P415 – Impact Assessment

Elexon

22 September 2022

FINAL REPORT

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1. EXECUTIVE SUMMARY

1.1. Context and scope

BSC Modification P415 (P415)[1] was raised in late 2020 and proposes to allow Virtual Lead Parties (VLPs) to trade flexible energy volumes directly in the wholesale market. These flexible energy volumes will be procured from electricity demand customers by VLPs. Deployment of flexibility will not require any involvement from the supplier to the customer who provides the flexibility.

P415 is intended to create benefits to consumers by enhancing flexibility of demand to meet periods of high and low RES output. This additional flexibility could reduce the demand-weighted average annual wholesale market price, flowing through to customers via lower bills. It could also help to reduce carbon emissions, avoid some level of generation capacity otherwise needed to meet demand at peak periods, and reduce curtailment of RES/low-carbon generation in periods when demand is too low for the system to accommodate it.

However, P415 could also introduce new costs and risks. The solution will require new systems and processes to measure VLP flexibility volumes. The modification may also have a range of positive and negative impacts on multiple market participants, and on consumers.

1.2. The proposed solution and compensation variants

The proposed solution introduces the concept of a Deviation Volume. The Deviation Volume represents the difference between forecast consumption (measured using a baselining methodology) and actual consumption, where the difference can be attributed directly to a VLP action taken at the relevant site. This allows the VLP to take responsibility for the Deviation Volume and trade it in the wholesale market.

The proposed solution involves the payment of compensation to affected suppliers to reimburse them for the energy that they no longer supply to a customer when the VLP takes a downwards energy action. The imbalance position of the supplier is also kept unchanged in the event of a Deviation Volume.

The P415 Workgroup has developed two alternative compensation mechanisms for consideration in the impact assessment. These compensation mechanisms each lead to a different set of liabilities for VLPs, consumers and suppliers. They therefore have important differences in terms of the potential extent of costs and benefits and for the market participants on which these costs and benefits fall.

We summarise the compensation variants in Table 1.1.

Table 1.1: Description of Compensation Variants

Variant	Terminology in this report	Who pays compensation?	Price of compensation per unit of energy
Proposer	Compensation 1	The VLP who is taking the action.	An estimate of the cost to the supplier of sourcing the energy[2] (the 'Sourcing Cost').
Alternative	Compensation 2	Compensation payments are recovered from all energy suppliers.	The wholesale day ahead market spot price at the time of the action.

[1] The Elexon modification proposal page is here: https://www.elexon.co.uk/mod-proposal/p415/

[2] Elexon and the Workgroup are continuing to finalise the details of the methodology.

Impacts of compensation variants on incentives to deploy flexibility

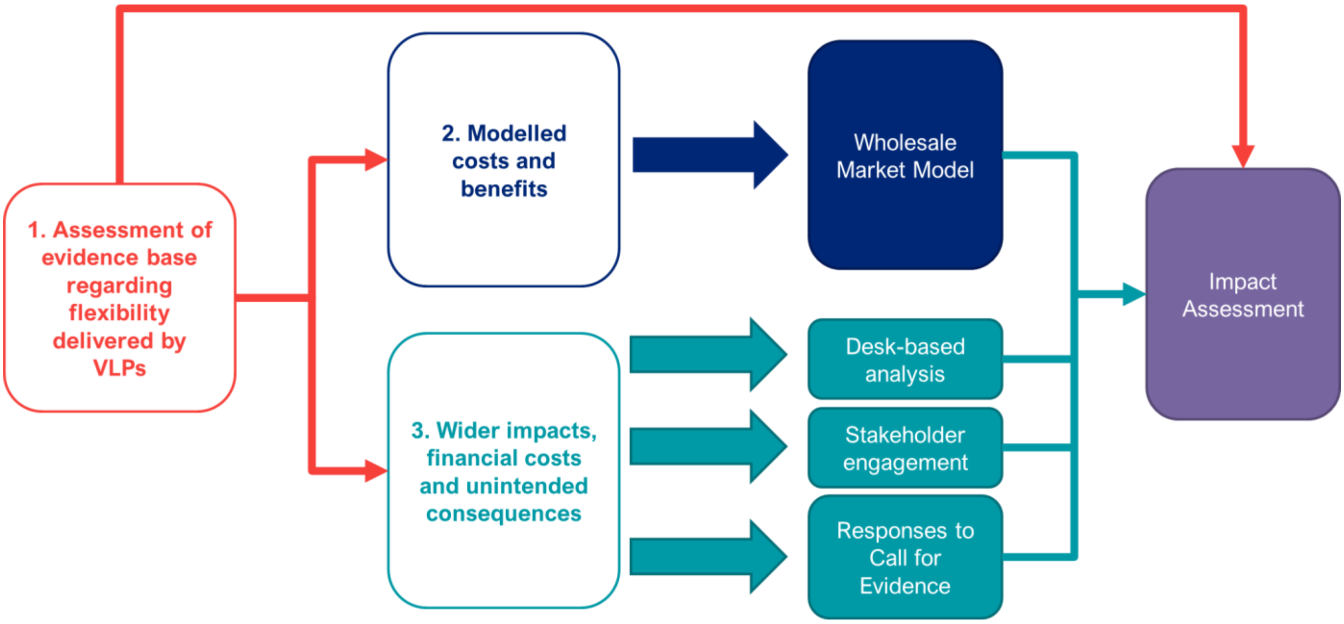
We have assessed the impacts of the compensation variants on incentives of VLPs to deploy flexibility relative to a supplier deploying flexibility from its own customers. We find that:

- Compensation 1 aligns VLP and non-VLP variable costs when deploying peak reduction flexibility. However, Compensation 1 may introduce a variable cost on VLPs that non-VLPs do not face when deploying load shifting flexibility.
- Compensation 2 aligns VLP and non-VLP variable costs when deploying load shifting flexibility. However, Compensation 2 allows VLPs to deploy peak reduction flexibility without internalising the same variable costs as a supplier would if they were taking a peak reduction action themselves.

1.3. Methodology for assessment

Figure 1.1 summarises the three main elements of our overall framework for the impact assessment:

Figure 1.1: Framework for impact assessment



We have undertaken a substantial amount of stakeholder engagement to inform our analysis. This has included:

- **Five sessions with the P415 modification workgroup**: These sessions have been used to discuss our impact assessment methodology, gather views on assumptions and to discuss draft and final analysis.
- **Three meetings with the BSC Panel**: Used to discuss our modelling methodology, interim and final results.
- **Three dedicated sessions with VLPs**: These sessions were used to gather information and data from VLPs, discuss our understanding of the proposed modification methodologies – e.g., in relation to compensation variants, and to inform our assumptions of VLP behaviour in the modelling.

- **Bilateral discussions**: We have engaged directly with more than 10 interested stakeholders to understand their perspectives on the impacts of P415. This has included discussions with VLPs, energy suppliers, the ESO, distribution network companies [3], BEIS and Ofgem.
- **A call for evidence**: We supported Elexon to develop a formal call for evidence to which they received nine responses. These responses have primarily helped to inform our analysis of financial costs of implementation, benefits, risks and unintended consequences.

1.4. Conclusions from assessment of how much flexibility could be deployed

P415 will provide an additional route for specialist flexibility providers to trade demand-side flexibility in the wholesale electricity market without the need to partner with electricity suppliers. This could add incremental opportunities and innovation in the flexibility space, helping to achieve the levels of flexibility envisaged in future decarbonisation scenarios. Additional volumes of flexibility may also be delivered by stimulating suppliers to develop more competitive and innovative flexibility propositions to consumers to allow them to compete with VLPs.

We have observed the contributions that aggregated DSR can make to wider markets from some of our international assessments – e.g., to the PJM capacity market. We consider it possible that implementation of P415 could lead to significant contributions of independent aggregation from VLPs to flexibility and be an important enabler of the transition to net zero.

However, we do not rule out the possibility that P415 could deliver only small volumes of additional flexibility. In the absence of P415, existing routes to market already exist for the provision of flexibility in the wholesale market with evidence of customer propositions being actively developed by suppliers, including partnerships with specialist flexibility providers. Over time, it is possible that residential and small commercial customers may reveal a preference for an integrated energy and flexibility service from suppliers, eliminating a significant growth market for VLP delivered flexibility. Considering international examples, evidence does not yet exist of independent aggregators delivering volumes of flexibility into the wholesale market at the kind of volumes included in our modelled scenarios.

The extent of flexibility delivered by both VLPs and non-VLPs will also depend on wider trends, in particular on future energy system and demand conditions, take up of flexible technologies and behaviour/societal change.

Conclusions from our assessment of the evidence therefore highlights significant uncertainty regarding the extent of flexibility that would emerge under the status quo regardless of P415; and even more uncertainty about the extent to which P415 could contribute further volumes.

We account for this uncertainty in our modelling of the impacts in two ways:

- We place our modelled analysis into the context of three FES scenarios, each of which adopts a different pathway for the electricity system and flexibility.
- We adopt a range of assumptions for the additional volume of flexibility that VLPs could deliver to help understand how this affects the magnitude of potential benefits.

1.5. Benefits and insights from market modelling

Figure 1.2 shows the main results of our modelling, which provides useful insights regarding the total welfare benefits and how benefits and costs may be distributed across market participants.:

[3] We held a short workshop with the Energy Networks Association at which several distribution companies were in attendance.

Total welfare benefits

- Greater volumes of flexibility deliver larger benefits in several ways, so long as this flexibility is deployed efficiently. Our results regarding the benefits of flexibility align with findings from other studies and modelling of flexibility in the future electricity system.
- Our assessment identifies the potential for significant benefits where P415 leads to deployment of significant volumes of additional flexibility. While benefits hold with lower volumes, they are more marginal.
- As opportunities for load shifting grow with technological change, Compensation 2 allows for greater volumes of deployment of flexibility and hence, greater total welfare benefits compared to Compensation 1.

Distributional implications

- However, Compensation 2 introduces a cost burden on energy consumers from socialised compensation costs. In our modelling, this can result in a transfer from those consumers who don't provide flexibility to consumers that do.

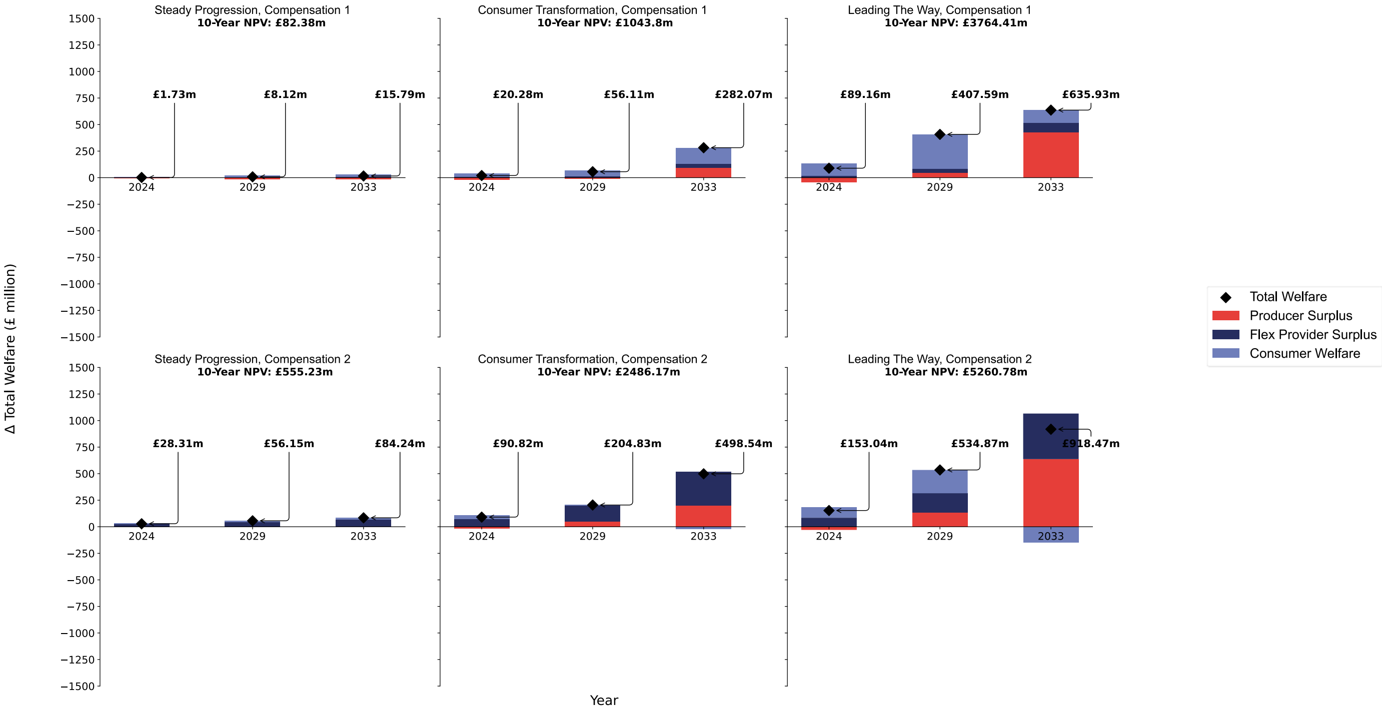
Funding entry of the flexibility capability deployed by VLPs

- Not surprisingly, VLPs earn larger revenues under Compensation 2 than Compensation 1.
- Under Compensation 2, our modelling suggests that VLPs could cover even higher estimates of fixed costs from wholesale market revenues. They would also have more surplus to share with flexibility providers to develop a more attractive customer proposition.
- Under Compensation 1, VLPs would cover lower estimates of fixed costs but may be more dependent on other markets to stack required revenues to cover higher estimates. However, stakeholder engagement and evidence from other markets suggests that revenue stacking across markets is a common business model for flexibility providers.

Value of initial units of flexibility

- Comparison against a 'no flex' sensitivity allows us to test our assumptions of the level of flexibility enabled by VLPs. The initial units of flexibility deployed under our counterfactual deliver substantial levels of benefit.
- This illustrates the sensitivity of our results to assumptions about flex deployment under the counterfactual. To the extent that P415 enables more or less flexibility, we would expect benefits to increase/decrease accordingly.

Figure 1.2: Breakdown of total welfare



1.6. POTENTIAL FOR WIDER BENEFITS

We also considered a range of non-modelled benefits suggested by stakeholders. Table 6.1 presents a summary of our assessment of non-modelled benefits.

Table 1.2: Summary of assessment of non-modelled benefits

Benefit	Considerations	Impact level
Spillover impacts on balancing market	Flexibility providers will seek to stack revenue and opportunities from the wholesale market which could lead to greater levels of flexibility overall. We would expect at least some of this flexibility to enhance competitiveness of the balancing market.	Medium
Spillover impacts on CM and system services	While spillover benefits may also be present in the CM, the extent of benefit will be dependent on whether flexibility provision from VLPs is likely to represent the marginal price setting unit in the CM. System services have stricter requirements than the wholesale market. There may be less natural crossover with the nature of flexibility deployed in the wholesale market.	Low-medium
Security of supply and resilience	In our modelling, we observe the potential for flexibility to reduce the reliance on fossil-fuel generation at times of system peak. This should help to avoid stress on the system during such periods though the magnitude of this impact may be relatively limited and unreliable, at least in initial years.	Low-medium
Wider benefits	There are several wider benefits suggested by stakeholders that are likely to have small/negligible impact in isolation but when taken together may introduce some additional benefit.	Low-medium
Local network benefits	The ENA stressed the localised nature of flexibility markets in comparison to the ability of VLPs to aggregate volumes of flexibility over large areas for participation in the wholesale market. At least in the near term, they suggest that this may reduce the scope for spillover effects in relation to local network benefits.	Low

1.7. Costs of P415

To enable greater volumes of flexibility VLPs will need to invest in flexible capability. This will require incurring upfront fixed costs to develop the customer proposition, systems and processes. Fixed costs may vary significantly depending on whether the VLP needs to install any enabling technology to allow for flexibility provision from the customer. Likewise, ongoing fixed costs will depend to a large extent on whether the VLP is responsible for any ongoing operation and maintenance costs of enabling technology.

Costs will also need to be incurred to implement the P415 solution. The solution will require new approaches to measure VLP flexibility volumes and ensure appropriate settlement for the suppliers of participating customers. This will require the BSCCo to develop new IT systems and processes and may require other market participants to incur costs to allow for the envisaged data and monetary flows. Our assessment of implementation costs is based on information provided to us by market participants. This suggests non-negligible costs, but which are outweighed by estimated welfare benefits so long as P415 results in deployment of a reasonable additional level of flexibility.

1.8. Risks and unintended consequences

P415 may also introduce a range of risks and unintended consequences for multiple market participants. To provide flexibility to VLPs, customers will need to enter into new forms of contractual relationships and engage in a new type of market activity. Given this, we have considered the potential for consumer detriment and impacts on effective competition.

Consumer detriment

While some risks of consumer detriment may exist, we believe that the materiality is relatively low due to the context of the relationship between the VLP and the customer. In particular:

- **A VLP is not responsible for delivering a critical service** as VLPs do not take responsibility for energy supply but only for energy deviation volumes, i.e., flexibility.
- **An energy customer does not need to enter into an agreement with a VLP**: All energy consumers in GB must have an agreement with a supplier to receive energy. The same is not true for VLPs as customers can enter and exit from such agreements depending on the value they receive from them.
- **Suppliers are able to compete directly with VLPs to offer customer flexibility propositions**
- **In general, the flow of payments will be from VLPs to customers rather than the other way round**: As a result, VLPs are unlikely to build up the same level of credit balances and customer debt risk as a supplier.

Impacts on suppliers

The design of the P415 solution protects the supplier from some of the impacts of the downwards energy action. Under the solution, the action should not affect their imbalance position and the supplier receives compensation for the volume of energy they cannot sell.

However, suppliers are more likely to face challenges where the downwards action results in a different level of demand from the customer in a different period – i.e., a load shifting flexibility action. In this case, the supplier may be exposed to demand forecasting and hedging risk from the VLP activity. To some extent, demand side flexibility is likely to create new challenges of a similar nature regardless of P415. While P415 may exacerbate these challenges, the need for increasing sophistication of demand forecasting and hedging in the presence of growing volumes of flexibility may exist anyway. Improvements and learning regarding demand forecasting and hedging in the presence of larger flexibility volumes may provide some mitigation against such impacts.

Gaming risk

We identify a potential gaming risk under the Compensation 2 mechanism. In this case, we consider it possible that a supplier could benefit from becoming a VLP to make use of flexibility from its own customers. Under such an arrangement, the supplier could benefit twice – once from trading flexibility in the wholesale market as a VLP and a second time from the receipt of compensation as a supplier. Under Compensation 2, the compensation received by the supplier would be socialised across the rest of the market. It is not clear to us whether a mechanism exists to prevent such an arrangement.

Baselining challenges

P376[4] defines the baselining methodology that is used to measure Deviation Volumes under P415. The P376 approach appears to be better designed for large, industrial customers with relatively consistent, predictable demand profiles.

Indeed, P376 notes that *'…not all sites will be suitable to use a Baselining Methodology; some sites may not follow any normal behaviour patterns or may be too variable for a Baselining Methodology to provide a useful estimate.'*

As dynamic loads like EVs and heat pumps allow residential and small commercial customers to become an increasingly important source of flexibility, the accuracy of the baselining methodology for such sources of flexibility may become an increasingly important driver of costs and benefits. Inaccurate baselines could lead to sub-optimal investment in flexibility and deployment of flexibility and introduce gaming risk from 'beating the baseline' without deployment of actual flexibility.

Assuming symmetric risk of baseline inaccuracy, we expect that VLPs would value accuracy of the baseline and may seek to develop baselining methodologies that can be applied more effectively for residential and small commercial customers. However, there could be an asymmetric incentive for VLPs to seek to correct baseline

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

inaccuracies that work against them while being less proactive about correcting baselining methodologies that may work in their favour.

Baselining methodologies for smaller customers with more dynamic and less predictable loads are by nature likely to be challenging. Without an appropriate baselining methodology which can reflect the particular characteristics of demand profiles and flexibility characteristics of smaller residential and commercial customers, we identify some potentially significant risks of baselining inaccuracies and possible gaming opportunities relating to the baseline for such customers.

2. SCOPE AND CONTEXT

2.1. Purpose of this report

BSC Modification P415 (P415)[5] was raised in late 2020 and proposes to allow flexible energy volumes to be sold by Virtual Lead Parties (VLPs) directly in the wholesale market with no involvement from suppliers. This is designed to enhance the flexibility of demand to help the electricity system better manage variations over time in the level of RES/low-carbon generation.

The purpose of this report is to provide information to the BSC Panel, P415 Proposer and P415 Workgroup on the potential benefits and costs of the implementation of the P415 solutions. It is also intended to support Ofgem's decision on whether to approve one of the P415 solutions for implementation, if and when the modification is submitted to Ofgem for decision.

The impact assessment is informed by both qualitative and quantitative assessment that explores the potential for P415 to increase the level of demand-side flexibility in the electricity system; thereby reducing the costs of decarbonisation. We also explore the potential downsides of P415, including the costs of implementation and associated risks and unintended consequences. Two compensation variants have been proposed under P415. The impact assessment also explores the differences between these variants to evaluate how the costs and benefits are impacted by each design.

2.2. The role of flexibility in the energy transition

Flexibility can lower the costs of energy system decarbonisation. For example, a 2021 analysis by Carbon Trust and Imperial College estimated potential savings of £10-17 billion per annum across the GB economy from making effective use of flexible energy resources[6].

The Government's own modelling of the benefits delivered by flexibility for its Smart Systems and Flexibility Plan[7] identified the potential for system costs to be reduced by up to £10 billion per year with higher levels of flexibility on the system.

