P415 CBA Options

Elexon

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DRAFT FINAL REPORT

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1. EXECUTIVE SUMMARY

P415[1] is a Balancing and Settlement Code (BSC) modification proposal to allow consumers to participate in the wholesale electricity market through independent aggregators, with no involvement from the consumer's supplier. The mechanism would be symmetrical, allowing for increases or decreases in consumption or distributed generation.

Elexon has engaged CEPA to develop an Options Paper for a cost benefit analysis (CBA) for P415. Elexon indicated that a spectrum of options should be included and that one of the options should represent a 'minimum viable product' (MVP).

We have compiled five options based on our understanding of P415 and our experience in conducting CBAs and other forms of economic appraisals. The main difference between the options is the way in which benefits are evaluated.

1. High-level CBA to develop 'order of magnitude'[2] assessment benefits
2. Case studies of CBAs conducted for similar proposals in other jurisdictions
3. A non-modelled CBA featuring a mix of qualitative and quantitative analyses – e.g., 'Breaking Point' analysis[3].
4. Market modelling to capture wholesale market dynamics but with non-modelled analysis of network impacts.
5. Combination of market and network modelling to capture wholesale market dynamics **and** network expansion.

All options involve a quantitative cost assessment which makes use of cost estimates provided by industry participants. However, the cost assessment under Options 3, 4 and 5 would be more detailed than in Options 1 and 2. The costs would be assessed for reasonableness (including through comparison between submissions) by Elexon and the service provider.

The options that we have identified vary with regard to sophistication, budget and/or time frame. Either Option 1 or Option 2 could represent an MVP depending on the requirements for the CBA and on the availability of relevant information/data.

Table 1 below provides an indication of the level of quantification which could be expected for costs and for the initial set of benefits that we identify based on Elexon's specification[4]. A full circle represents a quantified cost or benefit, while partial circles express the degree of partial quantification and likely precision of estimates. An empty circle represents qualitatively assessed benefits. Lighter shading is used where the ability to quantify benefits is less certain and is dependent on data availability, methodology, etc.

[1] https://www.elexon.co.uk/mod-proposal/p415/

[2] Benefits would be estimated based on an estimate of the 'order of magnitude', i.e., £100,000-£1m, £1m-£10m, £10m-£100m, etc.

[3] 'Breaking Point' analysis focusses on whether there is likely to be sufficient benefit resulting from a change to outweigh estimated costs. It provides a framework within which more abstract and less quantifiable benefits can be compared against more certain and quantifiable costs to develop an expectation about whether the former is likely to outweigh the latter.

[4] Note that our benefits categories differ from those set out by Elexon. We explain these differences below.

Table 1: Indicative extent of quantification

Option	Wholesale market impacts	Balancing market impacts	Reduced system costs	Reduced CO2-e emissions	Industry costs of P415
1. High-level CBA					
2. Case studies					
3. Non-modelled CBA					
4. Market modelling – wholesale impacts					
5. Market modelling – wholesale and network impacts					

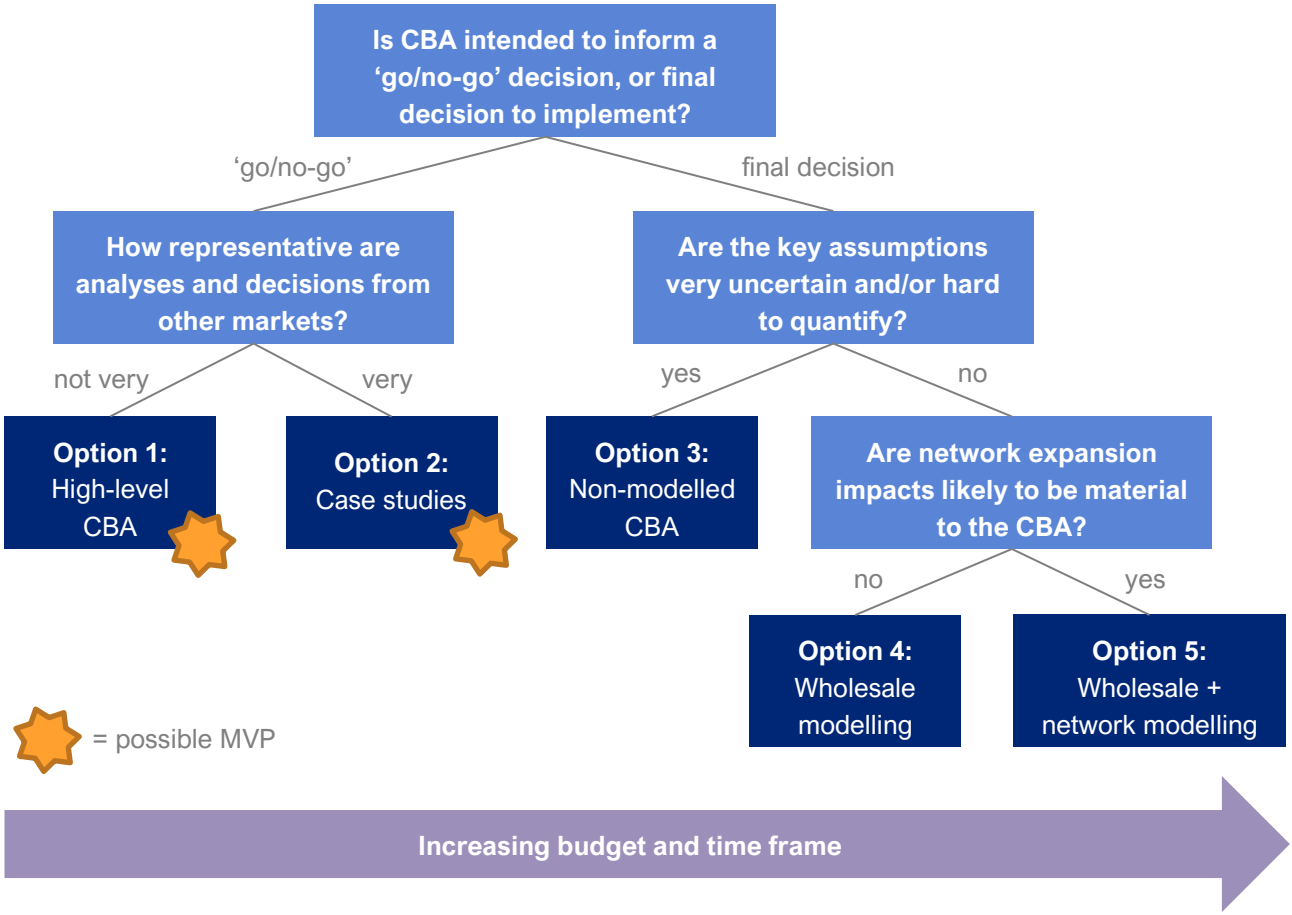
Note: System costs include the costs of new generation capacity as well as network expansion.

