main design options for MRLVC have been evaluated: common order books and preliminary order books.

2.1. COMMON ORDER BOOKS MRLVC

This high-level design assumes that the MRLVC will use the identical order books (representing the aggregated and anonymous orders from the relevant GB power exchange and BBZ NEMO) as used in the GB DAM and SDAC respectively.

Using the same order books implies a sequential process:

- The MRLVC algorithm cannot begin until after SDAC gate closure time, when the order books for the relevant BBZs and GB are available.
- SDAC and GB DAM cannot begin their matching calculations until after the MRLVC has calculated the interconnector flows.

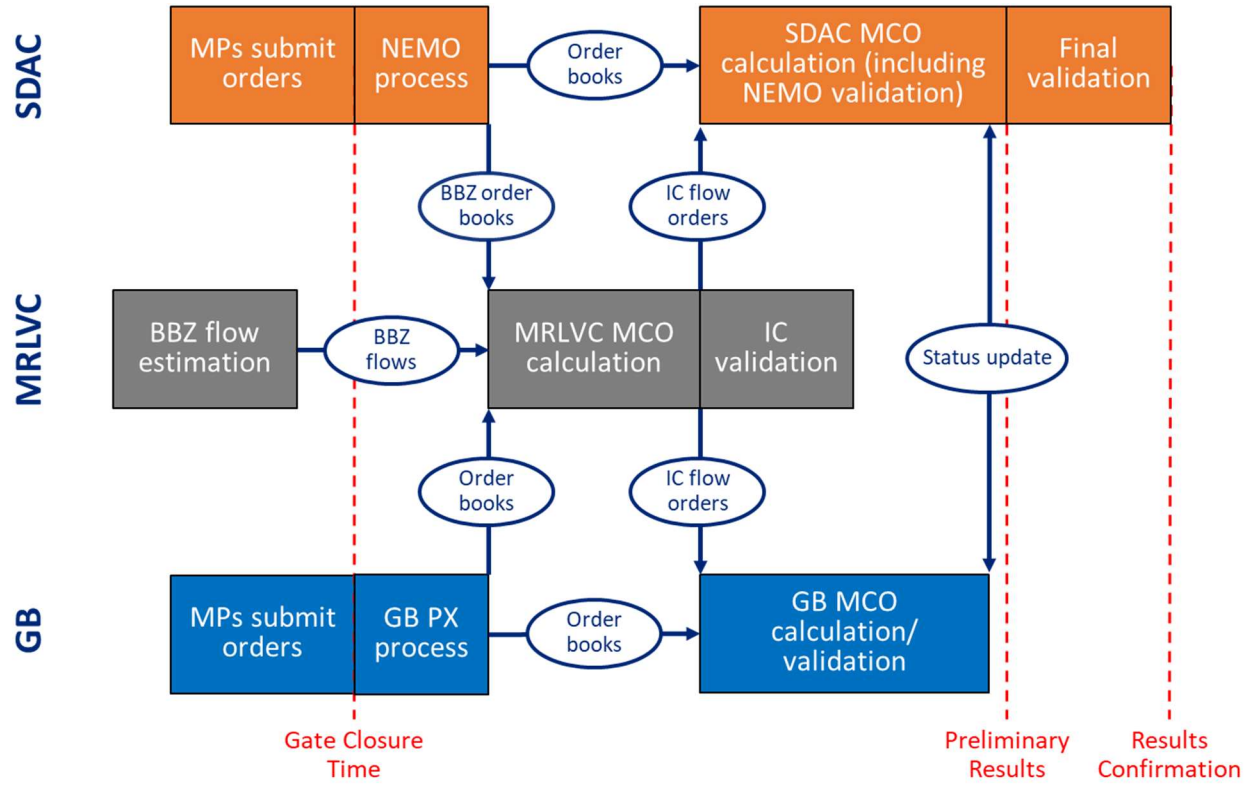
As shown in Figure 1, the sequence Gate Closure -> MRLVC -> SDAC/GB DAM would require changes to the timing and/or processes involved in SDAC.

[1] Annex ENER-4: Allocaiton of electricity interconnector capacity at the day-ahead market timeframe

[2] Department for Business, Energy and Industrial Strategy, January 2021, 'Electricity trading arrangements. Guidance from the Secretary of State for Business, Energy and Industrial Strategy to transmission system operators and relevant electricity market operators'

[3] Clauses 3 and 4 in Annex ENER-4.

Figure 1 – Indicative timeline for Common Order Books option for MRLVC



2.2. PRELIMINARY ORDER BOOKS MLRVC

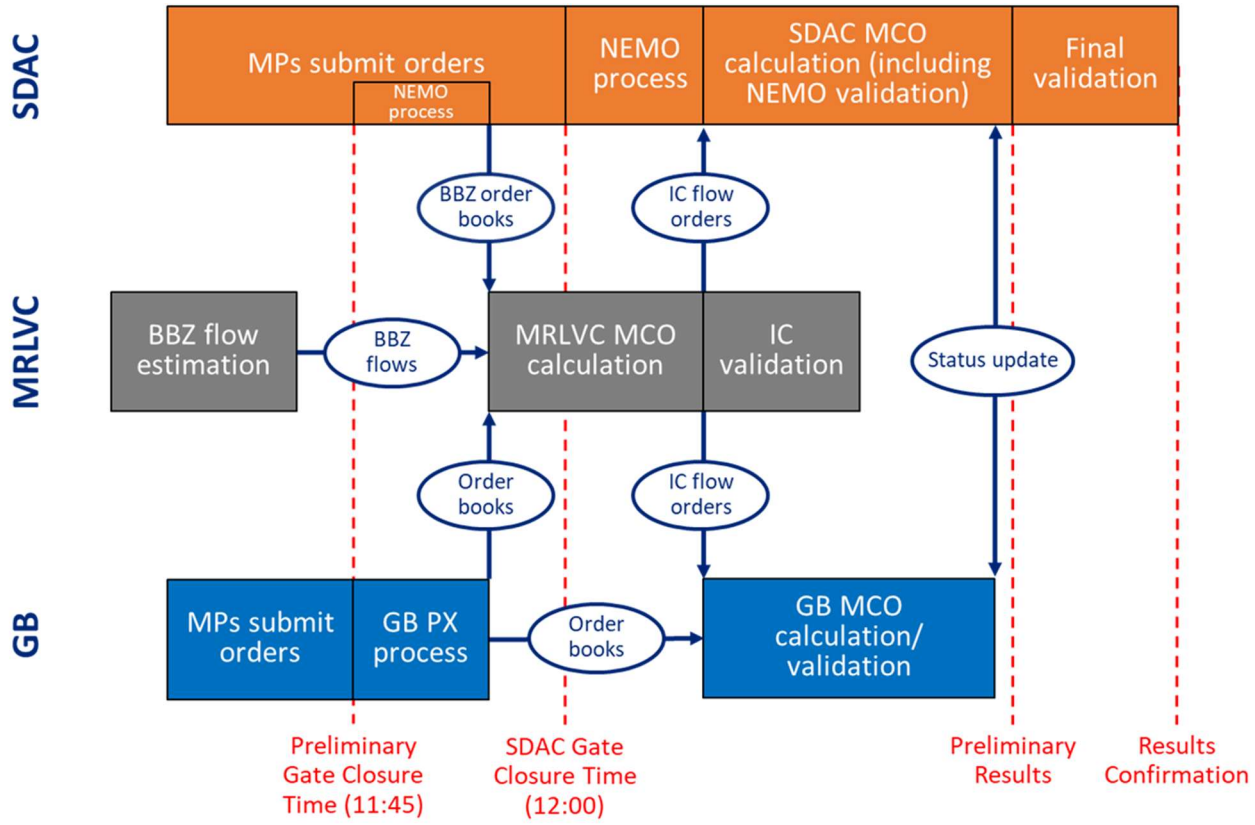
In order to minimise the impact of the MRLVC on SDAC timings and processes, an alternative MRLVC design is to use the orders as received by the NEMOs in the relevant BBZs at a point ahead of gate closure in SDAC. It is assumed in this model that market participants in SDAC are still free (as they are today) to submit new orders or amend orders already submitted up until SDAC gate closure at 12:00 CET. The gate closure time in GB would, however, be at the same time that the preliminary order books are taken from SDAC.

