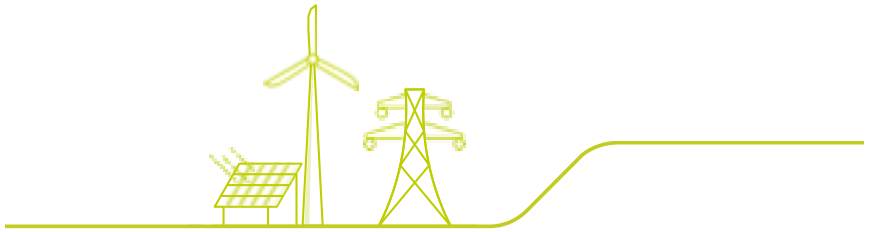
Balancing Costs: Annual Report and Future Projections

Technical Report

May 2024

ESO

Contents



Executive summary

Welcome to the first Annual Balancing Cost Report. This provides a look back on recent trends and provides a broad view of potential future balancing costs along with the ESOs role in minimising costs.

Our role as the Electricity System Operator (ESO) is to ensure electricity supply meets demand second-by-second, as well as managing the physical constraints of the network. This is what we refer to as 'balancing' the grid. Balancing costs pay for the wide range of tools, such as the Balancing Mechanism and balancing services, that help us to keep the electricity system stable and secure.

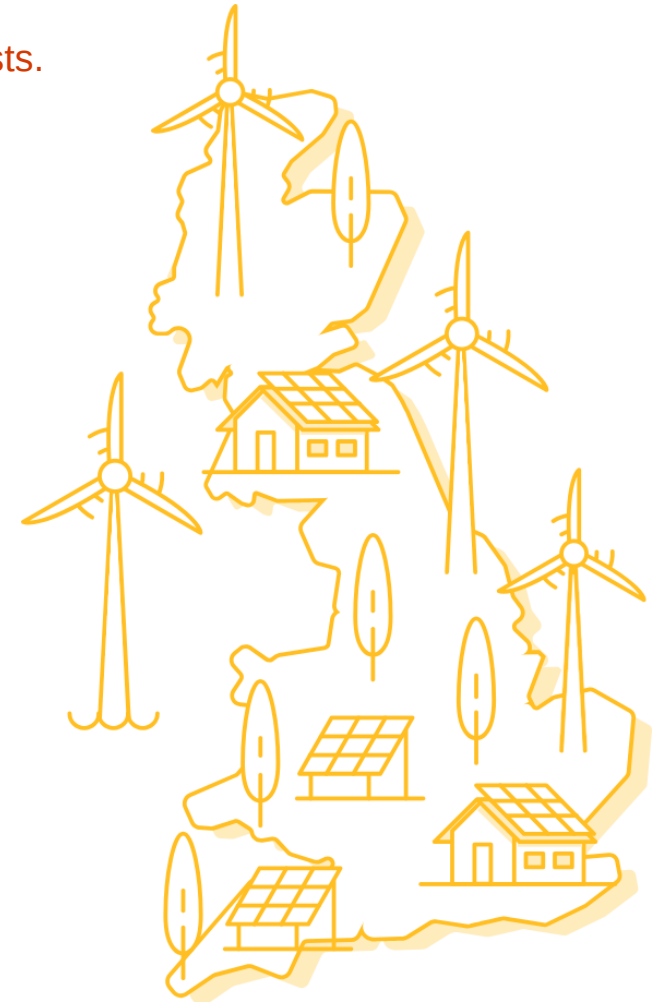
GB is leading globally on decarbonising electricity and connecting renewable and low carbon intermittent sources of generation. The variable nature of these energy types (i.e. wind and solar) can require us to undertake additional balancing actions which is managed by either turning down generation when there is too much or bringing on generation when there is too little.

We continue to recommend new transmission infrastructure to support a fully net zero carbon grid by 2035 and in March this year, we outlined our Beyond 2030 report, setting out network recommendations for network investment into the 2030s. Network optimisation is the most impactful lever available to minimise balancing costs as we progress with the energy transition. However, new network can take up to 14 years to build, far longer than connecting a new, renewable generation source. This results in a lag between new generation connecting and the infrastructure to transmit this renewable clean energy coming online.

We will continue to balance generation and demand, manage system constraints and operate a safe and secure network. Delivering these in the most economically efficient manner is paramount and why we closely monitor and report on system balancing costs. Balancing costs are predicted to rise until 2030, and the ESO will do everything within its control minimise this as outlined in this report. We will continue to work closely with industry to identify and accelerate new activities which will help us achieve savings.

In 2023/24 Balancing Services Use of System (BSUoS) charges contributed to ~4% of electricity bills for an average domestic consumer which works out to be about £4 a month on a typical domestic electricity bill. Although we are projecting balancing costs to rise out to 2030, balancing costs are one of many components making up energy bills and the energy transition will have variable impacts on these costs. For example, the integration of more renewables is often linked to reductions in the wholesale cost of energy. This report focuses only on costs related to balancing the electricity system.

Balancing costs in the future are also not fixed and can be lowered through proactive measures from the ESO and industry. The ESO strongly welcomes the Government's Transmission Acceleration Action Plan and its progress with the Review of Electricity Market Arrangements – both of which contain measures that can bring balancing costs down further in the coming years.



Executive summary

Work is already underway to ensure that the balancing component on consumer bills is kept as low as possible while maintaining security of supply and utilising market principles.

The ESO is continuing to undertake many significant endeavours, initiatives, and reforms to equip ourselves and the industry with the right systems, markets and capabilities to be able to manage an evolving electricity market and system at the optimal cost. We are working with industry to deploy new, world first technologies and services to balance the system, drive innovation and growth in the energy sector and create new opportunities for both businesses and consumers. We continue to seen significant industry engagement with new workstreams such as our Network Services Procurement Projects which have already realised millions of pounds of savings in thermal, voltage, and stability constraints in recent years. We greatly welcome and value this support from across the energy sector and continued input and collaboration will help us to keep balancing costs as low as possible.

Our Balancing Costs Strategy is helping us minimising balancing costs by leveraging initiatives in:

- **Network Planning & Optimisation.** Designing the GB network and manage a new generation mix and reduce Constraints.
- **Commercial Mechanisms.** Designing and Procuring new services, with greater competition at an optimised price.
- **Research, Innovation, Engagement.** Experimenting with first in sector approaches and technologies, collaborating with Industry and Academia.
- **ESO Capabilities.** Using enhanced products and services provided to the Control Room, optimising security, supply and cost.

ESO initiatives are already contributing to significant savings in balancing costs and we have identified further savings worth billions of pounds to consumers that we can achieve out to 2030. We will continue to work with Ofgem, Government and industry to realise these savings and identify further opportunities to minimise balancing costs.

Key messages

In FY23/24 balancing costs were still recovering from their peak in 2022 as gas prices eased off, but balancing costs lowered notably last year as we returned to less volatile conditions. Looking forward, balancing costs will continue to be subject to a range of drivers, notably changes to the GB generation mix and network build as we work to decarbonise the electricity system by 2035 while ensuring that the balancing component on consumer bills is as low as possible. In this report we explore work underway to manage balancing costs against the complexities associated with the whole system energy transition and key inflection points over the next decade.

Key Messages:

Balancing costs are projected to rise out to 2030.

Although wholesale prices have been a major driver of balancing costs in recent years, constraint costs are also rising due to significant changes to the GB generation mix, with up to 80 GW connecting by 2030 in our most ambitious decarbonisation scenario. Constraints will be the main driver of future balancing costs. ESO initiatives are mitigating this increase.

Decisions made now will shape balancing costs into the 2030s.

As we take on new roles in whole system planning, we can have a positive impact post-2030. Key decisions that will impact Balancing Costs include those considered in REMA, and those in Network Development, Connections, and new markets to aid balancing.

ESO initiatives create savings worth ~£18bn before 2030.

Future balancing costs are not fixed and can still be influenced by proactive initiatives from ESO and industry to reduce costs. We have been undertaking a wide range of initiatives within our balancing costs strategy that are aimed at minimising balancing costs, including our Beyond 2030 report, ASTI, new markets such as Balancing Reserve, and many others.

Methodology and Assumptions

This first Annual Balancing Costs Report shares the costs incurred in FY23/24 and provides insights into how these costs breakdown into different components. It also gives an overview as to how each of these cost components may evolve over the next decade based on the initiatives outlined in our Balancing Costs Strategy and portfolio of initiatives to minimise balancing costs.

The ESO has varying levels of control over factors that impact balancing costs, and this report aims to provide clarity of these factors. It is not a definitive projection of future costs, but rather an overview of anticipated trends and the factors that influence them. This report outlines ESO-led initiatives to minimise costs and key inflection points and factors that may impact costs beyond our direct influence.

What these projections are:
They are a best view of trends in future balancing costs based on historical costs components and potential future scenarios based on ESO initiatives. These projections offer a forward view of the future key inflections points over the next decade as well as a relative scale of how different influencing factors will impact balancing costs.

What these projections are not:
These are not a forecast or an accurate prediction of balancing costs and they will continue to be updated along with decisions of policy, markets and most significantly are entirely dependent and linked with wholesale energy prices.

Methodology:
To create the projections outlined in this pack we have looked at historical system balancing costs and overlaid these onto a combination of NOA7r (Pre-2030) and Beyond 2030 (Post-2030) Leading the Way residual thermal constraints. These have then been adjusted for future changes to market conditions, new transmission connections and new ancillary services.

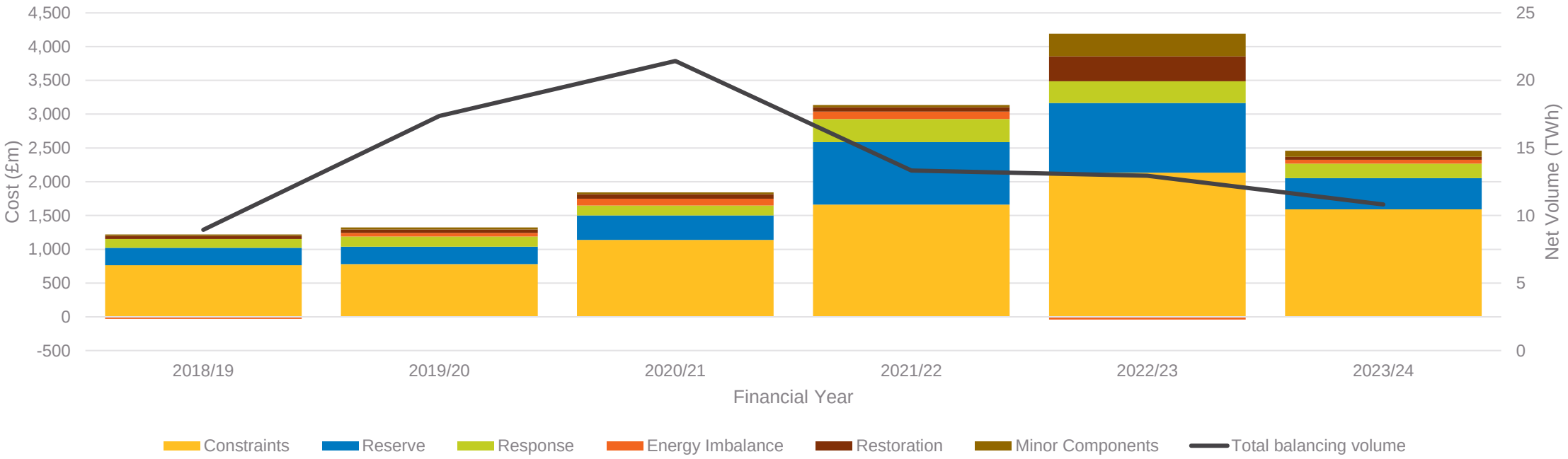
From historical data (last 5 years) we have assumed as a baseline that:
- Thermal constraints based on NOA7r and Beyond 2030 projections
- Voltage costs for FY 23/24 rolled forwards
- Stability costs for FY 23/24 rolled forwards
- Operating Reserve costs for FY 23/24 rolled forwards
- Response costs for FY 23/24 rolled forwards

Looking back

A look back on Balancing Costs over recent years, assessing the general trends, causes, and outcomes.

Outturn balancing costs and volumes

Figure 1. **Outturn balancing costs and volumes 2018/19-2023/24**

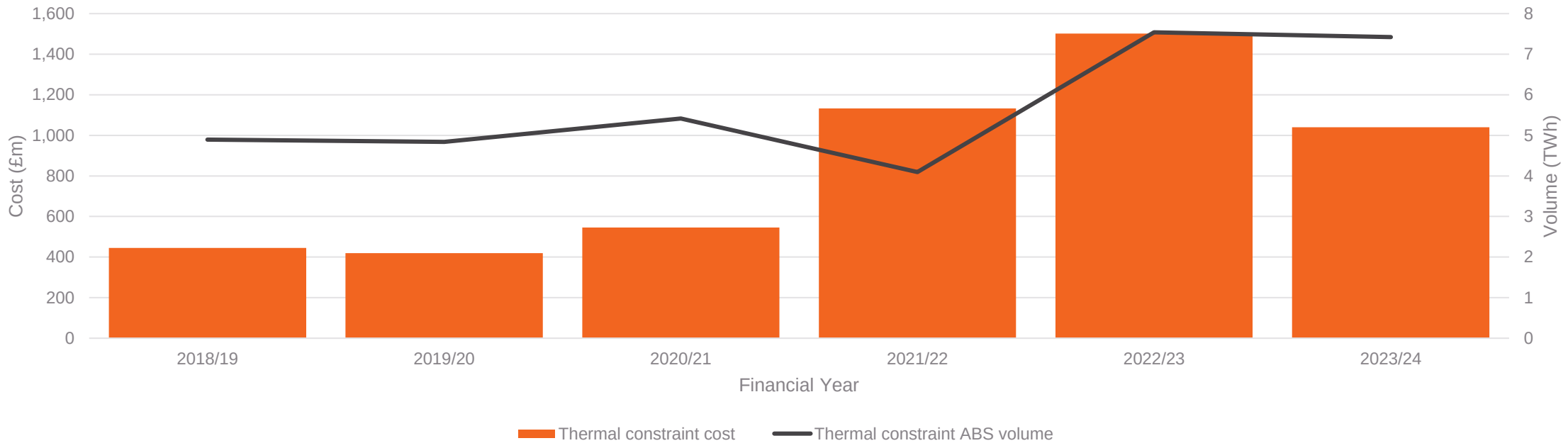


Overall Balancing Costs are significantly lower in 2023/24 (total spend £2.4 bn) compared to 2022/23 (total spend £4.1 bn). Net Balancing Volumes have also reduced in 2023/24 (10.8 TWh) and are much lower than the 2020/21 peak (21.4 TWh).