We consider that the key issues for deciding on the most appropriate CBA option are:

- **The purpose of the CBA** – is it intended to inform a 'go/no-go' decision, or a final decision to implement the modification? Do you expect Ofgem to do a further, detailed CBA dependent on the Panel's recommendation?
- **How representative are similar decisions taken in other markets**? – are contextual differences sufficiently small such that analysis and decisions in those other markets can be overlayed onto the GB market with sufficient confidence?
- **The level of uncertainty around the key assumptions** – if key assumptions are highly uncertain, a modelled CBA may introduce a spurious level of accuracy and therefore a misleading level of confidence in the final decision.
- **The budget and time horizon** within which Elexon and the Panel wish to develop the CBA.

The decision tree below is intended to provide a high-level guide as to how the questions above should be used to support a decision regarding the most appropriate choice of CBA. We provide further detail on each option in Section 2.

Figure 1: CBA options decision tree



2. INTRODUCTION

In this section we summarise the P415 modification proposal at a high level. We also summarise the costs and benefits that Elexon has identified through initial assessment and that we would expect to include in the CBA.

2.1. P415 PROPOSAL

Currently, consumers can only access wholesale electricity market prices if this service is offered by their supplier. This may be limiting for consumers who are able to flexibly manage their consumption and who may wish to obtain value from this flexibility in the wholesale market directly. This issue may become more material as changes in technology, energy price signals, and societal attitudes towards energy use lead to a greater uptake of flexible energy technologies (e.g., energy storage, electric vehicles, heat pumps and distributed generation).

In contrast, consumers can participate in the Balancing Mechanism through an independent aggregator, or directly (if they accede to the BSC), in addition to their electricity supplier. These aggregators bundle changes in loads or distributed generation output for sale in organised markets, but otherwise do not supply their customers with electricity.

P415 introduces arrangements which would allow consumers to participate in the wholesale electricity market in the same way as for the Balancing Mechanism, i.e., through independent aggregators, with no involvement from their supplier. The ability to participate in the wholesale market would be symmetrical, allowing for increases or decreases in consumption or distributed generation. In effect, these upwards and downwards actions would represent an additional source of 'demand side response' (DSR).

The proposed solution leverages two other modifications:

- P375: using asset-level metering in settlement, which was approved by Ofgem in February 2021.[5]
- P376: a baselining methodology for Balancing Services with baselines determined from recent historical data for the connection point. The BSC Panel has recommended that Ofgem approve this modification, but we understand that Ofgem is yet to make a decision.[6]

When an independent aggregator initiates downwards DSR, the incumbent supplier may initially be left 'out of pocket' for costs that they may have incurred to hedge the full level of consumption. The proposal notes that a payment would accompany the correction of the imbalance position of the supplier to compensate them for this cost. We understand that the P415 workgroup has developed two options regarding who would be liable to pay for supplier compensation, i.e., it could be independent aggregators, or the costs could be mutualised across all suppliers.

[5] https://www.ofgem.gov.uk/publications/p375-settlement-secondary-bm-units-using-metering-behind-site-boundary-point-0

[6] https://www.elexon.co.uk/mod-proposal/p376/

2.2. POTENTIAL COSTS AND BENEFITS

In this section we summarise the benefits and costs that we would expect a CBA to capture. We also summarise analytical challenges that may exist in capturing these costs and benefits.

2.2.1. Benefits

In Table 2 we expand upon four key benefits and hypotheses developed by Elexon and list the analytical challenges that would arise in attempting to quantify each one. We also summarise some key assumptions which would be required in undertaking the analysis.

