Assessment of the impacts of CLASS deployment

ENWL

June 2021

Executive summary

The objectives, approach and findings of this report

Report Objectives

- This report assesses the impacts of a wider deployment of CLASS across DNOs and informs the debate and discussion making ahead of ED2 submissions and final decisions on regulatory treatment.
- The report provides an objective, independent analysis of the potential impact of CLASS on the costs of operating a low carbon electricity system. The assessment considers both first and second order effects.

Our Approach

- A conceptual CBA was created and validated with key industry players such as DNOs, ESO and Ofgem to supplement our thinking.
- A cost benefit analysis of the first order effects was built to understand the benefit or disbenefit of a wider deployment of CLASS.
- Alongside the first order CBA, quantitative and qualitative analysis of potential second order effects was undertaken to ensure the full impacts of a wider deployment of CLASS were considered.

Key Findings

- CLASS could be effectively deployed to reduce the risk of automated disconnection as part of the OC6 buffer in the event of low frequency events, but purely in economic terms the costs would marginally outweigh the benefits costing customers approximately £0.09 per year on average across the modelled timeframe.
- However, if the ESO's Balancing Services (Dynamic Containment and Static FFR) requirement could be reduced by the equivalent volume – 1.3 GW (or approximately 2,250 substations) - the analysis shows an NPV of £1.2bn to 2050 or a customer bill saving of ~£1.50 per customer per year on average.
- In this scenario there would be carbon savings of approximately £76m (circa ~1.4 million tCO2 across the modelled timeframe) since CLASS would be displacing flexibility providers that are not fully zero carbon (mainly batteries) from these markets..
- The impact of CLASS leading to a lower requirement for ESO Balancing Services would be to displace some providers from the Balancing Services market into the wholesale market.
- The analysis suggests average annual revenues for batteries would reduce by around -£5/KW/yr (~6% reduction) as a result.
- CLASS can also be used as back up or a primary source of distribution level flexibility to support reinforcement deferral. The quantification of this benefit was outside of the scope of this analysis. Note that not all DNOs would choose to use CLASS in this way

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An overview of CLASS and the purpose of the report

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An overview of CLASS

- Customer Load Active System Services (CLASS) is a collective term used to describe the use of voltage management technologies on distribution networks. Voltage at a primary substation is varied to intentionally alter the level of power consumption at lower voltage connection levels. This change in power consumption can then be used to supply National Grid ESO with energy to help balance the wider integrated transmission system.
- Following an ENWL led innovation trial, the six GB DNOs have all agreed in principle to roll out CLASS. The majority are supportive of it being a regulated service, rather than DNOs participating in commercial markets, and sharing benefits with customers as a Directly Remunerated Service. This would mean including CLASS in the RIIO-ED2 business plans.
- The treatment of CLASS from a regulatory perspective has been the cause of some debate following its successful trial and launch into Balancing Services markets, given that regulated businesses are competing with commercial players.
- In its 2020 consultation, Ofgem was supportive of its deployment and minded towards a continuation of the current treatment under the TOTEX regime.
- However, not all DNOs have yet moved to deploy it, not least because of the commercial uncertainties. Including investment in CLASS as part of ex-ante allowances, and providing it as a mandatory service, is seen as a potential route for much wider adoption.

The purpose of the report

- The full impacts of CLASS need to be assessed from a consumer, markets and system resilience perspective to inform the decision over regulatory treatment and forward market design.
- The purpose of this report is to provide an objective, independent analysis of the potential impact of CLASS on the costs of operating a low carbon electricity system. This will inform the debate and decision making around regulatory treatment ahead of ED2 submissions and final decisions on how CLASS is treated within the RIIO ED2 framework.
- Baringa has engaged with all of the GB DNOs, National Grid ESO and Ofgem during the creation of the CBA, to ensure that views across the industry are captured and considered (shown on slide 10), to create an objective, independent and robust CBA.

Current and potential future applications of CLASS

The scale and regulatory methodology used today, and the potential applications in for RIIO2 and RIIO3

Current application

- Today, ENWL has around 150MW- 300MW of available response, following the deployment of CLASS at roughly 260 primary substations.
- It currently bids this capacity in to the frequency response and fast reserve markets and has been successful in securing contracts, worth several million pa.
- ENWL shares this revenue with its customers through the Directly Remunerated Service mechanism as approved by Ofgem

Future applications

DNOs have identified three potential future applications of CLASS:

1. **Support for OC6 buffer.** Currently DNOs deploy a range of technologies to manage system frequency during losses of generation in line with their obligations under OC6. As part of the OC6 buffer, DNOs can utilise automated load disconnection in the event of low frequency events, thus reducing the requirement for the ESO to contract more frequency response. CLASS could be deployed to reduce the need for automated disconnection as part of this service.
2. **Reduced need for Balancing Services**. Alternatively, CLASS could be deployed directly to provide certain Balancing Services such as Dynamic Containment and Static Fast Frequency Response. This would reduce the volumes of Balancing Services that the ESO would need to procure from the market. For this analysis we assume that this is provided as a mandated service by the DNOs and they would not participate in the Balancing Services markets as ENWL does today.
3. **Distribution level flex services.** CLASS is able to provide small volumes 3-5% of short term demand side response, which DSOs may be able to deploy as back up for or as a primary source of flexibility service at specific substations, to support reinforcement deferral, for example. It is assumed that the DSO would procure this service from its DNO business on a neutral basis alongside commercial providers of flexibility. We have not assessed the cost and benefits of this potential application of CLASS in this study.

Response services that CLASS can provide

Product	MW		
Dynamic Containment	1100		
Firm Frequency Response	Primary: 550	Secondary: 550	High: 450

- Currently the ESO is procuring around 1.65 GW of capacity for services that CLASS could provide
- These requirements are likely to grow in the future, with new services such as Dynamic Moderation and Dynamic Regulation being needed

2020/21 ESO Balancing Services expenditure

Cost £m	£m	%
Energy Imbalance	102.6	5.5%
Operating Reserve	182.9	9.9%
STOR	39.1	2.1%
Constraints	1070.7	57.9%
Negative Reserve	4.3	0.2%
Fast Reserve	116.2	6.3%
Response	145.7	7.9%
Other Reserve	22.0	1.2%
Reactive	65.1	3.5%
Black Start	69.3	3.7%
Minor Components	32.5	1.8%
Total	**1850.2**	**100.0%**

- Response services currently make up around 8% of the ESO's Balancing Services expenditure

Our approach to assessing the first order impacts of CLASS

The Cost Benefit Analysis focuses on first order effects only with a separate piece of analysis centring around second order effects

The key considerations for the first order effects CBA are the impacts on the components of consumer bills (DUoS and BSUoS), the impacts on current and future balancing service markets and what contribution CLASS could make to decarbonisation, by displacing more carbon intensive technologies. To do this, we have carried out the following steps:

1. We developed a conceptual CBA Framework (core deck – slide 9)

- A conceptual CBA is a box and wires flow chart, which portrays the costs and benefits of the model, highlighting how they interact.
- A draft conceptual CBA was created and used to facilitate discussions with the DNOs, ESO and Ofgem to gather feedback and incorporate different industry views into our wider analysis and validate our approach.
- These conversations did not fundamentally alter our conceptual framework but provided valuable insight into the second order effects analysis.