This decrease in costs can be attributed in part, to a substantial reduction in wholesale energy prices. The ESO has also directly contributed to this reduction through implementation of the initiatives outlined in our balancing costs strategy and elaborated upon in this report.

Outturn thermal constraint costs and volumes

Figure 2. **Outturn thermal constraint costs and volumes 2018/19-2023/24**

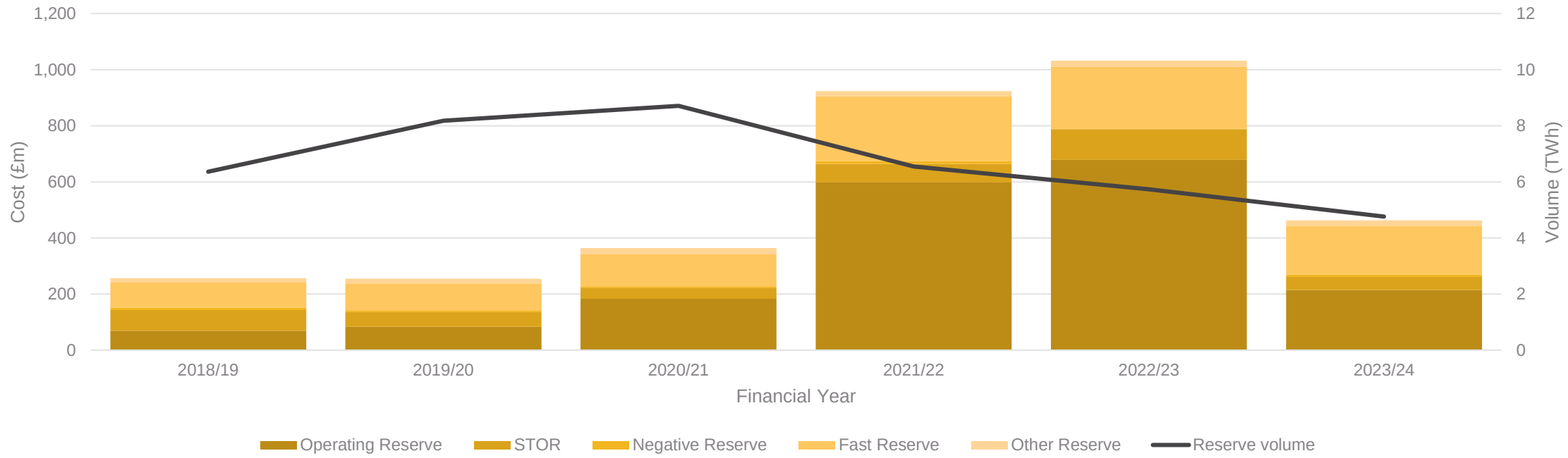


Thermal constraint costs are currently the most significant component of balancing costs, contributing to 40% in 2023/24 compared to 36% in 2022/23. Overall costs decreased significantly since in 2023/24 but are still higher than pre - 2021/22 levels. The volume of thermal constraints also remains high and is expected to increase in future years as the network becomes more congested.

Cost decreases in 2023/24 are in part due to ESO initiatives such as the B6 Intertrip service which has been in place since April 2022 and less wind curtailment due to lower overall wind outturn.

Outturn reserve costs and volumes

Figure 3. **Outturn reserve costs and volumes 2018/19-2023/24**

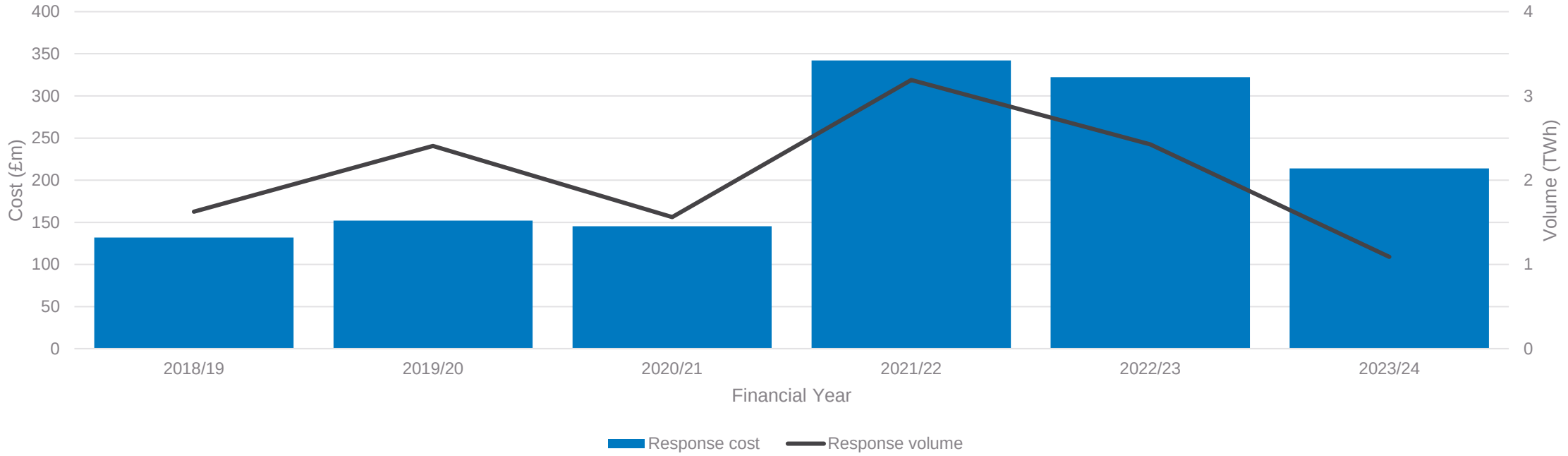


Reserve costs decreased significantly in 2023/24 compared to 2022/23 and 2021/22 and reserve volumes also continue to fall from 5.7TWh in 2022/23 to 4.8TWh 2023/24. Cost have lowered in line with wholesale energy prices and a reduction in utilised volume. Volume has decreased as we have optimised our reserve holding, resulting in less reserve held for wind shortfalls on average and the launch and growth of our dynamic suite of response products have reduced the amount of reserve needed to secure response capability in real time.

Our new Balancing Reserve service went live in March 2024. Balancing Reserve aims to reduce balancing costs and improve system security by procuring reserve volume in the day-ahead market, and we are continuing to reform our suite of pre- and post- fault reserve services.

Outturn response costs and volumes

Figure 4. **Outturn response costs and volumes 2018/19-2023/24**

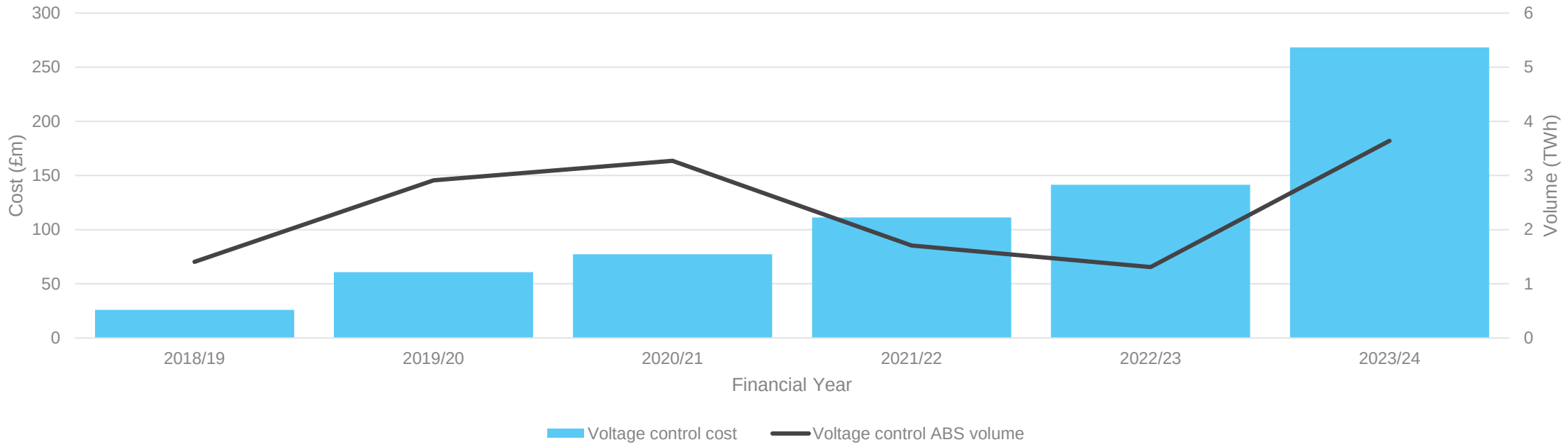


Response volumes have decreased significantly in 2023/24 since their peak in 2021/22 and yearly costs have fallen in that time period from £341m to £214m. This is largely due to major improvements in our response ancillary services which impacts volumes in the BM shown here.

We have been building the future of balancing services by introducing new Dynamic Response Services and Auction platforms. In 2023/24 we have started to see the benefit of more competitive and more liquid markets for our new ancillary services Dynamic Containment (DC), Dynamic Moderation (DM) and Dynamic Regulation (DR). Clearing prices for these services have lowered significantly since their launch due to an increase in the number of market participants, certainty around requirements and the auction process due to the continued development of the Single Market Platform. In November 2023 the procurement of DC, DM and DR was moved to the Enduring Auction Capability (EAC) platform which offered enhanced functionality such as splitting, co-optimisation and negative pricing leading to greater efficiency and reduced prices.

Outturn voltage costs and volumes

Figure 5. **Outturn voltage costs and volumes 2018/19-2023/24**

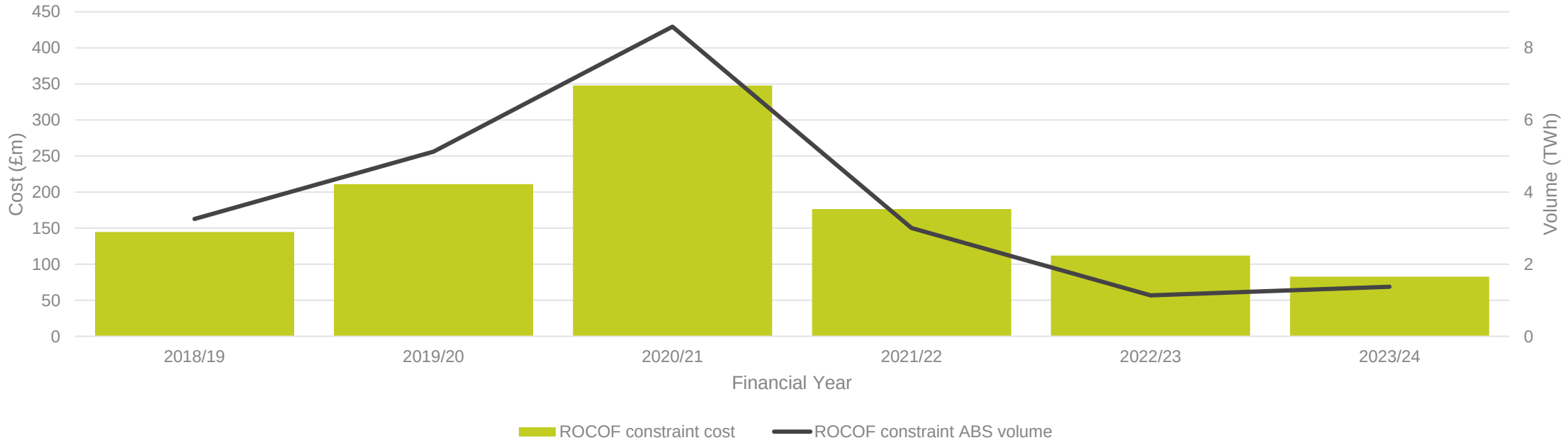


The volume of voltage constraints has increased from 1.3 TWh in 22/23 to 3.6 TWh in 2023/24, driving up costs to £268m in 23/24. There are various reasons for this rise including suppressed demand on embedded networks which increased the requirement for voltage management, and the impact of outages on transmission network owners' reactive equipment. High wind forecasts can also result in fewer CCGTs self-dispatching, requiring voltage support to be acquired through the BM and trading.

There are several initiatives in our strategy to lower voltage management costs such as the Voltage Mersey Network Services Procurement (started delivering April 2022) and Pennines Network Services Procurement (started delivering April 2024) as well as continued collaboration with Transmission owners to return reactive equipment on outage.

Outturn inertia costs and volumes

Figure 6. **Outturn inertia costs and volumes 2018/19-2023/24**



We continue to see huge benefits as a result of the action the ESO has taken to introduce the FRCR in 2021, new frequency response services, Accelerated Loss of Mains Change programme and the delivery of inertia from Phase 1 Stability Network Services Procurement.

Although there has been a slight increase in volume of actions for inertia to 1.4 TWh in 2023/24 compared to 1.1 TWh the previous year, this is still down significantly since 2020 and this small increase is expected within normal year-on-year fluctuations. As well as achieving an overall downwards trend since 2020 we have also successfully lowered the minimum inertia requirement to 130 GVA.s.