Table 2: Potential benefits of P415 and analytical challenges

Benefit	Hypothesis	Analytical challenges and key assumptions
Wholesale market price impacts driven by increased competition in the wholesale market	Independent aggregator participation in the wholesale market will facilitate greater volumes of price-responsive load, leading to lower peak demand and lower wholesale market spot prices. This effect could be partially offset by increases in consumption in periods when prices are low or negative.	• Estimating the volume of additional DSR which could be introduced into the market • Assessing additionality of DSR (i.e., would P415 create entirely new DSR, or instead bring forward DSR which would have happened without P415) • Assigning the price at which the new DSR would be offered into the wholesale market • Choosing assumptions for the availability of DSR across the day and year
Balancing market impacts driven by increased wholesale market liquidity	Independent Aggregator participation in the wholesale market will increase market liquidity allowing participants to manage their imbalance portfolios more effectively. This would reduce the need for TSO balancing actions which should reduce the balancing service costs to be recovered from the market	• As impacts would be on volumes of balancing actions, this would require separate assessment of balancing market impacts in addition to impacts on the wholesale market. • It would also require assumptions to be developed regarding the volume and costs of self-balancing with and without implementation of P415
Reduced costs for Total System infrastructure investment	Independent aggregator participation in the wholesale market will facilitate greater volumes of price-responsive load, leading to lower peak demand. This may result in reduced need for spending on new generation capacity and network assets.	• Potential impacts on the need for generation capacity can be analysed as an output from wholesale market modelling which may be more proportionate to impact than attempting to model endogenously • Modelling network expansion would require additional modelling functionality and assumptions regarding impacts of DSR on network capacity requirements, not included within market modelling. This would increase modelling complexity
Reduced carbon emissions and general 'Green' benefits	The increased use of flexible assets in the wholesale market (and possibly the reduced need for balancing actions) will reduce the need to activate conventional generation and so reduce CO2-e emissions. The monetised impact of avoided emissions can be estimated.	• As these emissions savings would result from impacts observed elsewhere, the analytical challenges would consist of those presented in relation to other impacts

In the table above we have intentionally focussed on the ultimate benefits as would be observed by consumers and/or society. Note that this leads to some differences with the set of benefits included by Elexon in its specification. Firstly, we consider that the benefit identified by Elexon as increased competition in the wholesale market will ultimately lead to impacts on wholesale market outcomes – e.g., on the average wholesale day-ahead market price. We also consider that enhanced liquidity will be an interim mechanism which allows for additional self-balancing and can therefore impact on the ESO's costs to balance the system. We describe the ultimate impact on consumers as balancing market impacts.

Finally, Elexon identified a fifth benefit from a reduction in the costs of developing DSR resources. Elexon considered that adding a revenue stream for independent aggregators will reduce their cost of developing additional demand response resources. We believe that this impact is also an intermediate mechanism for benefit rather than being a benefit in and of itself. We would expect cheaper DSR to result in benefits in relation to wholesale market prices, balancing market and infrastructure requirements. We therefore believe that the impacts of reducing costs of developing DSR will flow through the benefits included in the table above and have removed this as an explicit benefit channel to avoid double counting of benefits.

Potential wider benefits

Other potential benefits that have been put forward by Workgroup members include:

- consequential benefits of additional DSR availability for CM prices and DNO procured flexibility;
- security of supply and resilience;
- benefits in the supply chain for demand side response services and products;
- supporting distributed energy and renewables integration; and
- enhanced ability to support electrification of heat and transport

To ensure proportionality of analysis and avoid the need for additional modelling budget and complexity, we recommend that these wider benefits are assessed qualitatively rather than further increase the complexity of the modelled analysis.

2.2.2. Costs

The costs which Elexon has identified so far fall in two categories: system costs, which could be one-off or on-going, and supplier compensation costs. System costs have been identified in relation to BSCCo (Elexon) and NGESO, but may also exist for other market participants, such as suppliers. The expected supplier compensation results from sourcing costs for actions taken by an independent aggregator at their registered sites. This cost could be paid by either independent aggregators or, under an alternative solution, mutualised across all suppliers. The analytical implications of these alternative solutions are discussed in Section 4.

In Table 3 we list the analytical challenges which we anticipate a service provider would encounter as part of the cost assessment exercise for a CBA of P415. All costs would be separated into expected one-off and ongoing components.

Table 3: Potential costs of P415 and analytical challenges

Cost	Hypothesis	Analytical challenges
Supplier compensation	Suppliers may incur mutualised costs to compensate suppliers impacted by the operation of independent aggregators at the meter points which they supply. The presence of these costs depends on the policy decision on who should pay suppliers' 'out of pocket' expenses.	• General uncertainty around cost impacts and the extent to which they would depend on the final design. This may not be known at the time when costs are collected • Dependence on market participants to estimate costs and the potential for optimism or pessimism bias in responses • Assessing the distributional impacts of these costs on market participants and on consumers, including the extent to which costs falling on market participants can be passed on to consumers • Extrapolating cost estimates from a sub-set of market participants (e.g., suppliers, or distribution network operators) to calculate cost impacts for the whole industry
BSCCo costs	BSCCO will incur costs to operate the calculations necessary to facilitate P415.	
NGESO costs	NGESO will incur costs as system operator.	
Other costs	Costs to other market participants, or other costs to suppliers, may be identified as the modification progresses.	

3. CBA OPTIONS

The CBA options are based on our understanding of P415 and our experience in conducting CBAs and other forms of economic appraisals. In order to develop this set of options, we initially developed a 'long list' of options which we then refined to produce five separable and complementary options. The main difference between the options is the way in which benefits are evaluated. The cost assessment approach would be similar across all but would involve broader consultation and more detail in Options 3, 4 and 5.

1. High-level CBA to develop 'order of magnitude' assessment of benefits with indicative assessment of costs.
2. Case studies of CBAs conducted for similar proposals in other jurisdictions plus indicative assessment of costs.
3. A non-modelled CBA featuring a mix of qualitative and quantitative analyses – e.g., 'Breaking Point' analysis.
4. Market modelling to capture wholesale market dynamics but with non-modelled analysis of network impacts.
5. Combination of market and network modelling to capture wholesale market dynamics AND network expansion.

In developing the range of options, we have sought to capture a broad range of techniques, while providing options from across the spectrums of budget and time frame. We note that a greater level of analytical sophistication does not necessarily correspond with a more robust result. Under the wrong conditions, such as uncertainty around key inputs, more complex analysis can produce spurious level of accuracy and a misleading level of confidence in the outcomes.