Figure 2 sets out an example process using an indicative gate closure at 1145 CET for the preliminary order books:

- The MRLVC will start using whatever order books have been received by 11:45 CET in the BBZs, and final order books from GB.
- Market participants in SDAC BBZs are free (as they are today) to submit new orders or amend orders already submitted up until SDAC gate closure at 12:00 CET.
- GB gate closure would be at 11:45 CET.
- MRLVC results need to be available to SDAC ahead of 12:10 CET (normal start of SDAC computation) – implying no delay or change to SDAC process.

The timings above and in Figure 2 are indicative. In practice, they will depend on the MRLVC processing time and the speed with which results can be transferred to the SDAC Market Coupling Operator (MCO).

Figure 2 – Indicative timeline for Preliminary Order Books option for MRLVC



2.3. COMMON FEATURES OF BOTH HIGH-LEVEL MRLVC DESIGNS

We have identified the following commn features of both of our high-level MRLVC designs:

- Single GB price.
- MRLVC-determined flows used as price taking orders (PTOs) in SDAC and in GB.
- MRLVC PTOs are firm, at least for SDAC, with the development of appropriate fallback procedures in case of operational problems.
- MRLVC support to the existing order types currently available in SDAC (e.g. complex orders).

Single GB price

The TCA is silent on the issue of GB price formation as it is a GB-specific issue rather and hence is outside the scope of the design of the MRLVC arrangements set out in the TCA. Similarly, the implementation and design of any single GB price (currently EPEX and N2EX operate separate day ahead markets in GB) falls outside the scope of this CBA. However, the existence of a single GB price affects the assessment of the MRLVC design.

The UK Government has published guidance on the electricity trading arrangements.[4] This guidance document sets out the expectation of the UK Government that the relevant market operators in GB will support the implementation of the the TCA arrangements by developing similar cooperation arrangements to enable a de-facto single GB price.

In addition, our assessment has identified that a single GB price is highly desirable for the efficient implementation of the MRLVC [90-92]. Therefore, for the purposes of our assessment, we have made a common assumption across MRLVC designs that there is a single GB price. An alternative of volume coupling the GB PXs using MRLVC is addressed as a detailed design option.

MRLVC-determined flows used as price taking orders (PTOs) in SDAC and in GB

Volume coupling is not a fully defined term, indeed there have been a range of solutions implemented with that name. The approach in the ITVC was to take the flows calculated by the volume coupler as "price taking orders" (PTOs) in the relevant BZs in the subsequent Nordic and CWE regional price couplings. A price taking order is filled whatever the price – so in effect the interconnector flows are fixed in the subsequent price couplings. An import is treated as a sell order, while an export is a buy order.

Firmness of MRLVC PTOs

We assume that MRLVC PTOs are firm, at least for SDAC. This means that mutual completion confirmation is not required from both GB and SDAC before either can report firm results. This reduces the operational interdependency between SDAC and GB DAM, and the need to change SDAC fallback procedures. Nonetheless, there will be a need to establish coordinated fallback procedures between MRLVC, SDAC and GB – these procedures can be designed to minimise the impact on SDAC [95, 96]. The interconnector TSOs, however, face a risk of having an unmatched position if the SDAC (or GB) price couplings resort to fallback, and they will need to find effective ways to trade this out (e.g., the in fallback DAMs, intraday continuous markets or other arrangements used for outage management).

The alternative of requiring mutual confirmation is assessed as a detailed design option [94].

Complex orders

We have assumed that the MRLVC can support orders currently used in SDAC. This is particularly important to all markets – not least the SEM, where complex orders are widely used.

[4] Department for Business, Energy and Industrial Strategy, January 2021, 'Electricity trading arrangements. Guidance from the Secretary of State for Business, Energy and Industrial Strategy to transmission system operators and relevant electricity market operators'

3. ASSESSMENT APPROACH

We have carried out a quantitative and qualitative assessment of the two high-level MRLVC options, which is compared to a counterfactual for the capacity allocation arrangements on all borders between GB and the BBZ. The counterfactual is:

- ID implicit allocation (price coupling) – as in place on SEM-GB border.
- Separate DA implicit allocation (price coupling) – as planned for NSL (between GB and NO2).
- DA explicit allocation – as in place on all other borders.

This counterfactual is based on what is expected to be in place in the absence of the implementation of the MRLVC. It represents the current or planned arrangements on each border, none of which represent a solution compliant with the requirements of the TCA. The assessment of these counterfactuals can also be used to inform any future consideration of the case for any phasing of the introduction of MRLVC on different borders.

Many of the design choices do not lend themselves to robust quantification, particularly with the timescales available for this study. Therefore, our focus on the assessment of these design options is a qualitative assessment, informed by quantitative analysis where possible. The analytical slidepack contains more details on the type of evidence gathered for each assessment element [12].

In particular, our assessment is informed by:

- Review of literature on previous volume coupling arrangements in Europe[5] [23-28, 99-106].
- Results from market simulation models that allow us to explore the impacts of different trading arrangements on market prices and interconnector flows. We use multiple scenarios exploring different market conditions (e.g. fuel and carbon prices, generation portfolio, and demand patterns) and expected future IC build.[6] The market simulation models produce results for individual bidding zones and interconnectors.
- Historical analysis of market prices and interconnector flows, including from the counterfactuals (in place since 1 January 2021 on all links currently operating[7]), and from explicit auctions on the Swiss-German border.
- High-level analysis of the magnitude and drivers of implementation and operation costs from previous market coupling arrangements.