2. We mapped CLASS capabilities to Balancing Services and undertook a market sizing exercise (appendix– slide 24)

- We discussed CLASS capabilities with the ESO to ascertain which Balancing Services CLASS could provide and discussed how these markets might evolve over the CBA time period (out to 2050) to ensure a realistic case was modelled.

3. We analysed Balancing Services auctions to understand the supply associated supply stack (appendix– slide 24)

- Supply analysis was required to understand which technologies would be displaced by CLASS and at which price this would occur, we then undertook analysis of previous auctions results to create a merit order.

4. We performed scenario analysis to understand the impact of different scenarios (core deck – slide 8)

- We applied various deployment, pricing and implementation scenarios to our model (see slide 8 for an overview of the scenarios used).

Our cost benefit analysis approach

The benefits identified in the CBA were a reduced volume of automatic load disconnection due to OC6 requirements, reduced customer bills and potential reduction in carbon emissions

Benefits	Overview of the benefit	Modelling approach
Reduced volume of automatic load disconnection due to OC6 requirements	• CLASS can reduce the amount of automatic load disconnection due to OC6 requirements which reduces the likelihood of an August 2019 style event from taking place in the future, where 669 MWh was lost • The value materialises through a decrease in the cost of lost load associated with these low probability, high impact events.	• The August 2019 event was used as the counterfactual here, assuming an event of this order occurs once every ten years. • In scenarios where CLASS is deployed to support the OC6 buffer we assume that it significantly reduces the need for automated load disconnection in the event of low frequency events.
Reduced customer bills	• CLASS is a cost effective method for delivering certain ESO Balancing Services. • We assume that the benefit flows through to customers via lower BSUoS and/or DUoS charges depending on the regulatory treatment.	• The Balancing Services applicable for CLASS are Dynamic FFR, Dynamic Containment and Quick Reserve (using the current Static FFR requirement as a proxy for initial market size for this new service). • We assume that CLASS is a mandated service covered by ex-ante TOTEX allowances (i.e. does not participate in commercial balancing services markets). • For simplicity, we assume that the full cost and benefit of CLASS flow through to customers via DUoS and BSUoS.
Reduced carbon emissions	• The provision of CLASS into the Balancing Services markets results in other technologies being displaced leading to reductions in carbon emissions. • The second order effects of this displacement are discussed in more detail later in this report.	• We estimated the carbon emissions from displaced technologies, factoring in the reduction in losses also.

Source: https://www.ofgem.gov.uk/system/files/docs/2020/01/9_august_2019_power_outage_report.pdf - pg. 19

Scenarios used in our first order effects CBA

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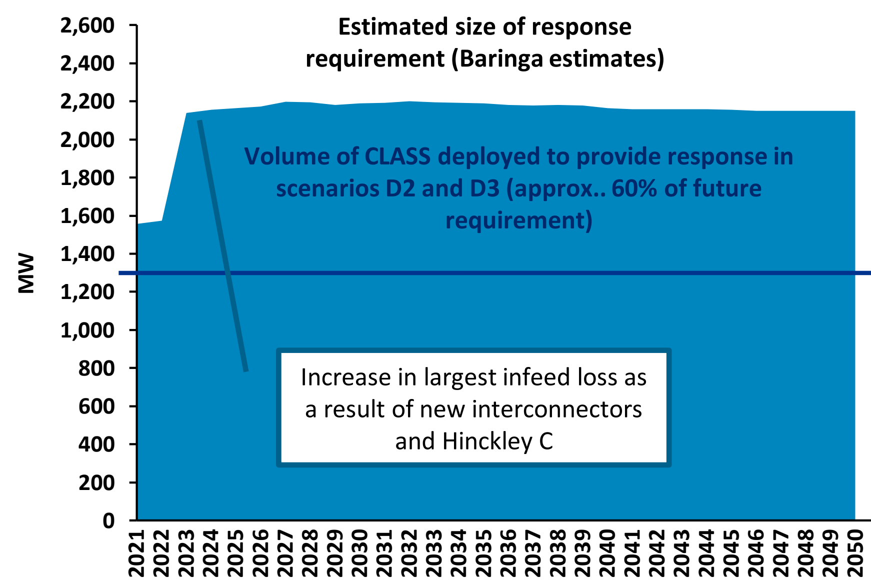
A variety of deployment, pricing and implementation scenarios were used in the CBA to highlight the impact that a further roll-out of CLASS could have in different situations

Deployment Scenarios
D1 – 1.3 GW (OC6 buffer requirement only)
D2 – 1.3 GW (deployed for Balancing Services)
D3 – 2.6 GW (1.3GW into OC6 and 1.3GW in Balancing Services)
Pricing Scenarios
P1 – Zero
P2 – Long-run marginal cost of CLASS
P3 – Price-taker (assume price of highest successful commercial bid)
Implementation Scenario
I1 – CLASS implemented in all licence areas
I2 – CLASS implemented in half of the licence areas