Flexibility will take several forms, including interconnection, storage and possibly hydrogen power plant. However, demand side response may also play an important role. For example, the take-up of technologies such as electric vehicles and heat pumps will provide a new untapped source of flexibility from residential and commercial customers who until now have had relatively fixed demand profiles.

National Grid Electricity System Operator's (NGESO's) Future Energy Scenarios include four scenarios for the development of the energy system. Three of these scenarios achieve or exceed the Government's Net Zero objectives. A common theme across these three scenarios is the need to deploy significant amounts of flexibility, including from DSR[8], in order to accommodate high volumes of non-dispatchable RES generation.

In its response to the call for evidence we issued as part of this project, NGESO stated that a range of initiatives, regulatory and policy developments will be needed to achieve the levels of flexibility envisaged in the FES.

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[5] The Elexon modification proposal page is here: https://www.elexon.co.uk/mod-proposal/p415/

[6] See: https://www.carbontrust.com/resources/flexibility-in-great-britain

[7] See: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1003778/smart-systems-and-flexibility-plan-2021.pdf

[8] We use DSR and 'demand side flexibility' interchangeably in this report.

2.3. Summary of the P415 solution

A draft summary of the P415 solution is available on Elexon's website[9] and is not reproduced in full here.

Key to the solution is a new type of Settlement volume named a Deviation Volume. The Deviation Volume represents the difference between forecast consumption and actual consumption where the difference can be attributed directly to a VLP action taken at the relevant site. This allows the VLP to take the responsibility for the Deviation Volume and sell it into the wholesale market.

P415 makes use of two other modifications (P375[10] and P376[11]) to support accuracy in determining settlement of VLP actions.

To measure the forecast consumption/generation at a particular site, a baselining methodology is required to estimate what the consumption/generation volume would have been had the VLP not taken an action. P376 defines the baselining methodology that is used for such purposes.

P375 allows for the flexibility deployed by VLPs at a particular asset to be measured using metering behind the site Boundary Point. P375 was designed with P376 in mind such that settlement can make use of the baselining methodology to set Physical Notifications for such assets.

Compensation variants

Where the VLP takes an action, the supplier of the relevant customer has their imbalance position corrected to account for that action so that supplier's imbalance position remains as it was before any VLP action. However, where VLPs take downwards energy actions, suppliers also face a reduction in the volume of energy that they sell to their customers in that period. The P415 Workgroup determined that suppliers require compensation where the VLP takes a downwards energy action as they may have purchased energy to cover a unit of demand that no longer exists due to the VLP action[12].

The Workgroup developed two variants for this compensation mechanism as summarised in Table 2.1.

Table 2.1: Description of Compensation Variants

Variant	Terminology in this report	Who pays compensation?	Price of compensation per unit of energy
Proposer	Compensation 1	The VLP who is taking the action.	An estimate of the cost to the supplier of sourcing the energy[13] (the 'Sourcing Cost').
Alternative	Compensation 2	Compensation payments are recovered from all energy suppliers.	The wholesale day ahead market spot price at the time of the action.

[9] See: https://www.elexon.co.uk/documents/change/modifications/p401-p450/p415-draft-solution-summary/

[10] See: https://www.elexon.co.uk/mod-proposal/p375/

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

[12] The inverse would be true for upwards energy actions taken by the VLP. Here, the supplier would sell a volume of energy to the customer while the supplier would not be exposed to such volumes through imbalance. Under such arrangements, the Workgroup determined that compensation should flow from the supplier to the VLP as the supplier can sell power for which they do not take imbalance responsibility.

[13] Elexon and the Workgroup are continuing to finalise the details of the methodology.

2.4. Structure of this Report

We structure the remainder of this report as follows:

- In **Section 3** we set out our methodology for the impact assessment – covering our qualitative and quantitative assessment of impacts.
- In **Section 4** we discuss the evidence base regarding the potential contribution of VLPs to the level of demand-side flexibility capability in the wholesale market if P415 is approved and implemented.
- In **Section 5** we summarise the findings from our wholesale market modelling, particularly in relation to the assessment of benefits in different scenarios for the increase in flexibility capability resulting from the implementation of P415.
- In **Section 6** we appraise the potential for wider benefits that are not captured in our wholesale market modelling.
- In **Section 7** we draw on stakeholder responses to assess the financial costs of the implementation of P415.
- In **Section 8** we consider the potential for risks and unintended consequences.

We include three appendices:

- In **Appendix A** we provide further detail on our modelling methodology.
- In **Appendix B** we provide detailed analysis of the market dynamics when VLPs deploy flexibility.
- In **Appendix C** we provide a breakdown of the changes in overall welfare under our 'no flex' sensitivity.

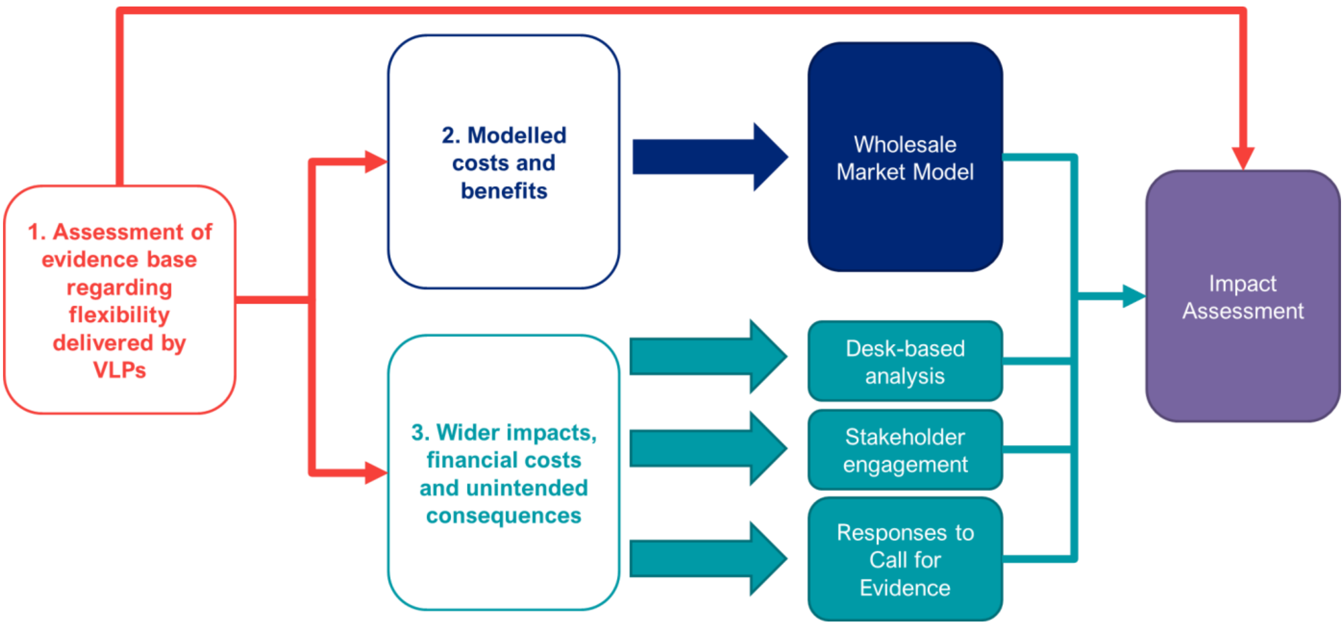
3. METHODOLOGY

3.1. Elements of our assessment

Figure 3.1 summarises our overall framework for the impact assessment which includes three overarching elements:

- **Assessment of evidence base for the flexibility that could delivered by VLPs**: We have assessed several sources of evidence that provide insight into the potential volumes of additional flexible capability that may be delivered by VLPs if P415 is implemented. We explore the enablers and barriers for the evolution of flexibility in the GB market over the next decade and consider how flexibility is likely to evolve under the counterfactual (i.e., if P415 is not implemented). We also assess international examples of participation of independent aggregation in energy markets. Our analysis informs our understanding of the extent of flexibility provision which could be stimulated by the implementation of P415.
- **Modelling of key costs and benefits:** We use CEPA's energy market model to estimate the key impacts of P415 on consumers, flexibility providers and producers. We manage uncertainty by carrying out modelling under three 'Cases', taking into account different potential future electricity systems and varying levels of flexibility deployment from VLPs. We also model a sensitivity in which we compare results against a hypothetical scenario in which no flexibility is deployed. The modelling provides qualitative insights as well as quantitative outcomes.
- **Analysis of wider, non-modelled impacts, financial costs of implementation, risks and unintended consequences:** Several potential benefits were suggested by stakeholders that are not captured in our market modelling. We assess these separately, drawing on stakeholder input and our own analysis. We also assess the financial costs of implementation of P415 and the potential and risks for consumer detriment resulting from unintended consequences.

Figure 3.1: Framework for impact assessment



3.2. Stakeholder engagement to inform our analysis

We have undertaken a substantial amount of stakeholder engagement to inform our analysis. This has included:

- **Five sessions with the P415 modification workgroup**: These sessions have been used to discuss our impact assessment methodology, gather views on assumptions and to discuss draft and final analysis.

- **Three meetings with the BSC Panel**: Used to discuss our modelling methodology, interim and final results.
- **Three dedicated sessions with VLPs**: These sessions were used to gather information and data from VLPs, discuss our understanding of the proposed modification methodologies – e.g., in relation to compensation variants, and to inform our assumptions of VLP behaviour in the modelling.
- **Bilateral discussions**: We have engaged directly with more than 10 interested stakeholders to understand their perspectives on the impacts of P415. This has included discussions with VLPs, energy suppliers, the ESO, distribution network companies[14], BEIS and Ofgem.
- **Call for evidence**: We supported Elexon to develop a formal call for evidence to which they received nine responses. These responses have primarily helped to inform our analysis of financial costs of implementation, benefits, risks and unintended consequences.

3.3. Assessment of evidence base regarding flexibility delivered by VLPs

We base our assessment of the potential volumes of flexibility that could be deployed by VLPs on several sources of evidence:

- **Future development of demand-side flexibility in the GB electricity system**: We consider published scenarios and pathways set out in publicly available documents[15], noting the factors which are likely to influence the deployment of flexibility most heavily.
- **Supplier delivered flexibility, particularly under the counterfactual in which P415 is not implemented:** An electricity supplier currently provides the main route for its customer to provide demand-side flexibility for trading in the wholesale market. We consider activities of suppliers in relation to flexibility and what this suggests for the deployment of flexibility under the counterfactual. This is important because P415 is only likely to deliver benefits if it leads to additional flexibility being deployed, beyond that which would have been delivered anyway.
- **Views of stakeholders**: We draw on our engagement with a range of stakeholders to consider their views on the contribution of P415 to flexibility deployment. Our stakeholder engagement included eight workshops, multiple bilateral meetings with interested stakeholders and a call for evidence[16].
- **International examples of the independent aggregation of demand-side flexibility**: We reviewed evidence on the participation of independent aggregators in energy markets in three international examples:
    - the Pennsylvania, New Jersey and Maryland (PJM) market;
    - the French energy market; and
    - the Australian National Energy Market.

3.4. Modelled costs and benefits

We used CEPA's proprietary wholesale market model to perform our assessment of the key impacts of P415 that were possible to model. We summarise the approach taken below and provide further detail in Appendix A.

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[14] We held a short workshop with the Energy Networks Association at which several distribution companies were in attendance.

[15] Including the FES, the Smart Systems and Flexibility Plan and Flexibility in Great Britain published by The Carbon Trust.

[16] Responses to the Call for Evidence are published on the Elexon P415 website.

3.4.1. Modelling framework

Our model is 'deterministic' and simulates day-ahead market prices for the GB wholesale market. For this assessment, we set up our wholesale market model as follows:

- **A single GB market with no zonal configuration**[17]: Our modelling used a national representation of the wholesale market. Given the existing national representation of the wholesale market, our modelling was not intended to capture any impacts on network reinforcement or constraint management which were considered to be second order.
- **Endogenous dispatch, demand and price formation**: In Section A.1 we set out the generation and demand technologies that we included in the model. Dispatch of each generation type, demand and the use of flexibility vary in response to the day-ahead market (DAM) electricity price which is itself determined by the interaction of supply and demand curves[18]. This endogeneity allowed us to consider the impacts of the P415 variants on dispatch and wholesale market prices in comparison to the counterfactual. The exception is where there is good reason to assume that dispatch and/or demand profiles are generally independent of prices (e.g., for non-dispatchable renewable generation, nuclear generators and inflexible demand). For these technologies and customers, we model fixed dispatch profiles but allow for these generators to be curtailed where total system dispatch exceeds demand.
- **Hourly granularity with sample 'spot years'**: Our model includes hourly resolution of the wholesale market with modelling of dispatch, demand and DAM prices across 8760 hours in each calendar year (24 hours a day for 365 days of the year). We modelled the wholesale market in three spot years over the ten-year horizon of the impact assessment – 2024, 2029 and 2033. We interpolated the results between these years to allow for assessment of the costs and benefits over the full period.

3.4.2. Assessment period and spot years

Elexon specified a time horizon for the impact assessment of 10 years. We agree that this represents a sensible appraisal period as there may be several market designs, technological and societal changes beyond this period that introduce an additional level of uncertainty as to the costs and benefits of P415.

When P415 was raised, the requested Implementation Date was 'as soon as possible'. However, at the time Elexon had not assessed both the central and industry implementation timescales and interactions with other industry changes. Due to large volumes of industry change and the complexities associated with P415, we understand from discussions with Elexon that P415 is unlikely to be implemented before 2024. We therefore modelled 2024 as the initial spot year with 2033 as the final year of the assessment (to allow for a ten-year period). To inform the interpolation between these two years, we modelled an interim spot year of 2029.

Within a window of 2-3 years, we would expect the insight from our analysis to hold irrespective of the implementation date. Beyond this, it is possible that some of the assumptions regarding deployment of flexibility under the counterfactual may begin to be overtaken by feedback from the market, e.g., in relation to policy or technological developments which provide better information about the evolution of demand side response. In the case that our analysis is used to inform future development of this modification or others related to it beyond the

[17] Under its Review of Electricity Market Arrangements (REMA), BEIS is considering whether the fundamental structure of the wholesale electricity market should be reformed to support the transition of the system. This includes consideration of the bidding zone formulation and whether the wholesale market should become zonal or nodal rather than the existing national model. Reform of this nature would have fundamental impacts on the electricity market and on the value delivered by flexibility. Our analysis and modelling have been developed in the context of the existing market structures with consideration of fundamental reform out of scope.

[18] Our wholesale market model takes as an input gas, carbon and hydrogen prices. Gas and carbon prices are taken directly from the FES 2021. Hydrogen prices are calculated based on our own analysis of BEIS Hydrogen Production Costs 2021. We take the costs of Steam Methane Reformation with CCUS and update them for FES 2021 assumptions for CO_2 and gas prices.

suggested 2-3 year timeframe, we would advise consideration of the assumptions underpinning our analysis to help inform any future decision making.

3.4.3. Welfare assessment

To fully consider the impacts of P415 on various market participants, we separate our welfare assessment into three groups:

- Energy consumers
- VLPs, non-VLPs and providers of flexibility
- Producers

Energy consumer welfare

This group captures costs and benefits falling on all energy consumers in relation to their consumption of electricity, i.e., not taking into account any additional costs or benefits falling on those consumers that provide flexibility. We assume that the supply market is competitive such that suppliers fully pass on any change in costs or revenues to their customers.

Table 3.1 summarises the cost and benefit components that are allocated to energy consumers in our welfare assessment.

Table 3.1: Consumer welfare impacts

#	Component	Description
1	Wholesale market price	The impact the change in the spot price in each period on total wholesale market costs faced by consumers.
2	Carbon emissions	Any reduction in carbon emissions from avoided dispatch of fossil fuel generation.
3	Spare generation capacity	Flexibility may allow for avoided use of generation capacity, allowing for savings from ongoing fixed costs.
4	CfD top-up payments	Any impact on the top up payments needed to make CfD payments at the strike price when CfD supported generators are dispatched – i.e., not during periods where they are curtailed; or during negative price periods for CfD supported generation post TR4.
5	Avoided curtailment	Any impacts on balancing market payments due to the need for, and costs of, curtailment. We assume that any additional balancing market costs are passed through to consumers.
6	Compensation cost (Compensation 2 only)	We assume that suppliers will pass on the costs of compensation that they need to pay under the Compensation 2 mechanism when VLPs deploy flexibility. Compensation costs under Compensation 1 are captured in the VLP's variable costs of deploying flexibility.
7	Supplier compensation surplus (Compensation 2 only)	Under Compensation 2, suppliers are compensated at the prevailing wholesale market spot price where the VLP makes use of their customers' load. After covering the costs falling on the supplier, we estimate that this is likely to result in a surplus above such costs (see Section 4.5). We assume that suppliers pass on this surplus to their own customers.

Flexibility provider surplus

To deliver flexibility, both non-VLPs and VLPs will need to contract with flexibility providers. They will need to share the benefits derived from providing flexibility into the wholesale market to obtain these services.

Under our assumption of a competitive market, VLPs and non-VLPs would need to recover fixed costs and earn a reasonable return on investment. Beyond this, we assume that any change to costs and benefits would be passed onto the customer who provides the flexibility. We explore the revenues of VLPs and how these may compare against estimates of fixed costs in Section 5.7.

Table 3.2 summarises the costs and benefits falling on flexibility providers.

Table 3.2: Flexibility provider impacts

#	Component	Description
1	Non-VLP revenues shared with flexibility providers	The revenues accruing to non-VLPs from utilising flexibility of their own customers. After recovering fixed costs and a reasonable return on investment, we assume that revenues are paid to customers who provide the flexibility. Non-VLPs may also need to pay customers to activate this flexibility as a variable cost. Where the supplier deploys their own customers' flexibility, demand of the customer is reduced. The supplier therefore foregoes the opportunity to sell the unit of energy to the customer, without receiving the compensation that it would do had a VLP activated the reduction in demand under P415.
2	VLP revenues shared with flexibility providers	The revenues accruing to VLPs from utilising flexibility of the customer of a supplier. After recovering fixed costs and a reasonable return on investment, we assume that revenues are paid to customers who provide the flexibility. VLPs may also need to pay customers to activate this flexibility as a variable cost. Under Compensation 1, the VLP would also need to pay compensation to the supplier of the customer whose flexibility they have used.

Producer surplus

Table 3.3 lists the types of producer who will be affected by the outcomes of P415.

Note that CfD-supported generators who continue to receive the strike price where they dispatch in periods of negative prices will remain net neutral under P415 relative to the counterfactual in our modelling. Where they continue to dispatch, they will receive top up payments to the strike price regardless of the market price. Where they are curtailed, we assume they bid into the BM such that they continue to receive the strike price.

Table 3.3: Producer impacts under P415

#	Component	Description
1	Producers exposed to the wholesale market	Revenues captured by generators who are exposed to the wholesale market price.
2	CfD supported producers	In our modelling, only generators who do not receive the CfD in negative price periods (TR4 onwards) will be affected. All other CfD supported generators will either be paid or the strike price, or when curtailed will be paid the equivalent in the BM.
3	Interconnectors	Revenues captured by interconnectors based on arbitrage between markets – we only assign half of the value to GB interconnector ownership.
4	Producer-retailer contracting factor	We assume that retailers have contracted forward to cover the demand of their customers before flexibility is deployed which changes their demand position. However, in our market model, any reduction in demand is met by a fall in generation dispatch, therefore reducing producer surplus. Elsewhere in our welfare analysis, we have already taken account of the cost to suppliers of contracting forward for energy that is then not supplied. To avoid double counting of the impact of a reduction in demand, we introduce a 'producer-retail contracting factor' which reflects the forward contracting position. This reflects the assumption that producers still receive their contracted position when flexibility is deployed.

3.5. Wider impacts, financial costs and unintended consequences

Wholesale market modelling is not able to capture the full range of impacts that have been proposed as possible costs and benefits of P415.

3.5.1. Non-modelled benefits

There are several benefits that have been put forward by stakeholders that cannot be included in a market modelling assessment:

- **positive externalities** of additional DSR availability for balancing market participation, CM prices (where additional to capex benefits of capacity reduction) and wider system services;
- **local network benefits**, e.g., for localized flexibility markets and/or deferred reinforcement**;**
- **security of supply** and resilience from diversification of the market;
- benefits related to **consumer engagement and satisfaction;**
- providing **choice** and **competitive pressures** for customers looking to provide flexibility in the wholesale market;
- additional source of DSR which can support **distributed energy and renewables integration**;
- additional source of DSR which can support **electrification** of heat and transport; and
- benefits in the **supply chain** for demand side response services and products.

Our assessment of the potential magnitude of these benefits is informed by our stakeholder engagement, responses to our call for evidence and our own analysis.

3.5.2. Financial costs of implementation

Delivery of the systems and processes needed for implementation of P415 will require resource and time investment from BSCCo, and from several other market participants. We draw on responses to our call for evidence in our assessment of the potential costs of implementation.

3.5.3. Risks of consumer detriment and other unintended consequences

P415 would be a material change to market arrangements and would establish a new form of relationship between VLPs and energy consumers when they act as flexibility providers. It is therefore important to consider the potential for any detriment to consumers, whether financial, related to engagement and understanding of the market or through implications for retail market and flexibility market competition.

Our assessment of these issues is informed by stakeholder engagement, responses to the call for evidence and our own analysis.

4. EVIDENCE BASE: FLEXIBILITY AND INDEPENDENT AGGREGATION IN THE WHOLESALE MARKET

The potential for P415 to provide benefits depends on the extent to which it can deliver additional volumes of flexibility that would not have existed without its implementation. It aims to achieve this by providing a new route to market for flexibility providers, and more choice for customers who can provide flexibility into the wholesale market.