The analytical slidepacks provided alongside this report provide further details on the approach and results for the market simulation models we used to proxy the MRLVC options and the counterfactual arrangements – the SDAC Simulation Facility (SF) and the TheMA fundamental power market model.

3.1. WHOLESALE MARKET SIMULATION TOOLS

We used the SDAC Simulation Facility (SF) and the TheMA fundamental power market model to inform our overall assessment of:

[5] Kontek volume coupling I (Sep – Oct 2008); Kontek volume coupling II (Nov 2009 – Nov 2010), Baltic Cable added May 2010; Interim Tight Volume Coupling, ITVC (Nov 2010 – Feb 2014); BritNed embedded solution (Apr 2011 – Feb 2014).

[6] The following new interconnectors were included in our modelling for this study: IFA2 (GB-FRA), NSL (GB-NO2), ElecLink (GB-FRA), GreenLink (GB-SEM) and Viking Link (GB-DK1).

[7] This does not include NSL which is expected to begin operation later in 2021.

- welfare effects (consumer surplus and producer surplus) in each BZ, including BZs not directly connected to GB;
- value to interconnectors, including congestion revenue, opportunity costs (sub-optimal flows) and costs of Flows Against Price Differences (FAPDs), and UIOSI/FTR payouts; and
- the impact on carbon emissions resulting from different generation patterns in the market simulations.

In particular, we used these tools to investigate the impact of different levels of accuracy of the BBZ flow forecast methodology.

In the modelling results, we can focus in on periods where price differentials are small and/or rapidly changing direction. These are particularly challenging situations for capacity allocation.

The SF allowed us to model the SDAC and GB markets using actual order books (OBs) under different network topologies, such as new interconnectors. We analysed the period from 4 July 2019 to 3 June 2020 as this provides a window of nearly a year with a constant grid topology. [8] This ensures feasible set up and run times for delivering results in the timescale available for this study. Using data from 2019 and 2020 means GB OBs are available as GB was part of SDAC at that point.

The SF period includes four months during which much of Europe was under lockdown due to the Covid pandemic. Nonetheless, the price spreads during this period are not materially different from the period before. In general, the price spreads are heavily towards GB on all interconnectors, with relatively few periods when spreads were in the opposite direction.

The TheMA model is widely used for analytical projects, such as the preparation of price forecasts, scenario analysis and investment evaluations. The modelling was performed using THEMA Consulting's February 2021 'Best Guess' scenario for 2022 and 2025, which takes all known developments and targets into account.[9]

The use of two simulation tools is complementary and has helped to provide a more robust set of insights – however, these tools are not designed to provide directly comparable results. Using actual OBs in the SF will ensure the welfare analysis is based on actual DA markets, to a level not possible through a fundamental market model alone. A fundamental market model is based on cost-based optimization of individual generators rather than bidding behaviour or the DA market specifically.

Using the TheMA market model helps us to simulate the effect of changing generation mix, changes in demand patterns and/or variations in fuel and carbon prices that would not be possible using the SF. It also produces estimates of physical impacts of the trading arrangements, including carbon dioxide emissions.

Market simulation models are designed to produce optimal or efficient results with reference to one market timeframe. This means that using such models to simulate inefficiencies can provide insights; however, the results must be interpreted with care and not too much weight placed on detailed estimates from the simulation tools of changes in level and distribution of welfare, interconnector revenues and carbon dioxide emissions.

3.2. CONSIDERATION OF CAPACITY ALLOCATION IN OTHER TIME FRAMES

The market simulation models calculate welfare based on the DA timeframe. Efficient ID markets for capacity and energy can mitigate some of the negative impact on net welfare of inefficient DA allocation. However, this will not be captured in the market simulation modelling results.

[8] There were two days not used in that period: 5/2/20 (decoupling) & 22/5/20 (technical reasons). Therefore, the selected period covered 334 days with constant grid topology. To produce the annual values, the SDAC SF results are scaled up by a factor of 365/334.

[9] A representative weather year is used whereby annual volumes for wind, PV and demand are scaled to normal levels, while hourly volatility is based on historical observations

Overall net welfare and carbon output depends on whether the optimal generation is actually runs. The ability of intraday markets to correct for inefficiencies in the DA allocation depends on the ability of generation (and demand) to respond flexibly, including the depth in the intraday markets and the technical limits on changing IC flows [34, 35].

Even with efficient ID markets, the redistribution effects of inefficient DA allocation will not be rectified. Redistribution of surplus from producers to consumers in the importing market (due to decreased prices) – and vice versa in the exporting market – will be significantly reduced due to the relative size of the ID markets compared to DA.

In addition, interconnector revenue is likely to be less overall. This is based on historical observations of weaker price spreads (in implicit auctions) and lower prices for capacity (in explicit auctions) in ID markets compared to DA markets. This implies a transfer from TSOs to traders.

4. ASSESSMENT FINDINGS

4.1. MAIN FINDINGS OF OUR ASSESSMENT OF MRLVC PERFORMANCE

This section highlights the main findings of our detailed quantitative and qualitative assessment of the two MLRVC high-level design options, and the counterfactual trading arrangements on each border between GB and a BBZ. This counterfactual is used to provide a reference point for what is expected to be in place in the absence of the implementation of the MRLVC. It does not represent options that are compliant with the requirements of the TCA. Our detailed findings and analytical results are set out at length in comprehensive slidepacks provided alongside this report.

The main findings from the assessment are as follows:

1. MRLVC is potentially able, subject to the quality of the BBZ flow forecast, to offer improved economic welfare compared to the counterfactual.
2. TSO congestion revenue under MRLVC is very dependent on the BBZ flow forecast and market conditions, and the impact can vary by border.
3. The Preliminary Order Books MRLVC design option presents major risks in terms of welfare, interconnector revenues, and meeting market needs.
4. The Common Order Books MRLVC design option requires material changes to SDAC timings and processes, which have not yet been resolved.
5. A modified MLRVC may be necessary to support the development and operation of hybrid offshore projects in the North Sea.
6. A poor quality MRLVC adversely impacts the operation of and confidence in the energy markets, including the impact on DAM price formation and the potential loss of forward trading opportunities.
7. Efficient intraday allocation is very important but there are challenges to adopting the MRLVC model for intraday.
8. The interaction of four separate processes (MRLVC, BBZ flow forecasting, SDAC and GB DAM) increases operational and governance complexity.

1. Evidence of positive welfare impacts

Our quantitative assessment has identified that MRLVC is potentially able to offer improved economic welfare to the UK and IEM compared to the counterfactuals – i.e. explicit auction on most borders [39]. Importantly, however, this finding is very sensitive to the BBZ flow forecast methodology being able to produce a reasonably accurate forecast. Indeed, the BBZ flow forecast largely determines the quality of, and market confidence in, the MRLVC arrangements.