All scenarios are interchangeable, resulting in 18 modelled outputs

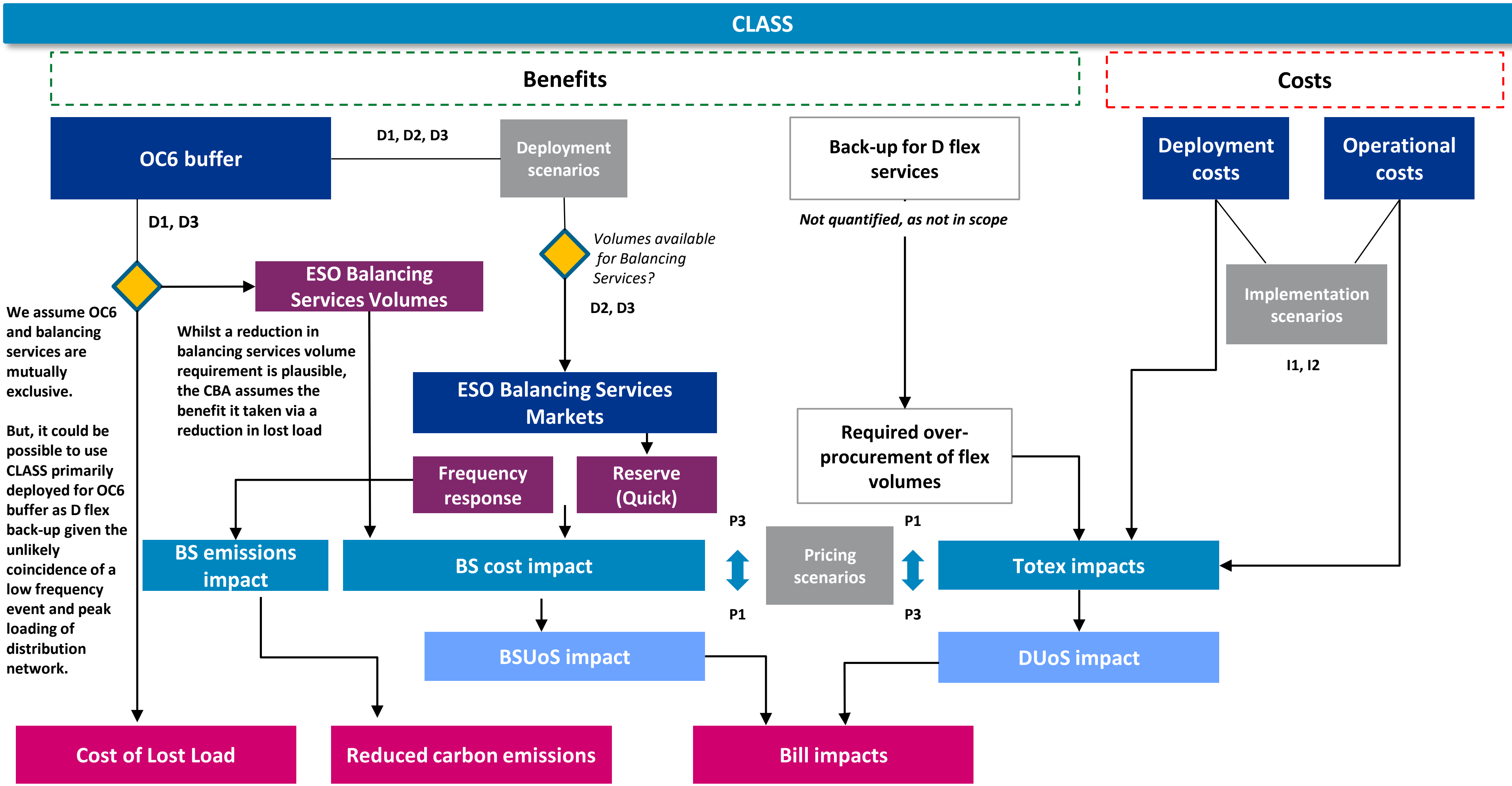
Today, ENWL has around 150MW of available response, following the deployment of CLASS at roughly 260 primary substations.

The deployment scenarios modelled would require approximately 2,250 primary substations to participate in CLASS across GB to provide 1.3GW and 4,500 to provide 2.6 GW.



Conceptual CBA: How benefits from CLASS could be realised

The conceptual CBA was discussed with key stakeholders and highlights how the costs and benefits of CLASS flow through to impact the CoLL, carbon emissions and customer bills

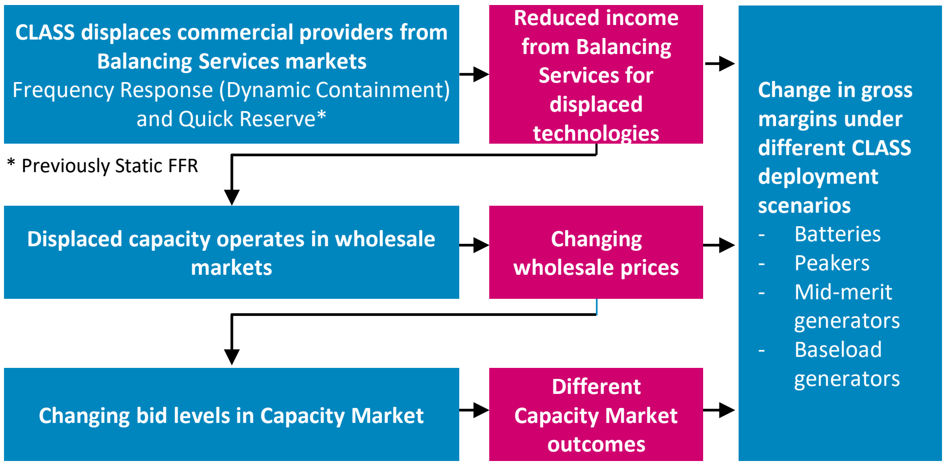


Our approach to assessing the second order impacts

Our second order impact assessment includes quantitative and qualitative analysis

Quantitative Analysis

- Our quantitative analysis focuses on the knock-on impact that CLASS creates when displacing a technology from the Balancing Services Markets, as shown in the figure below:



Qualitative Analysis

- Our qualitative analysis focussed on the potential impact of CLASS on:
  - Investor confidence in renewable technologies.
  - The independence of DSO decision making.

Feedback from stakeholder sessions

We have had conversations with all of the DNOS, ESO and Ofgem. This has informed our thinking but not fundamentally changed our approach to the CBA

Overview of stakeholder sessions

- There was alignment on the potential role of using CLASS to reduce the risk of automated load disconnection as part of the OC6 buffer.
- Some DNOs are concerned about the deploying CLASS for ESO Balancing Services given the potential impact on commercial flexibility service providers, and the risk of an unintended consequence of less providers of flexibility for distribution services.
- There were divergent views on whether CLASS should be used as back up for distribution flexibility or even for primary distribution flexibility. However, volumes are likely to be small where primary distribution flexibility is concerned, given low locational disaggregation and the need to cycle CLASS.
- There were different views on whether the future DSO business rather than the DNO would deploy CLASS, and also concerns that the use of CLASS could bring into question the independence of the DSO.

Development of the cost benefit analysis tool

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The CBA enables the user to mix and match deployment, pricing and implementation scenarios to understand the impact scenarios have on NPV, customer bills and non-bill impacts

Model Structure

The model is structured into **6 sections**:

- **Information & user guide** – provides background on modelled balancing services and directions for the user.
- **Control tab** – allows the user to test different scenarios and inputs.
- **Results** – presents a summary of relevant model results.
- **Calculations** – contains detailed calculations supporting the results.
- **Input data** – presents all relevant data used in the model.
- **Sources** – sets out relevant input data sources.