Looking forward

A overview of possible projections of Balancing Costs and when we are expecting future initiatives / risks to occur and what their impact will be, with suggested priorities

Future drivers of balancing costs - network investment

Investment in electricity transmission infrastructure will lower balancing costs

In June 2023, Nick Winser's independent report on Accelerating Electricity Transmission Network Deployment outlined the need for unprecedented development of Britain's transmission infrastructure to meet the UK Government's commitment for a fully decarbonised system by 2035, subject to security of supply considerations.

In March this year, the ESO outlined our Beyond 2030 report, setting out network recommendations throughout the 2030s. This investment in the electricity network will build on the Holistic Network Design (HND) to facilitate the connection of an extra 21GW of offshore wind and other low carbon generation across Britain.

Although, this rapid transformation of the electricity system will require significant levels of investment, the impact on consumer costs will vary across key components that make up energy bills. The network delivery recommended in the Beyond 2030 report is expected to significantly reduce balancing costs by alleviating network congestion. Investment in and optimisation of the national electricity network is consequently the most impactful lever available to minimise balancing costs as we progress with the energy transition. This section of the report assesses the future of balancing costs in consideration of the current proposed system developments and wider cost saving initiatives put forward by the ESO and wider industry.

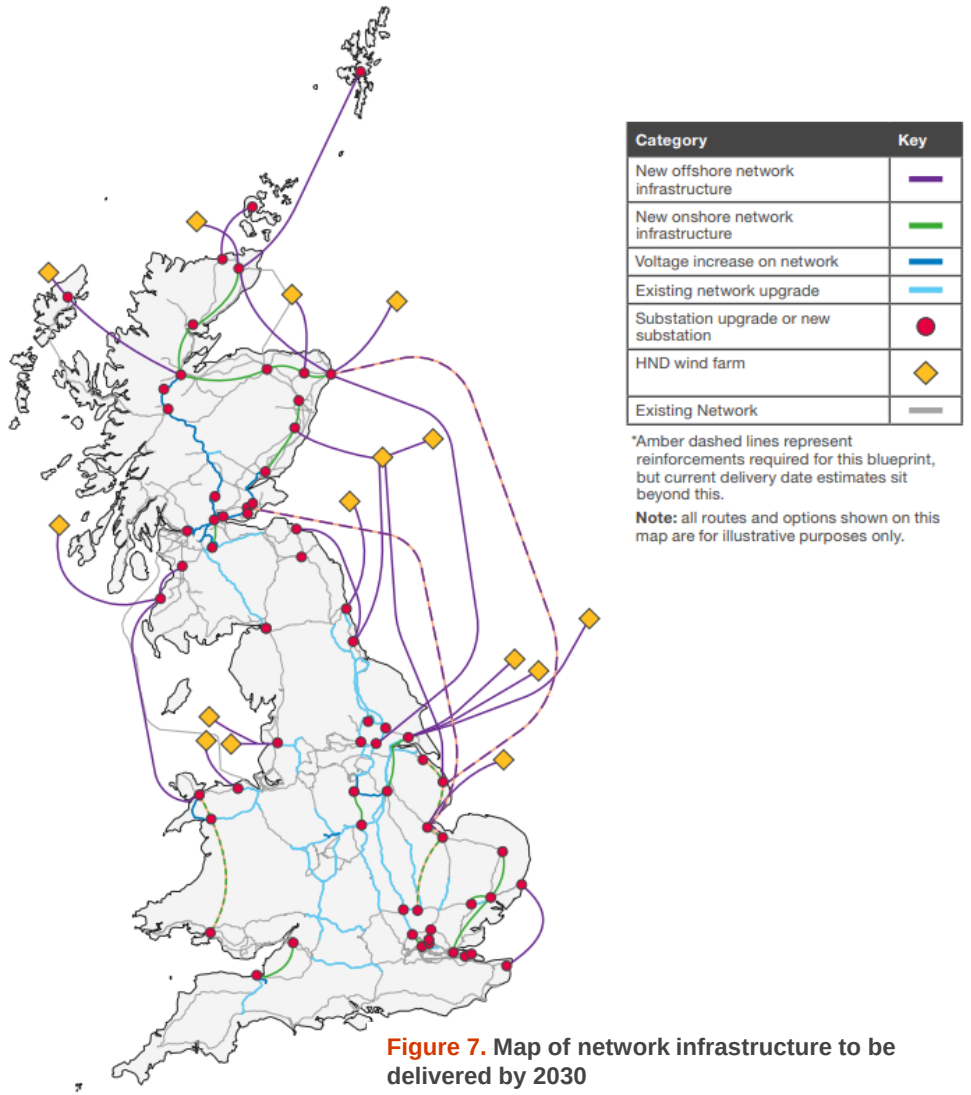


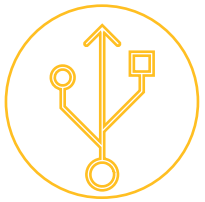
Figure 7. **Map of network infrastructure to be delivered by 2030**

Future drivers of balancing costs - constraints

Constraints are contributing to rising balancing costs

The ESO manages the flow of energy on the transmission system. When the level of electricity being carried exceeds the capability of the network, we must take actions to protect it from damage and ensure that the power supply is secure. These events are known as system constraints and can be thought of in the same way as congestion on our roads which cause bottlenecks. Thermal, voltage, and stability constraints all require the ESO to take action to manage. Thermal constraints are expected to be a significant driver of costs over the next decade as large quantities of generation connects to the system.

To manage constraints, the ESO will typically need to pay generators to stop generating electricity in constrained areas, while paying other generators to come online in areas that are free of constraints. This is known as a balancing action and forms part of the everyday running of the electricity system to help us reduce the strain on the network at certain times. Our recommendations in the Beyond 2030 report for a new and upgraded network, combined with the wide range of ESO led initiatives outlined in this report will help manage congestion across the system and limit the number of balancing actions we will need to take, minimising the level of balancing costs faced by consumers. However, even with optimal reinforcement of the grid, annual constraint costs are expected to rise out to 2030 due to the lag between new generation connecting and transmission investment coming online.



Thermal Constraints

Where the amount of energy that would flow naturally from one region to another exceeds the capacity of the circuits connecting the two regions.

Voltage Constraints

Where generation is needed in a particular area to support the local voltage.

Stability Constraints

Where particular circuit configurations have to be avoided because of the risk of oscillations in voltage or current.

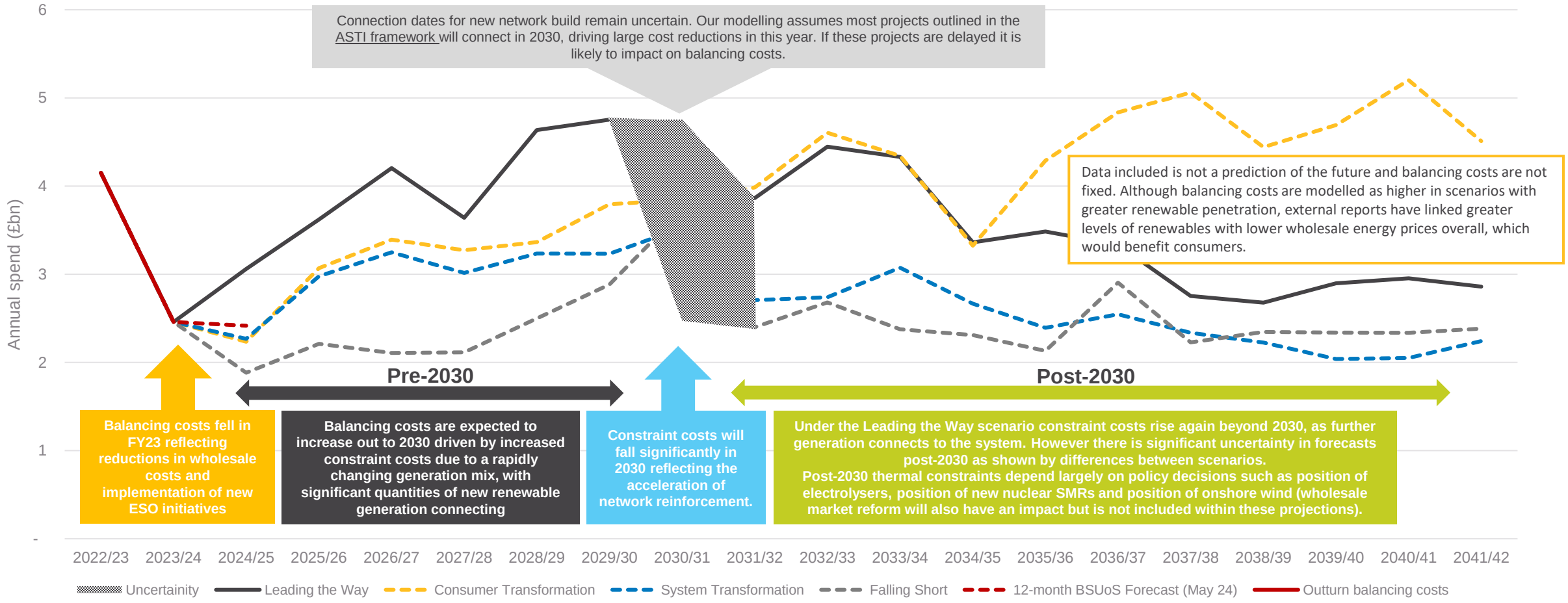
Other types of constraints are explained in the latest Operability Strategy Report

The following view of balancing costs has been based on the NOA7r and Beyond 2030 Leading the Way residual thermal constraint projections, and FY23/24 costs have been rolled forwards for other components and overlayed on top of this.

Balancing costs are projected to rise out to 2030 and decisions made now will shape balancing costs into the 2030s

Balancing costs currently contribute to ~4% of electricity bills for an average domestic consumer, making them a minor component of electricity bills.

Figure 8. Projection of balancing costs extrapolated from Leading the Way residual thermal constraint projection



For more information on pathways see our latest Future Energy Scenarios (FES) report

Balancing costs and the Future Energy Scenarios

Consumer Transformation

The net zero target is met in 2050 with measures that have a greater impact on consumers and is driven by higher levels of consumer engagement. They will have made extensive changes to improve their home's energy efficiency and most of their electricity demand will be smartly controlled to provide flexibility to the system. A typical homeowner will use an electric heat pump with a low temperature heating system and an Electric Vehicle (EV). The system will have higher peak electricity demands managed with flexible technologies including energy storage, Demand Side Response (DSR) and smart energy management.

Development of infrastructure is out paced by consumer changes resulting in higher balancing costs post-2030. For example, 5GW of hydrogen is not reached until the 2040s compared to the 2030s in LW and ST scenarios. However, overall consumer costs under this scenario would also likely benefit from consumer focused upgrades such as energy efficiency improvements and greater integration of EVs and heat pumps.

System Transformation

The net zero target is met in 2050. The typical domestic consumer will experience less change than in Consumer Transformation as more of the significant changes in the energy system happen on the supply side. A typical consumer will use a hydrogen boiler with a mostly unchanged heating system and an Electric Vehicle or a fuel cell vehicle. They will have had fewer energy efficiency improvements to their home and will be less likely to provide flexibility to the system. Total hydrogen demand is high, mostly produced from natural gas with Carbon Capture, Usage and Storage (CCUS).

Due to faster development of system assets such as hydrogen transport and energy storage balancing costs are lower under this scenario. However, due to slower development of consumer focused upgrades, consumer savings could be lower.

Leading the Way

The net zero target is met by 2046. We assume that GB decarbonises rapidly with high levels of investment in world-leading decarbonisation technologies. Our assumptions in different areas of decarbonisation are pushed to the earliest credible dates. Consumers are highly engaged in reducing and managing their own energy consumption. This scenario includes more energy efficiency improvements to drive down energy demand, with homes retrofitted with measures such as triple glazing and external wall insulation, and a steep increase in smart energy services. Hydrogen is used to decarbonise some of the most challenging areas such as some industrial processes, produced mostly from electrolysis powered by renewable electricity.

Faster generation build sees balancing costs rise directly after 2030 but significant system development throughout the 2030s in this scenario eventually balances this increase. Overall consumer costs may also benefit from consumer focused upgrades.

Falling Short

This scenario does not meet the net zero by 2050 target. There is still progress on decarbonisation compared to today, however it is slower than in the other scenarios. While home insulation improves, there is still heavy reliance on natural gas, particularly for domestic heating. Electric Vehicle take-up grows more slowly, displacing petrol and diesel vehicles for domestic use. Decarbonisation of other vehicles is slower still with continued reliance on diesel for Heavy Goods Vehicles (HGVs). In 2050 this scenario still has significant annual carbon emissions, short of the 2050 net zero target.