There is some uncertainty around the estimation of the welfare losses under the explicit allocation counterfactual, and what is shown probably represents an upper bound on the welfare losses [39-41]. Nonetheless, the difference between the welfare impacts is large enough to give us confidence in the conclusion that the MRLVC with a reasonably accurate BBZ flow forecast should offer increased welfare benefits over explicit allocation.

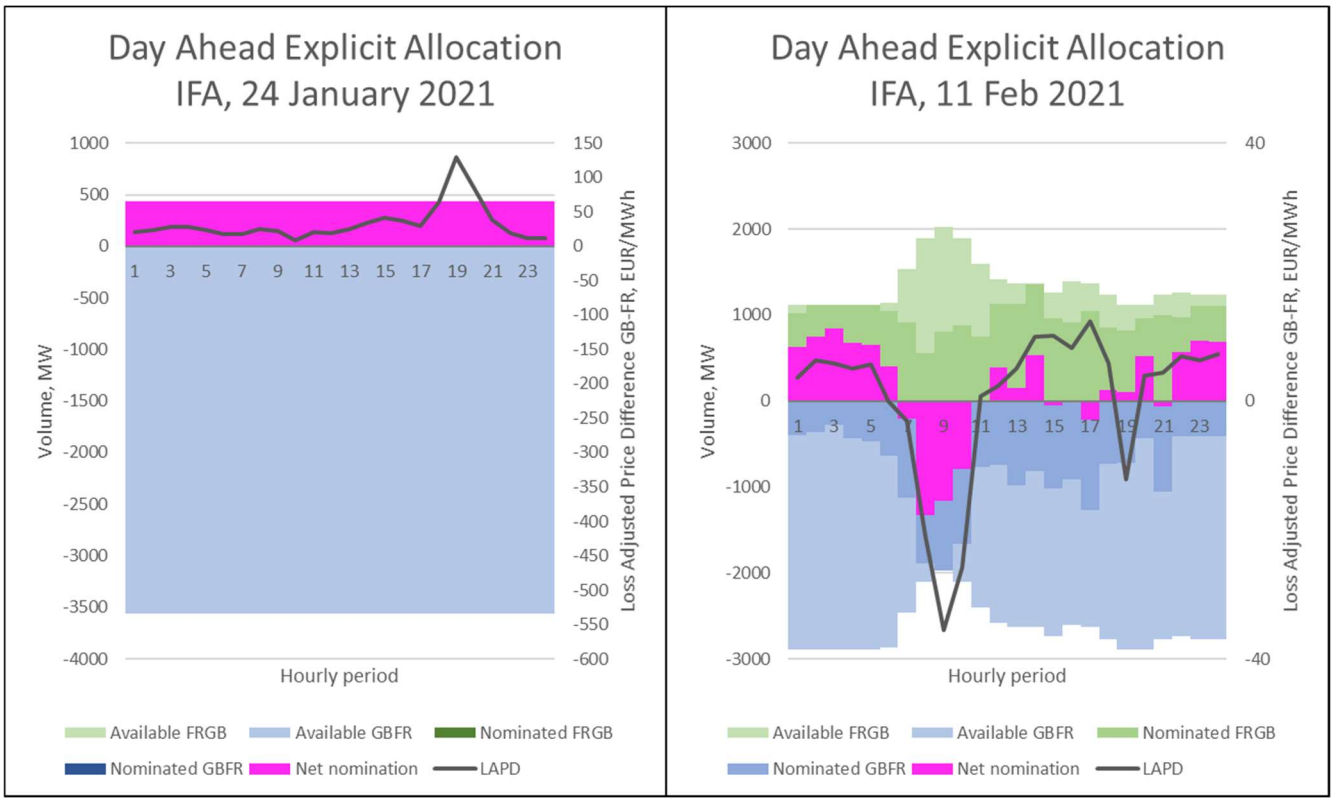
Inefficient flows have historically been observed with explicit capacity allocation, including on links between GB and the BBZs in Q1 2021, particularly when price differentials are small, and especially when changing direction. Figure 3 provides an example of two recent days on the IFA link (GB-FRA). In the chart on the left-hand side, the day-ahead Available Transfer Capacity (ATC)[10] is fully nominated to GB through the day, which is in line with the positive price

[10] i.e. after nominations of forward capacity rights.

spread between GB and France. However, in the chart on the right-hand side, the ATC is not fully nominated at any point during the day, despite some hours with large price spreads. There are even two hours with a small flow against the difference in DA prices (i.e. flows from the higher price market to the lower price market).

The literature review identified that sub-optimal use of interconnector capacity under explicit auctions was a common driver of moves towards volume coupling arrangements.

Figure 3 – Flows and prices on IFA



Source of data: NordPool, EPEX, JAO, ENTSO-E

Section 3.1 discussed the challenges of using market simulation models to make definitive estimates of welfare losses under explicit auctions. We consider the welfare estimates produced in our modelling to represent the upper bound of welfare losses under the explicit auction. The two main reasons for this is the cumulative impact of applying sub-optimal flows simultaneously on all the interconnectors using explicit auctions, and poor forecasting of price differentials that would result from flow nominations. [11]

We have tested the impact of one of our assumptions in this modelling – which is the impact of applying sub-optimal flows simultaneously on all the interconnectors using explicit auctions.[12] By applying in turn the sub-optimal flow on an individual border using explicit auctions in the counterfactual, and summing up the results, the estimated welfare losses under explicit reduced by approximately 40-50% [39]. These losses are still materially greater than observed under the MRLVC arrangements. However, the losses estimated by applying in turn an explicit auction on an individual border and summing the results only represent around 5-10% of the estimated total welfare benefits of

[11] The flow nominations are based on price spreads produced by optimal coupling; and are consistent with historical patterns seen on the Swiss-German border. However, the low level of nominations across multiple interconnectors at times of price convergence across GB and the BBZ linked by explicit auctions pushes up the modelled day-ahead price spread significantly (primarily through the impact on GB prices which are impacted by a large fall in flows across multiple interconnectors). This creates a large price spread, with no feedback into higher flow nominations, which would then reduce the price spread and so on.

[12] This covers the links between GB and the following BBZs: France, Belgium, Netherlands and Denmark. Explicit auctions are not used in the counterfactual for links between GB and Norway or between GB and SEM.

trade between the BBZs and GB. Furthermore, the modelling of explicit auctions on single borders does not yield worse performance than the historical performance seen on the German-Swiss border.

2. Uncertainty around impact on revenues for individual interconnectors

The position is less clear on interconnector revenues [44, 45]. There is a significant downside risk from a worsening in the accuracy of the BBZ flow forecast accuracy, but if the quality is good then the TSO revenues should be close to efficient.