Model Functionalities

- **The model enables the user to mix and match deployment, pricing and implementation scenarios, providing.**
- **There are three different CLASS deployment scenarios**:
  - D1 - 1.3 GW deployed to the OC6 buffer.
  - D2 – 1.3 GW deployed to provide balancing services.
  - D3 – 1.3 GW deployed to provide balancing services and 1.3GW deployed to the OC6 buffer.
- **There are three pricing scenarios and two implementation scenarios:**
  - **CLASS pricing** (P1 – £0, P2 – long run marginal cost (LRMC) of CLASS, P3 – price taker).
  - **CLASS implementation in licence areas** (I1 – CLASS deployed in all licence areas, I2 – CLASS deployed in 7 licence areas).
- **The model enables the user to test the effects of different CLASS costs, Cost of Lost Load and financial parameters.**

The model does not

- Model the distribution reinforcement deferral benefit from using CLASS as an alternative to flex procurement.
- Consider where CLASS is deployed in the UK.

Model Outputs

- **Net present value** of bill and non-bill impacts out to 2050.
- **Customer bill impact**, split by BSUoS and DUoS.
- **Non-bill impacts**:
  - Carbon impacts.
  - Cost of Lost Load impacts.

Modelling logic and assumptions

Underpinning the model is the assumption that CLASS is a mandated service covered by ex-ante TOTEX allowances, with any DNO revenues arising from CLASS also entering TOTEX

	Modelling logic	Assumptions
Calculate system need and develop market sizing	• We used the Baringa Reference Case scenario for demand and generation by technology to 2050. • We mapped different generating technologies to the relevant Balancing Services they can provide and undertook regression analysis to calculate the response and reserve requirements. • We then calculated the growth rate in response and reserve requirements over time and applied it to the size of the relevant Balancing Service Market today to create our market sizing over time.	• The Balancing Services applicable for CLASS are Dynamic FFR, Dynamic containment and Quick Reserve (using Static FFR as a proxy for initial market size). • These assumptions were validated by ESO.
Undertake analysis of Balancing Services to create a market size	• We reviewed recent auctions to understand which technologies are winning to create a supply stack. • We reviewed how the winning technologies margins changed over time in the Baringa Reference Case and applied this growth rate to the current size of the balancing services market.	
Calculate revenues from Balancing Services and impacts on customer bills	• In scenarios where CLASS is deployed to provide Balancing Services, the CLASS deployment is multiplied by the relevant pricing scenarios (see appendix for an overview of scenarios). • This then flows through to customer bills via BSUoS and/or DUoS (depending on pricing scenario).	• We assume the 1.3 GW of CLASS used to increase system resilience via the OC6 buffer does not reduce the size of the Balancing Services requirement. • We assume that excess CLASS capacity is deployed to meet the highest value Balancing Service. • We assume that the full costs and benefits of CLASS flow through to customers i.e. no sharing mechanism.
Calculate the benefit where automatic disconnection is replaced by CLASS in the OC6 buffer	• The counterfactual is a high impact, low probability event in which automated disconnection occurs. • Disconnected load is multiplied by an assumed probability and Value of Lost Load (VoLL) to derive the Cost of Lost Load (CoLL) of an event occurring in that year. • Where 1.3GW of CLASS is deployed to the OC6 buffer this event is avoided.	• We used the August 2019 event as the counterfactual for the OC6 buffer, assuming a similar event occurs once every 10 years. • We only considered the immediate energy impact (MWh disconnected x VoLL) and did not model any wider economic consequences.
Calculate carbon impacts	• Where CLASS is deployed to provide Balancing Services, it displaces other technologies (predominantly batteries in response and bio-fuel in reserve), the carbon intensities of the displaced technologies are calculated.	• CLASS does not have any carbon impacts. • Batteries suffer 8% losses through the total energy cycle. • Baringa reference model view on carbon intensity used

Assessment of CLASS Impacts

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The NPV for CLASS providing Balancing Services is strongly positive; but is negative purely on economic grounds as a means of reducing risk of automated disconnection as part of the OC6 buffer

Deployment Scenario 1 – 1.3 GW deployed into the OC6 buffer

- This scenario returns a disbenefit as the costs associated with the wider deployment of CLASS dominate the benefit gained by a reduction in automated disconnection due to CLASS, which results in:
  - An NPV of ~-£76m
  - This represents a customer bill impact of ~£-0.09 per customer per year on average, based purely on the value of lost load.
  - The deployment scenarios assume that CLASS cannot support the OC6 buffer and provide Balancing Services simultaneously. However, as inertia control and demand management grow over time this may change.

Deployment Scenario 2 – 1.3 GW deployed to provide Balancing Services

- This scenario provides the a firmly positive NPV:
  - An NPV of ~£1.2bn and a customer bill impact of £1.15 - £1.56 saving per customer per year on average depending on pricing scenario/regulatory treatment.

Deployment Scenario 3 – 1.3 GW deployed into the OC6 buffer and 1.3 GW deployed to provide Balancing Services

- The benefit driven from providing Balancing Services outweighs the disbenefit associated with supporting the OC6 buffer:
  - An NPV of ~£1.2bn and a customer bill impact of £1.06 - £1.47 saving per customer per year on average depending on pricing scenario/regulatory treatment.
  - Even with the fixed (central) costs covered by the positive business case for Balancing Services, the incremental benefit of using it for OC6 is negative. This is because we assume that the 'services' are mutually exclusive,.

Deployment scenario	Net Present Value (£)
Counterfactual	
D1 - 1.3 GW CLASS Deployment for OC6 buffer	£(76.03m)
D2 - 1.3 GW CLASS Deployment for Balancing services	£1,247.66m
D3 - 2.6 GW CLASS Deployment for OC6 buffer and Balancing services	£1,173.81m