In this section we consider the evidence base that exists regarding the deployment of flexibility by independent aggregators to help us consider the potential magnitude of additional flexibility volumes that P415 may deliver.

The compensation variant will also impact on the extent of deployment of flexibility if P415 is implemented. In this section, we also consider the competitive dynamics between VLPs and suppliers under P415 and how these differ between the two compensation variants.

4.1. FUTURE DEVELOPMENT OF FLEXIBILITY IN GREAT BRITAIN

A key challenge in assessing the impact of P415 is that past and present experiences of overall demand-side flexibility provision within the GB electricity system are unlikely to represent strong predictors of the future. The volumes of DSR which exist within scenarios such as the FES and the Smart Systems and Flexibility Plan far exceed the levels currently of flexibility currently deployed. New sources of flexibility will be driven by a mixture of the following factors:

- **Social change**: Customers may become more used to 'energy as a service', caring less about when and how they consume energy and more about the services that energy provision allows for. This may facilitate flexibility providers to access customers' flexible loads in return for payment.
- **Regulatory and policy change**: Ongoing regulatory change such as Market Wide Half-Hourly Settlement (MWHHS) will support the value proposition of flexibility. Stakeholders have also told us that several wider changes to regulation and policy are required if the levels of flexibility envisaged in future scenarios are to be achieved.
- **Technological change**: Electrification of heat and transport coupled with automation technologies will introduce large, controllable sources of energy demand into homes and businesses. While there is some potential for flexibility which does not depend on technological change and which may be delivered today, take-up of new technology, particularly by residential and small commercial customers are likely to be a key driver of the step-change in flexibility that is envisaged under energy decarbonisation scenarios.

The evolution of these trends will affect the volumes of deployed flexibility, whether or not P415 is implemented. There is therefore significant uncertainty regarding how flexibility develops in general, as well as the success of P415 in delivering additional volumes.

4.2. DSR UNDER THE COUNTERFACTUAL

Many of the existing electricity suppliers publicise examples of developing customer value propositions that would allow them to access emerging flexibility opportunities. A selection of these examples is listed below.

- Octopus Energy[19] offers several flexibility offerings into the market including:
    - Agile Octopus – which passes through Day Ahead prices to customers.
    - Octopus Go – a traditional two-tier tariff.

[19] https://octopus.energy/

- Intelligent Octopus – allowing scheduling against day ahead, intraday, balancing mechanism and capacity markets.

- Ovo Energy[20] has partnered with Kaluza[21], a flexibility platform which incorporates Kaluza Flex[22], designed to intelligently charge smart home devices.
- Shell has acquired Limejump[23], a technology platform provider that aims to maximise revenue streams from decentralised asset owners.
- Ecotricity has partnered with Next Kraftwerke[24], providing access to a software platform that allows it to regulate and balance demand across the country in real time.

Some of these initiatives are already bringing flexibility to the market. For example, Octopus suggests that Octopus Go is already shifting around 350 MW of EV charging out of the evening peak to overnight periods. Projecting forward, they would expect multiple GW to be participating in wholesale markets by 2034.

As the importance and potential of flexibility services develop over time, we would expect this market activity to turn into increasing volumes of flexibility capacity. Some of this flexible capacity is likely to participate in the wholesale market directly through the supplier.

4.3. Views of stakeholders

We used a formal call for evidence, bilateral meetings, and workgroup discussions to gather views of stakeholders regarding the additional flexibility that could be delivered by the implementation of P415. Views differed substantially between stakeholders.

Two existing suppliers believed that P415 would add little additional flexibility. They referenced several blockers to the deployment of flexibility which they considered to be significantly more important than facilitating direct VLP access. They drew attention to the initiatives set out in the previous section, including partnerships between suppliers and dedicated flexibility providers, as evidence of the development of flexibility without P415.

A further two suppliers identified potential for P415 to deliver additional volumes of flexibility but urged caution in ensuring that the appropriate regulations were put in place to ensure a level playing field between different types of flexibility providers and to protect consumers. We consider these issues in Section 8.

VLPs considered P415 to be essential to unlock the full potential of flexibility in the wholesale market. They expected direct potential of new and innovative customer propositions to emerge from specialist flexibility businesses. In addition, they stated that (potential) entry by VLPs would significantly increase competitive pressures on suppliers to provide better and more innovative flexible procurement offerings to their own customers. VLPs emphasised that suppliers had not delivered significant volumes of flexibility from DSR in the past, despite their ability to do so. They suggested this as evidence that suppliers would not deliver the potential from DSR without competitive pressure from VLPs.

NGESO also believed that P415 could unlock additional volumes of flexibility in the market and identified potential benefits from enhanced competition. While they did not comment specifically on the potential volumes of flexibility that P415 could contribute, they welcomed the potential benefit delivered by VLPs as an additional tool to manage the transition to a net zero emission energy system. NGESO also noted that the FES acknowledge the importance

[20] https://www.ovoenergy.com/

[21] https://www.kaluza.com/the-kaluza-platform/

[22] https://www.kaluza.com/demand-response/

[23] https://www.limejump.com/knowledge-hub/limejump-acquired-by-shell/

[24] https://www.ecotricity.co.uk/our-news/2018/ecotricity-and-next-kraftwerke-partner-to-create-a-greener-grid#:~:text=Britain's%20greenest%20energy%20company%20has,the%20country%20%2D%20in%20real%20time.

of market mechanisms to incentivise and enable the magnitude of DSR that is required to manage a high-RES system.

4.4. International Case studies

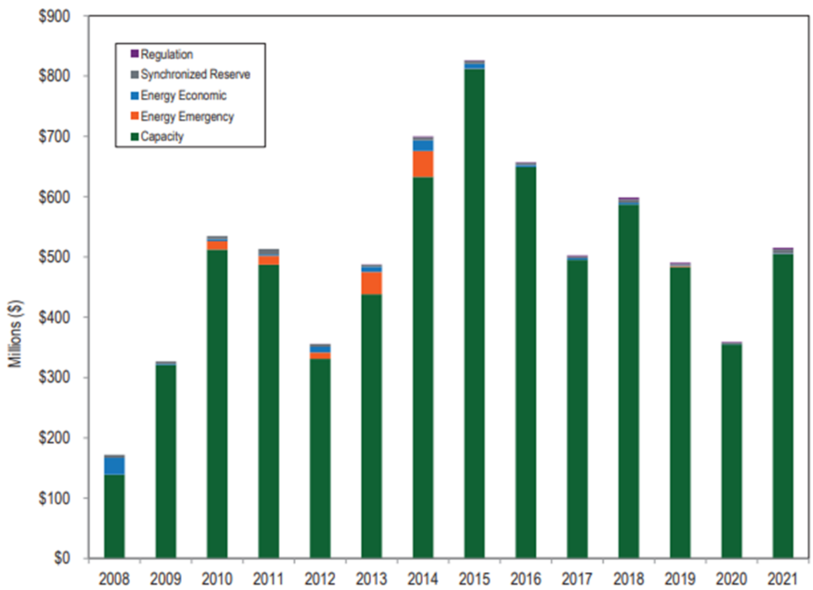
To inform our consideration of the potential for P415 to deliver volumes of flexibility, we explored a small number of international examples of DSR deployment by independent aggregators. We have applied caution in drawing direct conclusions from these examples given the specific contextual factors existing within each. As with the emergence of flexibility in GB, we also believe that the future of flexibility in each of these examples is likely to be somewhat different from the present as the customer proposition develops.

4.4.1. The Pennsylvania, New Jersey and Maryland market (PJM)

The PJM is often cited as a success story for DSR. Indeed, we understand that PJM has largest registered capacity of DSR in any electricity market. As of 2017, 9.8 GW of DSR capacity was registered in the PJM[25]. All markets in the PJM are open to DSR and allow for aggregator participation (known as 'Curtailment Service Providers' (CSPs)). There are several regulatory arrangements designed to encourage participation from the demand side based and allow it to compete with supply on a technology neutral basis. The PJM also has relatively high penetration of smart meters.

Despite the energy market being open to DSR since at least 2007, the vast majority of DSR participation and revenue comes from the capacity market (See Figure 4.1). High, stable and transparent revenues from the capacity market have meant that this represents the primary revenue stream for most DSR providers who may be able to support a business case based on capacity market revenues alone. In contrast, low prices and price volatility in the wholesale market may have limited DSR participation in those markets.

Figure 4.1: Demand response revenue by market (PJM)

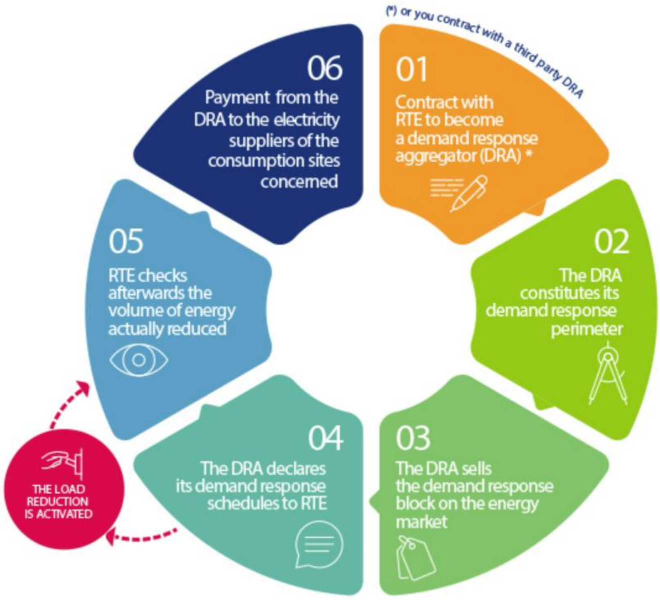


[25] See: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/657142/DSR_research_Country_case_studies_report.pdf

4.4.2. France

France opened up the wholesale market to independent aggregator participation in 2014. The Block Exchange of Demand Response ('NEBEF') mechanism[26] allows all consumption sites in mainland France to provide demand response and to be remunerated in the wholesale market (either over-the-counter or via day-ahead and intraday power exchanges). Sites above 100 kW can participate directly by becoming an aggregator themselves while sites below 100 kW have to participate through a third- party aggregator with all aggregators requiring a contract with the transmission operator (RTE).

Figure 4.2: Process for participation in the NEBEF mechanism



Source: RTE

The NEBEF includes a mechanism to compensate suppliers for the volumes of energy they can no longer sell following the downwards energy action. Compensation is targeted at the VLP responsible for then energy actions, similar to Compensation 1 under P415 (see Table 2.1).

Deployment of DSR in the NEBEF mechanism

RTE publishes data on the deployment of DSR under the NEBEF mechanism. At the time of writing, there were 12 registered DSR operators in the NEBEF mechanism[27].

Between 2016 and 2020, realised and declared volumes were less than 40 GWh over the course of the year. However, partly driven by the increase in the global gas price, RTE data[28] suggests that volumes of DSR have been increasing since then. Around 59 GWh was deployed in 2021 and almost 172 GWh was deployed in the first 5 months of 2022 (i.e., by the end of May)[29].

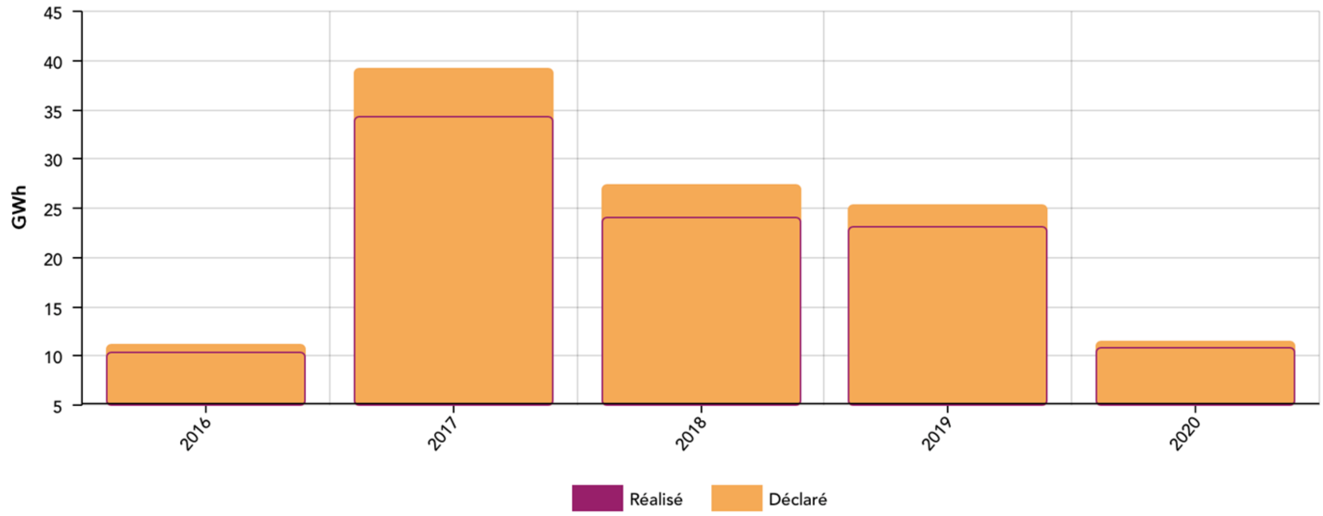
[26] See: https://www.services-rte.com/en/learn-more-about-our-services/participate-nebef-mechanism#:~:text=All%20consumption%20sites%20connected%20in,this%20without%20the%20agreement%20of

[27] Data available on RTE website. User login required: https://www.services-rte.com/en/view-data-published-by-rte/nebef-mechanism-demand-response.html

[28] See: https://www.services-rte.com/en/download-data-published-by-rte.html?category=market&type=demand_response&subType=volumes

[29] Note that seasonality in DSR deployment is likely to mean higher volumes are deployed in winter than in summer.

Figure 4.3: Volumes of DSR deployed in France through the NEBEF mechanism (Déclaré = Declared, Réalisé = Delivered)



4.4.3. Australia

Wholesale market participation

In October 2021, the Australian Energy Market Commission (AEMC) introduced a market rule change to allow industrial and commercial customers to sell demand side response into the wholesale market, either directly or through specialist aggregators[30].

The rule change has been in place for less than a year and stakeholders have mentioned other policy developments that they believe are needed to complement the rule change and facilitate more independent aggregation. Therefore, the conclusions that can be drawn from the evidence are limited.

As of March 2022, a single participant had registered a total of 58 MW of capacity. Around 16 MW of capacity had been dispatched for approximately two – four hours at a time.

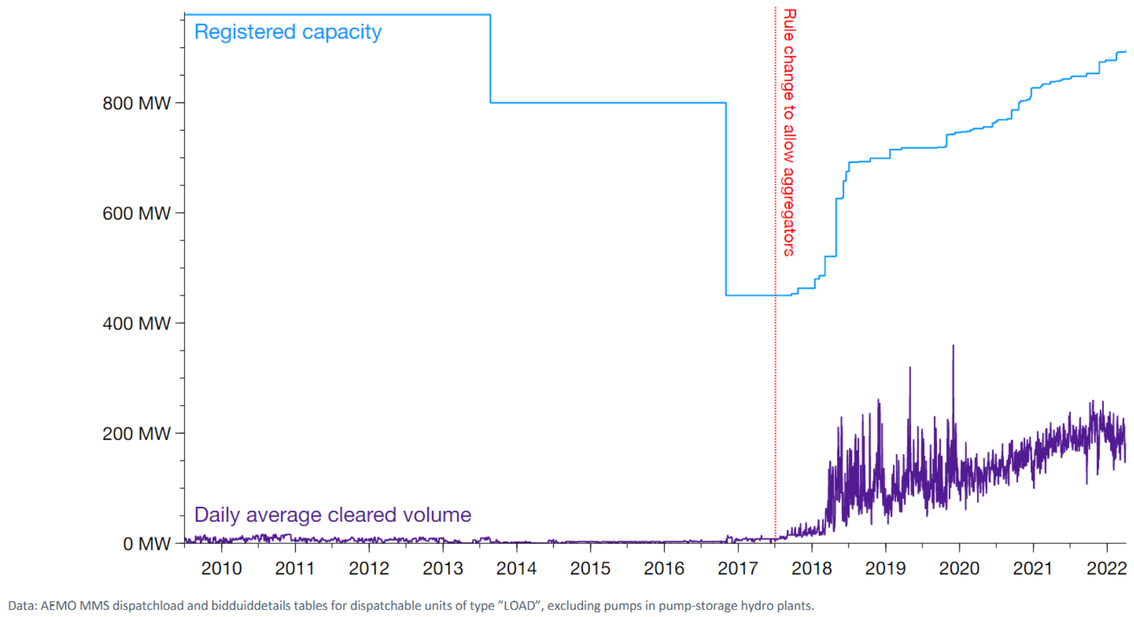
Frequency control ancillary services (FCAS) market

A similar rule change allowed aggregators to start participating in Australia's FCAS market in 2017. The rule change was made in response to reductions in capacity participating in the FCAS as thermal generation exited from the market. Combined with attractive prices in the market, this provided a potential source of additional revenue for aggregated DSR.

From the date of the rule change, aggregated DSR started to participate in the market, growing in volume and replacing a proportion of the lost capacity from thermal generation (Figure 4.4).

[30] See: https://www.aemc.gov.au/rule-changes/wholesale-demand-response-mechanism

Figure 4.4: Participation of demand side response in the Australian FCAS market



Source: Courtesy of Enel X

When drawing conclusions from this example we consider it important to take into account the very different nature of the FCAS market to the wholesale market. Frequency response requires providers to demonstrate specific technical capabilities in very short timescales requiring advanced metrology and thus limiting the number of potential providers. In addition, the size of the FCAS market is orders of magnitude smaller than the wholesale market – which means that cleared volumes of aggregator participation in FCAS are also much smaller than the flexibility included within the FES pathways.

4.5. VLP AND NON-VLP COMPETITION

Below, we consider the nature of competition between VLPs and non-VLPs and how this differs depending on whether flexibility provided takes the form of peak reduction or load shifting. We consider how the variable costs of deploying flexibility compare between VLPs and non-VLPs when they are deploying flexibility. We also assess the position of a supplier where a VLP deploys flexibility from one of its customers.

In practice, the exact dynamics will be complex and dependent on several contextual factors. Our analysis is necessarily simplified and reflects our approach to modelling of these forms of flexibility. We apply several assumptions:

- Suppliers contract forward for energy with generators and with consumers.
- The Sourcing Cost, as defined by the P415 workgroup, represents a good proxy for the 'cost of energy' included in a consumer's retail bill.
- Where the demand of a supplier is reduced as a result of a downwards flexibility action by a VLP, the supplier would have their imbalance position corrected under P415 such that they do not face any resulting imbalance.

- Where a supplier faces an increase in demand from one of their customers as a result of load shifting, we assume they can estimate this demand increase perfectly and purchase the additional volumes from the spot market[31].
- While the P415 solution allows for VLPs to take upwards flexibility actions, the workgroup do not expect this to account for a significant volume of VLP actions, at least in initial years. For this reason, we assume that where load shifting results in an increase in demand in a given period, the supplier takes responsibility for meeting that additional unit of demand.

Below, we provide a summary of the findings regarding market dynamics under peak reduction and load shifting. We set out the analysis which leads to these conclusions in full in Appendix B.

Peak reduction

When a supplier acts as a non-VLP and deploys its own flexibility, we find that it is able to benefit by the arbitrage between the prevailing spot price and the sourcing cost that it would be paid by the customer.

In the case of peak reduction, we find that the internalised variable cost of deploying flexibility is equivalent between VLPs and non-VLPs under Compensation 1. Both VLPs and non-VLPs internalise the Sourcing Cost when deploying peak reduction flexibility.

As compensation under Compensation 2 is socialised, VLPs do not internalise any variable cost of compensation when deploying peak reduction. Non-VLPs therefore internalise a variable cost into their deployment of flexibility that VLPs would not face.

Under Compensation 1, when a VLP deploys flexibility, the compensation payment at Sourcing Cost remunerates the supplier for the lost potential to sell a unit of energy to its customer. The imbalance position of the supplier is corrected under the P415 solution such that the supplier is made whole for energy volumes[32] . It does not make any profit or loss from the foregone opportunity to sell the unit of energy.

Under Compensation 2, when a VLP deploys flexibility, the supplier receives a compensation payment at the spot price. After taking into account the lost opportunity for the supplier to sell a unit of energy, we find that the supplier's position is the same as if it had deployed the flexibility itself – i.e., it benefits by the arbitrage between the prevailing spot price and the Sourcing Cost. This implies that both the VLP and the supplier of the customer who has flexibility deployed both benefit from the VLP's deployment of flexibility.

Load shifting

In the case of load shifting, we find that the internalised variable cost of deploying flexibility is higher for VLPs than for non-VLPs under Compensation 1. While the VLP internalises the Sourcing Cost included in the compensation payment, a non-VLP who is deploying its own load shifting flexibility may expect to sell an additional unit in a future/earlier period, thus balancing the loss of potential to sell a unit of energy in the initial period.

As compensation under Compensation 2 is socialised, VLPs face equivalent variable costs as we estimate that a supplier would face for the costs of energy sold when deploying load shifting flexibility. Non-VLPs therefore internalise a variable cost into their deployment of flexibility that VLPs would not face.

Where load shifting takes place, we assume that a VLP takes responsibility for the downwards flexibility action, but not for the additional unit of demand in a later/earlier period. In the case of the downwards energy action, the imbalance position of the supplier would be corrected so they would not face any change to their position.