Elexon indicated that one option should represent an MVP. For CBAs to inform regulatory decisions, we interpret 'viability' to correspond with a CBA outcome which is acceptable to stakeholders (i.e., for BSC members, policymakers, Ofgem, non-BSC members with an interest in the modification), especially stakeholders who may not agree with the outcome. Acceptability can commonly be achieved through analysis which is consistent with established and authoritative methodologies,[7] open consultation, and alignment between the CBA and the regulator's statutory obligations.

The minimum requirements for acceptability will vary depending on the nature of the regulatory decision. For example, the requirements may be lower in the case of a CBA to inform a 'go/no-go' decision relative to a final decision to implement a policy change. The MVP should also be consistent with the level of certainty in the outcomes from the modification, and the availability of information and data which can inform analysis. At this time, we believe that either Option 1 or Option 2 could be the MVP depending on the specifics of the situation. For instance, if sufficiently detailed and relevant case studies exist and can be robustly transposed to the GB market, then the case study option may represent a preferred MVP. If this is not the case, then the high-level CBA may be preferable.

While we have set out a range of options, in practice, there are several variants within each option design that can be tailored to the detailed specification. In practice, it may be possible to combine certain options, or components of one option with another option. For example, a 'high-level' CBA could draw on international case studies to develop assumptions of potential impacts of reform.

The remainder of this section starts with a summary of the options and a comparative analysis. This analysis is supported by detailed descriptions of each option, containing the scope, indicative methodology, analytical challenges, as well as pros and cons. These detailed descriptions make up the remainder of the section.

[7] Such as HM Treasury's Green Book and Ofgem's Impact Assessment Guidance.

3.1. SUMMARY

In Table 4 we summarise and compare the CBA options available. We include an indication of the benefits that should and could be quantified under each option. The exact number of benefits that could be quantified would depend on the specific budget and timing as well as availability of data and assumptions.

Table 4: Summary of CBA options and comparative assessment

Option	Time frame	Benefits *quantitatively* assessed	Assessment
1. High-Level CBA[8]	1-2 months	*Potential for partial quantification for:* wholesale market impacts; balancing market impacts; reduced CO2-e emissions; reduced system cost.	The fastest and lowest budget option in this paper, but this comes at the expense of detail and precision. An important consideration is how this CBA would be received by wider stakeholders, including Ofgem. It could be suitable to inform a 'go/no-go' decision at the start of a change process. An advantage of this option over the case study (option 2) is that the high-level CBA is specific to the modification proposal and the GB context. It can also provide a platform for more detailed quantitative analysis later in the process.
2. Case studies	1.5-3 months	Quantification only possible by transposing analysis of impacts in the context of other markets	The appeal of this option is that it leverages existing analyses, but in doing so it does not directly assess the benefits to the GB electricity industry and GB consumers. It is a relatively low budget option. Like the high-level CBA, it could be suitable to inform a 'go/no-go' decision.
3. Non-Modelled CBA[9]	4-6 months	*Potential for partial quantification for:* wholesale market impacts; balancing market impacts; reduced CO2-e emissions; reduced system cost.	More thorough than the high-level CBA and literature review, and more flexible and targeted than either of the modelling options. It sits in the middle in terms of budget and time frame. Most suitable when the expected benefits are highly uncertain and/or difficult to quantify. Some stakeholders may be deterred by the partial quantification, but this can be improved by a comprehensive and transparent process of analysis.[10]

[8] A high-level CBA approach has precedent within Elexon's previous modification assessments. In practice, the approach may have some parallels with the impact assessment included in the final assessment of modification P344 ('Project TERRE'). In practice, we may expect the 'high-level CBA' to go a little further in developing a robust evidence base from which to construct analysis: https://www.elexon.co.uk/mod-proposal/p344/

[9] CEPA's previous impact assessment of P379 is an example of a non-modelled CBA which combined quantitative and qualitative analysis to develop conclusions regarding merits of the modification: https://www.elexon.co.uk/documents/change/modifications/p351-p400/p379-final-cost-benefit-analysis-report/

[10] This type of analysis would be similar to that conducted for P379.

Option	Time frame	Benefits *quantitatively* assessed	Assessment
4. Market Modelling – Wholesale Impacts	4.5 – 7.5 months	*Quantification of*: wholesale market impacts; reduced *generation* costs; and reduced CO2-e emissions. *Possible partial quantification of*: balancing market impacts	Market modelling would allow for a higher degree and sophistication of quantification but would come at a higher price and with longer timeframes. A key challenge relative to the non-modelled CBA is maintaining balance between the modelling outputs and other parts of the assessment, such as wider implications and unintended consequences. Spurious accuracy is also a concern which can lead to quantification being over-weighted relative to broader analysis. Market modelling is most suitable when there is robust evidence to support key assumptions and the options being analysed are closely linked to the dynamics being modelled. The key assumptions that would be needed for the detailed modelling of each impact are summarised in Table 2. For Option 4, these assumptions include the volume, availability and offer price of additional DSR. If balancing costs were also included in quantitative analysis, assumptions would also be needed in relation to self-balancing volumes and costs with and without implementation of P415.[11]
5. Market Modelling – Wholesale + Network Impacts[12]	6-9 months	*Quantification of*: wholesale market impacts; reduced *system* costs; and reduced CO2-e emissions. *Possible partial quantification of:* balancing market impacts;	This option would be favoured over the option in which only market modelling is conducted where network impacts are central to the research question and/or likely to be material for the outcome of the CBA. Otherwise, the additional budget and time frame of this option would imply that this additional sophistication may be disproportionate to the requirement. Further to the assumptions required for Option 4, this option would require additional assumptions regarding the impacts of DSR on network costs (e.g., in relation to how distribution network companies take DSR into account when planning and developing the network).