Carbon impacts

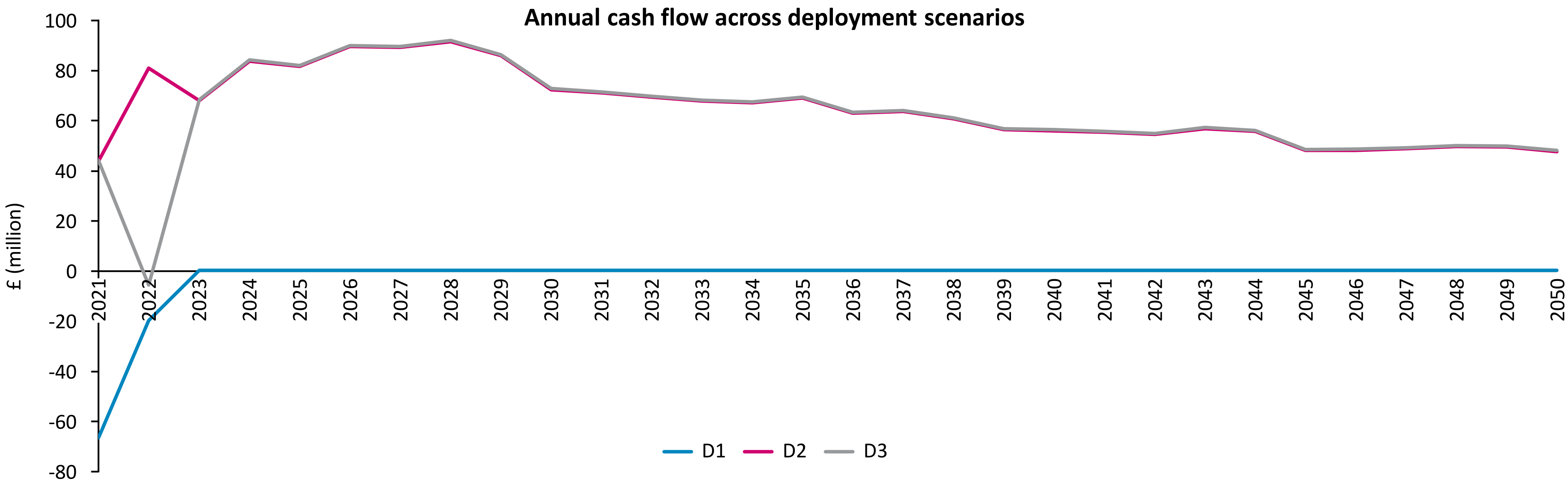
- D1 scenario does not have a carbon impact as CLASS is not deployed into the Balancing Services markets.
- D2 and D3 shows a carbon benefit NPV of ~£76m and cumulative carbon savings of ~1.4 million tCO2 across the modelled timeframe.

Cost of Lost Load

- In D1 and D3, where CLASS is deployed to reduce the risk of automated load disconnection as part of the OC6 buffer, the NPV of the benefit is ~£7.3m.
- The CBA assumes a uniform, static view of the Value of Lost Load of £6,000 per MWh, which in reality may vary by customer and duration, and there may be wider socio-economic benefits from reduced risk of supply interruptions.

Assessing CLASS impact over time – DNO cash flow

Assuming a rapid roll-out is possible, we see immediate payback on investment where CLASS is deployed in Balancing Services



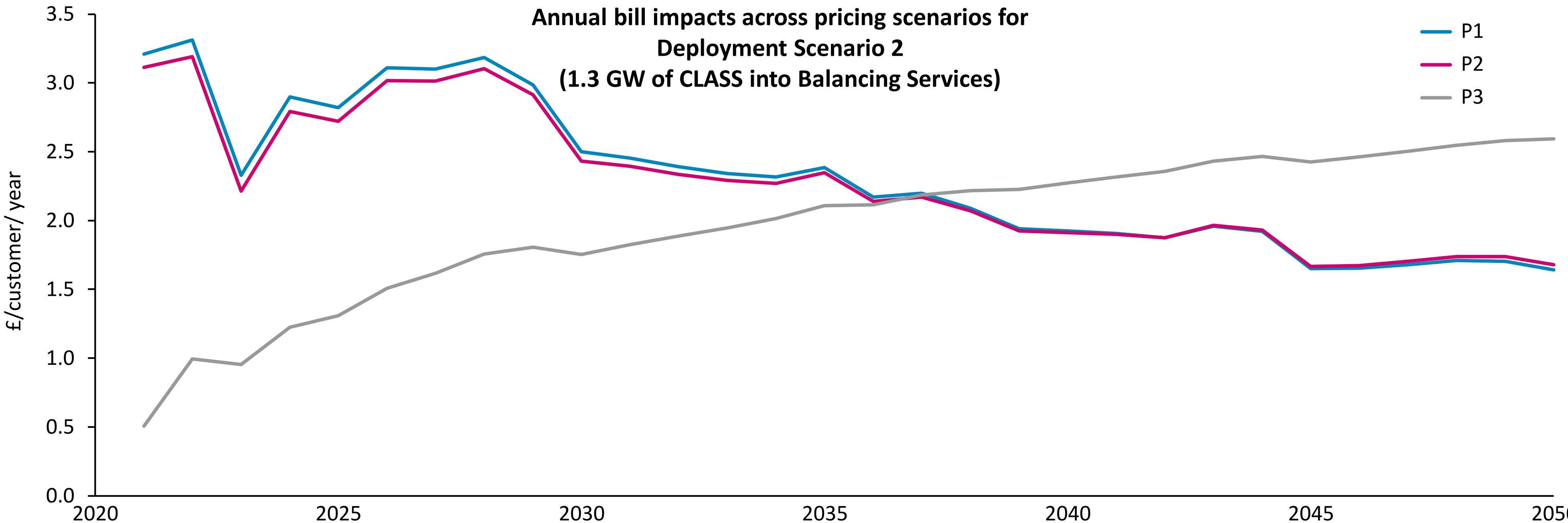
Findings

When CLASS is deployed for Balancing Services an immediate return on investment as shown in D2 and D3 in 2021 but where when CLASS is deployed to support the OC6 buffer a initial loss is seen as shown in D1 initially and D3 in 2022:

- **D1** shows a net cashflow in the early years as capex is spent installing CLASS, before showing marginal net benefit from the reduced risk of automated load disconnections
- **D2** shows the strongest business case for CLASS as it is deployed to provide Balancing Services and sees an immediate payback in the early years
- **D3** cashflows broadly reflect an aggregation of D1 and D2, but with marginal incremental benefits since the fixed dashboard costs are offset against larger overall deployment volumes

Assessing CLASS impact over time – customer bill impact

The savings on customer bills depend on the regulatory treatment of CLASS, and whether the benefits flow through BSUoS or DUoS.