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[31] We consider implications if the supplier is not able to estimate the upwards demand shift perfectly and so are left with an imbalance position in Section 8.

[32] We note that there may be several wider costs for the supplier resulting from the VLPs deployment of flexibility – e.g., hedging and demand forecasting costs. We explore these potential costs in Section 8, and they are not included here.

However, in the period of increased demand, a supplier would be liable for purchasing the additional unit of energy from the spot market or would need to take a short imbalance position. In either case, we assume they would face the prevailing spot price in the period of the increased demand.

Under the assumption that the load would be shifted to a period in which spot prices are likely to be low, we find that the net position to the supplier is likely to be positive under either compensation variant. The supplier faces an additional cost of the spot price in the period of increased demand but sells a unit of energy in that period. It also receives compensation from VLPs for the downwards adjustment, either at the Sourcing Cost or at the spot price in the period of the downward energy action (when the market price is likely to be relatively high).

Under Compensation 1, we calculate the benefit to the supplier at the difference between the Sourcing Cost and the spot price in the period of increased demand. We would expect this to be lower than the benefit to suppliers under Compensation 2 which we estimate to be the arbitrage value between the spot price at the time of the downward energy action (in which we assume the spot price is generally higher than the Sourcing Cost) and the spot price at the time of increased demand (in which we assume the spot price is generally lower than the Sourcing Cost).

5. MODELLING OF KEY BENEFITS

In this section, we summarise the outcomes from our modelling. Before doing so we provide some guidance on how to interpret these outcomes and discuss how we have managed two key sources of uncertainty in our modelling framework.

5.1. Interpretation of modelled impacts

An important conclusion from our assessment of the evidence available on flexibility deployed by independent aggregators is that there is a significant level of uncertainty regarding the extent of flexibility that P415 may deliver relative to the counterfactual. Layered on top of this is uncertainty regarding how the system will evolve in future.

This uncertainty has implications for the interpretation of the modelled costs and benefits. As with any modelling, outcomes will be influenced by the assumptions which are included. Revising assumptions regarding the extent of additional flexibility delivered by VLPs and/or the set of system scenarios used for analysis will inevitably produce a different set of estimates.

When interpreting the modelled outcomes in the remainder of this section, we encourage the reader to focus on the insight from the modelling rather than the precise outcomes. We expect the insight to hold under a much broader set of assumptions, even if the precise numerical estimates would change.

5.1.1. Scenarios and Cases

Before presenting our findings, we discuss how we have managed two key sources of uncertainty in our modelling framework.

These two key sources of uncertainty are:

- Future energy system and demand conditions, including generation deployment, technology take-up and demand outlook.
- Contribution of P415 to the deployment of flexible capability relative to the counterfactual.

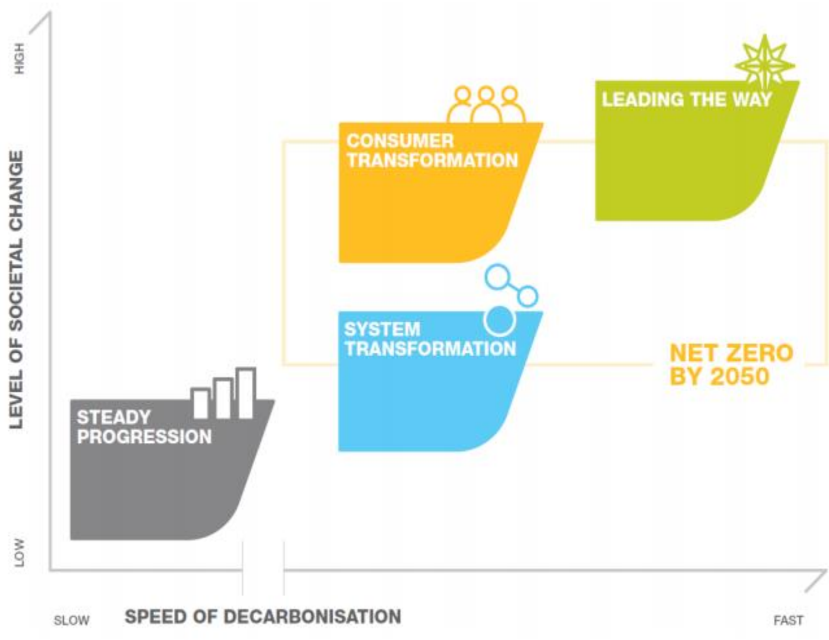
Energy system and demand conditions

To accommodate the first source of uncertainty, we have used National Grid's Future Energy Scenarios, 2021 (FES)[33][34]. The FES are well-established, publicly available scenarios developed with the help of intensive stakeholder engagement. The scenarios differ in two dimensions: the speed of decarbonisation of energy sources, and the level of societal change. The speed of decarbonisation will affect the value of flexibility in the modelling; while the level of societal change generally reflects the level of decentralisation and the extent of flexibility which consumers have the capacity to deliver.

[33] https://www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2021

[34] The FES 2022 is now available. However, our model development began too early to incorporate these new scenarios. The fundamental structure of the scenarios remains similar but with the 'Steady Progression' scenario now re-labelled to 'Falling Short'. The FES 2022 is available here: https://www.nationalgrideso.com/document/263951/download

Figure 5.1: FES 2021 scenarios



Source: National Grid

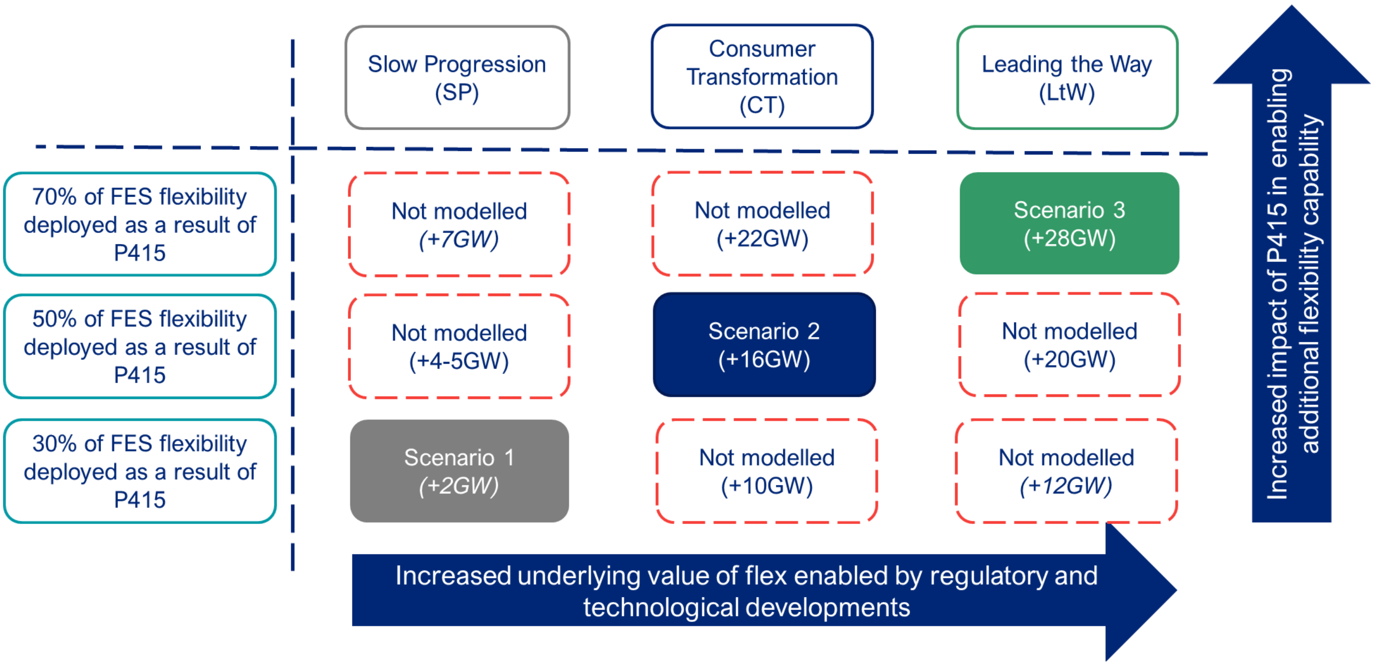
To reflect a sufficient range of potential future systems, we have modelled P415 against three FES scenarios: 'Steady Progression' (SP), 'Consumer Transformation' (CT) and 'Leading the Way' (LtW).

'Steady Progression' represents the slowest decarbonisation scenario modelled by National Grid. 'Consumer Transformation' provides a high electrification, decentralised scenario in which 2050 decarbonisation objectives are met with a high level of societal change. 'Leading the Way' represents the fastest possible decarbonisation scenario, going beyond achievement of the Net Zero targets.

Modelled Cases

The combination of three FES scenarios and three conditions for VLP flexibility contributions lead to nine possible modelled 'Cases'. We selected three of these Cases for our modelling, designed to reflect a range of possible outcomes. We illustrate the three modelled Cases in Figure 5.2 – the numbers in brackets reflect the peak flexibility contributions enabled by VLPs under the respective Case in 2033.

Figure 5.2: Modelled Cases



As a new category of market participant, there is some uncertainty regarding the extent to which flexibility would be deployed by VLPs or non-VLPs if P415 is implemented. As well as developing assumptions for the total additional level of flexibility deployed as a result of P415, we separate deployment between VLPs and non-VLPs. In doing so we have taken several factors into account:

- Energy suppliers can become VLPs. By doing so, they will be able to access flexibility from customers other than their own. For this reason, those suppliers who are active in deploying flexibility could become a VLP themselves to benefit from such opportunities. This would imply a lower level of non-VLP flexibility capability after the implementation of P415.
- Some of the flexibility accessed by VLPs may have already come to the market in any case under the counterfactual. I.e., a customer who provides flexibility to a VLP under P415 may have provided flexibility through their own supplier if P415 was not implemented. This suggests that a proportion of the flexibility deployed by VLPs may be 'cannibalising' flexibility which already exists. This would imply a lower level of non-VLP flexibility capability after the implementation of P415.
- P415 may stimulate non-VLPs to enhance their flexibility customer propositions in the presence of new competition for their customers' flexibility. This would imply a higher level of non-VLP flexibility capability after the implementation of P415.

Given the opportunities available to suppliers from becoming VLPs, we expect that many suppliers who are active in deploying flexibility would become VLPs if P415 was introduced. In response to our Call for Evidence, even some suppliers who were opposed to P415 were planning/considering becoming a VLP. Considering the balance of potential outcomes, we developed the assumptions included in Table 5.1.

Table 5.1: Deployment of flexibility capability in each scenario

Scenario	Modelling run	Non-VLP percentage of FES flex capability	VLP percentage of FES flex capability	Total deployed FES flex capability
Steady Progression	*Counterfactual*	*70%*	*0%*	*70%*
	P415	**50%**	**50%**	**100%**
Consumer Transformation	*Counterfactual*	*50%*	*0%*	*50%*
	P415	**25%**	**75%**	**100%**
Leading the Way	*Counterfactual*	*30%*	*0%*	*30%*
	P415	**20%**	**80%**	**100%**

'No flex' sensitivity

The extent of flexibility that will be deployed under the counterfactual is a key uncertainty within our impact assessment. It will be particularly important if flexibility deployment demonstrates decreasing marginal benefits because the first units of flexibility help to eliminate the highest price spikes and periods of very low/negative prices.

To test the value delivered by the first units of flexibility, we modelled a condition in which no flexibility is deployed – i.e., where demand profiles are fully fixed and without the implementation of P415. We do not expect this to represent a realistic outcome whether or not P415 is implemented. However, it allows us to comment on the extent to which P415 may add more or less value than we have modelled if the extent of flexibility delivered under the counterfactual is lower than included in our modelled Cases.

5.2. Total welfare

We summarise the overall total welfare results under each scenario and compensation variant in Figure 5.3.

We observe positive total welfare benefits in all years of all scenarios and under both Compensation 1 and Compensation 2. Total welfare benefits are generally larger where more flexibility is deployed. This leads to greater benefits under scenarios with high take up of flexible technologies, and where we assume greater deployment of flexibility capability by VLPs as a result of P415.

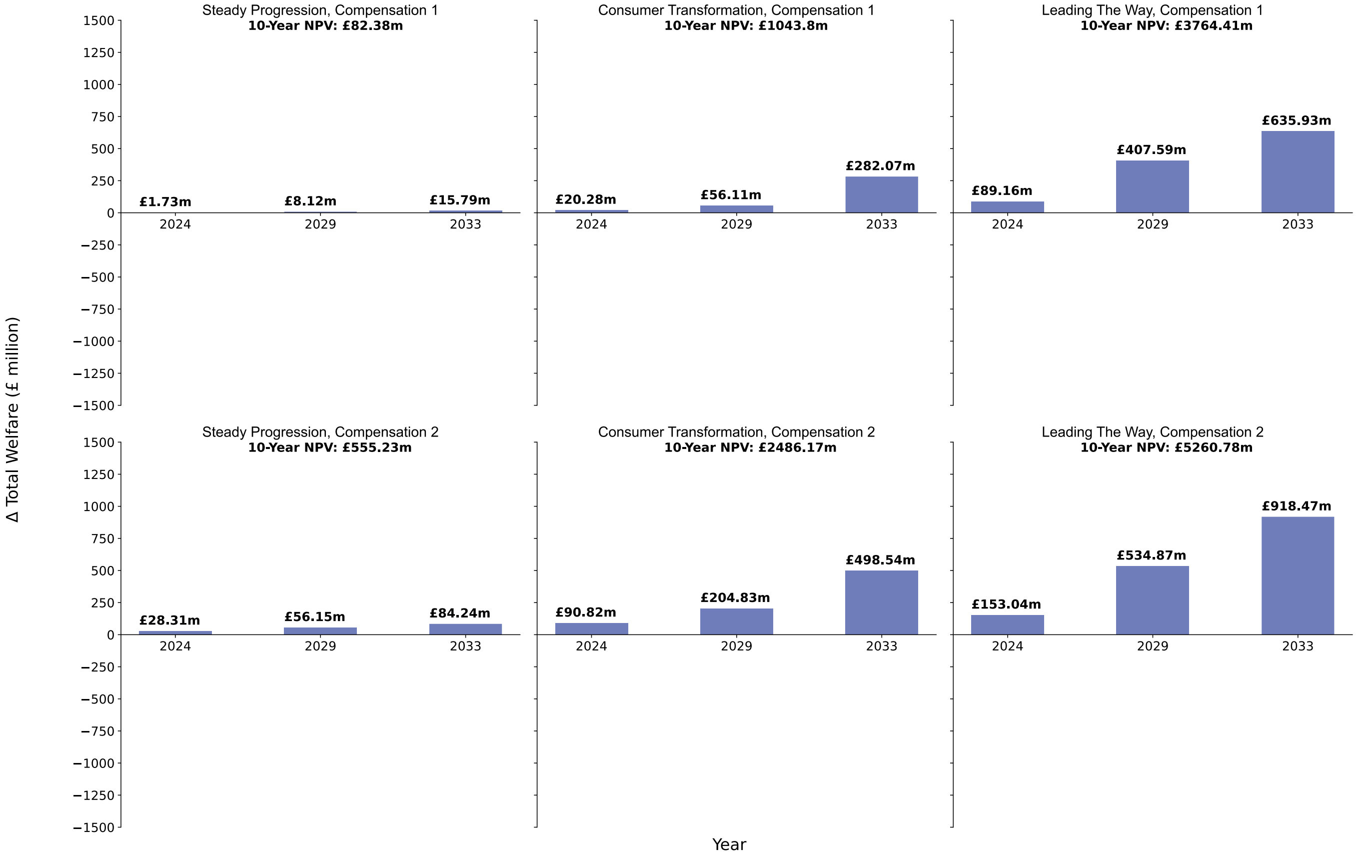
This also leads to greater total welfare benefits under Compensation 2 across all scenarios. Available flexible capability is used more extensively by VLPs under Compensation 2 given the lower variable costs that exist for deployment of flexibility by VLPs.

In the remainder of this section, we break down these total welfare impacts to appraise the impacts on energy consumers, flexibility providers and producers, developing important insight into the effects of P415 compensation variants as we do so.

It is important to note that a proportion of the welfare benefits accruing to flexibility providers would be passed through to consumers who provide flexibility to VLPs and non-VLPs. When considering consumer welfare, both the 'energy consumer' and 'flexibility provider' categories need to be considered. We separate these welfare impacts for two reasons:

- Not all consumers will have the technology and capability to provide flexibility services. Therefore, the set of consumers who make up the 'flexibility provider' category will only represent a proportion of the total energy consumer population. Separating welfare impacts into each group helps to identify distributional impacts of P415 compensation variants across consumers.
- Some of the welfare benefits accruing to flexibility providers will be used to recover the fixed costs of VLPs and non-VLPs and to allow for a return on investment. While we consider the fixed costs of VLPs in Section 5.7, these costs are uncertain and context specific. Therefore, the extent of flexibility provider welfare which will be passed through to consumers is less certain than 'energy consumer' welfare which is considered separately.

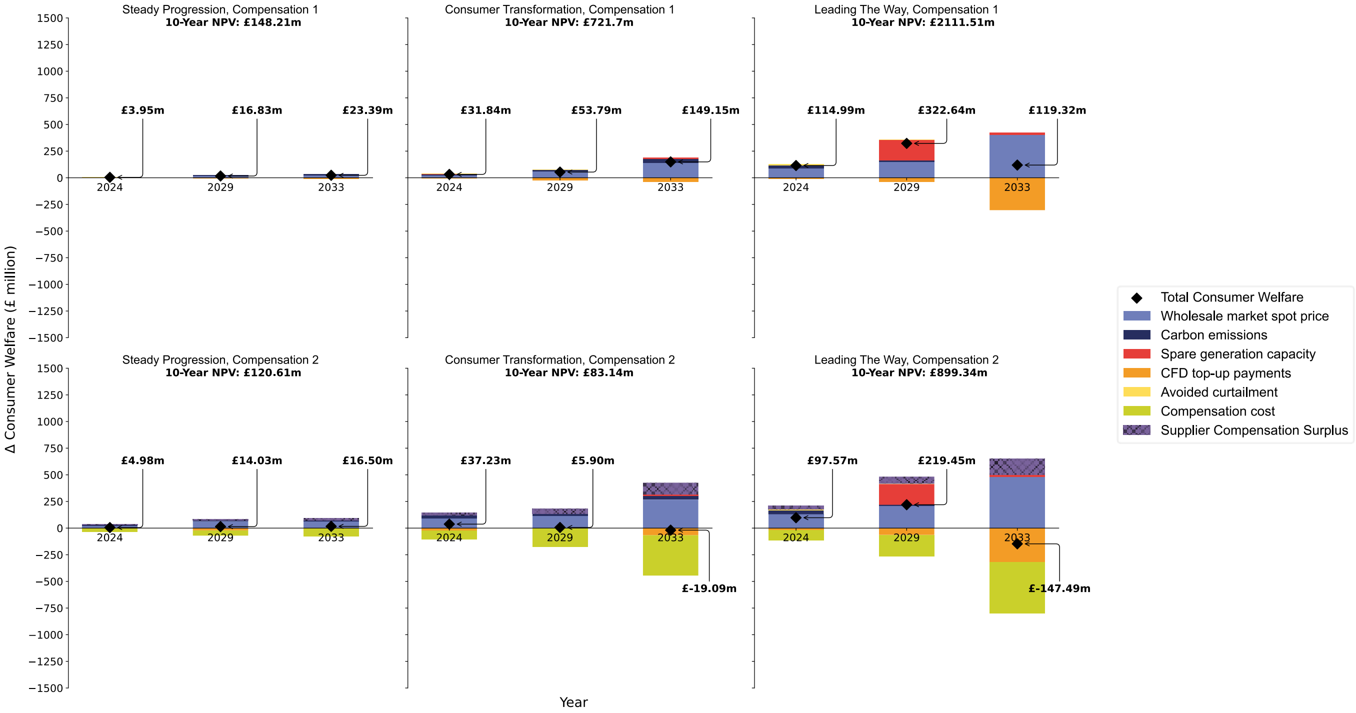
Figure 5.3: Total welfare



5.3. Consumer welfare

We summarised the components of consumer welfare in Section 3.4.3 and present findings from our modelling in Figure 5.4.

Figure 5.4: Consumer Welfare impacts



We summarise the range of impacts affecting energy consumers in Table 5.2.