[11] We note that additional assumptions would be required to develop the scenarios within the analysis, e.g., including generation build, demand growth, electric vehicle demand, electrification of heating, fuel and carbon prices, interconnector capacity, etc. We would expect service providers to depend on one of several publicly available data sources for development of these scenarios, e.g., National Grid's Future Energy Scenarios.

[12] CEPA and TNEI's quantitative analysis of Ofgem's Access and Forward Looking Charges Significant Code Review provides an example of a modelling framework developed to assess impacts of reform: https://www.ofgem.gov.uk/sites/default/files/2021-06/%283%29%20CEPA-TNEI%20Report%20-%20Quantitative%20Analysis%20of%20Access%20SCR%20Options%20%281%29.pdf

3.2. Option 1: High-Level CBA

Table 5 provides further detail on the 'high-level' CBA option. This is the cheapest and quickest of our options but has a lower level of sophistication than other options presented.

Table 5: Detailed description of Option 1, High-level CBA

Description	An 'order of magnitude' assessment to identify the indicative costs and benefits of the proposal. The CBA would leverage publicly available data and existing studies only to inform simple calculations for each benefit. Cost estimates would be collected directly from Elexon working group members.
Scope	• Partial quantification for: wholesale market impacts; reduced CO2-e emissions; reduced system cost • Costs provided by BSCCo and P415 working group members for system changes only. Excludes consideration of supplier compensation on basis that this is largely a distributional impact.
Methodology	For benefits: • Identify mechanism for each benefit • Identify necessary assumptions for each benefit • Research appropriate sources for assumptions • Test assumptions with P415 working group • Use assumptions to calculate indicative benefits using simple 'excel based' analysis where possible • Where benefits are not quantified through the approach above, a clear mechanism for benefit would be described and a discussion of the potential 'order of magnitude' of the benefit included For costs: • Identify likely categories of system change costs • Request indicative cost estimates from BSCCo and NGESO, and from P415 working group members for other cost impacts, if these are identified • Where necessary, extrapolate individual costs to derive indicate cost for whole industry
Outputs	Concise note, around 20 pages long, which sets out the assumptions and calculation for each benefit and summarises the cost responses.
Estimated project duration	1-2 months
Analytical challenges	• Identifying suitable data sources for benefit assumptions (e.g., amount of additional DSR and impact on wholesale market price, etc) • Finding suitable ways to simplify benefit calculations
Pros	**Cons**
• Relatively simple to undertake • Easy to understand	• Involves high-level assumptions which may seem arbitrary • Outputs subject to wide band of uncertainty • Quantification limited to highest priority costs and benefits
When to choose this option	A high-level CBA is most suitable at a relatively early stage of assessment, when data to inform assumptions is readily available and where the emphasis is on developing a broad assessment of the 'order of magnitude' of benefit rather than sophisticated analysis. This CBA may be more suitable to inform a 'go/no-go' decision at the start of a change process, to decide if further design work or

Description	An ‘order of magnitude’ assessment to identify the indicative costs and benefits of the proposal. The CBA would leverage publicly available data and existing studies only to inform simple calculations for each benefit. Cost estimates would be collected directly from Elexon working group members.
	CBA analysis should be undertaken, as opposed to a final decision on whether to implement the reform. This option may also be more suitable if it is envisaged that Ofgem would carry out a detailed CBA, following the Panel’s recommendation.

3.3. Option 2: Case studies

In Table 6, we provide detail on the option of case studies. This option is still relatively cheap and quick to undertake as it leverages exiting analyses, but it is not a CBA and does not assess the specific benefits of P415.

Table 6: Detailed description of Option 2, Case studies

Description	Case studies of CBAs or other forms of economic appraisal conducted for similar proposals in other jurisdictions.
Scope	• Up to five case studies from other jurisdictions, ***depending on availability*** • Commentary on the applicability of the CBAs to proposed modifications under P415 and to the GB electricity industry • Costs provided by BSCCo and P415 working group members for system changes only. Excludes consideration of supplier compensation on basis that this is largely a distributional impact.
Methodology	• Identify suitable case studies • Review and summarise the case studies in terms of the CBA methodology, scope, costs, and benefits • Review and summarise the market conditions and policy settings of the jurisdictions covered by the case studies • Form view on the extent to which the results of the case study CBAs may be transferrable to the GB electricity industry, i.e., which market conditions and assumptions used in the case studies would or would not apply to GB? For costs: • Identify likely categories of system change costs • Request indicative cost estimates from BSCCo and NGESO, and from P415 working group members for other cost impacts, if these are identified • Where necessary, extrapolate individual costs to derive indicate cost for whole industry
Outputs	A report of approximately 40-50 pages
Estimated project duration	1.5-3 months
Analytical challenges	• Identifying suitable case studies • Finding and interpreting the information necessary to compare jurisdictions • Assessing applicability to GB electricity industry and P415 modifications
Pros	**Cons**
• Leverages existing analyses	• Does not directly assess benefits to GB electricity industry and GB consumers
When to choose this option	A case study review of this nature is most suitable when there are existing reforms/developments in other markets that can be translated into the GB context relatively directly. This could be through established similarities between the markets and/or common regulatory frameworks. Like the 'high-level CBA', a case study approach may be more suitable to inform a 'go/no-go' decision at the start of a change process, as opposed to a final decision on whether to implement the reform.