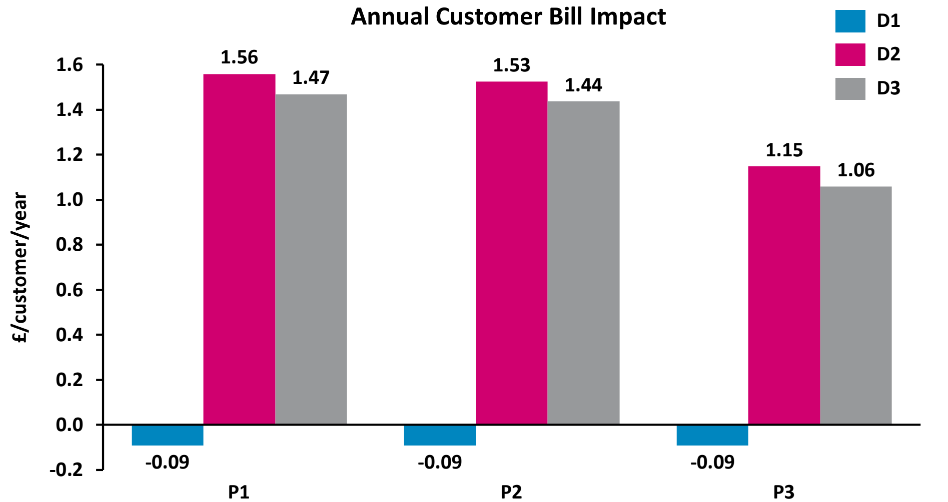


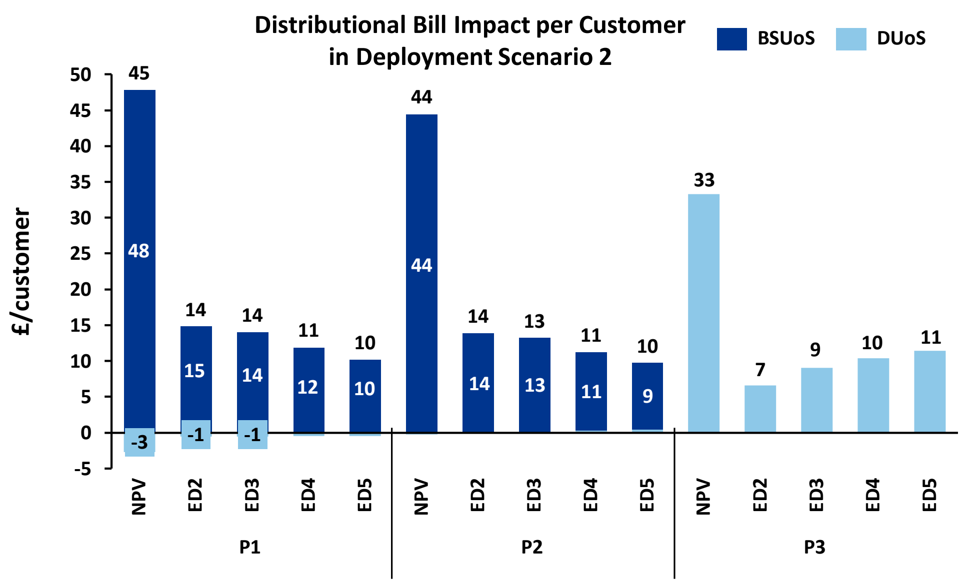
Findings

- Where CLASS is deployed for Balancing Services, we see a positive customer bill impact almost immediately, given the scale of benefits relative to the deployment costs
- In pricing scenarios where CLASS is made available to the ESO at zero (P1) or long run marginal cost (P2), the customer bill savings are sooner since the impact flows through in lower BSUoS which we assume suppliers pass on to customers. The benefits fall over time since we project that the costs for other flexibility providers will also fall.
- Where the value of the CLASS service is paid to the DNO (P3), and added to the RAV, the bill benefits accrue over a longer time through lower DUoS charges
- Alternative regulatory treatments are possible, as is the possibility of the DNO receiving some sharing benefit. For this analysis, we have simply assumed that the net benefit of CLASS is fully passed on to customers either through lower BSUoS and/or lower DUoS.

Analysis of customer bills

In terms of bills, customers benefit most where CLASS is deployed only for Balancing Services





Bill impact per customer

- Distribution network costs accounted for £93 of the average customer bill in 2020[1] and CLASS would reduce this on average by ~£1.50 in D2 per year (~1.6%)
- D2 shows the largest customer bill saving as it only includes CLASS deployed for Balancing Services, whereas D3 includes a small disbenefit associated the extra costs of deploying to support the OC6 buffer which is not fully matched by the benefit.

BSUoS impacts

- The largest BSUoS saving occurs when the ESO can reduce the Balancing Services procured from the market, and receives the CLASS services for free (P1).
- This saving is fully passed through to customers as the cost of CLASS deployment are incurred by the DNOs and fully passed through to customers via DUoS.
- Under P3 the ESO remunerates the DNOs are the market value for CLASS and hence there is no material BSUoS benefit.

DUoS impacts

- There are two aspects to DUoS: (1) The costs associated with deploying CLASS and (2) the revenues received from the ESO for the service it provides. For this analysis we have assumed that both are fully passed through to customers via TOTEX treatment (with no sharing factor).

Overall distributional bill impacts

- P3 shows lower customer benefit on a NPV basis than P1 or P2, given the regulatory treatment assumed, despite net benefit in nominal terms being the same across pricing scenarios.

Source:[1] Ofgem

Output – Non-bill impact

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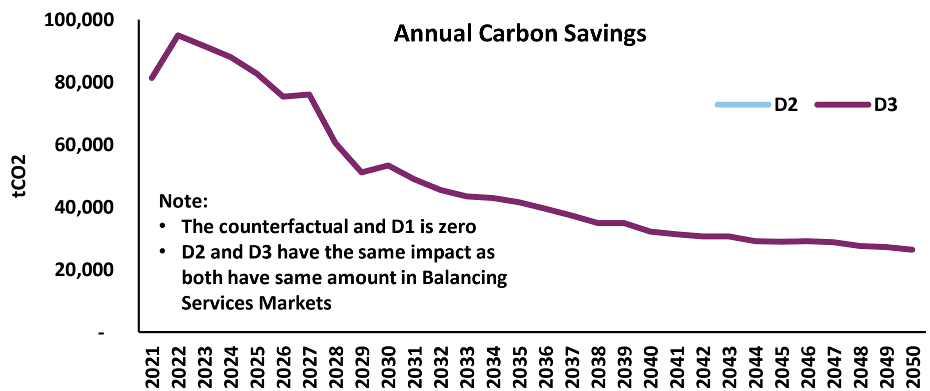
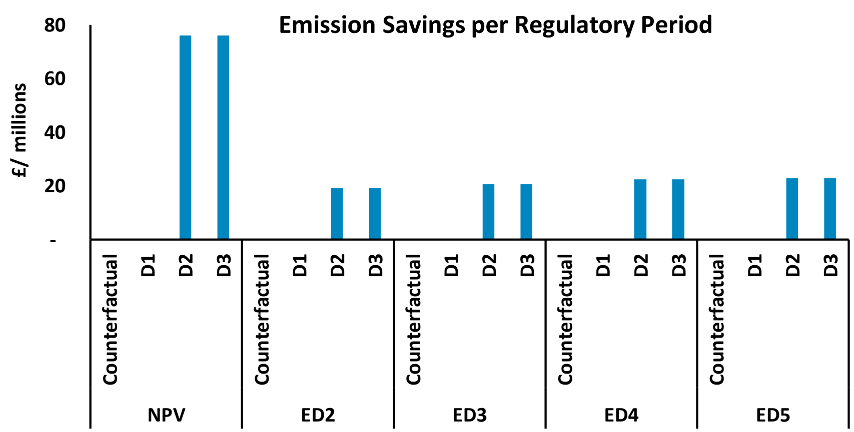
CLASS provides cumulative carbon savings of ~1.4 million tCO2 across the modelled timeframe