Table 5.2: Breakdown of consumer welfare impacts

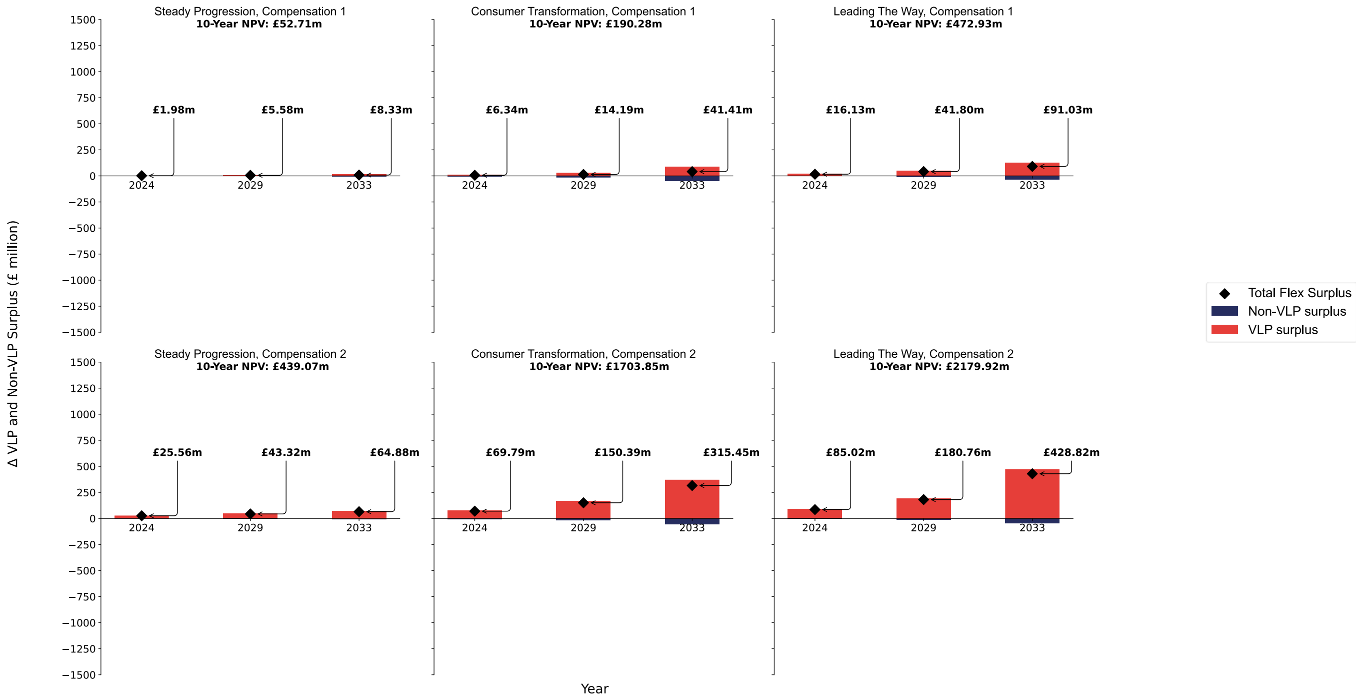
#	Component	Impact
1	Wholesale market price	Additional flexibility deployment following P415 reduces the demand-weighted wholesale market spot price under all scenarios, years and compensation variants. We assume that these reductions are passed through to consumers through lower bills. Reductions in the spot price become more pronounced over time as flexibility deployed by VLPs increases. Reductions are generally larger under Compensation 2 as more load shifting flexibility is deployed over time.
2	Carbon emissions	The deployment of flexibility under P415 is able to shift demand away from system peak periods and to periods with higher deployment of RES. This reduces the dispatch of conventional fossil fuel generation, leading to reductions in carbon emissions. This impact is less evident under the LtW scenario as RES is deployed rapidly over the modelling period, meaning that there is already low dependence in the counterfactual on fossil fuel generation to meet demand. Much of the benefit relating to displacement of fossil fuel generation is achieved by peak reduction flexibility deployment by I&C customers. As we observe similar volumes of this type of flexibility under both compensation variants, there are not significant differences in carbon emission benefits between compensation variants.
3	Spare generation capacity	While carbon emission benefits are less pronounced under the LtW scenario, we do observe some spare capacity resulting from deployment of flexibility in the 2029 spot year. The ability to reduce demand in peak periods leads to less of a need for generation capacity to meet peak demand periods. This benefit is only observed to a small degree in other years and scenarios suggesting that the same level of generation capacity is needed as exists under the counterfactual even if it is dispatched less often.
4	CfD top-up payments	While the overall reduction in the average spot price leads to lower bills, it results in a lower captured price by RES generators supported by CfDs. The impact is generally proportional to the size of the spot price benefits. However, as VLP flexibility deployment can shift demand to periods of higher RES dispatch, in those periods CFD-supported generation is able to capture more revenue. The benefit to consumers from the lower wholesale market price (Benefit 1) outweighs the additional costs of CfD support under all scenarios.
5	Avoided curtailment	By shifting demand into periods of high-RES dispatch, deployment of VLP flexibility leads to avoided curtailment of RES generators that would otherwise be compensated in the balancing market.
6	Compensation cost (Compensation 2 only)	Under Compensation 1, the costs of compensation are internalised by VLPs within their variable cost of flexibility deployment. Therefore, consumers only face the costs of compensation under Compensation 2. In this case, whenever a VLP deploys flexibility, compensation to the relevant supplier is at the prevailing spot price and is spread across suppliers. We assume suppliers pass these costs onto consumers. The magnitude of the cost of compensation falling on consumers is relative to the level of flexibility deployment. It is therefore more significant under the CT and LtW scenarios and becomes larger over time as more flexibility is deployed by VLPs.
7	Supplier compensation surplus (Compensation 2 only)	A proportion of these compensation costs cover the supplier's lost opportunity to sell a unit of energy. However, as we explored in Section 4.5, under Compensation 2, we would expect the compensation at the spot price to go beyond meeting the costs of this lost opportunity. There is therefore an additional surplus that we assume is passed onto a sub-set of consumers; namely the consumers who have a contract with the supplier who has its customer's flexibility deployed by the VLP. This will result in a transfer from all consumers who pay the compensation cost to a sub-set of customers who receive any compensation surplus. We explore these implications further in Section **Error! Reference source not found.**.

5.4. FLEXIBILITY PROVIDER SURPLUS

We summarised the components of VLP and non-VLP surplus in Section 3.4.3 and present results from our modelling in Figure 5.5.

A proportion of this surplus would be used to cover the fixed costs of VLP and non-VLP deployment of flexibility and allow for a return on investment. We assume a competitive flexibility market in which the remainder of surplus not required to cover these costs would be passed through to those consumers who provide flexibility. Under this assumption, VLPs and non-VLPs would offer this surplus to consumers to remain competitive and to ensure an attractive commercial offering. We consider the contribution that revenues would make to VLP fixed costs in Section 5.7.

Figure 5.5: VLP and non-VLP surplus



We summarise the range of impacts affecting providers of flexibility to these participants in Table 5.3.

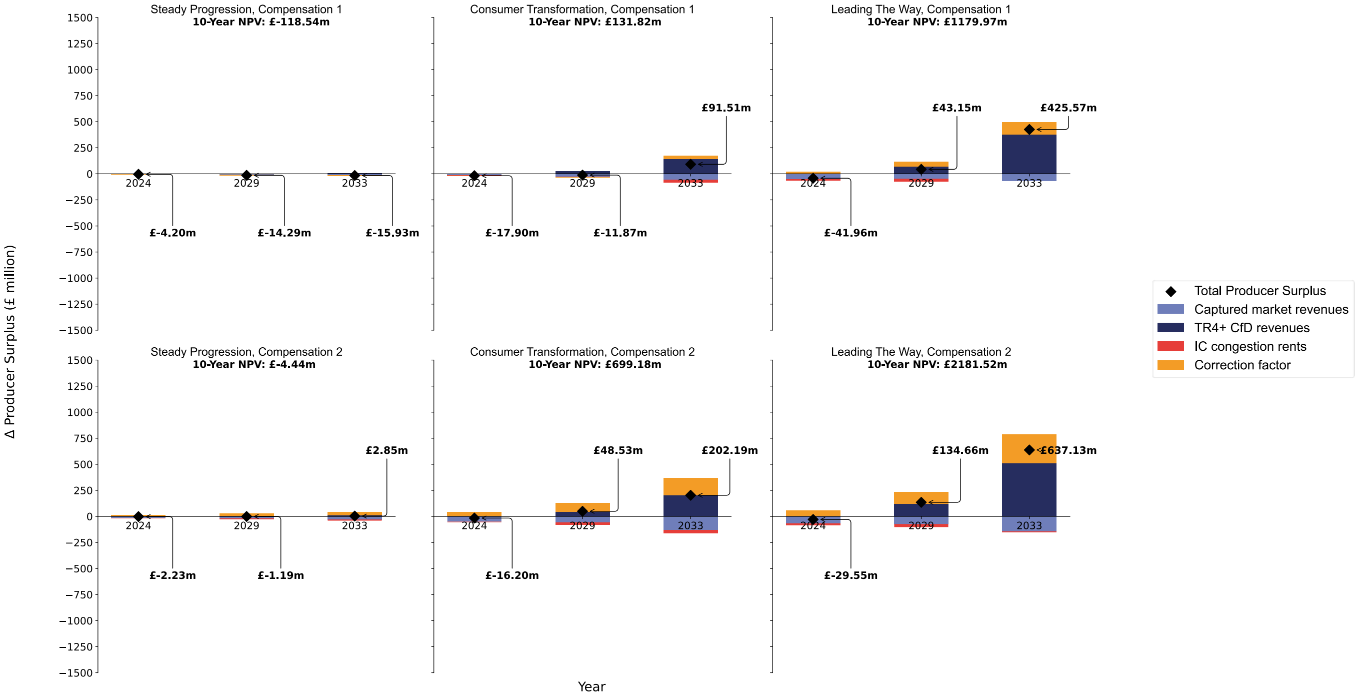
Table 5.3: Breakdown of Non-VLP and VLP surplus shared with flexibility providers

#	Component	Impact
1	Non-VLP surplus	Non-VLP surplus decreases relative to the counterfactual in all model runs as we assume that VLPs take a proportion of non-VLP market share. The impact is relatively consistent across Compensation 1 and Compensation 2. As we showed in Section 4.5, under Compensation 1, VLPs and non-VLPs have the same variable costs for peak shaving deployment but VLPs face additional costs for load shifting. Under Compensation 2, VLPs face less significant variable costs for peak reduction. However, as we observe that peak reduction deployment is generally used at its capacity, non-VLPs continue to deploy the potential peak reduction flexibility they retain in any case. For load shifting flexibility, VLPs and non-VLPs face equivalent variable costs and hence, non-VLPs deploy a similar level of load shifting flexibility to VLPs.
2	VLP surplus	VLPs earn greater revenues over time as they deploy increasing volumes of flexibility. Revenues are significantly higher under Compensation 2 for two related reasons: • **Revenue per unit of flexibility deployed is higher** under Compensation 2 as VLPs do not face any variable cost of compensation when they deploy flexibility. • **Volumes of deployed VLP flexibility are higher**. As VLPs do not need to take into account variable costs of compensation, they are able to profitably deploy flexibility more often at lower wholesale market spot prices.

5.5. Producer surplus

We summarised the components of producer surplus in Section 3.4.3 and present results from our modelling in Figure 5.6.

Figure 5.6: Producer surplus



We summarise the range of impacts affecting producers in Table 5.4.

Table 5.4: Breakdown of producer surplus impacts

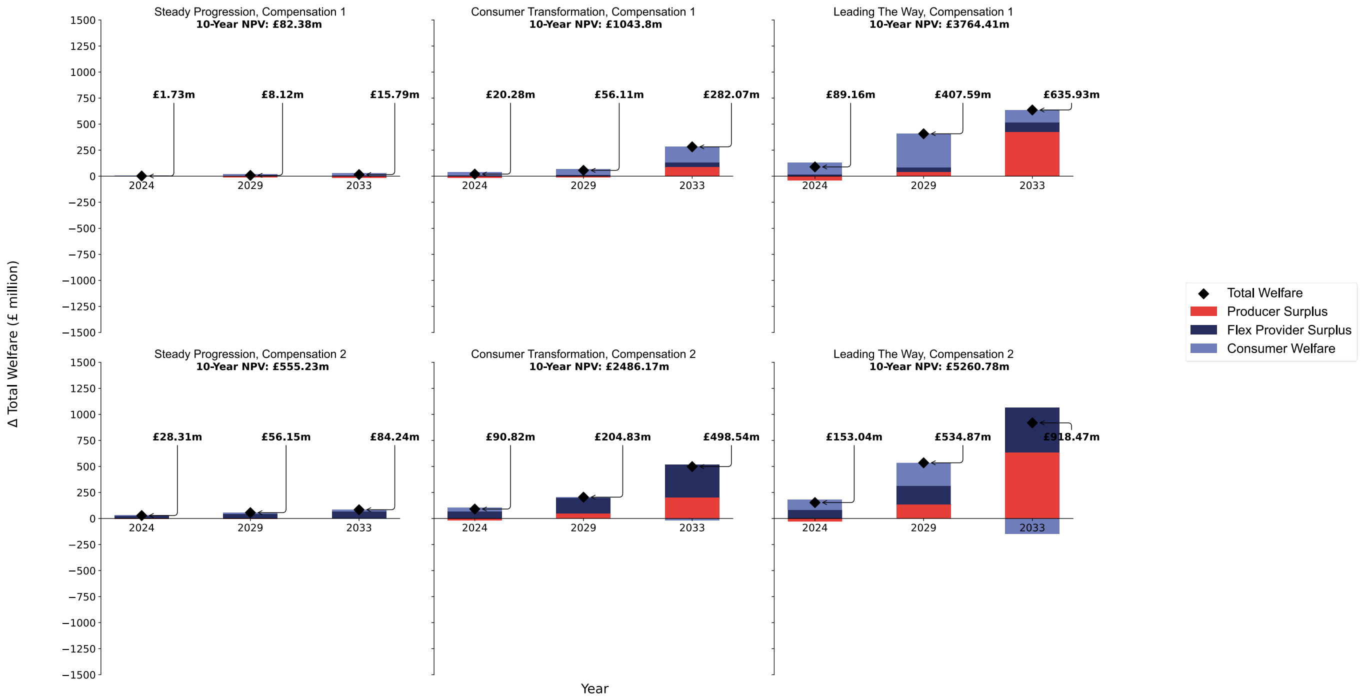
#	Component	Impact
1	Captured market revenues	The downwards impact of flexibility deployed by VLPs on the wholesale market price benefits consumers. But this trend leads to lower captured market revenues for those producers who are exposed to wholesale market prices without any form of CfD support. The impact is larger where the downwards impact on prices is more significant and under scenarios in which a greater proportion of generation is from conventional technologies with no CfD support.
2	TR4+ CfD revenues	We include a set of generators who receive CfD support under contracts issued from CfD TR4 onwards. These generators do not receive the CfD strike price in periods of negative pricing and when they are curtailed. As P415 helps to avoid curtailment of these generators, we observe producer welfare benefits from the prices they capture in the wholesale market. The additional deployment of load shifting under Compensation 2 allows for a more significant reduction in curtailment volumes, therefore resulting in a greater benefit for these producers than Compensation 1. The impact is larger under CT and LtW. Benefits increase over time as RES generation is deployed at scale and VLPs access more flexibility which can be shifted into high-RES periods.
3	IC congestion rents	We assume that ICs are also exposed to the wholesale market price given the impact on their ability to capture rents from the arbitrage in prices between countries[35]. We observe a similar direction of impacts as is observed for generators who are exposed to the wholesale market price but with lower magnitude.
4	Producer-retailer contracting factor	Although we assume retailers contract forward for energy from generators, our model reduces dispatch of generators when flexibility is deployed. The correction factor therefore represents the value to the producer of contracting forward for expected volumes of demand such that they are not exposed to volume risk for downward flexibility actions in our modelling. The correction factor is proportionate to the amount of flexibility deployed and is relative to the difference between the Sourcing Cost and the spot price in the periods in which flexibility is deployed. We observe an increase in this correction factor over time and a higher correction factor in Compensation 2 relative to Compensation 1.

5.6. Breakdown of total welfare impacts

We break down total welfare impacts by each type of market participant in Figure 5.7.

[35] For the avoidance of doubt, we do not include any cap and floor mechanism in our modelling, and we assign 50% of all impacts on rents to the GB side of the interconnector.

Figure 5.7: Total welfare



While total welfare benefits are smaller under Compensation 1, we observe that most market participants benefit to some degree although there may be some exceptions within welfare groups (e.g., we observe lower revenues for non-VLPs under P415).

Under Compensation 2, the results are more nuanced. While total welfare benefits are larger, the flows of welfare between market participants and different consumer groups are affected by the presence of compensation payments and receipts.

Under Compensation 2, VLPs do not face any costs of compensation which is instead spread across suppliers who we assume pass these onto their consumers. Compensation receipts flow to those suppliers who have customers with flexibility deployed by VLPs, representing only a sub-set of the full consumer population.

This effectively results in two transfers of surplus:

- Relative to Compensation 1, VLPs deploy more flexibility and capture and share larger revenues as they don't face any compensation costs when deploying flexibility. This creates a transfer of surplus from energy consumers to those customers who provide flexibility to VLPs. This transfer is at the Sourcing Cost, i.e., the cost of compensation under Compensation 1.
- Under Compensation 2, we expect compensation receipts to exceed the Sourcing Cost. Therefore, even after recovering the Sourcing Cost, the supplier has a surplus which we assume they share with their customers. This surplus will equal the volume of VLP flexibility deployment multiplied by the difference between the compensation price and the Sourcing Cost (i.e., 'Volume of VLP flexibility deployment' * ('Spot Price' – 'Sourcing Cost')). As only a sub-set of consumers will receive these compensation payments, this will result in a transfer of surplus from the general population of energy consumers to the set of energy consumers that are with suppliers who have more flexible customers.

The extent of transfer between consumer groups will depend on the separation of the market into suppliers with and without significant volumes of customers who provide flexibility to VLPs.

If flexibility is spread evenly across suppliers, then compensation receipts will flow to suppliers, and onto consumers, in a similar proportion to the costs of compensation. As the costs of compensation will scale with the deployment of flexibility, where compensation costs are higher (e.g., under CT and LtW), it is likely that an increasing proportion of costs will be covered by suppliers who deploy increasing amounts of flexibility.

However, under any scenario, there will be a proportion of consumers who do not have technologies which enable flexibility, particularly in early years. If certain suppliers take on more customers who provide a flexible response to VLPs while other suppliers focus on a different sector of the market, then the transfer will be more significant. There is likely to be some segmentation of supplier and consumer types in initial years. This may continue to be the case if some suppliers specialise in supplying customers with flexibility capability while other suppliers focus on customers who are less interested/able to provide flexibility.

5.7. VLP RECOVERY OF FIXED COSTS

We explored VLP surplus under Compensation 1 and Compensation 2 in Section 5.4. Here, we consider the extent to which this surplus is able to cover the anticipated up-front and ongoing fixed costs of a VLP. This is important for two reasons:

- If VLPs find it easier to recover fixed costs, we are more likely to observe greater levels of entry of VLPs into the market.
- Where VLPs recover revenues above fixed costs we assume they share additional surplus with the providers of flexibility.

5.7.1. Estimates of fixed costs of a VLP

We requested information from VLPs regarding the estimated up-front and ongoing fixed costs of deploying flexibility. To turn these figures into the estimates of annual fixed cost recovery requirements shown in Table 5.5., we annuitize the up-front capital costs and ongoing costs over a 10-year period using an assumed hurdle rate of 7%.

Table 5.5: VLP fixed cost estimates

Cost	Residential customers	I&C customers	Cost
Up front fixed costs (£/MW)	Dependent on whether the VLP needs to pay for the installation of standalone enabling technology: If not: c. £4k/MW If they do: Up to £160k/MW	c. £2.5k – 6k/MW	Up front fixed costs (£/MW)
Ongoing fixed costs (£/MW/yr)	Dependent on whether the VLP needs to pay for the ongoing maintenance of standalone enabling technology. If not: May only be admin and settlement costs. If they do: Up to c. £30k/MW/yr	c. £1.2k – 5k/MW/yr	Ongoing fixed costs (£/MW/yr)
Assumed annuitized fixed costs (£/MW/yr)	c. £0.6k- £53k/MW/yr	c. £1.6k/MW – 5.9k/MW/yr	Assumed annuitized fixed costs (£/MW/yr)

5.7.2. Comparison of VLP revenues against fixed costs

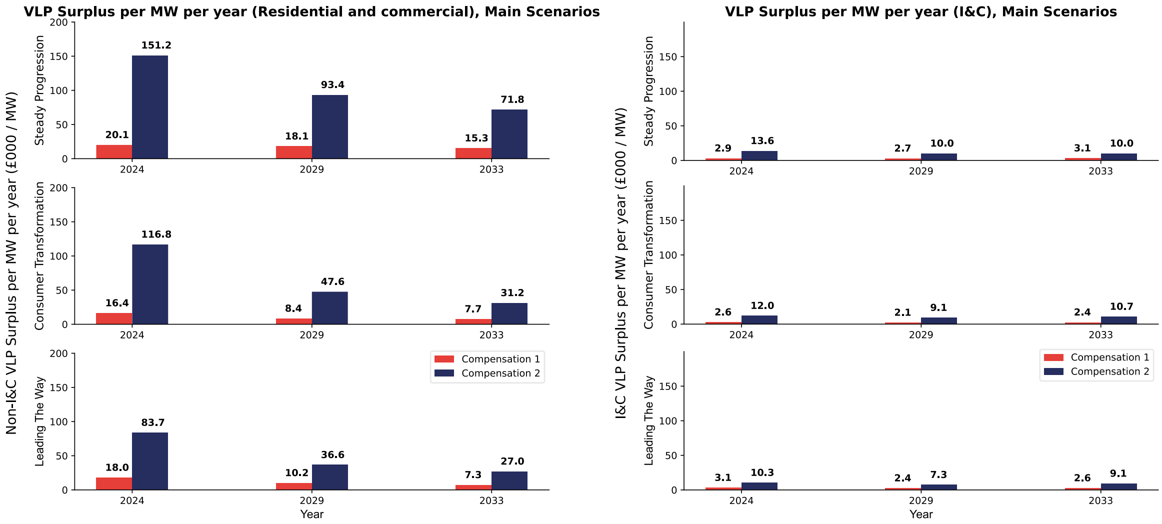
We summarised overall VLP surplus in Section 5.4. In this section, we estimate VLP revenue per unit of capacity contracted. We then assess the extent to which VLPs are likely to be able to recover fixed costs and enter into the market given estimated revenues.