The impact of errors in the BBZ flow forecast on revenue achieved by different interconnector revenues is highly sensitive to underlying market conditions and price spreads [46, 47]. The impact of poor BBZ flow forecasts is greatest when the price spreads are low and the error can cause flows in the wrong direction. When spreads are large, the impact is very small.

The impact of BBZ flow forecast errors can also vary by interconnector, where a poor allocation on one interconnector – resulting in a flow against price difference – can nonetheless result in an increase in revenue on another, with even a net increase possible [48].

We estimate that the interconnector revenues in the counterfactual may be a lower bound estimate of what could be achieved, particularly through explicit allocation where the estimated explicit revenues do not fully take into account the likely widening of price spreads that would occur. It is quite probable that the TSO revenue from explicit auctions would be higher than the congestion rent under MRLVC.

The value of capacity in explicit auctions tends to be very low in the opposite direction from the normal direction of flow. During the 2019-20 period analysed in the SF, interconnectors were rarely exporting from GB (10-5% of hours), During such periods, the TSO revenue under explicit auctions is forecast to be significantly below MRLVC. This suggests that if market spreads were to converge or invert more often, then revenues from explicit allocation would deteriorate more than for MRLVC.

3. Major risks associated with using preliminary order books

Our assessment finds that using preliminary order books would create major risks for the performance of the MRLVC arrangements because of the potential damage to orderly price formation on the energy markets [36]. The implications are highly inefficient flows, erroneous price signals, losses in welfare, and reduced confidence amongst market participants.

There is much uncertainty about the difference that may exist between the preliminary and final order books for SDAC in any such arrangements. Even if further analysis can be carried out on the differences that exist under historical and current market arrangements, it is hard to predict how market participant behaviour may change if preliminary SDAC order books were used to determine flows between GB and BBZs.

Furthermore, using non-firm market orders exposes the MRLVC arrangements to the potential impacts of market manipulation/strategic bidding. For example, if generators in BBZ A wished to raise the DAM price in A, they could deliberately increase demand in A by inducing exports on the interconnector to GB (even when an efficient allocation would indicate imports from GB) by bidding large sell volumes at low prices at the preliminary gate closure. They could subsequently modify their orders before the SDAC gate closure. The revised orders, and not the ones used in MLRVC, would then be used in the SDAC process.

Smaller BZs with low price resilience are particularly vulnerable to the impacts of such behaviour. It would be almost impossible to police effectively; as the incentive to bid strategically would be widespread and any such bidding would be hard to prove.

The risks and associated uncertainties, including the exposure to possible market manipulation, are so great that we do not recommend taking this design forward. We do not see credible ways to mitigate these risks. This conclusion

is further supported by our finding from the literature review that common order books has been a feature of all four of the implementations of volume coupling in Europe.

The use of preliminary order books in MRLVC would, nonetheless, avoid any material operational impact on the normal SDAC processes. There would be implications, however, for the NEMOs in the BBZs having to process two sets of order books, one for MRLVC and one for SDAC, with attendant operational risks.

4. Common order book option requires changes to SDAC timings and processes

Our literature review highlighted the issues around volume coupling being a sequential process that is likely to require additional time in the overall market process.

In this regard, our assessment has identified the impact on the SDAC operational timeline and processes as the biggest challenge to the implementation of an effective MRLVC design based on the use of common order books [68]. Using common order books will entail changes to the SDAC operational timeline: the feasibility and timescales for any such changes is a critical issue to resolve before going further with the implementation of the MRLVC arrangements.

In addition, it will be important to have appropriate incident management processes to manage the risk of decoupling while minimising impact on SDAC [95, 96].

5. Modified MLRVC may be necessary for hybrid offshore projects in the N. Sea

Our analysis with the TheMA power market model indicates small carbon emission benefits from MRLVC implementation compared to the counterfactual, which might be mitigated by ID trading [55]. The bigger environmental benefit of MRLVC, however, may be whether the arrangements support the development of hybrid offshore projects in the North Sea: combining interconnection between GB and SDAC with links to offshore energy installations [56-62].

The TCA provisions refer to cooperation “in the development of offshore energy”, with a reference to the North Seas and hybrid projects.[13] The British government has also expressed its support for this concept, noting that “this will facilitate the development of hybrid projects that combine interconnectors and offshore windfarms, and opens up the potential for a North Sea grid. This will help realise the region’s huge potential, enabling renewable energy to continue to power our homes and businesses in the future”.[14]

The proposed development of offshore reneable energy in the North Sea consistent with European and UK climate targets envisages the creation of hundreds of GWs of offshore wind capacity, much of it linked to multiple shores through so-called hybrid projects (hybrid interconnection and generation). The EU’s offshore renewable energy strategy has raised the possibility of creating offshore bidding zones to account for structural bottlenecks in the offshore grid.

Development of such projects requires trading arrangements that support efficient pricing and capacity utilization on the hybrid offshore network. Use of Offshore Bidding Zones gives the market coupling process a greater role in undertaking the challenging job of optimising flows within the offshore network. The optimal cross-zonal flow for borders within the offshore network is likely to be far more sensitive to flows on adjacent borders because these cross-zonal flows will represent a very large share of total implied demand/supply in the relevant offshore zone as compared to existing onshore zones.[15]

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[13] Article ENER.23: Cooperation in the development of offshore renewable energy

[14] UK Prime Minister’s Office, 24 December 2020, ‘UK-EU Trade and Cooperation Agreement: Summary’

[15] A parallel can be drawn with the challenges faced by small onshore BBZs with relatively large zones to big BZs not connected to GB, and hence whose data is not included in the MRLVC process.

Our assessment is that it will be very difficult for the counterfactual explicit auctions to support the efficient flows needed because of the challenges for market participants of making forecasts of price spreads involving the offshore zones.

Therefore, the design and performance of MRLVC will be critical to the development of the North Sea and hybrid interconnectors, and may necessitate changes (e.g., use of offshore bidding zones and grid data). MRLVC should be better than explicit allocation for a North Sea Hub, but may not be good enough to enable full development of the North Sea unless it has access to more data than is currently allowed under the TCA Annex.

6. Poor quality MRLVC adversely impacts energy markets

Unless the MRLVC can compute near optimal flows, there is likely to be a material imbalance between the congestion revenue received by TSOs and payouts under 'Use It or Sell It' (UIOSI) arrangements[16] or under Financial Transmission Rights (FTRs) [49]. Our modelling shows that as the BBZ flow forecast quality worsens, then the UIOSI or FTR payment goes up while congestion revenue received goes down [50].

If the risk proves material, either long term capacity rights may be withdrawn or the UIOSI/FTR terms might need to be changed. Either way, this could harm the formation of forward energy prices and the ability of market participants to manage risk efficiently.