3.4. Option 3: Non-Modelled CBA

The non-modelled CBA, detailed in Table 7, is an enhancement on Options 1 and 2 in terms of budget, time frame and level of analytical sophistication. This approach can be structured in different ways depending on the number of options and the nature of the decision which is required.

Table 7: Detailed description of Option 3, Non-modelled CBA

Description	Benefits assessed through a mix of qualitative and quantitative analyses chosen depending on the feasibility of quantification. For example, could be developed as 'Multi-criteria analysis' or 'Break-even analysis'. Costs would be collected via an industry request for information.
Scope	• Key benefits (wholesale market impacts; reduced CO2-e emissions; reduced system costs) assessed in terms of order of magnitude (e.g., high/medium/low) and probability • Assessment of full range of costs including system changes and supplier compensation • E.g., 'break-even analysis': Comparison of potential magnitude of benefit to cost estimates to assess whether benefits likely to outweigh costs and under what conditions • Consideration of distributional impacts, risks and unintended consequences
Methodology	For benefits: • Define counterfactual scenario that policy change will be compared against • Identify categories of benefit and the mechanisms by which benefits are expected to occur • Choose analytical approach for each benefit category. Consider quantitative and qualitative analysis that could include stakeholder interviews, stakeholder surveys, consumer research, desktop research, as well as historical analysis and forecasting using electricity market data. • Undertake analysis and categorise benefits in terms of scale (i.e., high/medium/low) and probability • Identify risks and potential unintended consequences • Evaluate distributional impacts for consumers and electricity industry participants For costs: • Identify categories and cost and the mechanisms/processes through which the costs are expected to arise. • Collect costs via an industry request for information • Extrapolate individual costs to derive indicate cost for whole industry
Outputs	• A report of approximately 40-50 pages • Optional: Quantitative spreadsheet incorporating quantified benefits and costs
Estimated project duration	4-6 months
Analytical challenges	• Capturing disparate benefits in a consistent framework • Combining quantified and qualitative analysis into common assessment
Pros	**Cons**
• Flexible to evidence which may emerge through evidence-gathering	• Partial quantification means analysis must be considered with a degree of subjectivity

Description	Benefits assessed through a mix of qualitative and quantitative analyses chosen depending on the feasibility of quantification. For example, could be developed as 'Multi-criteria analysis' or 'Break-even analysis'. Costs would be collected via an industry request for information.

- Bespoke to the specifics of the proposal and its stakeholders
- Ability to combine qualitative and quantitative analyses within a single framework
- Helps to avoid impacts being over-weighted simply because they are easier to quantify
- Acceptance depends on there being a comprehensive and transparent process

When to choose this option	A non-modelled CBA can be a good option when some important benefits are highly uncertain and/or difficult to quantify. These conditions may exist for policy changes involving many subjective factors (e.g., technology uptake rates, consumer preferences, new business models) or changed commercial incentives which can be difficult to model (e.g., balancing market impacts, or consumer losses due to 'gaming'). Within this context, it provides more sophisticated analysis than the 'high-level CBA' or the case study approach and avoids a focus on quantifiable impacts that may introduce a spurious level of accuracy.

3.5. Option 4: Market Modelling of Wholesale Impacts

Market modelling is a common analytical method for gaining insights about energy market changes. The models used for this are typically proprietary to service providers and there is considerable variation in modelling technique and capability.

Generally, market models require inputs covering future demand, generation and interconnector operational parameters, fuel costs, and CO2-e emissions intensities. They can often provide sophisticated estimates of future prices, CO2-e emissions, as well as generator and DSR utilisation to inform how these outputs may be impacted by reform under a given set of inputs and assumptions. Modelling can be carried out under several background scenarios to account for future uncertainty and sensitivities can be employed to test the impacts of key assumptions further.

This presents a specific challenge for modelling the effects of P415, which we identified in Section 2.The modelled benefits will be highly dependent on the volume, price and availability of additional DSR, yet there would be considerable uncertainty around the extent to which P415 delivers additional DSR and a lack of empirical data to inform this assumption. This challenge could be mitigated through the use of several scenarios of DSR deployment following introduction of P415 – e.g., impacts could be modelled under a 'low', 'medium' and 'high' additional DSR scenario.

Depending on the sophistication of the modelling, some impacts may or may not be captured directly. For example, analysis of the benefit of balancing market impacts may require analysis separate to the modelling structure and may require several assumptions regarding the changes in the ability for market participants to self-balance if P415 is introduced. Detailed analysis of network impacts would require a specific network expansion module.

In this section and the next we present two variations of a model-based CBA. The first (Option 4, covered in Table 8) focuses on modelling wholesale market dynamics only, while the second (Option 5, in Table 9) covers both wholesale market dynamics and electricity network expansion. Both involve a higher level of analytical sophistication than the other three options covered in this paper but would be more expensive and take longer to complete. Depending on the level of certainty over expectations of outcomes and the ability to develop a robust set of inputs and assumptions, a modelled CBA can also lead to a spurious level of accuracy and hence, a misleading level of confidence in the outcomes.