There are two important considerations that are not captured in our modelling:

- **Revenue stacking**: Flexibility providers generally seek to stack revenues across multiple markets to support their business case. Our model only captures revenues that VLPs would capture from trading flexibility in the wholesale market. In practice, they may cover costs and earn returns from the capacity market, balancing market, local flexibility markets and system services.
- **Sharing of surplus**: Consumers who have the capability to provide flexibility will only contract with a VLP if the customer offer is sufficiently attractive. In a competitive market, we would expect VLPs to share all surplus with consumers other than that needed to cover fixed costs and earn a reasonable return on investment. When considering VLP revenues in the following text, we do not incorporate the percentage of revenue that is passed through to customers.

We summarise VLP revenues per unit of capacity in Figure 5.8.

Figure 5.8: VLP surplus per MW per year for residential and commercial customers and for I&C customers



VLP revenues per MW are significantly higher under Compensation 2 than Compensation 1. This reflects a combination of the lower costs of deployment as VLPs do not pay any costs of compensation, and higher levels of deployment from contracted flexibility as flexibility is deployed profitably at lower market prices.

This means that VLPs are generally able to cover even our higher estimates of fixed costs from revenues in the wholesale market under Compensation 2 in 2024. Over time, we observe falling revenues per MW as the additional value of increasing volumes of flexibility diminish with scale, and driven by wholesale market prices which fall over time in our modelling.

In later years, revenues for VLPs are not able to cover our higher estimates of fixed costs of residential and commercial customer flexibility deployment from the wholesale market alone. However, we expect that fixed costs would also fall over time given learning over time and economies of scale.

Under Compensation 1, VLPs are able to recover the lower estimates of fixed costs for both residential and commercial customers and for I&C customers in all years and scenarios. However, they are only able to cover a proportion of the higher estimates of fixed costs – a maximum of 38% of the higher estimates of residential and commercial fixed costs, and a maximum of 54% of the higher estimates of I&C fixed costs.

This implies that under Compensation 2, VLPs would be less dependent on revenue stacking across markets to enter volumes of flexibility into the wholesale market. They may be able to cover fixed costs from wholesale market revenues alone and may be able to share more surplus with consumers to get them to provide flexibility.

Estimates of fixed costs at the lower end of the range provided to us suggest that VLPs with a certain business proposition may be able to cover much/all of their fixed costs through wholesale market revenues alone, even under Compensation 1 where recovered revenues are lower. However, other VLP business models are likely to be more dependent on revenue stacking across multiple markets, particularly under Compensation 1. After covering fixed costs, they may have less surplus available to share with potential flexibility providers and to attract them into the market.

5.8. Results from sensitivity of 'no flexibility'

We summarise total welfare impacts relative to the 'no flex' sensitivity in

Figure 5.9 and Table 5.6. This demonstrates that our assumptions of the deployment of flexibility under the counterfactual deliver a significant proportion of the overall potential benefit of flexibility under each scenario.

This demonstrates the relevance of the assumptions we include in each Case (see Section 5.1.1) and gives a sense of the potential upside/downside impacts if we were to revise these assumptions. This implies that if we assumed a higher or lower level of flexibility under the counterfactual, we would continue to observe benefits of P415 implementation under all scenarios.

Figure 5.9: Total Welfare compared to the "No Flex" scenario

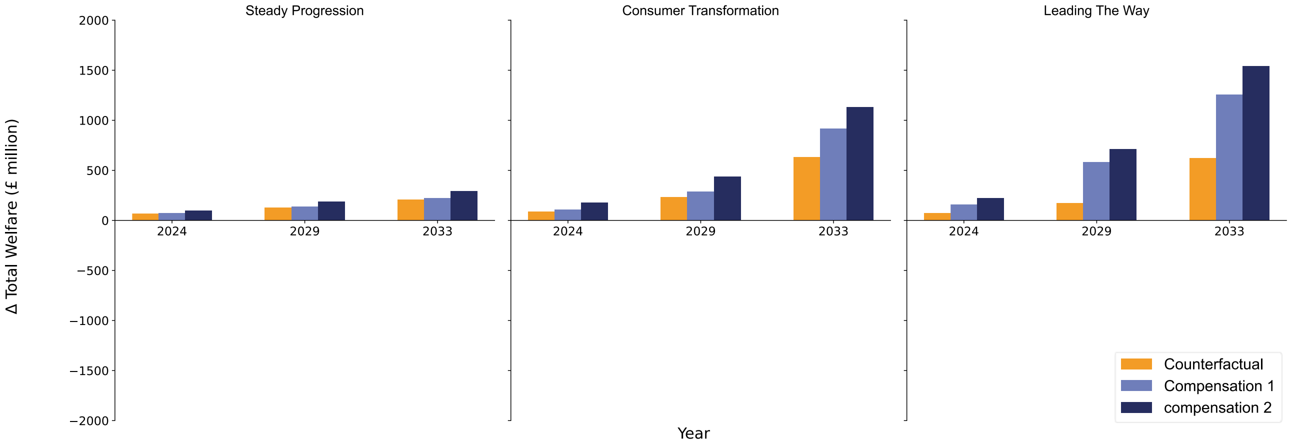


Table 5.6: 10-Year NPV total welfare impact relative to 'No Flex'

	Steady Progression	Consumer Transformation	Leading The Way
Counterfactual	£1,319.48m	£2,944.80m	£2,605.57m
Compensation 1	£1,401.85m	£3,988.60m	£6,369.98m
Compensation 2	£1,874.71m	£5,430.97m	£7,866.35m

A full set of welfare impacts against the 'no flex' sensitivity, broken down by consumer welfare, flexibility provider welfare and producer surplus are included in Appendix C.

6. APPRAISAL OF POTENTIAL FOR WIDER NON-MODELLED BENEFITS

Our modelling methodology was designed to capture the most significant potential benefits of P415 that stakeholders communicated to us when scoping the modelling and developing the modelling methodology. However, stakeholders also identified a range of potential benefits that are not captured within the modelling framework. In this section, we explore each of these hypothetical benefits and consider their magnitude. We do not seek to develop a quantitative assessment of these benefits but classify them based on the following:

- **Large impact**: Comparable to modelled impacts. Likely to be relevant for impact assessment evaluation.
- **Medium impact**: Small compared to modelled impacts. May be somewhat relevant for impact assessment evaluation.
- **Low impact**: Negligible in comparison to modelled impacts. Unlikely to affect impact assessment evaluation.

6.1. Summary

We discuss our rationale for our evaluation of each of the wider potential benefits in the remainder of this section. Table 6.1 presents a summary of our assessment

Table 6.1: Summary of assessment of non-modelled benefits

Benefit	Considerations	Impact level
Spillover impacts on balancing market	Flexibility providers will seek to stack revenue and opportunities from the wholesale market could lead to greater levels of flexibility overall. We would expect at least some of this flexibility to enhance competitiveness of the balancing market.	Medium
Spillover impacts on CM and system services	While spillover benefits may also be present in the CM and system services markets, the extent of benefit will be dependent on whether flexibility provision from VLPs is likely to represent the marginal price setting unit in the CM. System services have stricter requirements with less natural crossover with the nature of flexibility deployed in the wholesale market.	Low-medium
Security of supply and resilience	In our modelling, we observe the potential for flexibility to reduce the reliance on fossil-fuel generation at times of system peak. This should help to avoid stress on the system during such periods though the magnitude of this impact may be relatively limited and unreliable, at least in initial years.	Low-medium
Wider benefits	There are several wider benefits suggested by stakeholders that are likely to have small/negligible impact in isolation but when taken together may introduce some additional benefit.	Low-medium
Local network benefits	The ENA stressed the localised nature of flexibility markets in comparison to the ability of VLPs to aggregate volumes of flexibility over large areas for participation in the wholesale market. At least in the near term, they suggest that this may reduce the scope for spillover effects.	Low

6.2. Spillover impacts on the balancing market

6.2.1. Stakeholder views

Some stakeholders identified the potential for P415 to result in positive externalities for balancing market participation and prices. Sources of flexibility tend to build a business case on stacking revenue across multiple markets. Some stakeholders expected that by providing an additional source of revenue for flexibility providers, the market for flexibility would grow across multiple markets.

NGESO manage the balancing market and agreed with the hypothesised benefit. They suggested that the participation of VLPs and the value delivered in the balancing market could be maximised if VLPs could also provide a locational service to help address localised constraints on the transmission network.

However, other stakeholders suggested that evidence of participation of VLPs in the balancing market thus far suggests that volumes may be low. They argued that the additional revenues from the wholesale market would be relatively small in comparison to the hurdle rate of many projects. One stakeholder also noted barriers to entry for DSR resources in the balancing market would prevent VLPs from bringing benefits to the balancing market.

6.2.2. Our evaluation

DSR providers generally seek to stack revenues from multiple markets, and we would expect VLP entry to also be dependent on such a commercial proposition. We therefore expect that should entry into the wholesale market be observed, it is likely that this will support delivery of flexibility volumes into other markets.

While VLP participation in the balancing market has been low, this may increase with the implementation of P376, the take-up of flexible technologies, and the emergence of more attractive customer propositions.

Several stakeholders noted the importance of regulatory developments to unlock access to the balancing market for several flexibility business models. While there may be barriers to VLP participation in the near term, if and when barriers are removed, the additional revenue potential for VLPs may support entry into the balancing market. NGESO set out several thoughts on the removal of barriers to DSR provision in the balancing market, identifying the need for system development and data management processes.

We conclude that spillover effects in the balancing market are unlikely to be of a similar order as the impacts assessed through our modelling. However, if barriers to entry for DSR can be removed, P415 may enable revenue stacking which delivers additional volumes into the balancing market. Overall, we consider the potential for spillover effects in the balancing market to be **medium impact**.

6.3. Spillover impacts on the CM and system services

6.3.1. Stakeholder views

The mechanisms for benefit in the CM and system services are theoretically similar to the balancing market effect considered above. By allowing for additional revenue stacking, P415 may encourage greater volumes of DSR participation which enhance competition in the CM and system services markets.

Stakeholders differed in the extent to which they believed that greater VLP participation would allow delivery of lower CM clearing prices. Several cited existing barriers to participation for DSR such as the existing baselining criteria. Another stakeholder noted that DSR participation in the capacity market has stayed relatively level (c. 1 GW) regardless of the clearing price, suggesting limits on the capacity that can participate under the current rules.

Some stakeholders suggested that any change to competition in the CM would be unlikely to have a material impact on clearing prices. However, another stakeholder suggested that DSR is often a marginal resource in capacity markets. Therefore, they would expect that revenue stacking would allow for DSR resources to reduce the revenues they need to recover in the CM, thereby reducing clearing prices.

Considering wider system services, stakeholders have provided examples of where entry of certain forms of DSR has replaced a proportion of volumes of conventional generation who traditionally provided such services (e.g., frequency response).

NGESO welcomed the provision of additional tools with which to manage the system, particularly as energy system transition requires greater flexibility close to real time.

6.3.2. Our evaluation

As with impacts on the balancing market, we recognise the mechanism for spillover effects into other markets. As with the balancing market, the emergence of these benefits may be dependent on wider changes to rules and processes to allow for more effective participation of DSR resources. In this case, the impact on clearing prices will depend on the extent to which DSR represents the marginal price setting unit of capacity in the CM.

While the specific requirements of wider system services may restrict the proportion of VLP delivered DSR that could participate in certain services, there may also be spillover effects from the emergence of additional volumes of DSR around the margins.

Overall, we consider the potential for spillover effects in the balancing market to be **low-medium impact**.

6.4. Local network benefits

6.4.1. Stakeholder views

As energy generation and demand profiles become increasingly localised, the ability to flex demand and generation at a local level is becoming increasingly important. Distribution system operators are responding to this need with the development of local flexibility markets, providing them with tools to manage local supply and demand mismatches and allowing them to defer some need for network reinforcement.

Similar to the spillover effects identified regarding the balancing market, some stakeholders have suggested that by providing additional potential revenues in the wholesale market, P415 could also result in greater volumes of flexibility being able to participate in localised flexibility markets. One stakeholder suggested that it is rare for participants to be able to develop a business case based on revenues from these markets alone. They expected that providers of local flexibility services would most likely develop the proposition based on stacking of revenue across multiple markets such that access to the wholesale market would support this.

We held a workshop with the Energy Networks Association[36] (ENA) to get their views on the potential for such benefits. ENA members were somewhat sceptical about the potential for benefits, at least in the near term. They noted that the need for flexibility could be very localised, and that aggregation of multiple consumer volumes may be more dispersed, at least before significant volumes had been accessed. They therefore expected the spillover effect from wholesale market participation (a national market) to very localised flexibility markets to be relatively limited. They also noted the level of confidence that they would need in the provision of flexibility to allow them to defer network reinforcement and the time it may take to develop this confidence in aggregated flexibility volumes.

6.4.2. Our evaluation

Similar to the potential for balancing market benefits, we recognise the potential mechanism for benefits at distribution network level. However, we also acknowledge comments from network companies that these benefits may only materialise over a longer time period as aggregated volumes reach a threshold within more localised network zones and as confidence is developed in their deployment.

Overall, we consider the potential for spillover benefits in the local network to be **low impact**.

[36]See: https://www.energynetworks.org/

6.5. Security of supply and resilience

6.5.1. Stakeholder views

Some stakeholders believed that P415 would enhance security of supply and resilience. Some stakeholders proposed that P415 would allow for enhanced integration of renewables by providing flexibility to shift demand close to real time, depending on resource availability. Another suggested that additional volumes of flexibility delivered by P415 would allow the electricity system to draw on additional national flexibility resources, reducing dependence on international gas and electricity supplies.

6.5.2. Our evaluation

One of the benefits identified in our modelling is the ability of additional flexibility to reduce reliance on fossil fuel generation at periods of high demand relative to renewables output. Our modelling estimated the beneficial impacts this could have on price and carbon emissions. Additional to these benefits, the ability to provide demand reduction at peak could provide additional mitigation against extreme peak periods in which electricity resources would otherwise struggle to meet demand. As noted by stakeholder this would provide an additional form of national response, reducing dependence on international gas and electricity supplies to some extent.

The extent of this benefit would be highly correlated with the additional volume of flexibility delivered by VLPs. At low volumes, the benefit would be marginal and NGESO is unlikely to build potentially uncertain volumes into its assessment of any capacity margin during extreme events. However, over time there is some potential for such benefits to become less marginal.

Overall, we consider the potential for spillover benefits for security of supply and resilience to be **low-medium impact**.

6.6. Wider benefits

6.6.1. Stakeholder views

Stakeholders proposed several other potential benefits that they considered could be delivered by P415. These included:

- **Supply chain benefits**: If P415 leads to an increase in volumes of aggregated flexibility services, stakeholders suggested the potential for aggregation businesses and equipment suppliers to increase scale, resulting in cost reductions.
- **Increased liquidity in the intraday market**: One stakeholder identified the potential for greater participation in intraday markets to increase bids and offers in the spot market and thus stimulate liquidity close to real time.
- **Consumer engagement**: One stakeholder identified the potential for consumers who are encouraged to provide DSR developing a better understanding of their consumption and the potential for wider revenue streams from energy and system services management. It may also lead to an additional focus on energy efficiency for example. Another stakeholder identified the potential for enhanced competition, choice and innovation for customers to participate in flexibility as a result of VLP entry into the market.
- **Acceleration of electrified transport and heat**: One stakeholder noted the potential for the additional opportunities for consumers to provide flexibility to stimulate greater uptake of electric vehicles, heat pumps and other low carbon technologies.

6.6.2. Our evaluation

We note the potential for wider benefits, several of which have crossovers with some of the benefits identified previously. There may be scope for several of these wider benefits to emerge if and when P415 allows for additional flexibility volumes to enter into the market. However, we would not expect these benefits to fundamentally impact on the P415 impact assessment case.

Taken together, we consider the potential for contribution from the range of wider impacts to be **low-medium impact**.

7. FINANCIAL COSTS OF IMPLEMENTATION

We considered the financial costs of implementing P415 based on submissions of stakeholders in response to Elexon's Call for Evidence. We identified four sets of stakeholders who may need to incur costs to implement the P$15 solution:

- **BSCCo**: New systems and processes will be needed to allow for effective data and settlement flows regarding deviation volumes to account for VLP flexibility actions, to reflect imbalance settlement arrangements and to introduce the relevant compensation flows and procedures.
- **VLPs**: VLPs may need to introduce new systems and processes to align with BSCCo's own systems. Note that we do not include compensation payments under Compensation Variant 1 within our consideration of financial costs as these are already reflected in our welfare analysis.
- **Suppliers**: Suppliers may need to introduce new systems and processes to align with BSCCo's own systems. Note that we do not include socialised compensation payment requirements under Compensation Variant 2 within our consideration of financial costs as these are already reflected in our welfare analysis.
- **National Grid Electricity System Operator (NGESO)**: We do not expect NGESO to incur any significant direct costs to allow for the P415 solution. However, NGESO may need to develop systems and processes to allow for additional volumes of participation by VLPs in the balancing market if P415 results in such positive externalities.

7.1. Costs falling on BSCCo

Elexon commissioned a 'Rough Order of Magnitude' impact assessment from its service providers regarding the likely implementation costs for BSCCo. These cover the costs that it expects to incur to deliver the required systems and processes to implement P415. These costs are expected to depend to some extent on the compensation variant that is chosen and would include 'up front' costs of systems development and ongoing costs to manage new systems. Elexon notes some uncertainty regarding the exact systems changes that would be required as well as a complex pipeline of systems change. They therefore estimate implementation costs within a range that remain subject to some refinement as the detailed P415 solution continues to be developed.

Elexon has also signalled that the costs of implementation may be dependent to some degree on the chosen compensation variant. For example, Elexon expected that they may need to procure a third-party service provider for additional data to calculate supplier compensation under Compensation 1, though noted that the exact requirements are not clear at this stage.

Elexon also expected implementation of P415 to impact on its operational teams, for example requiring new processes, team members, deliverables, user acceptance testing and additional customer support for VLPs.

Noting this uncertainty, Elexon estimates up front and ongoing costs as set out in Table 7.1.

Table 7.1: Estimate of costs falling on BSCCo

'Up front' costs (£m)	Ongoing annual costs (£/year)
c. £2.7 – 3.7 million, but with potential to exceed the upper range depending on finalisation of the solution.	c. £10k per year

7.2. Costs falling on VLPs

7.2.1. Call for Evidence responses

Direct implementation costs

We received three responses from stakeholders who would consider becoming a VLP if P415 is implemented that commented on the expected implementation costs falling on VLPs.

One respondent noted that much of the cost of introducing systems and processes for VLP participation has been or is already being incurred by VLPs who want to participate in the balancing market as reflected in the requirements of P375 and P376. They believe that much of the functionality required for participation in the wholesale market is therefore already in place, with new functionality limited to coupling with wholesale market trading systems, providing volume notifications and activity notifications in the wholesale market and calculating supplier compensation payments. They expected the complexity of such changes to be low in comparison to functionality that has already been developed.

Another respondent considered that VLPs would only incur costs if they chose to participate in the wholesale market, therefore implying that the revenues they expected to recover would exceed the up front and ongoing costs.

Only one respondent provided any numerical estimates of costs. They estimated costs of registration at approximately £40k with approximately £10k of annual ongoing costs to maintain registration.

7.2.2. Our view

Direct implementation costs

While we acknowledge that VLPs would only incur additional incremental costs of participation in the wholesale market if the expected additional revenues would be likely to exceed the additional cost, these costs should still be taken into account as part of the impact assessment.

We understand the views raised by potential VLPs regarding the extent of change relative to that which has been/is being incurred to participate in the balancing market. We would expect potentially significant economies of scale/scope for VLPs regarding provision of services into the wholesale market if they have already incurred costs to participate in the balancing market.

For example, we expect that the costs set out by one stakeholder regarding registration costs for a VLP would be needed for VLP registration to act in the balancing market regardless of whether the VLP also wanted to participate in the wholesale market. We would expect that any incremental cost regarding participation in the wholesale market - e.g., to reflect coupling of systems with the wholesale market - would take into account relevant economies of scale/scope in service provision.

In summary, based on the responses submitted to us, we would not expect the direct implementation costs for VLPs to be excessive given the expected potential size of benefits to the system of increased flexibility. We consider that the system provider registration costs of £50k up front costs and £10k annual ongoing costs may represent an upper bound on direct implementation costs.

Beyond direct implementation costs, we agree that VLPs would need to incur ongoing costs to grow and manage their customer portfolio. These costs would scale with the number of VLPs operating in the market.

Wider fixed costs

Engagement with VLP participants as part of our assessment has highlighted the diverse range of business models of VLP entrants. Each has a different customer proposition and business model, potentially targeting use of different customer technologies and customer types for the provision of flexibility. Estimates of up front and ongoing operational fixed costs are therefore wide ranging.

At a minimum we would expect that all VLPs would need to invest time and resource in developing a customer proposition, marketing and managing their customer portfolio. While some proportion of these costs may allow for economies of scale/scope from customer engagement for VLP services in the balancing market, potential volumes could be substantially larger in the wholesale market while may also allow for different types of customers to participate. We therefore expect that costs would scale with the extent of volume of participation in the market, regardless of the business proposition of the VLP.

7.3. Costs falling on suppliers

We received four responses from suppliers that made reference to potential implementation costs. Suppliers noted the potential for up-front system costs to reflect the need for additional monitoring of asset dispatch and imbalance. They also identified the potential need for additional resource to maintain data requirements and operational efficiency of system changes. One respondent noted the potential for additional costs to educate and engage with customers regarding the changes to service provision, e.g., due to a lack of clarity regarding responsibilities between the supplier and VLP.

Only one supplier provided numerical estimates of potential implementation costs, providing a range of estimates to reflect remaining uncertainty regarding the solution. This supplier identified potential up front implementation costs of £100k - £1m and ongoing costs of between £50-100k per annum.