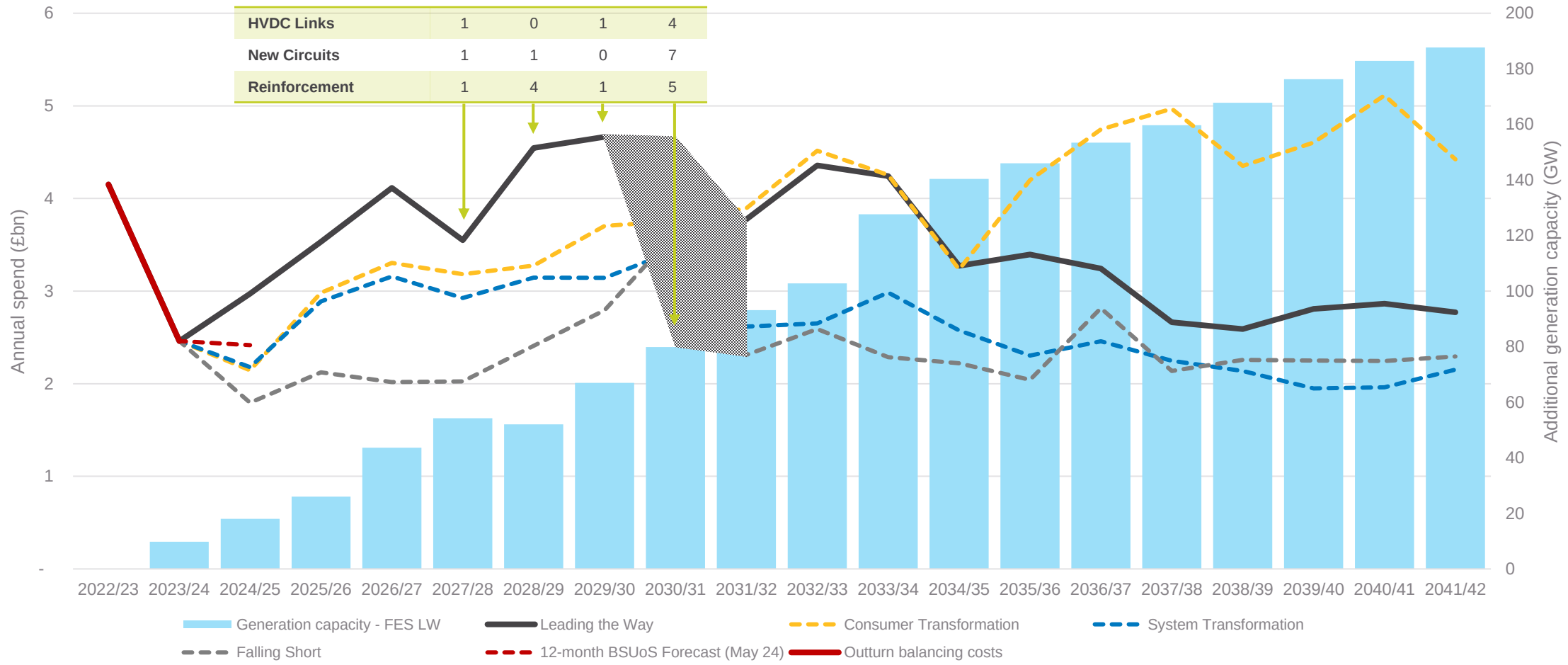
Slower progress on decarbonisation than other scenarios means the energy system has less change to adapt to and balancing costs remain lower, but Great Britain also fails to meet the net zero target by 2050 and wider benefits from supply side and consumer side upgrades are not fully realised.

For more information on pathways see our latest Future Energy Scenarios (FES) report

Balancing costs are projected to rise out to 2030 and decisions made now will shape balancing costs into the 2030s

Figure 9. **Network and generation build impact on balancing costs**

ASTI connections	2027	2028	2029	2030
HVDC Links	1	0	1	4
New Circuits	1	1	0	7
Reinforcement	1	4	1	5



Balancing costs are projected to rise out to 2030 and decisions made now will shape balancing costs into the 2030s

Figure 9. Network and generation build impact on balancing costs

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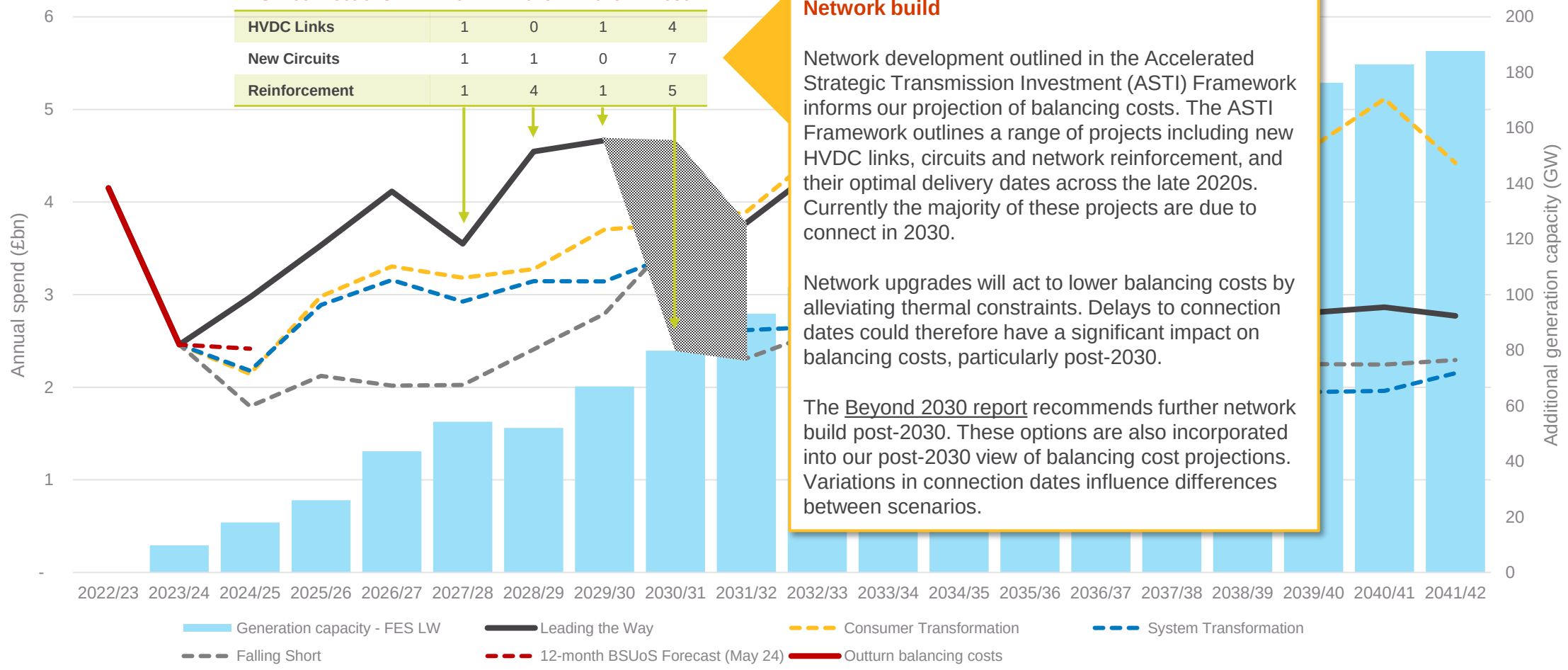


Network build

Network development outlined in the Accelerated Strategic Transmission Investment (ASTI) Framework informs our projection of balancing costs. The ASTI Framework outlines a range of projects including new HVDC links, circuits and network reinforcement, and their optimal delivery dates across the late 2020s. Currently the majority of these projects are due to connect in 2030.

Network upgrades will act to lower balancing costs by alleviating thermal constraints. Delays to connection dates could therefore have a significant impact on balancing costs, particularly post-2030.

The Beyond 2030 report recommends further network build post-2030. These options are also incorporated into our post-2030 view of balancing cost projections. Variations in connection dates influence differences between scenarios.

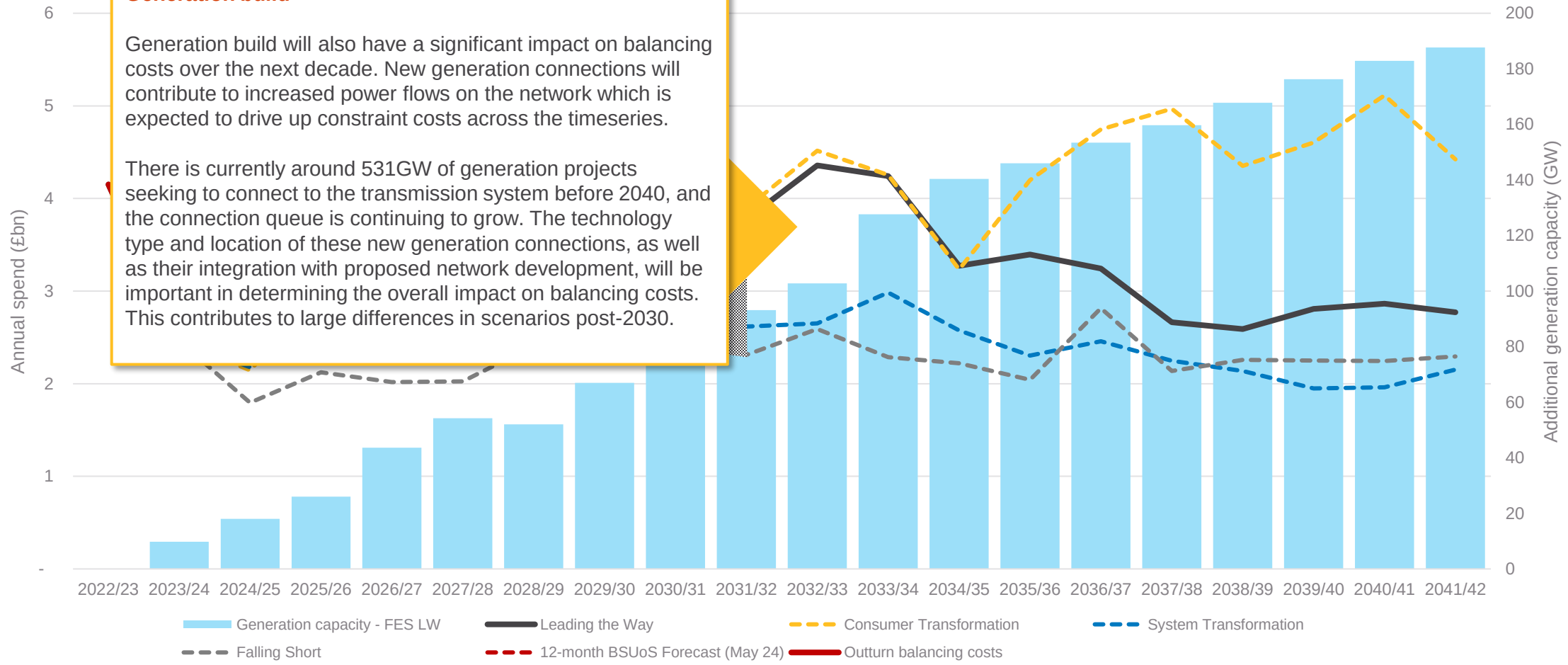
Balancing costs are projected to rise out to 2030 and decisions made now will shape balancing costs into the 2030s

Figure 9. **Network and generation build impact on balancing costs**

Generation build

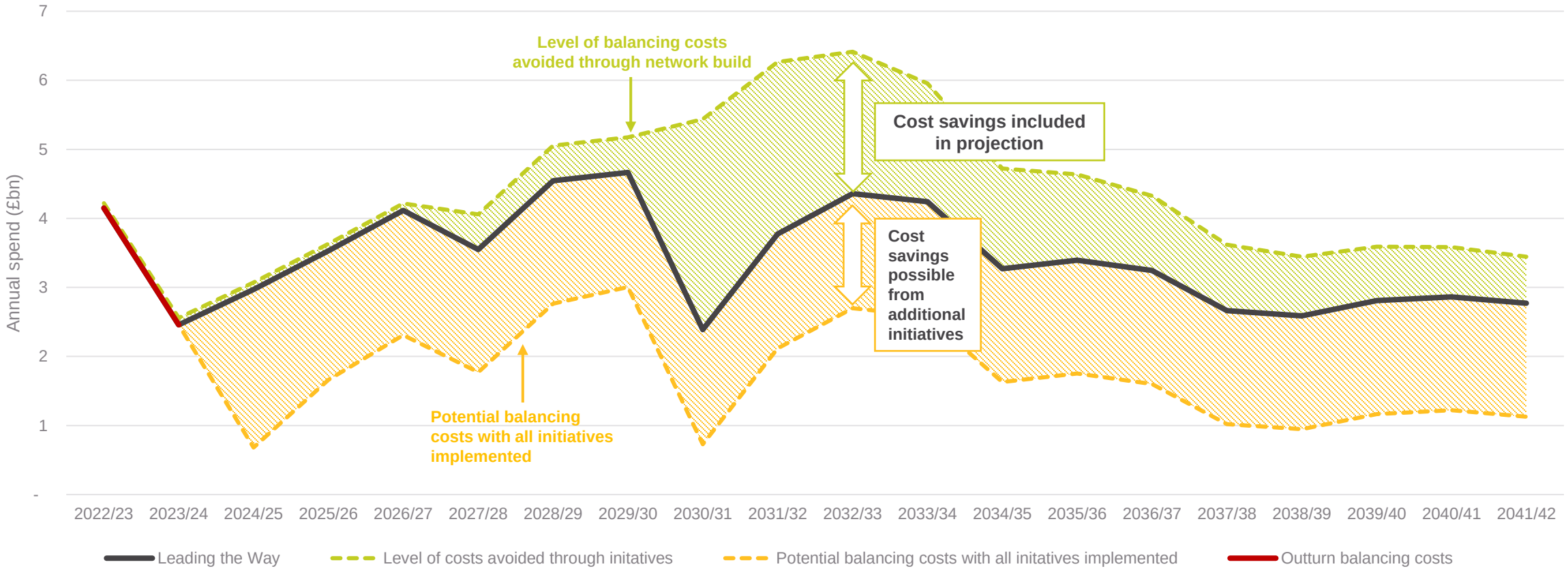
Generation build will also have a significant impact on balancing costs over the next decade. New generation connections will contribute to increased power flows on the network which is expected to drive up constraint costs across the timeseries.

There is currently around 531GW of generation projects seeking to connect to the transmission system before 2040, and the connection queue is continuing to grow. The technology type and location of these new generation connections, as well as their integration with proposed network development, will be important in determining the overall impact on balancing costs. This contributes to large differences in scenarios post-2030.



ESO initiatives create savings worth ~£18bn before 2030

Figure 10. **Balancing cost savings delivered through network reinforcement and initiatives**



Some cost saving initiatives are already baked into the cost projection and are therefore already reflected in our baseline balancing cost assumptions. These avoided costs **(green)**, largely account for network reinforcement projects outlined in initiatives such as the Holistic Network Design (HND) that aim to manage thermal constraints. Network delivery in 2030 is expected to deliver £13.1bn savings in constraint costs across asset lifetime, significantly lowering costs around this period.