Carbon benefits findings

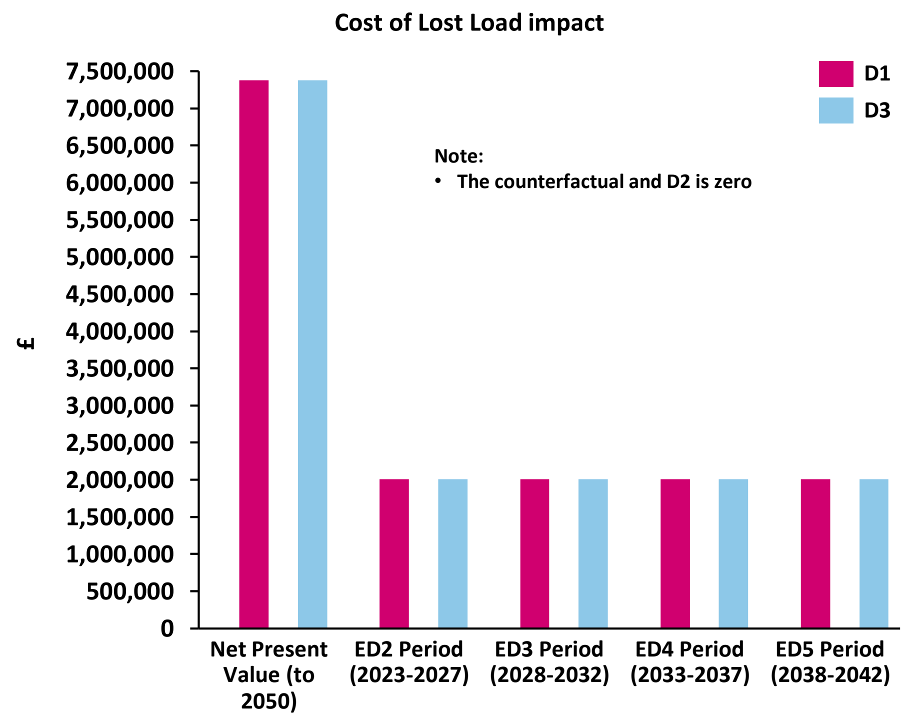
- tCO2 savings fall over time as the carbon intensity of the grid reduces.
- However, the value of the carbon saving holds up since the assumed social cost of carbon increases over time.
- Overall, this results in an NPV of ~£76m.





Cost of Lost Load findings

- The NPV of the benefit from the reduced risk of automated load disconnection where CLASS is deployed to support the OC6 buffer (D1, D3) is estimated at ~£7.3m.
- The CBA assumes a uniform, static view of the Value of Lost Load of £6,000 per MWh, which in reality may vary by customer and duration.
- There may be other socio-economic benefits of increased supply reliability that we have not attempted to quantify in this study.



Source: Grid Carbon Intensity is taken from Baringa Reference Case Model

Assessment of CLASS Impacts: Second order effects

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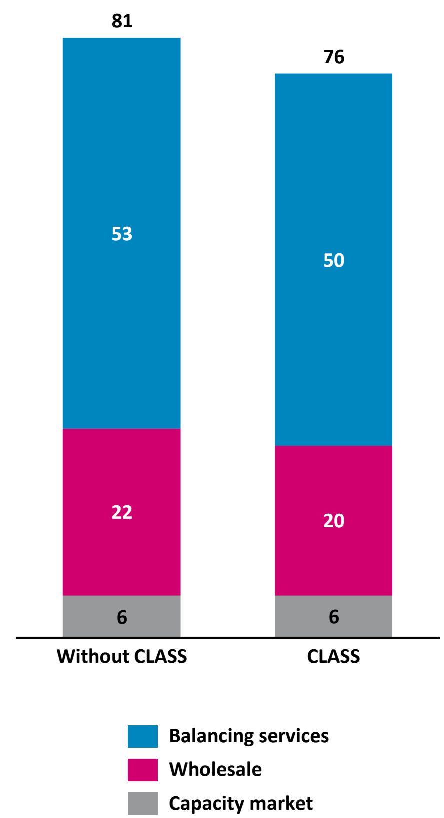
The deployment of CLASS for certain Balancing Services is likely to reduce the volume of services procured from batteries; we estimate that this would reduce annual revenues for batteries on average by around 6%

Findings

- We assume that the deployment of CLASS for response services will displace an equivalent volume of batteries from the Balancing Services (response) markets
- This will push more battery capacity into the wholesale market which will in turn impact on wholesale prices, and potentially Capacity Market clearing prices
- Using the Baringa Reference Case, as one potential future scenario, we estimate the potential annual average revenue impacts to be around a 6% reduction, made up as follows:
    - ~5% reduction from Balancing Services
    - ~10% reduction from the wholesale market
    - marginal reduction from the Capacity Market (~0.05%)
- Batteries are far less reliant than they were on long term contracts for Balancing Services, and increasingly relying on revenues from the wholesale market and Balancing Mechanism for their business cases. Hence, the impact of deploying class for response services on these business is less than it would have been a few years back.
- Response services, where CLASS could be deployed, only make up around 8% of National Grid ESO's Balancing Services costs.
- We do not foresee a reduction in security of supply since the Capacity Market targets a particular security standard
- Allowing a wider deployment of CLASS does undoubtedly present a regulatory risk for flex service providers, but the impact would be significantly less than other changes, such as the removal or the TRIAD benefit which reduced gross margins in the region of 30-40%.

Average annual battery revenues (£/kW)



Conclusions

Deploying CLASS to provide Balancing Services could lead to bill savings for customers and carbon reductions, but would have small but material impact on the commercial flexibility markets

1. CLASS could be effectively deployed to reduce the risk of automated disconnection as part of the OC6 buffer in the event of low frequency events, but purely in economic terms the costs would marginally outweigh the benefits costing customers approximately £0.09 per year on average across the modelled timeframe.

2. However, if the ESO's Balancing Services (Dynamic Containment and Static FFR) requirement could be reduced by the equivalent volume – 1.3 GW (or approximately 2,250 substations) - the analysis shows an NPV of £1.2bn to 2050 or a customer bill saving of ~£1.50 per customer per year on average.

3. In this scenario there would be carbon savings of approximately £76m (circa ~1.4 million tCO2 across the modelled timeframe) since CLASS would be displacing flexibility providers that are not fully zero carbon (mainly batteries) from these markets..