Table 8: Detailed description of Option 4, Market modelling of wholesale impacts

Description	Market modelling to capture wholesale market dynamics, such as electricity demand, prices, CO2-e emissions, and generation capacity utilisation over a modelling horizon (e.g., 10 years). Costs collected via an industry request for information.
Scope	• Modelling to quantify the potential benefits from wholesale market impacts, reduced carbon emissions, and reduced costs of generation infrastructure • Balancing market impacts may be quantifiable through a separate assessment (potentially outside of the model) • Excludes benefit of reduced need for future network investment which would require a different model and is covered in Option 5 • Assessment of full range of costs including system changes and supplier compensation
Methodology	For benefits: • Confirm mechanism through which each benefit will be quantified by the model • Identify suitable inputs and assumptions • Set up the model, or models, including 'background scenarios' against which modelling will be run • Run the model

Description	Market modelling to capture wholesale market dynamics, such as electricity demand, prices, CO2-e emissions, and generation capacity utilisation over a modelling horizon (e.g., 10 years). Costs collected via an industry request for information.
	• Interpret the results, including consideration of modelling assumptions and limitations • Assess non-quantified / non-monetised benefits separately and comment on potential magnitude relative to quantified impacts For costs: • Identify categories of cost and the mechanisms/processes through which the costs are expected to arise. • Collect costs via an industry request for information • Extrapolate individual costs to derive indicate cost for whole industry
Outputs	• Assumptions log and modelling methodology paper • Slide deck and presentation of interim results • A report of approximately 50-80 pages
Estimated project duration	4.5-7.5 months
Analytical challenges	• Achieving acceptability of assumptions and inputs, especially volumes and costs for DSR, possibly supported by including several scenarios • Balancing focus on quantified and non-quantified impacts – focusing on market modelling outputs may distract from other parts of the assessment, such as incorporating wider implications and/or unintended consequences

Pros	Cons
• More in line with Green Book and Ofgem Impact Assessment Guidance for final stages of CBA • More tangible results relative to the non-modelled options	• Risk of spurious accuracy in the presence of uncertain inputs or assumptions • Smaller pool of suitable service providers • Does not quantify network effects

When to choose this option	Market modelling can be suitable when there is a robust evidence base for the necessary inputs and assumptions[13]and/or where these can be credibly assessed using a range of scenarios. Ideally the anticipated change should be closely linked to the wholesale market dynamics which are being modelled, such that external factors, such as non-quantified impacts or unintended consequences, are less material. A model excluding network effects can be a good option where market impacts are expected to be the more material. In the case that anticipated impacts on network investment are less material and/or less tangible, the additional cost and time required to model these impacts may be disproportionate to the added value.

[13] The key assumptions are identified for each area of benefit in Table 2. They include the volume, availability and offer price of additional DSR, as well as assumptions around self-balancing with and without implementation of P415.

3.6. Option 5: Market Modelling of Wholesale and Network Impacts

We are not aware of an electricity sector model which incorporates the functionality needed to assess wholesale market impacts, balancing cost impacts *and* network infrastructure investment impacts together. To incorporate modelling of a wider range of benefits, we expect that service providers would need to combine more than one model into a single internally consistent framework. Under this framework, certain benefits (e.g., impacts on the balancing market) may still need to be considered separately. However, such a modelling framework should allow for wholesale market, network and CO2-e impacts to be captured in an internally consistent framework. Relative to Option 4, the development of this framework would increase, time frames and complexity.

Table 9: Detailed description of Option 5, market modelling of wholesale and network impacts

Description	Market modelling to capture wholesale market dynamics AND network expansion. As above, plus network build over a modelling horizon (e.g., 10 years). Costs collected via an industry request for information.
Scope	• Modelling to quantify the potential benefits from wholesale market impacts, reduced carbon emissions, and reduced costs of generation infrastructure and network expansion • The balancing market impacts may be quantifiable through a separate assessment • Assessment of full range of costs including system changes and supplier compensation
Methodology	For benefits: • Confirm mechanism through which each benefit will be quantified by the model • Develop modelling framework (likely combining more than one model) to assess these impacts • Identify suitable inputs and assumptions • Set up the model, or models, including 'background scenarios' against which modelling will be run • Run the model • Interpret the results, including consideration of modelling assumptions and limitations • Assess non-quantified / non-monetised benefits separately and comment on potential magnitude relative to quantified impacts For costs: • Identify categories of cost and the mechanisms/processes through which the costs are expected to arise. • Collect costs via an industry request for information • Extrapolate individual costs to derive indicate cost for whole industry
Outputs	• Assumptions log and modelling methodology paper • Slide deck and presentation of interim results • A report of approximately 50-80 pages
Estimated project duration	6-9 months
Analytical challenges	• Achieving acceptability of assumptions and inputs, especially volumes and costs for DSR • Setting up internally consistent modelling framework which combines multiple models and can capture impacts most effectively

Description	Market modelling to capture wholesale market dynamics AND network expansion. As above, plus network build over a modelling horizon (e.g., 10 years). Costs collected via an industry request for information.
	• Balancing focus on quantified and non-quantified impacts – focusing on modelling outputs may distract from other parts of the assessment, such as incorporating wider implications and/or unintended consequences

Pros	Cons
• More in line with Green Book and Ofgem Impact Assessment Guidance for final stages of CBA • More tangible results relative to the non-modelled options Comprehensive quantitative analysis which captures most/all key benefits	• Risk of spurious accuracy • Even smaller pool of suitable service providers • Additional complexity relative to the wholesale-only option – most service providers would need to combine multiple models, which involves brings higher execution risk • Highest cost and time requirement (which may be disproportionate to the added value)

When to choose this option	Modelling can be suitable when there is a robust evidence base for the necessary assumptions and/or where these can be credibly assessed using a range of scenarios. Ideally the anticipated change should be closely linked to the market and network dynamics which are being modelled, such that external factors, such as non-quantified impacts or unintended consequences, are less material. A model covering network effects may be preferred when network investment impacts are expected to be central to the benefits case.