There is also a mismatch between congestion revenue received and FTR payments on SEM-GB. SEM appears to have fairly volatile prices, possibly due to the extensive use of complex orders, which can lead to price discrepancies.

There are other causes for concern that a poor MRLVC solution would damage markets [63]. Poor BBZ flow forecasts can have a significant impact on DAM energy prices, particularly in GB and SEM [64]. This is not a risk that market parties can manage easily. The BBZ flow forecast methodology is critical to market confidence in the MRLVC, and it needs to be transparent, auditable and reproduceable.

7. Challenges to adopting the MRLVC model for intraday

Efficient ID allocation is likely to be increasingly important given the growing importance of intermittent renewable generation. As discussed in Section 3.2, implicit allocation and markets can also mitigate the effects on welfare of poor DA allocation.

The TCA and Annex is silent on the issue of ID capacity allocation on the GB interconnectors. There is, however, considerable work underway within the IEM to implement ID implicit auctions closely modelled on the DA arrangements in SDAC. The question may arise whether an MRLVC approach could be applied to the ID timeframe.

In principle, the assessment of MRLVC in the ID timeframe would be similar to that for DA. A key challenge, however, would be the restricted timeline for ID auctions, and the impact of adding the MRLVC process to this. The assessment of the counterfactuals would also also be different in some ways: the SEM-GB ID auction might no longer be possible, and a separate ID auction on NSL would imply a highly fragmented ID market in NO2.

8. Challenges of managing interactions across four separate processes

Volume coupling creates greater organisational and operational complexity compared to price coupling since it involves several independent but interdependent computations. MRLVC involves four processes with quite separate governance arrangements: BBZ flow forecaster; MRLVC MCO; SDAC; and GB DAM.

[16] On Physical Transmission RIghs (PTRs).

This raises issues regarding operational coordination/inter-dependencies and managing the impact of any changes across all relevant processes [69]. In particular:

- Operational processes need to be closely coordinated, particularly in case of incidents.
- Process interfaces and data exchange needs to be robust and error-free.
- Performance of MRLVC depends heavily on the performance of the BBZ flow forecaster.
- Any changes need to be coordinated across all affected processes.

The number of parties involved and their differing priorities further increases the magnitude of the challenge.

4.2. HIGH-LEVEL SUMMARY ASSESSMENT OF MRLVC PERFORMANCE

Figure 4 summarises at a very high-level the results of our qualitative and quantiative assessment, which has informed the main messages set out above. We have not attempted to give a relative weighting of each factor as different parties are likely to have varying priorities.

Figure 4 shows a score of 'orange' on consumer and producer welfare for the MRLVC Common Order Books design. This reflects the current uncertainty around the performance in practice of the BBZ flow forecast. As discussed under our first main finding in Section 4.1, the BBZ flow forecast largely determines the quality of, and market confidence in, the MRLVC arrangements.

The counterfactual represents the current or planned arrangements on each border, none of which represent a solution compliant with the requirements of the TCA:

- ID implicit allocation (price coupling) – as in place on SEM-GB border.
- Separate DA implicit allocation (price coupling) – as planned for NSL.
- DA explicit allocation – as in place on all other borders.

To show the differences between each of these capacity allocation arrangements, we have presented a separate assessment of each of them alongside the assessment of the MRLVC design.

In the operational aspects, all three capacity allocation processes in the counterfactual are scored as 'green'– this means that we identified either no or only small operational issues:

- Operational complexity – reflecting that the capacity allocation processes in the counterfactual are either explicit auctions (independent from the process of energy price formation) or independent price coupling process with few interfaces or parties involved (SEM-GB border, and NSL).
- Operational impact on SDAC – reflecting that the capacity allocation processes in the counterfactual have no direct interactions with the SDAC process.
- Roles and governance – reflecting that the capacity allocation processes in the counterfactual are largely discrete operations with well established and straightforward organisational arrangements.

The analytical slidepack includes a detailed assessment against each element:

- Consumer and producer welfare [33-42]
- Interconnector revenues [43-53]
- Impact on CO2 and low carbon targets [54-62]
- Meeting market needs [63-64]

- Compatibility with IC technical requirements [65]
- Operational complexity of allocation process [66]
- Futureproofing [67]
- Operational impact on SDAC [68]
- Roles and governance [69-74]

Figure 4 – High-level summary of quantitative and qualitative assessment

	High-level MRLVC options		Counterfactuals		
Aspect	Common Order Books	Preliminary Order Books	Explicit Auctions	ID Price Coupling **(SEM-GB)**	Separate DA Coupling **(NSL)**
Consumer and producer welfare					
Interconnector revenues					
Impact on CO2 and low carbon targets					
Meeting market needs					
Compatibility with IC technical requirements					
Operational complexity of allocation process					
Futureproofing					
Operational impact on SDAC					
Roles and governance					

No issues, or only small issues | Material issues, potentially manageable | Severe issues likely to be challenging to resolve

4.3. ASSESSMENT OF IMPLEMENTATION CHALLENGES

This section highlights the main findings of our assessment of the issues regarding the implementation of a MLRVC solution (where the counterfactuals are not relevant). The main findings from the assessment are as follows:

1. There are several critical implementation challenges to address.
2. Implementation costs and timeline are dependent on further clarifications and choices.

1. Major implementation challenges for MRLVC arrangements

There will be multiple significant challenges to be overcome in order to successfully implement a MRLVC trading arrangements [75].

- Four discrete groupings (MRLVC, SDAC, BBZ flow forecaster, and GB DAM) which need to coordinate closely with each other.
- Lack of established frameworks in which to undertake the implementation task (e.g. organisation and resources, decision-making, funding) for three new processes: MRLVC, BBZ flow forecaster, and GB DAM.
- Reliance on a novel concept not yet prototyped (BBZ flow forecast).

- Potential requirement to undertake tenders for systems, service providers.
- Potential impact of needing regulatory changes if modifications are needed to SDAC processes and/or timelines (in particular, if CACM needs to be changed).
- Significant new business processes to be implemented (systems, organisation, operational procedures, agreements, regulatory approvals/changes).

An outline of the main implementation tasks facing each of the four groups have been identified [76-80], together with the estimated time required. Many of these tasks can proceed in parallel, but the work load is significant.

2. Uncertainty of implementation costs and timings for MRLVC

There is scope for large variation in implementation costs [81-82]. For example, the costs of implementing the initial Central West Europe (CWE) market coupling (excluding flow-based) are estimated to have been over €30m, around five times the cost of implementing the Trilateral Coupling (TLC).

The main cost elements in such a project are typically:

- IT systems development (algorithms, data management and communications).
- Internal experts (market design, operations, legal and commercial).
- Testing.
- Project management.