The ESO is also undertaking a number of further initiatives that have the potential to reduce balancing costs below the projection. Additional potential savings **(orange)** consider a much broader range of options to lower costs associated with reserve, voltage, response, inertia, ESO operations, and market activities. Many of these initiatives are already underway, such as the roll out of the Open Balancing Platform which is creating savings by increasing control room capabilities.

Detailed Breakdown of Savings

A full breakdown of current initiatives expected to contribute to savings in Balancing Costs, key dates and estimate of what their impact will be

ESO's Balancing Cost Strategy

Levers to minimise balancing costs

Network Planning & Optimisation

Designing the GB network and managing delivery of changes to optimise availability and reduce Constraints.

Commercial Mechanisms

Designing and Procuring new services, with greater competition at an optimised price.

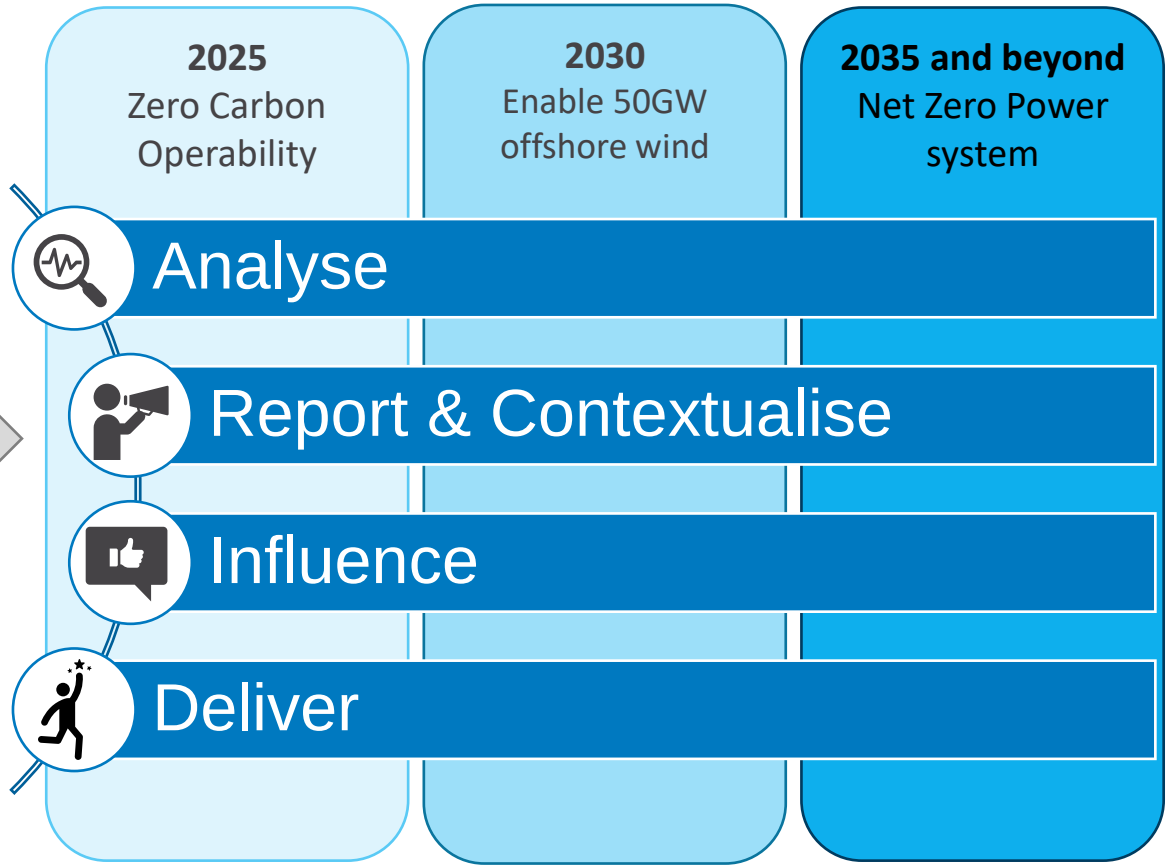
Research, Innovation, Engagement

Experimenting with first in sector approaches and technologies, collaborating with Industry and Academia.

ESO Capabilities

Using enhanced products and services provided to the Control Room, optimising security, supply and cost.

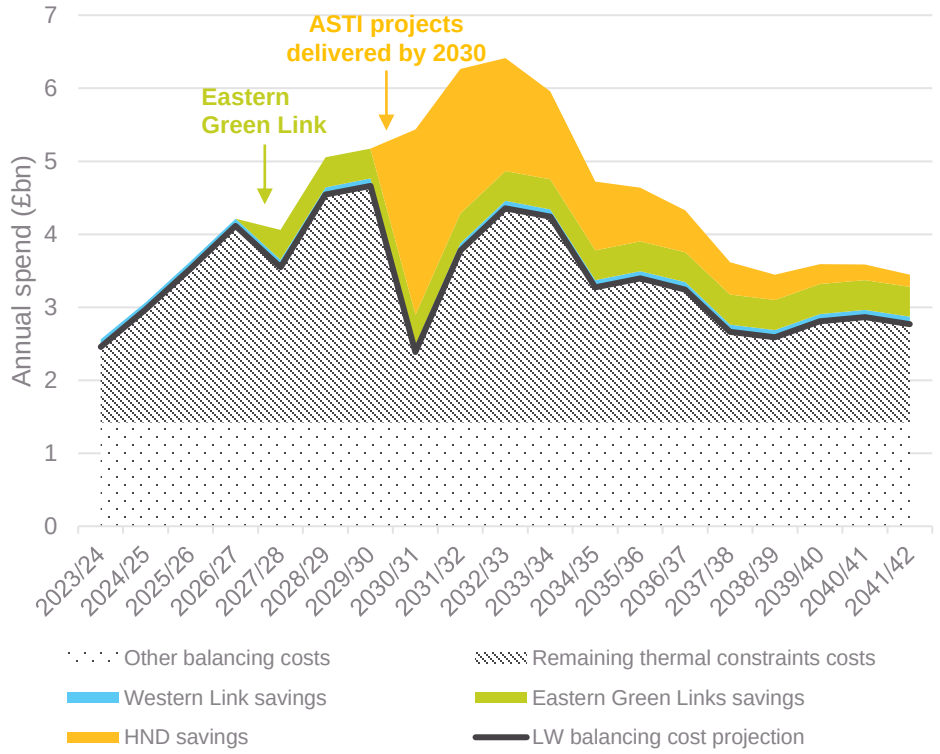
How we use these levers



See our full Balancing Cost Strategy here

Thermal constraints – network reinforcement

Figure 11. Potential thermal constraint costs avoided through network build



- The strategic network reinforcement projects outlined in this slide are integrated into the LW balancing cost projections.
- Cost reductions associated with these projects are outlined in the graph above.

Accelerated Strategic Transmission Investment (ASTI)

Network Planning and Optimisation

Description: Informed by the Holistic Network Design (HND), the ASTI is a new regulatory approval and funding framework for onshore transmission projects required to deliver the Government's 2030 net zero ambitions.

Key dates: Network development is planned across the 2020s and 2030s (projection assumes most delivery is in 2030).

Cost savings: The combined effect of a new offshore transmission system and the acceleration of onshore reinforcement projects causes a significant drop in thermal constraint costs in 2030 to around £1bn per year. The HND is expected to contribute to a **total £13.1bn savings in constraint costs across asset lifetime** (although it is also expected to impose £7.6bn capital costs). Further savings are expected from the additional network development outlined our Beyond 2030 report but are not yet quantified

ESO influence 5

Eastern Green Link

Network Planning and Optimisation

Description: Two underwater links between Scotland and England on the East coast that have recently received approval in ASTI.

Key dates: Current targeted operational dates in 2029 (this was previously 2027 as reflected in projection).

Cost savings: A delay to both projects could lead to additional **constraint costs of up to £409mn per year** (up to £225mn for EGL2 alone).

ESO influence 5

Western Link HVDC

Network Planning and Optimisation

Description: An underwater link between Scotland and England on the West coast.

Key dates: The link became operational in 2019.

Cost savings: Current annual savings **~£100m in constraint costs per year.**

ESO influence 5

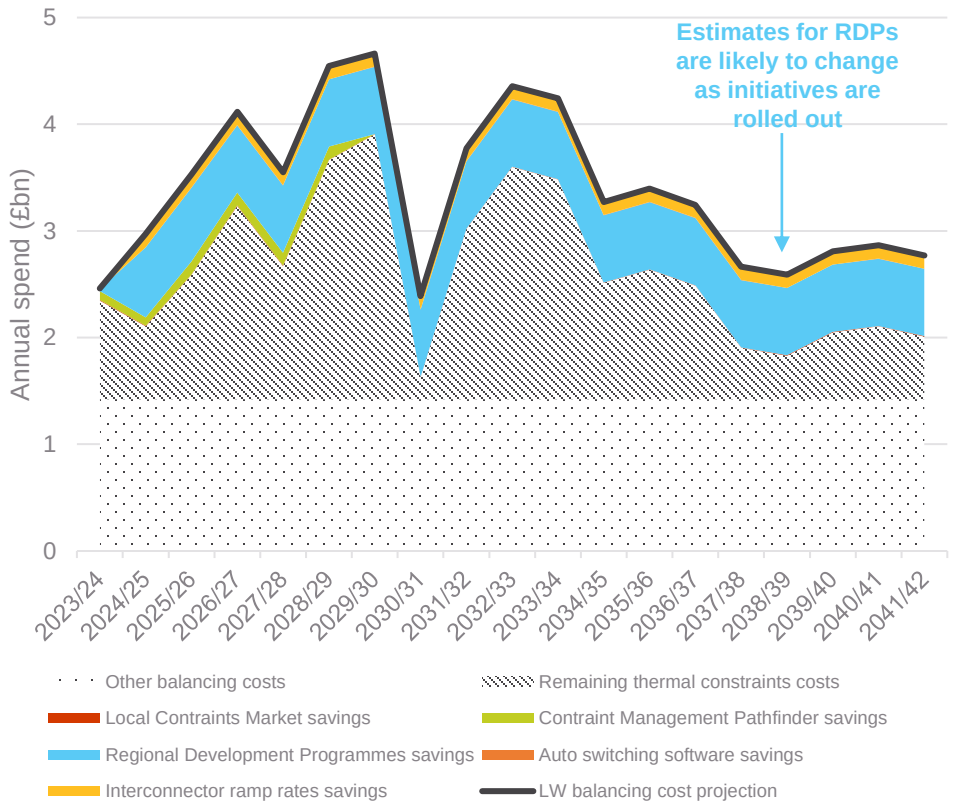
ESO influence:

1 =ESO has limited influence/support from industry is required for progression

10 = ESO has extensive influence over development and progression of initiative

Thermal constraints – market reform (1/3)

Figure 12. Potential thermal constraint savings achieved through initiatives



- The market reforms outlined in this slide are not integrated into the LW balancing cost projection.
- The graph above shows additional savings and the potential balancing costs that could be achieved if the following initiatives are implemented (grey).

Commercial Mechanisms

Interconnector ramp rates

Description: The ESO sees value in setting interconnector ramp rates within the Grid Code at 50 MW/min to minimise the impact of interconnector swings. This also has the potential to contribute to savings beyond thermal constraint costs i.e. voltage.

Key dates: This option was initially raised through the GC154 modification but the original proposal for 50MW/min ramping rate was rejected. The ESO still sees value in management of IC ramping and will look to progress other solutions in the future

ESO influence 4

Cost savings: An initial CBA assessment of a 50MW/min ramp rate suggested **balancing costs could be reduced by £865m** over a study period of 2023-2030 and reduces the risk to security of supply, because of simultaneous fast interconnector ramping.

Commercial Mechanisms

Local Constraints Market

Description: LCM will help to reduce constraint costs at the B6 boundary by providing access to additional Distributed Energy Resources (DER).

Key dates: The LCM has been open regularly since December 2023.

ESO influence 8

Cost savings: Savings are expected to remain very small in 2024 as higher than expected energy prices and challenges around a lack of energy compensation for aggregators makes demand side response significantly less competitive. Work is ongoing to learn how to grow volume, unlock value and provide larger savings.

Network Planning and Optimisation

Constraint Management Intertrip Service

Description: The Constraint Management Intertrip Service (CMIS) will seek intertrip services from new providers to help manage network congestion.

Key dates: Contracts successfully awarded to 15 generators for B6 CMIS 2024-25 delivery. Interim CMIS EC5 service launched February 2024 with Enduring Service from April 2025. The ESO is continually looking at constraint boundaries across GB where this service can also be applied.

ESO influence 8

Cost savings: CMIS B6-Interim cost savings of £80mn in 2022-23. Anticipated savings from the B6 CMIS are **£85m for 2023-24 and £70m in 2024-25.** Anticipated **CMIS EC5-interim savings of £10.4m in 2024-25 and £63m in EC5 Enduring for 2025/26.**

ESO influence:

1 =ESO has limited influence/support from industry is required for progression

10 = ESO has extensive influence over development and progression of initiative

Thermal constraints – market reform (2/3)

Network Planning and Optimisation

Regional Development Programmes

Description: RDPs are designed to address areas of the network challenged by large volumes of DER. They aim to improve transmission and distribution system coordination to unlock network capacity, reduce constraints and open new revenue streams for market participants.

Key dates: A number of RDPs are under development and at varying stages of progression.

Cost savings: RDPs are expected to contribute to significant savings in balancing costs, that will scale over time as initiatives are rolled out. To date RDPs have provided different benefits. Some RDPs remove the requirement for asset build, for example one RDP produced a saving of £13m in required asset build. Some RDPs facilitate early connection of renewable generation (i.e., ahead of required transmission investment works).

ESO influence 6

Network Planning and Optimisation

Auto Switching Software

Description: Auto switching software can be used to increase pre-fault flows on the network by allowing control engineers to use automated circuit switching.