3.7. DEVELOPING ASSUMPTIONS FOR ADDITIONAL VOLUME AND PRICE OF AGGREGATION

Under Options 4 and 5, a key assumption that will feed into the modelling is the additional amount of aggregation that will enter the market if P415 is approved. Analysis of the additionality of aggregator capacity based on the P415 modification design is not a standard feature of wholesale or network modelling. Instead, this additionality would form an input into the wholesale and network model framework.

We identify two alternative options for developing these assumptions. These represent variations on Options 4 and 5 (i.e. Options 4A, 4B, 5A and 5B):

A. **'Bottom-up' development of inputs/assumptions using bespoke investment model**: Appropriate inputs/assumptions regarding the likely impact of the options on the volume and price of aggregated DSR services could be built up using an investment model which is designed to assess the potential impacts of the options on a stylised aggregator participant. This approach may also depend on industry members being able to provide a suitable evidence base from which to understand how they would respond to P415 and bring additional aggregation capacity to the market.
B. **Scenario based assumptions**: Alternatively, a range of scenarios (e.g. 'low', 'medium' and 'high') could be developed to reflect the potential range of outcomes for DSR based on high-level analysis and intuition. For example, drawing on input from the industry, high-level analysis may indicate an approximate range of additional volume of aggregation that could come to market if P415 was implemented.

3.7.1. Reflecting compensation variants

We understand that the P415 workgroup may identify alternative solutions which they may wish to include in the CBA. In particular, we understand that the workgroup has developed two options for who would be liable to pay supplier compensation, i.e.; costs could be mutualised across all suppliers, or the additional compensation costs may be targeted on independent aggregators. We also understand that there are several potential variants regarding the pricing mechanism for supplier compensation which include using the retail price, the wholesale market spot price or the weighted wholesale market price.

The choice of compensation arrangements may affect the commercial decisions of aggregators. If independent aggregators are liable for the costs of compensation for suppliers, some Workgroup members have indicated that these additional costs could undermine the ability of aggregators to provide additional DSR services competitively. Relative to the alternative in which these compensation costs are mutualised, this could reduce the volume of additional DSR and could increase the price at which additional DSR is provided.

The approach for analysing the impacts of each compensation variant will depend on which option is chosen for developing assumptions regarding additional DSR volumes. Under Option A, two scenarios could be developed which are intended to reflect the differences in aggregator provision under each compensation variant. The assumptions under each compensation variant would be developed based on 'bottom-up' analysis.

Under Option B, the analysis would remain silent on which of the scenarios ('low', 'medium' or 'high') are intended to reflect each of the compensation variants. However, analysis of the three scenarios would allow for an 'ex-post' informed discussion of how outcomes would be impacted by the choice of variant. For example, stakeholders may determine that a socialised compensation mechanism would be more likely to allow for outcomes reflected in the 'medium' to 'high' scenarios while targeting compensation on independent aggregators would only allow for outcomes reflected in the 'low' to 'medium' scenarios.

4. COSTS, DISTRIBUTIONAL EFFECTS AND UNINTENDED CONSEQUENCES

In this section, we discuss the approach that would be taken towards an assessment of costs of implementation of the modification, consideration of distributional impacts and unintended consequences. We also discuss the alternative solution included by Elexon in the specification and how assessment would consider this.

4.1. ASSESSMENT OF COSTS OF IMPLEMENTATION

We expect the cost assessment approach for P415 to be broadly similar across all options. It would involve identifying the relevant categories of cost and the mechanisms or processes through which the costs are likely to arise. This work would expand on the costs already identified by Elexon and could be tested with the P415 working group. This analysis would inform either:

- targeted consultation to gather cost estimates from Elexon, NGESO and workgroup members (assumed under Options 1 and 2), or
- a public request for information (possible under Options 3, 4 and 5, where more time is allowed).

The latter option is more necessary if a range of stakeholder categories are likely to be affected, especially if there are system costs for suppliers which may not be appropriately captured through the narrower assessment. The collection should differentiate between on-going costs and implementation costs which only occur once.

Once collected, the costs should be assessed for reasonableness, based on Elexon's and the service provider's experience from similar change proposals. This assessment could consider the size of costs and the likelihood of the P415 costs being additional to 'business as usual' system development and other regulatory requirements.

A cost assessment methodology would need to consider whether or not the submitted costs capture the full industry impact. If not, a method would need to be developed to extrapolate individual costs and derive an indicative total cost for the whole industry. Once the total industry implementation and on-going costs have been identified, a total net present value for the CBA horizon (e.g., 10 years) could be calculated.

4.2. DISTRIBUTIONAL IMPACTS AND UNINTENDED CONSEQUENCES

The CBA would include an analysis of distributional impacts. This would be used to identify the industry participants or groups of consumers who would benefit from or pay for the policy change. These effects are not reflected in the net outcome of a CBA but can reveal undesirable effects for certain groups, such as inequitable outcomes for certain types of consumers. Such analysis can also identify the presence of wealth transfers between different stakeholder groups. The extent of this analysis would be proportionate to the choice of option. E.g., under the MVP, this assessment may be relatively light touch and qualitative. Options 4 and 5 may include some quantitative analysis on a small number of market participant and consumer 'archetypes'.

4.3. UNINTENDED CONSEQUENCES

P415 would represent complex industry change and may therefore have complex impacts on the market that are broader than the specific costs and benefits that are an intended outcome from the modification. For example, the modification may introduce a risk of perverse incentives or 'gaming' opportunities that lead to counter-productive market outcomes. The CBA should also include an assessment of what these unintended consequences may be, their impact and likelihood. The extent of this analysis would be proportionate to the choice of option. Under the MVP, the assessment of unintended consequences may be relatively light touch and high-level. Under more sophisticated options, the assessment would be more detailed, albeit generally captured quantitatively outside of market modelling.

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