The main drivers of cost are likely to be:

- Ability to re-use or modify existing solutions (technical, operational and contractual).
- Novelty of the problem and need for R&D (relevant to the BBZ flow forecaster).
- Experience and existing capabilities of the key service providers, and the basis of their involvement (e.g., self-interest or regulatory obligation).
- Organisational complexity, including the number of involved parties, the extent to which MRLVC is a shared priority, and the ability to establish a lean project structure, delegating responsibility to a core group.
- Implementation time, which is impacted by the points above plus issues such as the need for extended testing/parallel runs and whether the solution remains stable during the project or requires changes.

A realistic cost estimate is only possible once the principal elements of the MRLVC design and implementation plan are established.

5. CONCLUSIONS

Our assessment has discussed the various advantages and challenges faced by the operation and implementation of the different MRLVC options.

1. MRLVC common order book design is potentially a beneficial solution. This reflects the potential welfare benefits over the counterfactual, and the advantages for the development of a North Sea Hub.

Our assessment has identified these two major open questions regarding the successful implementation of a well-functioning MRLVC.

- The accuracy that can be achieved by the BBZ flow forecast methodology (EU TSOs).
- The scope for implementing a common order book MRLVC that is consistent with the operational constraints of SDAC (EU NEMOs and TSOs).

2. MRLVC preliminary order book design is fundamentally flawed. It would face many of the similar implementation challenges to the MRLVC common order book option. The main advantage would be that it would have far less impact on the operation of SDAC. However, we see the performance risks (and the associated economic and market impacts) of such an option being too great to be acceptable.

It would be preferable to concentrate on taking forward only the MRLVC common order book option. This should help to focus attention and effort on addressing the major obstacle to successful implementation – the potential impact on SDAC operation.

Going forward, we focus on the tasks in 3 areas:

- Critical implementation tasks in the next few months. There are several important steps over the next six months [80], but three are of particular importance:
  - Establish MRLVC project.
  - Develop and test the BBZ flow forecast methodology.
  - Establish the scope for implementing a common order book MRLVC that is consistent with the operational needs of SDAC (EU NEMOs and TSOs).
- Continuing to consider and develop possible enhancements and mitigation measures to the MRLVC design, such as:
  - Assess need for and design measures to mitigate sub-optimal flows resulting from errors in BBZ flow forecasts.
  - Review how the current design may need to evolve in order to perform adequately to meet possible future requirements, particularly in relation to supporting hybrid projects in the North Sea.
- Running new simulation model analyses to test specific high-priority questions (where such analysis cannot wait until the availability of the BBZ forecast methodology), such as:
  - Addition of NeuConnect (GB-DEU).
  - Addition of Celtic (SEM-FRA).

5.1. CRITICAL IMPLEMENTATION TASKS

Establish MRLVC project

A well functioning project is crucial to being able to take forward in an effectively and timely manner all the required activities. Establishing the MRLVC Project, alongside the BBZ Flow Forecast Project and GB DAM Project, is complex and is estimated to take 2-4 months [80].

The initial priorities in this area should be:

- Establishing a governance and project framework to allow the relevant UK and EU TSOs to undertake the development of MRLVC in conjunction with SDAC, EU TSOs (BBZ flow forecaster) and GB DAM.
- Clarifying the role of the GB PXs/NEMOs in the MRLVC solution and, as a result, in the implementation project.
- Setting up channels for effective stakeholder engagement – e.g., on the findings of the CBA, and on ongoing progress/issues.

The project framework needs to address the issues of organisation, decision-making, funding, and appointment of resources. Although in principle MRLVC is the joint responsibility of all GB and EU TSOs, this could lead to an unmanageable project structure. This could be addressed by delegating responsibility to a leaner project, funded and led by the directly impacted TSOs together with a wider process of information sharing/ratification with the non-directly involved parties.

There also needs to be coordination across the four groups (MRLVC, BBZ flow forecaster, SDAC and GB DAM), and the MRLVC steering committee is probably best placed to facilitate this.

The PXs/NEMOs have a critical role supporting the MRLVC through the submitting of their order books and the acceptance of the resulting flows as orders in SDAC/GB DAM. They also can potentially provide services to the MRLVC – notably in the areas of MCO operator and shipping.

The approach under CACM has been to govern such roles through regulation. However, the projects that actually established the day ahead market coupling across Europe (TLC, CWE, NWE, MRC/PCR) were organised as voluntary cooperations between interested PXs and TSOs. Such a 'coalition of the willing' is likely to be a quicker and less costly approach. It should also be possible to adopt some of the governance principles from the earlier projects. The backstop of using regulatory change can still be maintained as an option - for example, the involvement of all BBZ NEMOs is essential and must be ensured, while the involvement of all potential GB PXs is not necessary, provided at least one is willing.

MRLVC will have a significant impact on the energy markets, and there are, as has been noted in this report, several aspects that would be of particular concern to market parties. As has been successfully demonstrated on other projects, it is possible to proactively engage with stakeholders to both their benefit and that of the project.

In developing the project plan, it will also be important to identify opportunities to reduce cost and speed of implementation, as highlighted earlier in Section 4.3.

Development and testing of BBZ flow forecast methodology

The priorities are:

- Develop BBZ flow forecaster methodology (EU TSOs).
- Ensure that a structured testing programme is ready to enable an updated quantitative assessment once the BBZ flow forecast methodology is available[17] (Relevant UK and EU TSOs).

Given that different parties may be impacted differently by any biases in the BBZ flow forecast methodology, it is critical that it is auditable, reproduceable and avoids subjective inputs.

It will be difficult to make any firm conclusions about the acceptability of MRLVC until the BBZ flow forecasted methodology can be evaluated. Therefore, it will be important to review and update the quantitative assessment

[17] Our anaysis tested the impact of different forecast error patterns. It was not estimating how accurate the BBZ forecasting methodology will be.

once a BBZ flow forecast methodology is available. [18] The MRLVC needs to be fully tested with the chosen BBZ flow forecaster for an extended period of time as well as for a wide range of market conditions/scenarios.

Historically, GB has had a sustained price premium to continental Europe, which has made optimal capacity allocation easier. The expectations are that this may become harder in the future through a combination of greater convergence in fuel and carbon prices, increased renewable deployment and increased interconnector capacity.

These possible changes in market conditions should be captured in the structured testing programme, the development of which can be informed by the results of our simulation model analysis. This could involve identifying certain situations in which it is of particular interest to test the market arrangements (e.g. days with RES shares > x%; number of hours with price differential <y EUR/MWh). Either relevant days and events can be identified in historic data or new scenarios can be artificially created, allowing composite results to be constructed based on expectations on the frequency of such events in the future.

The structured testing programme should also incorporate testing against alternative weather patterns to identify the frequency of periods that put the trading arrangements under most stress. This will help increase understanding robustness of performance in atypical years, rather than just a representative weather year.