Key dates: Initial trial on Pembroke – Swansea North 3 circuit (date tbc).

Cost savings: Initial consumer savings from trial expected to total £2.1m (NGET portion ~£210k/year). On successful trial of this scheme further schemes are to be considered.

ESO influence 6

Network Planning and Optimisation

Outage Optimisation

Description: The ESO is optimising outage and project plans to minimise their impact on system constraints. ESO identify constraints ahead of time and agree enhanced services with TOs to mitigate impacts. Requests for network access have risen significantly in recent years and will continue to increase to facilitate the large amount of network development and new connections required for the net zero transition, so the need for outage optimisation will grow.

Key dates: A 30% increase in outages has been facilitated in the Year Ahead plan for 2024/25.

Cost savings: Enhanced outage optimisation will facilitate additional outages while maintaining system security and limiting additional balancing costs. **Our Outage Optimisation initiatives have saved up to £1,543m in balancing costs from April 2023 to March 2024.**

ESO influence 6

Outage optimisation is becoming more challenging and increasingly important as requests for network access grow. This is built into the background of our Balancing Cost projections rather than a standalone initiative.

ESO influence:

1 =ESO has limited influence/support from industry is required for progression

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Thermal constraints – market reform (3/3)

Commercial Mechanisms

REMA

Description: The fact that thermal constraint costs are rising forms an important part of the case for change for the Government's ongoing Review of Electricity Market Arrangements (REMA), which – among other objectives – seeks to ensure that our future renewables-dominated system can be operated safely and cost-effectively.

The second REMA consultation (published on 12 March 2024) seeks feedback on a wide variety of options, many of which have the potential to reduce thermal constraint costs. For example, one option under consideration is zonal pricing, which has the potential to significantly reduce thermal constraint costs by introducing locational signals to the wholesale market.

Other reforms that have the potential to reduce thermal constraint costs include changes to dispatch arrangements, and the idea of delinking CfD payments from metered output (deemed CfD and capacity-based CfD). Reforms to the Capacity Market are also under consideration.

ESO influence	4

Further solution to address thermal constraints are also being considered as part of the Constraints Collaboration Project.

Key dates: The Government expects to provide a summary of responses to the current consultation in Summer 2024. It intends to conclude the policy development phase of the programme by mid-2025 and move into implementation from 2025 onwards.

Cost savings: DESNZ commissioned modelling shows that locational pricing under the form of **zonal pricing could reduce the cost of running the electricity system in the region of c.£5-15bn over 2030- 2050*.** The key driver of this change in system costs is the movement of plants to locations that are more beneficial to the system. Under zonal pricing, plants are expected to locate more efficiently meaning lower cost plants such as renewables can dispatch more frequently without the need to turn on more expensive gas plants.

Commercial Mechanisms

BSC change P462

Description: P462 modification proposes to reduce consumer cost potentially caused by the interaction between the BM and support mechanism arrangements. This will be done by removing distortion of support mechanisms (such as Contracts for Difference (CfDs) and the Renewables Obligation (RO) schemes) to reduce actions being taken outside of consumer cost order when following the Bid stack merit order.

ESO influence	4

Key dates: P462 is undergoing workgroup consultation, with earliest possible delivery likely 2025.

Cost savings: £92m excess costs identified in 2022 as a result of an inefficient interaction between the BM and current CfD subsidy structure.

ESO influence:

1 **=**ESO has limited influence/support from industry is required for progression

10 = ESO has extensive influence over development and progression of initiative

*Not currently included in projection of savings

Thermal constraints – new connections

- The transmission queue currently stands at 531GW (increased by 271GW over the past 12 months.) Licensed applications have seen an 80% increase over 2 years.
- This is due to an increased generation load and the type and location of generation assets will be important in determining the impact on balancing costs. Battery storage (incl. hybrid) makes up a large proportion of the queue (around one third).
- The current connections queue is known and reflected in the balancing cost projections. This is subject to the benefits of connections reform impacting connection arrangements.

Connections Reform

Network Planning and Optimisation

Description: The Connections Reform project forms part of the ESOs long-term vision for change to the connections process. The Ofgem and DESNZ Connections Action Plan and ESO's Final Recommendations for a reformed connections process were published in Q4 2023. These seek to improve connection dates and enable a 'First Ready, First Connected' approach for projects. We are working with stakeholders on how to go further and faster in relation to our reformed process.

Key dates: 1 January 2025 has been proposed as the go-live date for the new process, with further development to take place throughout 2024. An interim two-step offer process is currently in place with over 100 two step offers issued so far.

ESO influence	7

Cost savings: Connections Reform will look to speed up grid connections which is likely to add to network congestion and increase constraint costs. However, co-optimisation of the connections, HND, CSNP network planning processes are expected to create significant savings in capital and constraint costs compared to the status quo. **Potential changes to clarify the existing Connect and Manage Guidance and MITS definition is underway.** This could result in a reduction in enabling works, allowing projects to connect faster. As this workstream is still under development the impact on balancing costs remains highly uncertain.

5-point plan for connections

Network Planning and Optimisation

Description: In 2023 the ESO launched a five-point plan which is a set of tactical initiatives to help improve the connections process in the short-term. This included introducing Queue Management milestones into Agreements, a TEC Amnesty, updating our construction planning assumptions and modelling assumptions and accelerating non- firm BESS connections. Ofgem and DESNZ launched the Connections Action Plan in November which introduced further tactical measures to improve connections.

Key dates: At the start of 2024, the ESO issued connection contracts with accelerated connection dates for 10 GW of BESS. These 21 projects were accelerated by an average of 4 years, connecting from 2026. In addition the ESO will progress a further tranche of hybrid BESS to start and conclude in 2024 before this process transitions into BAU.

ESO influence	6

Cost savings: The ESO will be able to constrain BESS under non-firm connection agreements when they are contributing to identified local constraints. However, the ESO will need to develop the operational processes to identify when access may need to be restricted.

ESO influence:

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Thermal constraints – Policy for new generation

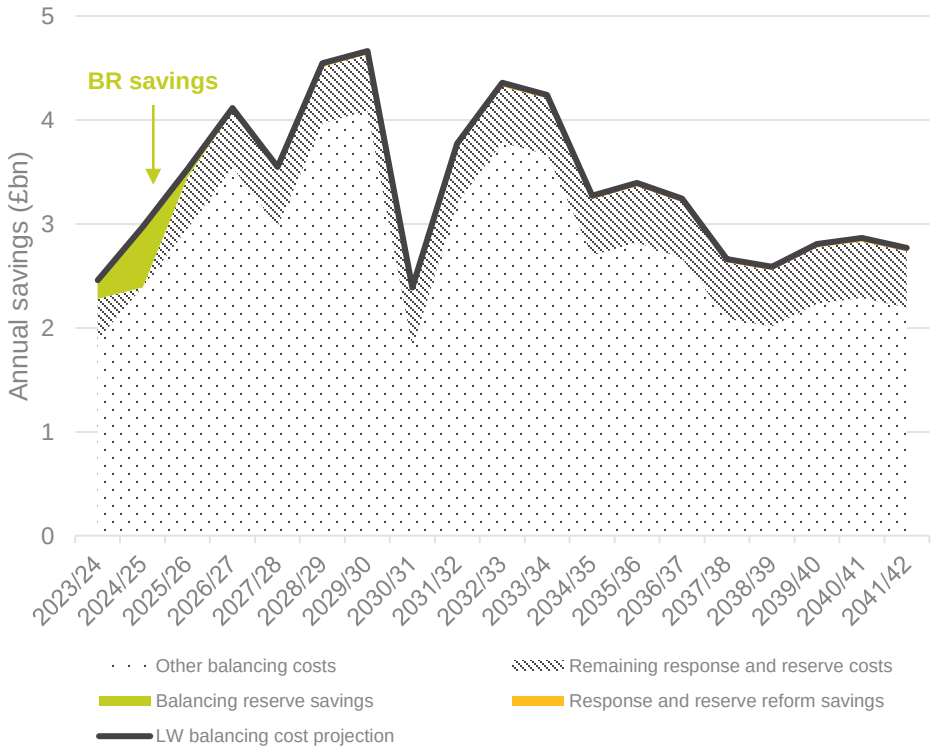
- Government policy for wind, hydrogen, and nuclear is also developing and will have an impact on future generation connections. This is reflected in the range in the constraint projections in the scenarios beyond 2030.

Network Planning and Optimisation

Technology	Description	Implementation	Impact on balancing costs
Wind	Wind curtailment is increasing balancing costs, particularly in regions north of the B6 boundary and in the EC5 region.	• Offshore wind net zero investment roadmap summarises policy. Government ambition of up to **50GW of offshore wind by 2030** (including up to 5GW floating offshore wind). This is being supported by ESO initiatives such as the HND. • Update to UK onshore wind planning policy to support onshore wind projects. • Scottish Government onshore wind policy statement set out ambition to reach **20GW of operational Scottish onshore wind capacity by 2030**, from c.10GW today.	Increased wind generation is expected to drive up balancing costs out to 2030. This will need to be supported by a range of initiatives to manage constraint costs and facilitate new connections.
Nuclear	As baseload capacity shrinks with the phase out of conventional generators, nuclear will become increasingly important in maintaining grid stability. SMR is likely to play an important role in the future of nuclear generation (circa. 2035).	• Government has set out a Civil Nuclear roadmap to 2050. • Ambition to deploy up to **24GW of nuclear power by 2050**. • Government is committing to exploring a further large-scale reactor project and will set out timelines and processes this Parliament, subject to the Sizewell C Final Investment Decision. • Aiming to secure investment decision to deliver **3-7GW every five years from 2030 to 2044**.	Location will be key in reducing balancing costs. The Government is consulting on its proposed approach for determining how new nuclear developments could be sited beyond 2025 and will **designate a new nuclear NPS in 2025**.
Hydrogen	Hydrogen's long-duration storage capability could increase system flexibility and co-locating with generators (especially wind) could aid the integration of intermittent low carbon technologies.	• Government has set out a Hydrogen production delivery roadmap setting out how the hydrogen production landscape is expected to evolve towards 2035. • Aiming for **10GW hydrogen capacity by 2030**. • 11 projects have been offered contracts in HR1, totalling 125MW capacity.	Hydrogen could be used to relieve grid constraints, particularly north of B6. However, the benefit will be highly dependent on siting location, with demand needing to be incentivised in congested regions.

Response and Reserve

Figure 13. Potential response and reserve savings achieved through initiatives



- The new response and reserve services outlined in this slide are not integrated into the LW balancing cost projection.
- The graph above shows additional savings and the potential balancing costs that could be achieved if the following initiatives are implemented (grey).

Response and Reserve Markets

Description: Reform to the response and reserve markets is expected to increase liquidity and optimise service acquisition. Several new services are being introduced for reserve and reform. These are outlined below.

Cost savings: The value of the response and reserve markets today is £479m per year. Moving closer to real time markets increases the number of potential participants. We have made a number of beneficial changes to our reserve and response markets, transitioning to a new set of frequency response products that we are able to procure via the Enduring Auction Capability (EAC) platform. This has features such as co-optimisation of auction products, splitting of bids across multiple products and negative price clearing leading to an increase in market liquidity and has greatly reduced the cost of procuring frequency response. **We assume a saving in the response and reserve markets each year due to increased liquidity, worth £86.5m. A further £18.8m annual saving is estimated from buying the optimal volume of response.**

Service	Description	Confidence rating
Balancing Reserve (BR)	Balancing Reserve allows the ESO to procure Regulating Reserve on a firm basis at day ahead. Balancing reserve is acting to reduce balancing costs and improve system security as the reserve capacity is guaranteed for the Control Room to access when they need it, reducing the need for potentially expensive real-time balancing actions. The ESO held the first auction for the Balancing Reserve (BR) service on 12 March. The BR service enables us to move to day-ahead procurement energy reserves. Estimated saving of **£639m over 2024-2027.**	ESO influence 9
Quick and Slow Reserve	New reserve services that will replace fast reserve and STOR. Quick and Slow Reserve will be dispatched in real time via the BM. Delivery has been delayed to facilitate direct integration with OBP. **Quick Reserve is expected to benefit an average annual saving of £17m.**	ESO influence 9
Dynamic Containment (DC) /Dynamic Moderation (DM) /Dynamic Regulation (DR)	New response services that are replacing Dynamic FFR. DC/DM/DR have now been running for several years, however, changes are due to be made to these services over BP2, including co-optimisation and stacking, that will further enhance market liquidity.	ESO influence 9

ESO influence:

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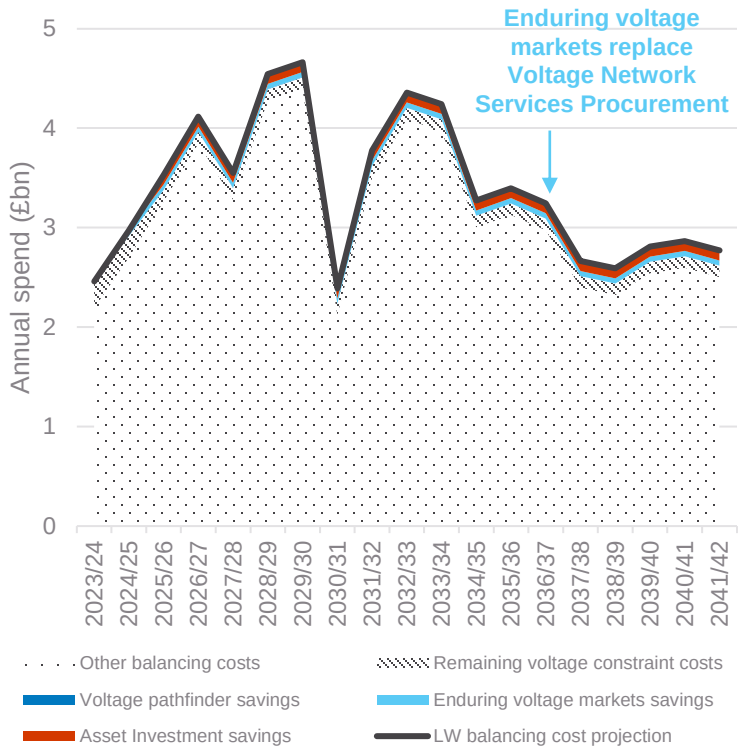
10 = ESO has extensive influence over development and progression of initiative

Voltage constraints

Figure 14. **Voltage constraint savings achieved through initiatives**



- The new voltage services outlined in this slide are not integrated into the LW balancing cost projection.
- The graph above shows additional savings and the potential balancing costs that could be achieved if the following initiatives are implemented (grey).