As part of further discussion on these estimates, VLPs disputed the level of additional costs to suppliers, noting that the solution is intended to ensure that the imbalance position of the supplier is not affected by any VLP action, and that compensation should flow directly to the supplier.

However, suppliers argued that some level of system change would be needed to reflect payment flows under either compensation mechanism – e.g., to incorporate costs of socialised compensation on the supplier community as new cost item.

While the scale of change may be relatively limited, the magnitude of implementation costs is likely to be related to the nature of supplier systems. Those suppliers who remain on legacy systems may incur larger costs for relatively small adjustments to their systems while those on more modern 'agile' systems are likely to face significantly lower systems costs of reform. It was noted that the numerical estimates provided reflected change to legacy systems.

We expect that the costs of £100k - £1m and ongoing costs of between £50-100k per annum, estimated based on legacy systems are therefore likely to represent an upper bound for suppliers.

Suppliers may face wider indirect costs as a consequence of P415. We consider these in Section 8.2.

7.4. Costs falling on NGESO

NGESO provided us with a view on the potential costs falling on it as a result of P415. NGESO did not expect any direct or short-term costs to implement the P415 modification in its own IT systems.

In the longer-term, NGESO identified the potential for additional systems costs to manage an increase in balancing mechanism units (BMUs). It identified a potential for up to £2-3m of additional costs to reflect this.

We note that the additional costs of growth of BMUs would be highly dependent on the number of VLPs that chose to participate in the market as a result of P415. NGESO also noted that there would likely be an overlap with wider programme of work which could lead to some economies of scope.

8. RISKS AND UNINTENDED CONSEQUENCES

As well as financial costs falling on industry participants, we have considered the potential for risks and unintended consequences. Through stakeholder engagement, we identified several themes of risk:

- Risks of consumer detriment, e.g., resulting from confusion, malpractice, etc.
- Risks falling on suppliers and/or impacting on competition.
- Risks of gaming to benefit from compensation arrangements.
- Risks arising from application of the baselining methodology.

8.1. Potential for consumer detriment

8.1.1. Issues raised by stakeholders

Stakeholders identified several potential mechanisms for consumer detriment, including:

- **VLP failure and/or financial governance:** Suggesting parallels with the energy supply market, some stakeholders questioned the impacts on customers if VLPs were set up without appropriate financial governance arrangements in place. Considering recent events in the supply market, they identified a risk of costs falling on consumers if entry from VLPs was followed by significant volumes of VLP failure further down the line. Several stakeholders suggested that similar regulations concerning financial suitability should be in place for VLPs as has been developed for suppliers.
- **Complexity and consumer confusion:** Several stakeholders identified the potential for complexity to increase as a result of a customer engaging with the combination of a supplier and a VLP. They suggested that this may introduce additional customer confusion regarding billing, rights and obligations, etc, particularly for residential and small commercial consumers who may have less resources to access and engage with the arrangements.
- **Clarity regarding responsibilities and disputes between VLPs and suppliers:** In addition to introducing new potential for customer confusion, some stakeholders suggested that customers may not know who to contact in the event of an issue which may lead to additional costs of customer education and communication. They also identified the potential for disputes between the supplier and the VLP regarding certain obligations or responsibilities.
- **Key consumer events:** Stakeholders had some specific concerns regarding the impact of the VLP arrangement at key periods, e.g., for agreed reads, change of tenancy, change of supplier, etc. They identified particular scope of additional complexity, confusion and sub-optimal outcomes for consumers during these events.
- **Misaligned incentives/malpractice:** One stakeholder noted the potential for complex customer propositions resulting from separate supply and flexibility contracting. They identified a risk of misaligned incentives and malpractice as a result. One stakeholder gave the example of a customer with a vehicle-to-grid EV. While VLPs would share the benefits of downward energy actions, including export to the grid, they would not face the non-energy costs applied on the bill during import. For this reason, the stakeholder believed that the VLP would be 'over-incentivised' to export, without internalising the costs on import.

Regarding the potential for consumer detriment, several stakeholders noted the lack of regulation which is in place to manage the relationship between a VLP and the customer. Some suggested that VLPs should only be allowed to enter into the market if they are subject to a similar level of regulation as applied to suppliers to govern their interactions with customers.

8.1.2. Our view on the magnitude of risk

The ability for VLPs to participate in the wholesale market may lead to new customer propositions and a new form of interaction between market participants and customers. For that reason, any potential for consumer detriment must be carefully considered as the details of P415 are developed.

However, we consider it important to differentiate between the role of the VLP and the role of the supplier in the market. Any consideration of the magnitude of impact on consumers and the potential for additional regulation should take into account the specific role that VLPs play. We note several important differences between the role of a supplier and a VLP that we believe should be taken into account:

- **A VLP is not responsible for delivering a critical service**: Unlike suppliers, VLPs do not deliver a critical service to customers. Under the P415 solution, VLPs do not take responsibility for energy supply but for energy deviation volumes, i.e., flexibility. In the event that a customer is in an agreement with a VLP who subsequently fails, the consumer should continue to receive their energy supply and would only lose their flexibility service.
- **An energy customer does not need to enter into an agreement with a VLP**: All energy consumers in GB must have an agreement with a supplier to receive energy. The same is not true for VLPs as customers can enter and exit from such agreements depending on the value they expect to receive from them. This implies that customers will only enter into and maintain such agreements if they are content with the service they receive. We would expect a customer who knowingly faces significant confusion or detriment to terminate the arrangement. Nevertheless, residual risk may remain. For example, customer detriment could take a form which is not transparent or well understood by the customer. In addition, a perception of poor customer satisfaction from flexibility providers could undermine the emergence of flexibility more generally.
- **Suppliers are able to compete directly with VLPs to offer customer flexibility propositions**: One stakeholder believed that customers benefit from straightforward customer propositions. They expected customers to prefer bundled services in which the energy and flexibility are delivered as part of a single customer proposition. While we do not speculate about customer preferences for flexibility provision, we identify that even after the implementation of P415, consumers can continue to choose bundled propositions from suppliers if that is indeed their preference.
- **In general, the flow of payments will be from VLPs to customers rather than the other way round**: One of the challenges in the energy supply market is the large credit balances that suppliers must manage, including the risks associated with customer debt. Unlike suppliers, VLPs will generally be paying customers to access their flexibility which VLPs then trade in the wholesale market. Therefore, we would not expect VLPs to build up the same level of credit balances and customer debt risk as a supplier.

We believe that differences in the function performed by VLPs in comparison to suppliers mitigates several of the issues raised regarding consumer detriment. While several risks may remain relevant to some degree, we expect the magnitude of such risks to be significantly lower than is the case for energy suppliers.

8.1.3. Mitigations

There are several regulatory developments that may provide further mitigation of the consumer detriment impacts identified above:

- **The Association of Decentralised Energy (ADE) Flex Assure Standard**[37]: Flex Assure sets standards of practice for flexibility service providers, in relation to sales and marketing, proposals, contracts and complaints. This voluntary scheme is intended to support the development of flexibility by providing

[37] See: https://www.flexassure.org/about-flex-assure

confidence to consumers about the service they receive from a flexibility provider. A compliance scheme also exists to ensure that Flex Assure registered providers meet the requirements of the standard. It is currently limited to large industrial and commercial customers, though we understand that the ADE is in the process of developing an equivalent for residential and small commercial customers.

- **Licensing of load controllers:** The Department of Business, Energy and Industrial Strategy (BEIS) published a consultation on 'Delivering a Smart and Secure Electricity System'[38] on 6 July 2022. This consultation includes proposals for licensing of organisations that 'enter into arrangements with domestic and small non-domestic consumers, for the purposes of DSR'. While the detail of regulation will be developed over time following the consultation, BEIS also consulted on the potential need for regulation to reduce the risk of consumer detriment in several areas, including:
    - a consumer's ability to compare service offerings and charges;
    - a consumer's ability to make informed choices;
    - preventing consumers from being locked into or locked out of certain services, e.g., as a result of unreasonable terms and conditions;
    - preventing DSR organisations from using their ability to control customer devices to the detriment of the consumer;
    - the potential for additional support for vulnerable customers;
    - routes to redress;
    - managing risks surrounding insolvency; and
    - consumer data privacy protections.
- **Consumer protection law**: In addition to the above, common consumer protection law may apply to the services provided to the customer. This includes:
    - **The Consumer Protection from Unfair Trading Regulations 2008**[39]: This provides protection against unfair and misleading trading practices and aggressive sales tactics.
    - **The Consumer Rights Act 2015**[40]: This legislation sets minimum standards regarding the care and skill applied in provision of the service, the binding nature of information provided to the customer and the requirement for a reasonable price.

8.2. Impacts on suppliers

8.2.1. Issues raised by stakeholders

Some stakeholders raised concerns regarding the impact of the P415 solution on suppliers. They suggested that these risks could lead to additional costs for suppliers which may be passed through to consumers and could exacerbate ongoing challenges faced by supplier business models, at its most significant leading to additional supplier exit from the market.

Stakeholders identified challenges relating to the deviation of energy volumes and how effectively they would be able to manage these deviations. They suggested that this would introduce new challenges regarding demand forecasting, hedging and risk management.

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[38] See: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1088796/smart-secure-energy-system-consultation.pdf

[39] See: https://www.legislation.gov.uk/uksi/2008/1277/contents/made

[40] See: https://www.legislation.gov.uk/ukpga/2015/15/contents/enacted

8.2.2. Our view on the magnitude of risk

We understand the views raised by stakeholders regarding new challenges for suppliers. The potential for deviations of energy volumes close to real time may introduce new risks for suppliers to manage. However, we note the following:

- The P415 solution is intended to ensure that a supplier does not face any imbalance risk when a VLP takes an action for one of its customers.
- The P415 solution includes a compensation mechanism which is intended to reflect the lost volume of energy that the supplier can no longer sell to the customer. The intention is that the supplier should effectively face the same demand profile as it would have done in the absence of the action.

We believe that the extent and nature of risk may be dependent to some extent on the nature of the flexibility action undertaken by VLPs. Where a flexibility action constitutes peak reduction, we consider that the provisions within the P415 solution may largely ensure that the relevant supplier is largely protected against consequences of the action, though note that this is subject to accurate baselining[41] and deviation volume methodologies. This is because the solution should ensure that suppliers remain in balance and are compensated for the foregone energy which they are no longer able to sell.

However, where a flexibility action results in load shifting, we expect that suppliers may face additional exposure. This is because the VLP is likely to initiate the downwards energy action for which the supplier is made whole but is less likely to take responsibility for the resulting increase in demand. As a result, the supplier is able to sell an additional unit of energy in a future period but may also need to purchase an additional volume of energy to cover the increase in demand close to real time. If the supplier is not able to cover this additional demand, they may take on a short imbalance position.

We expect an increasing proportion of flexibility actions to result in load shifting as the penetration of EVs and heat pumps increases over time. The nature of these technologies means that a reduction in demand in one period will often result in an increase in aggregate demand in other periods[42].

Supplier exposure may also depend to some extent on the compensation mechanism. The Compensation 1 mechanism compensates suppliers at the sourcing cost while Compensation 2 compensates them at the spot price. The Compensation 1 mechanism is likely to provide a more stable, but in most cases lower level of compensation[43] than the Compensation 2 mechanism. While the latter may often provide a higher level of compensation, it also increases exposure of suppliers to the spot price and is thus less predictable.

We conclude that suppliers may face a new set of risks and exposures under certain conditions, depending on the compensation mechanism and on the nature of the flexibility action. However, to some extent this is a necessary implication of an increase in flexibility more generally. As customers adopt flexible technologies and increasingly respond to temporal and locational signals, demand profiles are likely to change and become increasingly difficult to forecast ahead of time. The fact that an organisation other than the supplier is undertaking the activity may add an additional challenge for the supplier. However, we would expect the market to develop increasingly sophisticated demand forecasting and hedging strategies to reflect a developing understanding of flexibility whether or not VLPs are allowed to participate in the market.

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[41] We explore implications of the baselining methodology in the next section.

[42] Though we note that some business models aim to optimise heat provision such that overall energy demand is reduced with an almost imperceptible effect on the consumer perception of temperature.

[43] As we would expect most flexibility actions to be taken at higher wholesale market prices.

8.3. Gaming risk

In Section 4.5, we considered the position of a supplier when a VLP makes use of flexibility of one of its customers under the set of assumptions that we set out. We found that:

- Under Compensation 1, suppliers would be net neutral when VLPs deploy peak reduction flexibility and would benefit by 'Sourcing Cost – Spot Price (t')' when VLPs deploy load shifting flexibility.
- Under Compensation 2, suppliers would benefit by 'Spot Price – Sourcing Cost' when VLPs deploy peak reduction flexibility and would benefit by 'Spot Price (t) – Spot Price (t')' when VLPs deploy load shifting flexibility.

This raises a question regarding the incentives of a supplier to become a VLP in order to make use of flexibility from its own customer and whether it could do so without providing any additional system benefit compared to deploying that flexibility as a supplier.

Under Compensation 1, targeting of the compensation cost at the VLP means that the supplier would face a cost when it acts as a VLP to make use of flexibility from its own customer. Further to the position summarised above, acting as a VLP, the supplier would also have to pay the Sourcing Cost by way of compensation. Therefore, there does not appear to be any benefit to the supplier from deploying flexibility from its own energy customers as a VLP.

However, under Compensation 2, a gaming risk may exist. A supplier who deploys flexibility of its own customer as a VLP would benefit as summarised above. The supplier would only face a small fraction of the overall costs of compensation as these compensation costs are socialised. The supplier effectively benefits twice under such an arrangement. It benefits from making use of its customer's flexibility as a supplier. However, it also benefits from the receipt of compensation[44] without being liable for an equivalent payment of compensation.

It is not clear to use whether there are mechanisms in place within the arrangements for a VLP to prevent suppliers from acting as VLPs for their own customers. If there are no mechanisms to prevent such behaviour, this could present an important source of gaming risk.

8.4. Baselining methodology

8.4.1. Issues raised by stakeholders

One stakeholder raised concerns regarding the application of the baseline against which Deviation Volumes are calculated when a VLP takes and action. The stakeholder was concerned that the failure of a generic baselining methodology to reflect the specific nature of the customer could create residual imbalances for the supplier.

They suggested that generic baselines work poorly in practice for a heterogenous set of customers who each have different demand profiles and flexibility characteristics. They pointed to the wide-ranging approaches deployed internationally as evidence that there is little consensus regarding an appropriate baselining methodology. They also noted that the baselining methodology developed under modification P376 has not been implemented and tested. They suggested observing performance of the baseline before developing confidence for its use under P415.

On the other hand, VLPs have told us that they value accuracy of the baseline. Baseline inaccuracy introduces risk for VLPs as their flexibility actions will be measured relative to the baseline.

8.4.2. Our view on the magnitude of risk

We agree with the view raised that any baselining methodology will be imperfect when applied to a heterogenous set of customers. This will be the case in particular for those with dynamic and less predictable demand profiles.

[44] Because the change in demand is flagged as a VLP flexibility action,

The baselining methodology makes use of recent historic demand data to estimate future energy flows. It seeks to identify similar demand days for the relevant customer based on:

- Type of day (e.g., working or non-working day)
- Days in which there is no ‘special event’ such as balancing service provision or site shutdown.

The P376 approach appears to be better designed for large, industrial customers with relatively consistent, predictable demand profiles.

Indeed, P376 notes that *‘…not all sites will be suitable to use a Baselining Methodology; some sites may not follow any normal behaviour patterns or may be too variable for a Baselining Methodology to provide a useful estimate.’*

As dynamic loads like EVs and heat pumps allow residential and small commercial customers become an increasingly important source of flexibility, the accuracy of the baselining methodology for such sources of flexibility may become an increasingly important driver of costs and benefits. Inaccurate baselines could lead to sub-optimal investment in flexibility and deployment of flexibility.

As well as risks regarding inaccuracy and the impact on supplier imbalance positions, we also identify a related risk that VLPs may be able to profit from ‘beating the baseline’ without deploying any flexibility. This may arise where a VLP is better placed to forecast the demand of a customer type than is possible using the baselining methodology applied to that customer. A VLP could then declare a flexibility action and deviation volume but allow the customer to follow their existing demand profile. Under the P415 solution, the VLP would be remunerated assuming it had taken a flexibility action when in fact, this would represent inaccuracy of the baseline with no flexibility actually deployed.

The P376 solution notes that the BSC Governance processes allow for new baselining methodologies to be introduced or amended over time. However, this depends on a suitable baselining methodology being identified, raised, developed and approved.

Assuming symmetric risk of baseline inaccuracy, we consider that VLPs would value accuracy of the baseline and may seek to develop baselining methodologies that can be applied more effectively for residential and small commercial customers.

However, baselining methodologies for smaller customers with more dynamic and less predictable loads are likely to be challenging by their nature. There could be an asymmetric incentive for VLPs to seek to correct baseline inaccuracies that work against them while being less proactive about correcting baselining methodologies that may work in their favour.

Other BSC signatories would also be able to raise corrections to the baseline. Whether or not wider stakeholders such as suppliers would be likely to prioritise, identify improvements and develop such modifications in practice remains uncertain.

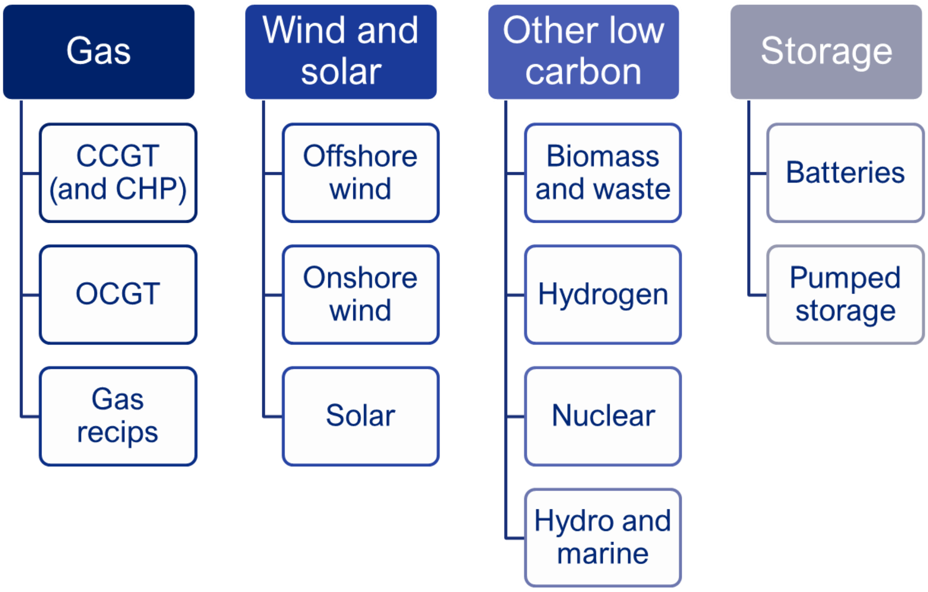
Without an appropriate baselining methodology which can reflect the particular characteristics of demand profiles and flexibility characteristics of smaller residential and commercial customers, we identify some potentially significant risks of baselining inaccuracies and possible gaming opportunities. We expect these risks to be less material for large I&C customers where international precedent has helped to inform the baselining approach and where demand profiles are more regular and predictable. P376 appears to acknowledge this differentiation within the solution.

Appendix A DETAILED MODELLING METHODOLOGY

A.1. GENERATION AND DEMAND ARCHETYPES

Our model includes a detailed set of generation technologies and demand archetypes (12 generator technologies and 12 demand types) which we duplicate across the transmission and distribution networks (Figures A.1 and A.2). Each generation technology is modelled as a single fleet across the market with dispatch based on the technical characteristics and variable costs of each representative dispatch type.

Figure A.1: Generation and storage technologies included in the model at transmission and distribution level



Modelling CfD-supported plant from Allocation Round 4 onwards

The Government's CfD Allocation Round 4 opened on 13 December 2021[45]. For Allocation Round 4, the Government introduced a rule change that prevents supported generators from receiving a top-up to the agreed strike price during periods of negative DAM prices. We assume that this rule will remain in place for future allocation rounds.

This rule change has a material impact on our assessment as it means that those generators with such a contract would most likely choose to be curtailed before prices became negative, in turn reducing the likelihood that negative prices are observed.

For this reason, we incorporate two separate fleets of technology for all CfD producers, one of which represents CfD supported generation that entered into a contract before Allocation Round 4 and the other which represents CfD supported generation from Allocation Round 4 onwards[46].

Modelling demand-side flexibility

Figure A.2 lists the consumer archetypes in our modelling. These all have an underlying demand profile. However, we assume that the majority of demand customer categories are able to respond flexibly to some degree to the DAM market price, either directly, through their supplier or after being contracted to provide flexibility by a VLP. We assume that all customers with an enabling technology have the potential to provide a flexible response.