Establish the scope for implementing a common order book MRLVC that is consistent with the operational needs of SDAC (EU NEMOs and TSOs)

The priorities are:

- Determine critical and feasible changes to SDAC.
- Identify impact on CACM and Methodologies.

Our CBA has highlighted some of the possibilities that could be explored with regards to implementing MRLVC in a way that is consistent with the needs of SDAC, such as:

- Earlier SDAC gate closure time (possibly only for BBZs): this would have implications for market participants and pre-gate closure time processes like capacity publication.
- Making parallel start to SDAC and MRLVC computations – e.g., starting SDAC with an estimate of the IC flows from MRLVC.
- Allow later results publication: this could have implications for backup procedures and the 15:30 nomination deadline in CWE.
- Identification of any other necessary changes to SDAC operational procedures.

Any such discussions would need to have regard for other priorities for possible changes to SDAC, such as a move to 15-minute settlement period. That is why it is important that it is taken forward by the SDAC experts who are responsible for implementing any such changes. However, we acknowledge that there are no easy options in this regard.

5.2. CONSIDERATION OF POSSIBLE ENHANCEMENTS TO MRLVC DESIGN

As more information becomes available – e.g. on the BBZ forecast flow methodology, on stakeholder acceptability of different aspects of the MRLVC design, and/or from further testing – further work can be done on the possible enhancements to the MRLVC design to address issues identified.

[18] For example, our simulation tested the impact of different forecast error patterns. It was not estimating how accurate the BBZ forecasting methodology will be.

There are two main areas for possible enhancement:

- Measures to mitigate sub-optimal flows resulting from errors in BBZ flow forecasts.
- How the current design may need to evolve in order to perform adequately to support hybrid projects in the North Sea.

Mitigating impact of sub-optimal flows

There are a range of sub-optimal flow situations. Flows in the wrong direction, or more than optimal in the right direction, result in negative loss-adjusted-price-differences (LAPDs) leading to negative congestion revenue (after losses). Flows that are less then optimal result in a loss of congestion revenue (i.e., missed opportunity costs).

Our assessment has considered two possible ways to mitigate the impact of sub-optimal flows.

The first route is to consider alternatives to the assumption that MRLVC-determined interconnector flows in SDAC/GB are treated as Price Taking Orders (PTOs) in SDAC and GB. An alternative would be to treat the MRLVC-determined flows as limit orders on the bordering BZ SDAC market, rather than as price taking orders [88, 89]. Limit orders set a limit price: if the market clearing price is above the limit price on a buy order, it is not matched (and vice versa for sell orders). The limit price would be the expected GB price (predicted by the MRLVC), adjusted for losses. Using limit orders will reduce the occurrence and severity of FAPDs (but possibly at the cost of some utilisation less than optimal).

There are potentially negative consequences of using limit orders – in particular, with regard to further delay to the GB DAM process and the likely inability to confirm the GB results before SDAC publishes its results. In addition, the impact of limit orders when considering flows across multiple borders is different to only considering a single border, and limit orders will not entirely eliminate FAPDs. Furthermore, it probably is not possible to respect ramping constraints if using limit orders. As a consequence, limit orders would not be the preferred solution if the standard MRLVC model proved to be adequate.

The second route is to manage the impact on interconnector revenue through changes to long-term transmission rights. Depending on the quality of the MRLVC arrangements, where PTRs or FTRs are offered TSOs face an unacceptably high risk that UIOSI or FTR payouts significantly exceed the congestion revenue that the TSOs receive. This risk would be removed by a switch to use-it-or-lose-it (UIOLI) rights on PTRs [98]. However, this should remain a contingency option, depending on the quality of the eventual MRLVC solution. This is because the expectation of market participants and NRAs is for UIOSI to be offered; and a move to UIOLI rights will be of lower value to market participants.

An alternative way of managing this risk of UIOSI payments exceeding congestion revenue received would to be cap payouts on long-term rights [98]. This could be applied to PTRs or FTRs, and there are some precedents for reduction/capping of UIOSI payouts to take account of specific factors (losses, curtailment). Again, the negative impact of this on market participants means that we recommend only considering it as a contingency option – for example, where the alternative would be that TSOs no longer offer long-term rights.

North Sea Hybrid

There is currently considerable efforts being made to develop the commercial and regulatory framework to support the development of renewables in the North Sea. This includes the development of hybrid interconnectors linking wind farms and countries. Possible models include treating offshore sites as part of existing Home Markets, or establishing Offshore Bidding Zones.

The exclusion of GB from SDAC will have a major impact on the operation of these potential models. It is unclear whether this is recognised yet by those directly involved, given the challenges of developing a workable solution even if GB were still in SDAC.

The development of an efficient commercial and regulatory framework is an essential precursor for the major investment needed to develop the North Sea. It should be a priority to consider the implications of MRLVC on this framework, and to identify if any modifications may be needed. There are potentially a range of options for how MRLVC and SDAC interact to manage capacity allocation in a North Sea grid, and some may require modifications to the MRLVC design. This might include, for example, relaxing the constraint that MRLVC can only see data from BBZs if this meant it lacked essential information.

5.3. Deepening and refining quantitative assessment

Ideally, any further market simulation modelling of the MRLVC design should only be done once the BBZ forecast flow methodology is ready for testing. The benefits of further quantitative assessment, even as part of a structured assessment programme, is limited without clarity on the likely performance of the BBZ flow forecast methodology.

However, we recognise that there may be specific questions of interest that stakeholders are interested in exploring in the meantime. Potential areas of study could include the impact of two specific changes to interconnection:

- Addition of NeuConnect (which would introduce German order book data into the MRLVC).
- Addition of Celtic, physically connecting SEM to SDAC.

Our existing assessment has already explored the impact of additional IC build, both to new markets (NO2, DK1) and increased interconnection to BZs already linked to GB (FRA, SEM). Therefore, the most interesting new interconnection to test would be the impact of NeuConnect (GB-GER) and the impact of Celtic (SEM-FRA). These are two ICs that we deliberately did not build in our study because we felt that that they could make it harder to see other patterns and trends in the MRLVC. Both ICs are now being scheduled for deployment in the mid-2020s.

Testing impact of connection of NeuConnect

Neuconnect would be of interest because it would result in the inclusion of the German Order Book in the MRLVC arrangements. This is expected to have a major impact on the quality of the BBZ fow forecast and the performance of the MRLVC, given the influence the German market has on NW European prices.

Testing impact of connection of Celtic

Including Celtic in the modelling would mean that SEM is no longer only connected to GB. Within our study, it was useful to explore the impacts of the alternative trading arrangements on SEM when it is only connected to GB – and so is not directly exposed to any BBZ flow forecast errors. In these circumstances, the MRLVC would actually be much closer to a ‘tight’ volume coupling between GB and SEM. The development of Celtic would change that situation, making SEM more exposed to the BBZ flow forecast error and loosening the volume coupling between SEM and GB.

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