Voltage Network Services Procurement (NSP)

Network Planning and Optimisation

Description: Voltage NSP identifies the most cost-effective ways to address high voltage system issues. It was developed through the Pathfinder programme with the first solutions delivering reactive power from April 2022. NSP is currently out to tender for delivery in the London and North West England regions from April 2026.

Key dates: The Voltage 2026 NSP results are expected by November 2024.

Cost savings: in the region of £50m so far from the Mersey pathfinder. Further savings from Pennine pathfinder that will begin operation from May 2024**. Total expected savings to be £10m's per year**.

ESO influence 8

ORPS service reform

Commercial Mechanisms

Description: Providers of Obligatory Reactive Power Service (ORPS) are all paid the same utilisation rate irrespective of technology type. Calculation of the payment rate was designed as cost recovery for providers, but is exposed to very high wholesale energy prices. Purpose of project is to review existing methodology and propose new mechanism which is fit for a future dominated by new provider types.

Key dates: The innovation project ends Nov 2024. We anticipate a code modification to be proposed.

Cost savings: Unknown but different ORPS default payment rates should reduce balancing costs.

ESO influence 8

Enduring Voltage Markets

Commercial Mechanisms

Description: The Reactive Power Market Design project is building on the recommendations from an innovation project to develop the best options to procure reactive power services in the long, medium and short-term.

Key dates: An update to industry was published in March 2024. Further development is ongoing.

Cost savings: Balancing cost savings are more associated with long term market considering the data from pathfinders, the benefits cases for mid and short term markets are being reviewed and validated.

ESO influence 8

Asset Investment

Network Planning and Optimisation

Description: National Grid Electricity Transmission (NGET) are working towards delivering seven new reactors by March 2025 at the earliest. We have worked closely with NGET to prioritise the right locations on the network for compliance, economic and zero carbon reasons

Key dates: Assets are expected to be delivered from March 2025 at the earliest.

Cost savings: The assets being delivered for economic benefit **could reduce balancing costs by ~£100m per year.**

ESO influence 5

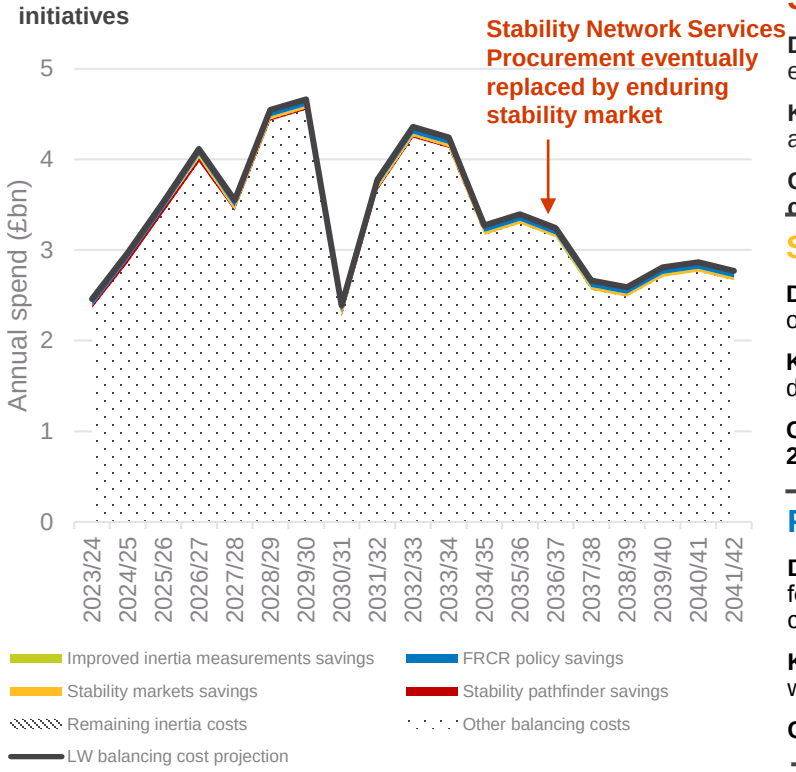
ESO influence:

1 =ESO has limited influence/support from industry is required for progression

10 = ESO has extensive influence over development and progression of initiative

Stability constraints

Figure 15. Potential stability constraint savings achieved through initiatives



- The new stability services outlined in this slide are not integrated into the LW balancing cost projection.
- The graph above shows additional savings and the potential balancing costs that could be achieved if the following initiatives are implemented (grey).

Network Planning and Optimisation

Stability Network Services Procurement

Description: Stability Network Services Procurement look for the most cost-effective way to address stability issues in the electricity system.

Key dates: Contracts signed under Phase 1 started delivering in April 2020. Phase 2 and 3 have awarded contracts and are awaiting launch.

Cost savings: Phase 1 has achieved an estimated £26m savings to date, with total potential savings across all Stability contracts of approximately £15bn* out to 2035.

ESO influence 9

Commercial Mechanisms

Stability Market

Description: The Stability Market Design project is considering current GB stability arrangements and investigating the best option for an end-to-end stability market design, including long-term, mid-term, and short-term stability procurement.

Key dates: Stability Market Design Network Innovation Allowance (NIA) project concluded in July 2023. The ESO now developing more detailed next steps towards implementation.

Cost savings: Initial assessment indicated the recommended approach would reduce re-dispatching costs by **~£30m in 2026 and ~£58m in 2030**

ESO influence 8

Research, Innovation, Engagement

Frequency Risk and Control Report (FRCR)

Description: Our FRCR dynamically assesses the magnitude, duration, and likelihood of transient frequency deviations, the forecast impact and the cost of securing the system. It allows us to change the system's inertia requirements to suit the system conditions.

Key dates: Implemented 2021. Minimum inertia requirement reduced under FRCR policy from 140GVA.s to 130GVA.s in 2024, with approval to reduce to 120GVA.s.

Cost savings: Estimated saving of approximately **£65m per year**.

ESO influence 9

Research, Innovation, Engagement

Improved Inertia Measurements

Description: Samuel Inertia Element project (SIM) aimed to reduce balancing costs associated with inaccuracies in estimating inertia.

Key dates: Completed a public procurement process to provide inertia-monitoring services (2016/17).

Cost savings: Estimated savings of **between £6m and £10m per year.**

ESO influence 9

ESO influence:

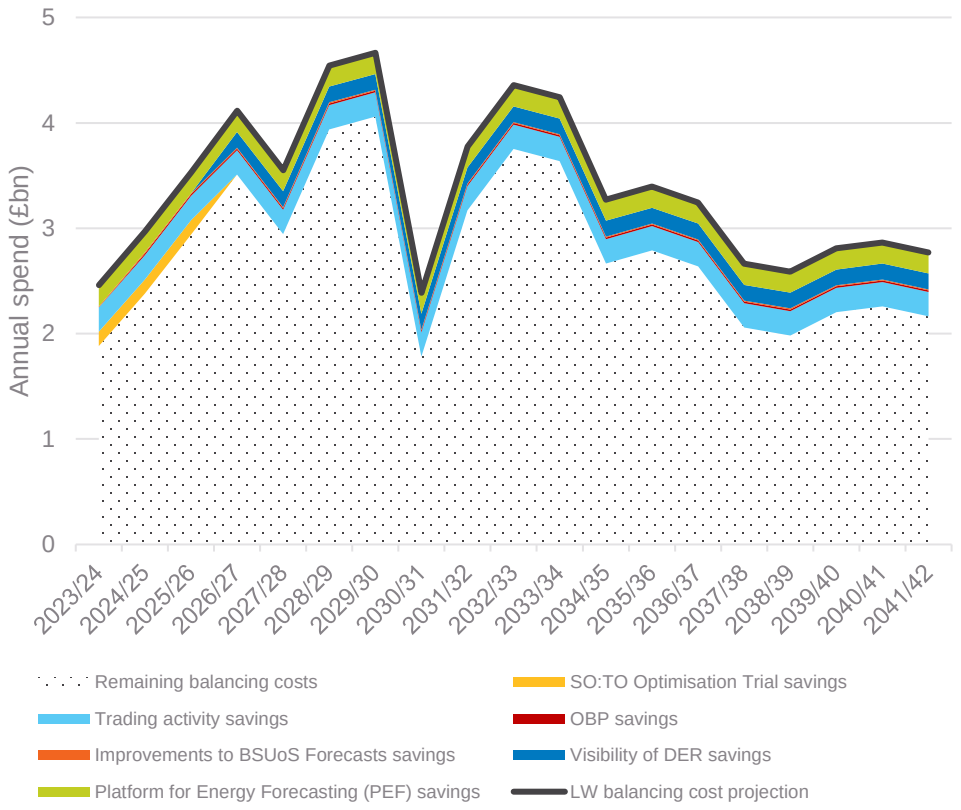
1 =ESO has limited influence/support from industry is required for progression

10 = ESO has extensive influence over development and progression of initiative

*Not currently included in projection of savings

Improving system operation (1/2)

Figure 16. **Potential response and reserve savings achieved through initiatives**



- The new initiatives outlined in this slide are not integrated into the LW balancing cost projection.
- The graph above shows additional savings and the potential balancing costs that could be achieved if the following initiatives are implemented (grey).

Research, Innovation, Engagement

SO:TO Optimisation

Description: SO:TO Optimisation is a trial Output Delivery Incentive (ODI) to encourage the TOs to proactively identify and provide solutions to the ESO to help reduce constraint costs (STCP 11-4).

Key dates: The trial initially applied to the first two years of RIIO-2 (2021/2022 & 2022/2023). In June 2023 Ofgem made the decision to retain the incentive for years 3-5 of RIIO-2 with some modifications to the incentive reward paid to TOs.

ESO influence 9

Cost savings: Assessment of the trial showed it delivered significant consumer benefits. The trial was found to contribute to **a £33m net consumer benefit in the first year of the trial, scaling to a £268m benefit by the second year.**

Commercial Mechanisms

Trading Activity

Description: Our trading with interconnectors and generators outside the BM provides us with access to generation from the continent and prices within GB that can be used for Balancing at a lower cost than BM actions.

ESO influence 6

Key dates: During BP1, trading capability on IFA2 and Eleclink have been added with bidding from up to 29 participants in the auction process.

Cost savings: Savings of **£396m achieved in 2022/23.**

ESO Capabilities

Platform for Energy Forecasting (PEF)

Description: Improved forecasting methodology incorporated into our control room.

Key dates: Partial implementation.

ESO influence 9

Cost savings: PEF supports the delivery of efficient system balancing decisions ahead of real time to deliver value to consumers. **It is expected to deliver benefits of over £1bn in RIIO-2.**

ESO influence:

1 =ESO has limited influence/support from industry is required for progression

10 = ESO has extensive influence over development and progression of initiative

Improving system operation (2/2)

Open Balancing Platform (OBP)

ESO Capabilities

Description: The OBP, part of our Balancing Programme, introduces a new real-time balancing capability to replace legacy ESO balancing systems and processes and support zero carbon grid operations. OBP allows increased use of flexible assets (bulk dispatch), improved situational awareness and will help to facilitate other initiatives.

Key dates: Release 1 of the OBP went live in December 2023. Several further releases are scheduled across 2024 and 2025 to increase capabilities.

ESO influence 9

Cost savings: The first stage of the OBP allows control room engineers to send hundreds of instructions to smaller Balancing Mechanism Units and battery storage units at the press of a button, which is **expected to provide £15m consumer benefit per annum.**

Improvements to BSUoS Forecasts

Commercial Mechanisms

Description: Fixing BSUoS and improving forecasts reduces the risk premium included in generation pricing to cover volatility. This has been reduced as BSUoS will be fixed and no longer being paid by Generators.

Key dates: CMP361 modification introducing ex ante fixed BSUoS implemented in April 2023. CMP408 modification progressing, considering updates to BSUoS notice period (FMR published October 2023).

ESO influence 8

Cost savings: Expected £10m per annum saving from fixed BSUoS.

Visibility of DER

ESO Capabilities

Description: Better forecasts, data sharing, and incorporation of Distributed Energy Resource (DER) (& Consumer Energy Resources (CER)) into ESO, DSO and TO decision making related to system operation, markets facilitation, connections, network planning and resilience.

Key dates: Roadmap is being co-created with industry, setting out 5 DER visibility programme phases, with full implementation by 2030.

ESO influence 6

Cost savings: Initial work has identified **consumer benefits of up to £150m / year** from greater DER Visibility. Delivery of the programme as a whole will deliver significant industry benefit in addition to this.

Single Markets Platform

ESO Capabilities

Description: SMP will support NGESO become a better buyer of ancillary services by providing users frictionless access to ESO markets.

Key dates: Foundational release of functionality on 10 February 2022. Continuous monthly release to add new functionality for the Market.

ESO influence 9

Cost savings: Savings achieved through SMP are indirectly realised through enhanced market entry for new and enduring day-ahead Frequency Response markets.