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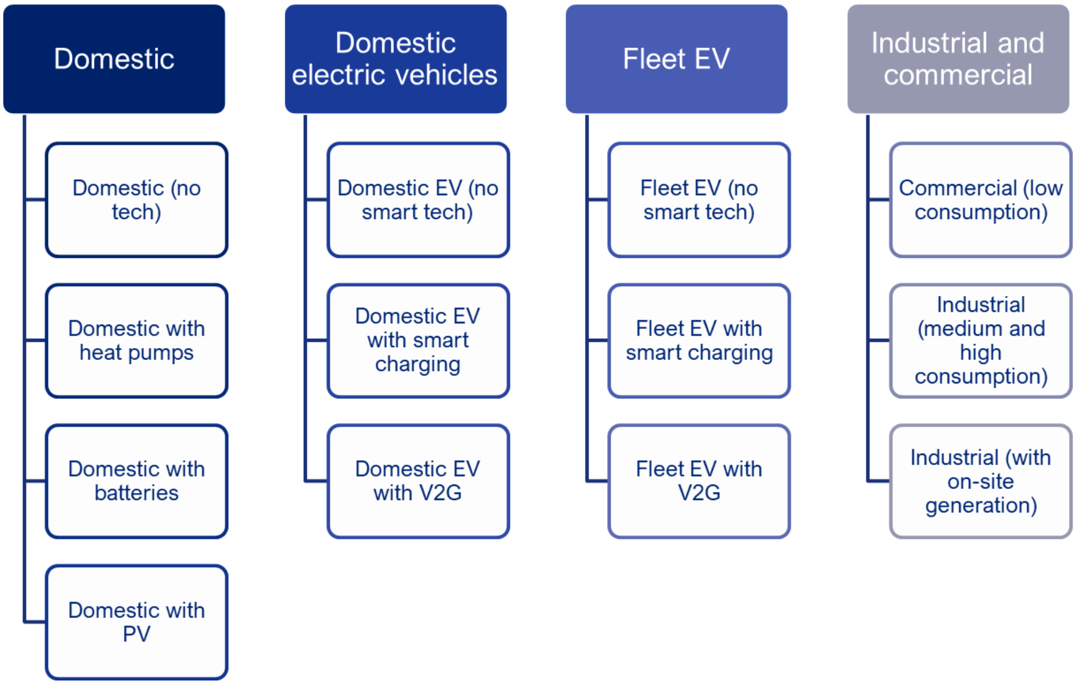
[45] See: https://www.gov.uk/government/collections/contracts-for-difference-cfd-allocation-round-4

[46] We assume that new-build nuclear is supported under a RAB model in which it effectively receives its LCOE regardless of the DAM price.

Figure A.2: Consumer archetypes represented in the model



To model the P415 variants, we create a second identical set of customer archetypes that can provide a flexible response. This allows us to allocate one set to flexibility contracted by VLPs while the other is allocated to non-VLP delivered flexibility. We use this to model a defined level of flexibility capability from VLPs that is separate to the flexibility capability provided by non-VLPs.

A.2. Modelling of flexibility

Our modelling incorporated the provision of flexibility from the relevant consumer types included in Figure A.2. In the model, demand-side flexibility effectively competes with producers (including generation, interconnection and batteries) in the wholesale market merit order, with variable costs defined based on any activation costs and, in the case of Compensation 1, the compensation cost which is borne by the VLP.

Take-up of each flexible technology under each scenario is taken directly from the FES. We define demand profiles of each technology, drawing on historical data for each customer type. Where customers have technologies which allow them to respond flexibly, we incorporate this ability using either a virtual battery or a virtual generator based on two distinct forms of DSR:

- 'Peak reduction' implies that any demand reduction is not balanced by an increase in other periods. This may reflect load that can be met with alternative back-up generation for example. In our model, this type of response is modelled as a 'virtual generator' unit at the demand node which nets off demand when flexibility is utilised.
- 'Load shifting' implies that any demand reduction is balanced by an increase in demand in other periods. In our model this type of response is modelled as a 'virtual battery' which discharges when flexibility results in a decrease in demand and charges when flexibility results in a corresponding increase in demand.

We assume that residential and commercial customers with enabling technologies generally provide load shifting flexibility. EVs and heat pumps that reduce demand in one period generally need to compensate this demand reduction with an increase in another period, otherwise the customer will not receive the same level of EV battery charge or heat comfort as they would have otherwise. Reflecting comments from the P415 Workgroup, we include a small amount of peak reduction for residential and commercial heat pump demand.

We model two types of large industrial and commercial flexibility. We model heat flexibility from I&C customers which we represent as load shifting. We assume that flexibility delivered from other I&C processes is peak reduction where consumers would be compensated for lost output or may have alternative means of production (e.g., on-site generators) that allow production to continue largely unaffected.

We model three tranches of response from I&C process which responds at different activation prices. The activation price is designed to reflect the costs to the I&C customer of reducing demand, either due to changes to processes or using a back-up generator for example. The activation prices were informed by workgroup members and are as follows:

- £50/MWh;
- £300/MWh; and
- £3000/MWh – designed to reflect the Value of Lost Load (VOLL) for an average I&C customer.

We had discussions with P415 Workgroup members about possible constraints on the frequency with which a I&C customer will be prepared to provide peak reduction. Therefore, we limit the number of hours that I&C customers are prepared to provide a flexibility service to 2% of the hours in the year. We assume that they can provide this service in the 2% of hours with the highest DAM prices helping them to avoid high price spikes.

Flexibility deployment under P415

To reflect the second uncertainty regarding the level of deployment of flexibility under P415 relative to the counterfactual (i.e., without the implementation of P415), we used the FES to define the total level of potential flexibility from each consumer archetype in our model.

We include flexibility deployment under the counterfactual. This represents flexibility through different mechanisms including:

- Responsiveness of consumers to wholesale market pass through contracts and tariffs – e.g., based on time of use tariffs provided to EV customers.
- Direct procurement of flexibility by suppliers, e.g., from direct contracting with large, flexible loads.

However, we assumed that only a proportion of the flexibility capability in the FES was deployed under the counterfactual, with the remainder only being delivered once we introduced the ability for VLPs to deploy flexibility in the wholesale market following implementation of P415.

To reflect our assessment of the level of uncertainty regarding the additional volumes that could be delivered by P415, we considered three possible assumptions: whereby P415 implementation delivered 30%, 50% or 70% of the flexibility capability envisaged in the relevant FES scenario[47]. The remainder of the flexibility incorporated in the FES scenario was included in the counterfactual and assumed to be delivered without implementation of P415 – i.e., 70%, 50% and 30% of the flexibility included in the FES scenario respectively.

A.3. Definition of flexibility from VLPs and non-VLPs

In some cases, the variable costs of delivering flexibility are likely to be low, in particular where customers observe little/no impact on their electricity supply. In other cases, VLPs will incur variable costs associated with compensating customers for inconvenience associated with the provision of flexibility. In this case we assume that non-VLPs will also incur variable costs of deploying flexibility as they would also have to compensate consumers for the deployment of any flexibility.

[47] Note that these assumptions do not represent a CEPA view on the extent of additional flexibility expected. Neither do CEPA consider that they represent the full range of possible outcomes.

VLPs will also incur fixed up front and fixed ongoing costs to develop their business, e.g., to acquire and manage a customer portfolio. P415 Workgroup members also say that in many cases they expect to incur the costs of installing enabling technology (e.g., 'smart' thermostats, 'smart' EV chargers, industrial process automation) to allow for flexibility to be delivered.

While fixed costs do not feature directly in our modelling, we compare revenues recovered by VLPs against these fixed cost assumptions to provide a commentary on the likelihood of entry and exit of the flexible capability assumed to be procured by VLPs.

To inform our consideration of the cost base of VLPs we submitted a data request to members of the Workgroup requesting their views on cost assumptions for three types of aggregators. Responses from VLPs to our request for information are summarised in Table A.1.

Table A.1: Assumptions for costs of deploying flexibility (provided by VLPs)

	Residential customers - load shifting and peak reduction	**Industrial and commercial – load shifting**	**Industrial and commercial – peak reduction**
Up front fixed costs (£/MW)	Dependent on whether the flexibility provider needs to pay for the installation of enabling technology: If not: c. £4k/MW If they do: Up to c. £160k/MW	c. £2.5k - £6k/MW	c. £2.5k - £6k/MW
Ongoing fixed costs (£/MW/yr)	Dependent on whether the flexibility provider needs to pay for the ongoing maintenance of the enabling technology. If not: May only be admin and settlement costs. If they do: Up to c. £30k/MW/yr	c. £1.2k - £5k/MW/yr	c. £1.2k - £5k/MW/yr
Variable costs (£/MWh)	~£0 (assuming minimal disruption for the flexibility provider)	~£0 (assuming minimal disruption for the flexibility provider)	Multiple tranches: 1st tranche: c. £50-60/MWh … Nth tranche: c. VoLL – 10%

A.4. Compensation variant definition

Table A.2 summarises the approach taken for modelling the two P415 compensation variants

Table A.2: Modelling of compensation variants

Variant	Who pays compensation?	Compensation price	Approach taken in the modelling
Proposer	VLPs	Estimate of supplier sourcing costs to approximate retail price	We incorporate compensation into the model as an additional variable cost faced by VLPs whenever they deploy flexibility into the wholesale market. We approximate the sourcing cost by taking a seasonal average of the DAM price in each model run. This proxy is consistent with our understanding of the Sourcing Cost methodology being developed by Elexon
Alternative	Socialised across all suppliers	Wholesale market spot price	We estimate the total level of socialised compensation based on volumes of VLP participation and the associated spot price in each period. We include this compensation cost in the welfare calculation as an additional cost passed through to consumers by suppliers.

Appendix B ANALYSIS OF MARKET DYNAMICS FOR PEAK REDUCTION AND LOAD SHIFTING

In this appendix we set out in full our analysis of how market dynamics differ depending on whether it is a non-VLP or a VLP deploying flexibility. We firstly consider peak reduction activity before assessing load shifting.

B.1. Peak reduction

In Table B.1 we summarise the costs that fall on VLPs and suppliers in the case that:

- A supplier, acting as a non-VLP uses peak reduction flexibility from its own customers;
- A VLP uses peak reduction flexibility from a supplier's customer under Compensation 1; and
- A VLP uses peak reduction flexibility from a supplier's customer under Compensation 2.

The analysis is intended to consider how the variable costs of deploying flexibility may differ between VLPs and non-VLPs and how suppliers would be affected when a VLP deploys the flexibility of their customer, taking into account the compensation payment that would flow to that supplier.

In this analysis, we only consider the variable costs resulting from the lost potential for the supplier to sell a unit of energy to the customer and the cost of any compensation. Other variable costs such as the payment to the customer for activating flexibility are likely to exist. However, we assume that these costs would be internalised equally by VLPs and non-VLPs under all scenarios and so are not considered here.

Table B.1: Supplier position following non-VLP and VLP peak reduction flexibility deployment

Peak reduction (in Period t)	Supplier uses own flex (assuming they are contracted forward)	VLP deploys flex: Compensation 1	VLP deploys flex: Compensation 2
Activity	Where a supplier uses flexibility from their own customer: • They can sell energy into the wholesale market or avoid taking a short position in a high price period. • They lose the opportunity to sell a unit of energy at the Sourcing Cost, ignoring the retail margin.	When flexibility is deployed by the VLP, the supplier foregoes the opportunity to sell a unit of energy. We assume they would sell this at the Sourcing Cost, ignoring the retail margin.	When flexibility is deployed by the VLP, the supplier foregoes the opportunity to sell a unit of energy. We assume they would have sold this at the Sourcing Cost, ignoring the retail margin. They are compensated at the Spot Price which is likely to be > Sourcing Cost in the given period.
Variable cost of deployment and competition with suppliers	The supplier internalises the Sourcing Cost in its own flex action.	The VLP internalises the Sourcing Cost in its own flex actions.	The compensation is socialised so the VLP doesn't internalise any compensation to suppliers as a variable cost of deploying flexibility.
Supplier position	The supplier benefits by: 'Spot Price (t) – Sourcing Cost'	The supplier is compensated at the Sourcing Cost so is net neutral.	The supplier benefits by: 'Spot Price (t) – Sourcing Cost'

B.2. Load shifting

The analysis is a little more complex for load shifting flexibility as we must now account for both the downwards flexibility action and the upwards shift in demand which could take place in a later or an earlier period. We consider the same three cases as for peak reduction and applying the same scope and assumptions. We set out this analysis in Table B.2.

Table B.2: Supplier position following non-VLP and VLP load shifting flexibility deployment

Load shifting*	Supplier uses own flex (assuming they are contracted forward)	Compensation 1	Compensation 2
Activity	Where a supplier uses flexibility from their own customer, in Period t: • they avoid taking a short position or can sell energy into the wholesale market. • they lose the opportunity to sell a unit of energy (we assume this is at Sourcing Cost). In Period t': • they have to buy energy from the wholesale market or take a short position. • they can sell a unit of energy (we assume this is at Sourcing Cost).	The supplier is net neutral from the downwards energy action (see Table B.1). They sell an additional unit of energy in Period t' at the Sourcing Cost. But they have to purchase this from the wholesale market at the prevailing Spot Price in Period t'. The Spot Price in this period is likely to be below the Sourcing Cost.	The supplier benefits from the downwards energy action in Period (t) by 'Spot Price (t) – Sourcing Cost' (see Table B.1) In Period t', the supplier can sell an additional unit of energy at the Sourcing Cost, benefitting by 'Sourcing Cost – Spot Price (t')'.
Variable cost of deployment and competition with suppliers	The supplier loses the opportunity to sell a unit of energy in t but gains an opportunity to sell a unit in t'. The supplier's variable costs from its ability to sell energy are zero.	The VLP faces a variable cost from the compensation payment at the Sourcing Cost that the supplier would not internalise.	The VLP does not face any variable cost of compensation as we estimate is the case for the supplier.
Supplier position	The supplier benefits from the price arbitrage between periods: 'Spot Price (t) – Spot Price (t')'	The supplier benefits by the arbitrage between the additional unit of energy it can sell in Period t' and the spot price in this period: 'Sourcing Cost – Spot Price (t')'	Total benefit to the supplier is the arbitrage between the spot price in Period t and the spot price in Period t'. I.e., Benefit = '(Spot Price (t) – Sourcing Cost) + (Sourcing Cost – Spot Price (t'))' = 'Spot Price (t) – Spot Price (t')'

**Load reduction takes place in Period t, with the corresponding load increase in Period t'*

Appendix C BREAKDOWN OF WELFARE FOR THE 'NO FLEX' SENSITIVITY

In this section, we provide the breakdown of total welfare impacts under our 'no flex sensitivity' across energy consumers, VLPs, non-VLPs and flexibility providers and producers.

This shows that there is a significant level of benefit from the initial units of flexibility that are included in the counterfactual. Similar insight continues to hold regarding the balance of welfare impacts between the compensation variants. For example, we observe lower energy consumer welfare benefits under Compensation 2 compared to Compensation 1 but higher flexibility provider and producer welfare benefits.

Figure C.1: Consumer welfare compared to the "No Flex" scenario

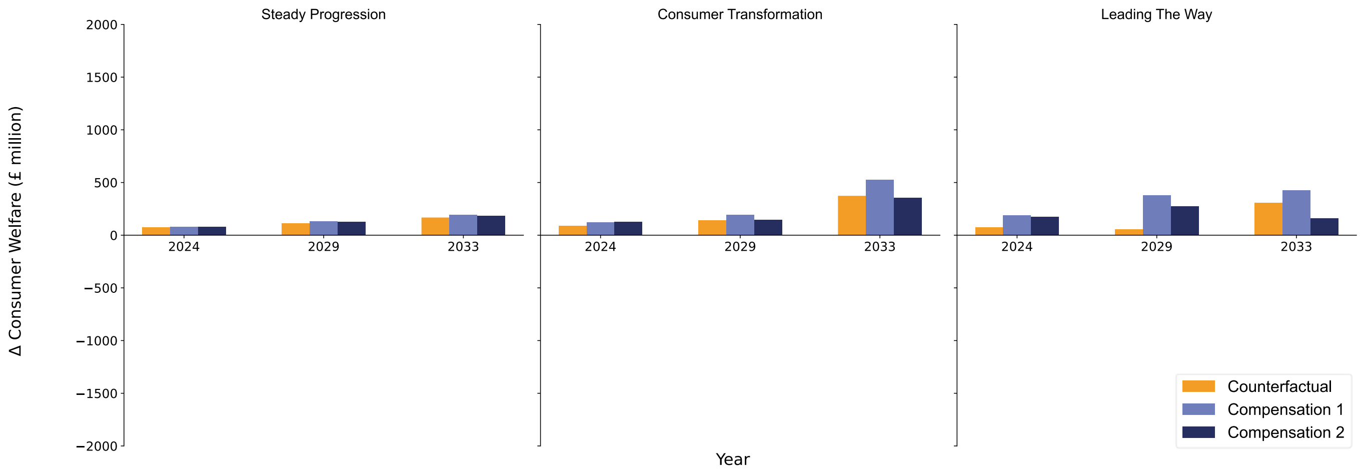


Table C.1: 10-Year NPV consumer welfare impact relative to 'No Flex'

	Steady Progression	Consumer Transformation	Leading The Way
Counterfactual	£1,163.52m	£1,862.84m	£1,250.12m
Compensation 1	£1,311.72m	£2,584.54m	£3,361.63m
Compensation 2	£1,284.12m	£1,945.97m	£2,149.46m

Figure C.2: Flexibility provider surplus compared to the "No Flex" scenario

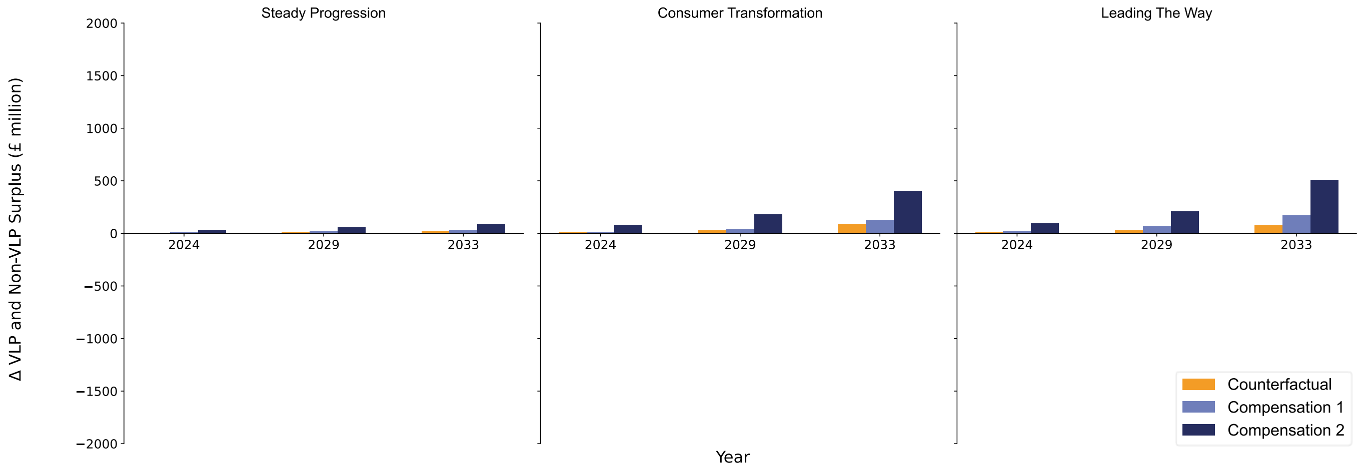


Table C.2: 10-Year NPV flexibility provider surplus impact relative to 'No Flex'

	Steady Progression	Consumer Transformation	Leading The Way
Counterfactual	£142.68m	£390.29m	£349.69m
Compensation 1	£195.38m	£580.56m	£822.62m
Compensation 2	£581.74m	£2,094.13m	£2,529.61m

Figure C.3: Producer Surplus compared to the "No Flex" scenario

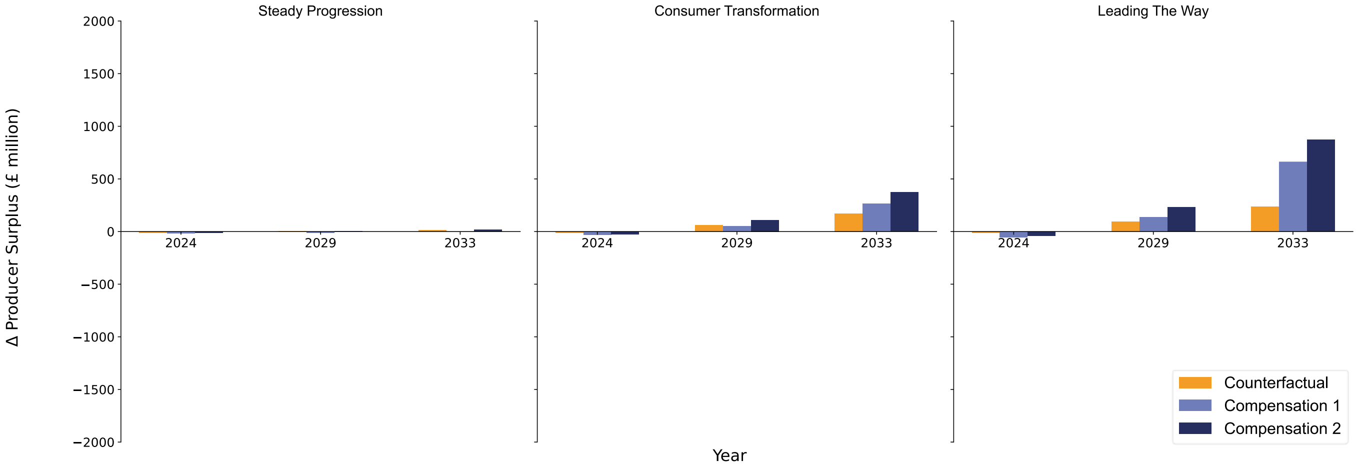


Table C.3: 10-Year NPV producer surplus impact relative to 'No Flex'

	Steady Progression	Consumer Transformation	Leading The Way
Counterfactual	£13.28m	£691.68m	£1,005.76m
Compensation 1	-£105.26m	£823.5m	£2,185.73m
Compensation 2	£8.84m	£1,390.87m	£3,187.28m

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