4. The impact of CLASS leading to a lower requirement for ESO Balancing Services would be to displace some providers from the Balancing Services market into the wholesale market.

5. The analysis suggests average revenues for batteries would reduce by around -£5/KW/yr (~6% reduction) as a result.

6. CLASS can also be used as back up or a primary source of distribution level flexibility to support reinforcement deferral. The quantification of this benefit was outside of the scope of this analysis. Note that not all DNOs would choose to use CLASS in this way.

Appendix

Scenarios, service mapping, market sizing, supply stack and CLASS costs

Model Assumptions: CLASS costs

A breakdown of CLASS costs can be found below

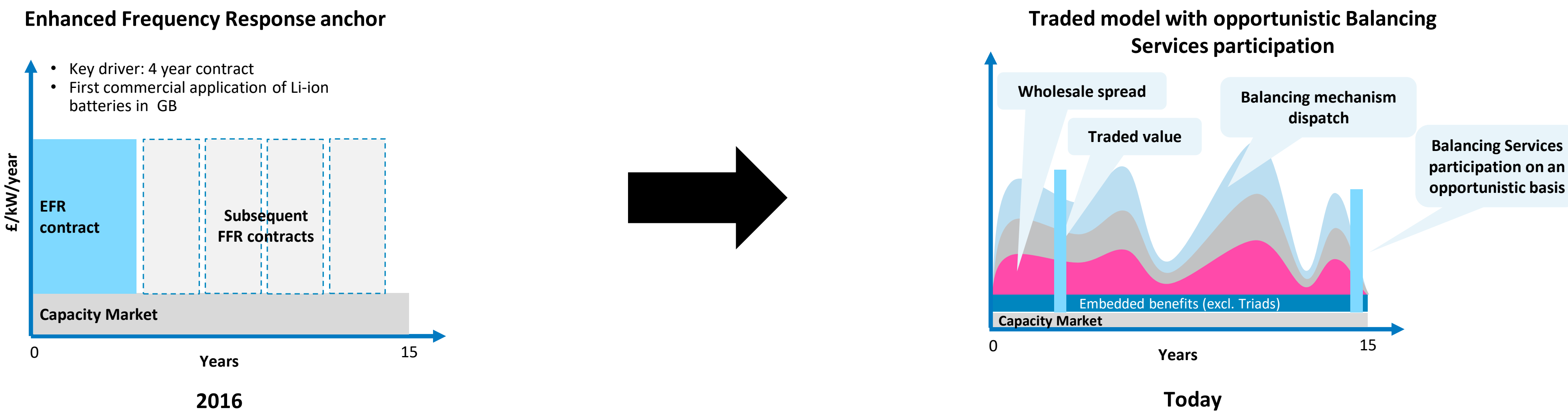
Description	Units	Value
Per-site CAPEX	£/site	31,000
Dashboard CAPEX (already incurred by ENWL)	£/CAPEX	1,000,000
# of sites		350
One-off CAPEX per site	£/site	2,857
Maximum capability per site	MW/site	0.51
CAPEX	**£/MW**	**66,937**
Lifetime (for CAPEX annuitisation)		25
OPEX	**£/MW**	**0**

For the purposes of the CLASS CBA:

- The per-site capex figure does not take into account routine maintenance and replacement of existing components that occur annually on a distribution network and therefore, through careful planning, this figure could be driven down.
- The dashboard CAPEX was included. In reality, ENWL would license this to DNOs to utilise, rather than multiple dashboard being built.

Second Order Effects: An overview of batteries

Batteries are far less reliant on long term contracts for Balancing Services, and increasingly relying on revenues from the wholesale market and Balancing Mechanism for their business cases. Hence the impact of deploying class for response services on these businesses is less than it would have been a few years ago.



Future batteries revenues and the impact of CLASS

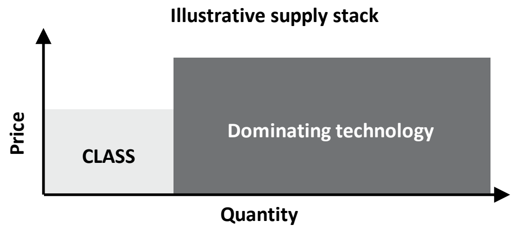
- The above shows the trend over the last 5 years which has seen batteries transition from long-term Balancing Service contracts to a traded model, becoming increasingly reliant on wholesale market revenue and less dependent on increasingly short-term Balancing Services contracts.
- This trend is expected to continue over time as more batteries are expected to enter the market and continue to saturate the requirement for Balancing Services. This results in increasing numbers of batteries spending time outside the Balancing Services markets, therefore, as a whole, batteries are becoming increasingly reliant on revenue from the wholesale market.
- **We note that the rollout of CLASS may accelerate this trend, however this transition is likely to continue with or without CLASS.**

Second Order Effects: Balancing Services markets

Our modelling highlighted a 38% increase in the combined response and reserve requirements from 1.5GW in 2021 to 2.2GW in 2050, indicating that 1.3GW of CLASS would equate to circa 60% of the market

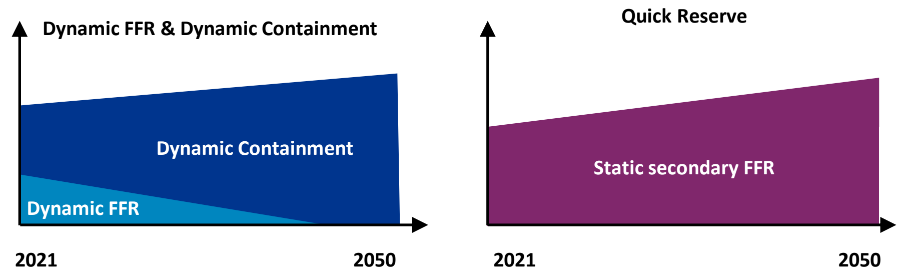
Balancing Services Supply Stack

A review of the recent Response and Reserve auction winners highlighted that a single technology dominated the auction (batteries for response and bio-fuel for reserve) and given that a core assumption is that CLASS is a mandated service covered by ex-ante TOTEX allowances (i.e. does not participate in commercial balancing services markets), the following illustrative supply stack was used:



Service Mapping and Future Market Sizing

Following conversations with NGESO, it was decided that CLASS could provide Quick Reserve and Dynamic Frequency Response services subject to careful specification and design. The figures below highlights what was modelled and illustrate how the areas change over time:



- Our modelling resulted in a 38% increase in the combined response and reserve requirements from 1.5 GW in 2021 to 2.2GW in 2050
- This indicates CLASS would equate to circa 60% of the market