ESO influence:

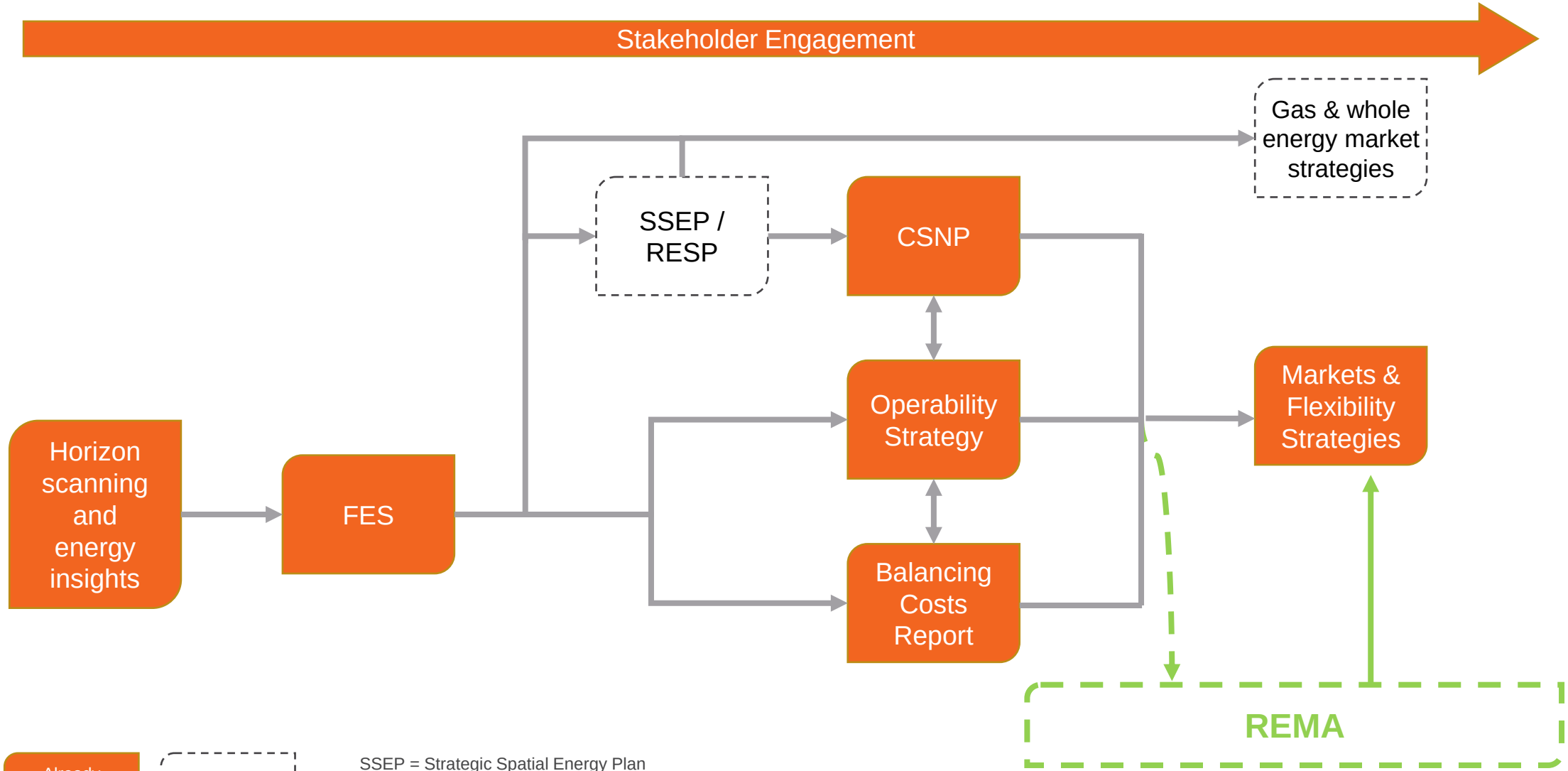
1 =ESO has limited influence/support from industry is required for progression

10 = ESO has extensive influence over development and progression of initiative

APPENDIX

ESO Planning, Modelling & Strategy Cycle

This flow diagram demonstrates where the Annual Balancing Costs Report fits into the fundamental processes performed by ESO from early horizon scanning through to tailored strategy and policy development. This will be repeatable as a closed loop.



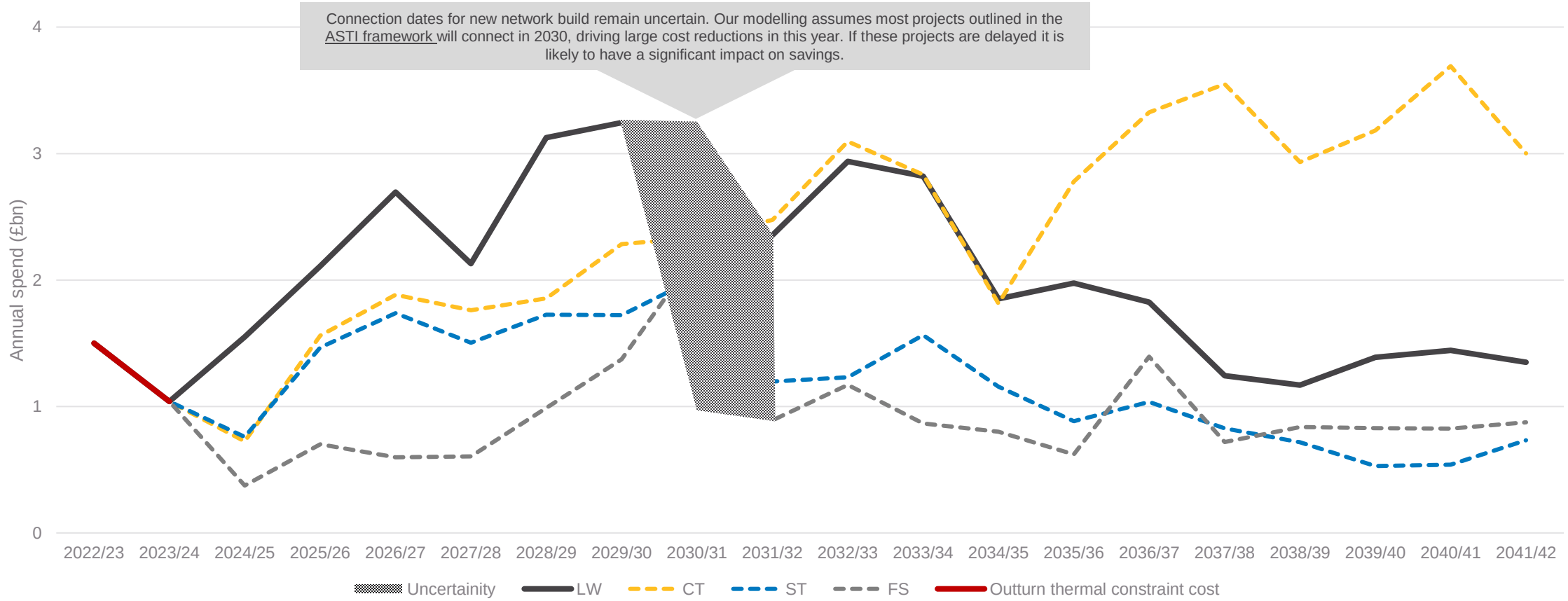
Already delivered / in development

Being scoped

SSEP = Strategic Spatial Energy Plan
RESP = Regional Energy Strategic Plan
CSNP = Centralised Strategic Network Plan
FES = Future Energy Scenarios

Thermal constraint costs

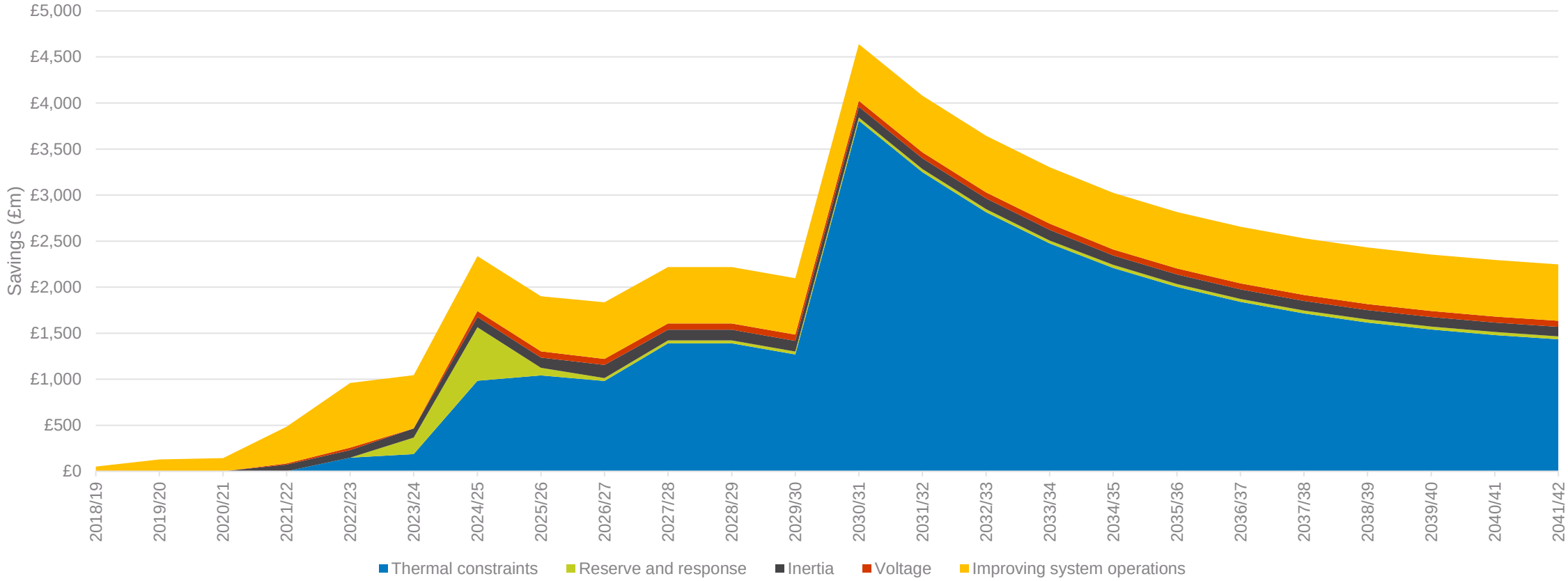
Figure 17. Thermal constraint projections



The above graph provides a projection of residual thermal constraint costs which are a key component of balancing costs. These projections of thermal constraint costs provide the basis for our view of balancing costs out to 2040.

Potential Balancing Cost Savings

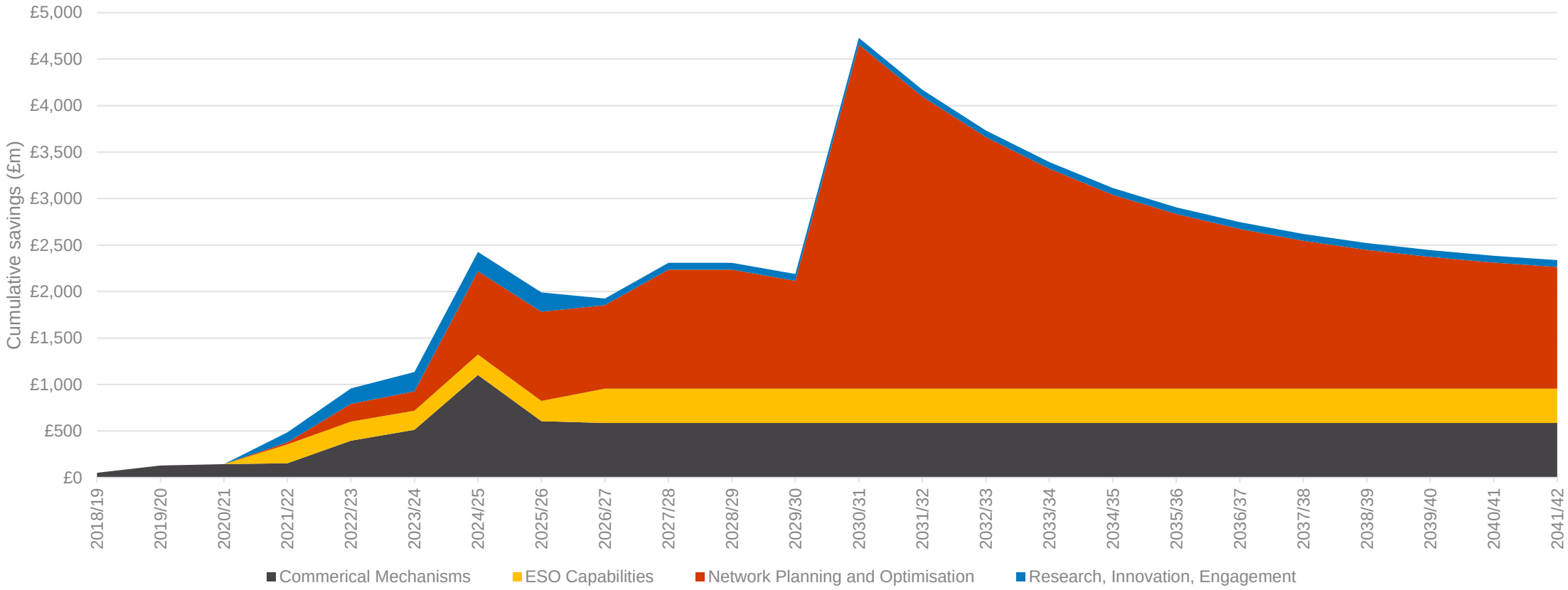
Figure 18. **Potential savings from current initiatives by component**



Thermal constraints are currently a significant driver of costs. Actions to improve thermal constraints therefore provide the most significant savings across all timeframes. Improvements to system operations, including activities such as the Balancing Programme, are also expected to contribute to notable cost reductions.

Potential Balancing Cost Savings

Figure 19. Potential savings from current initiatives by lever



Network Planning and Optimisation is expected to provide significant savings from 2030. Many of the initiative within this lever address thermal constraints. Commercial Mechanisms are also a key lever for shorter term savings

If you have any questions or queries relating to the Balancing Costs Strategy, please reach out to box.Balancing.Costs@nationalgrideso.com

For further information on ESO publications please visit: nationalgrideso.com

ESO