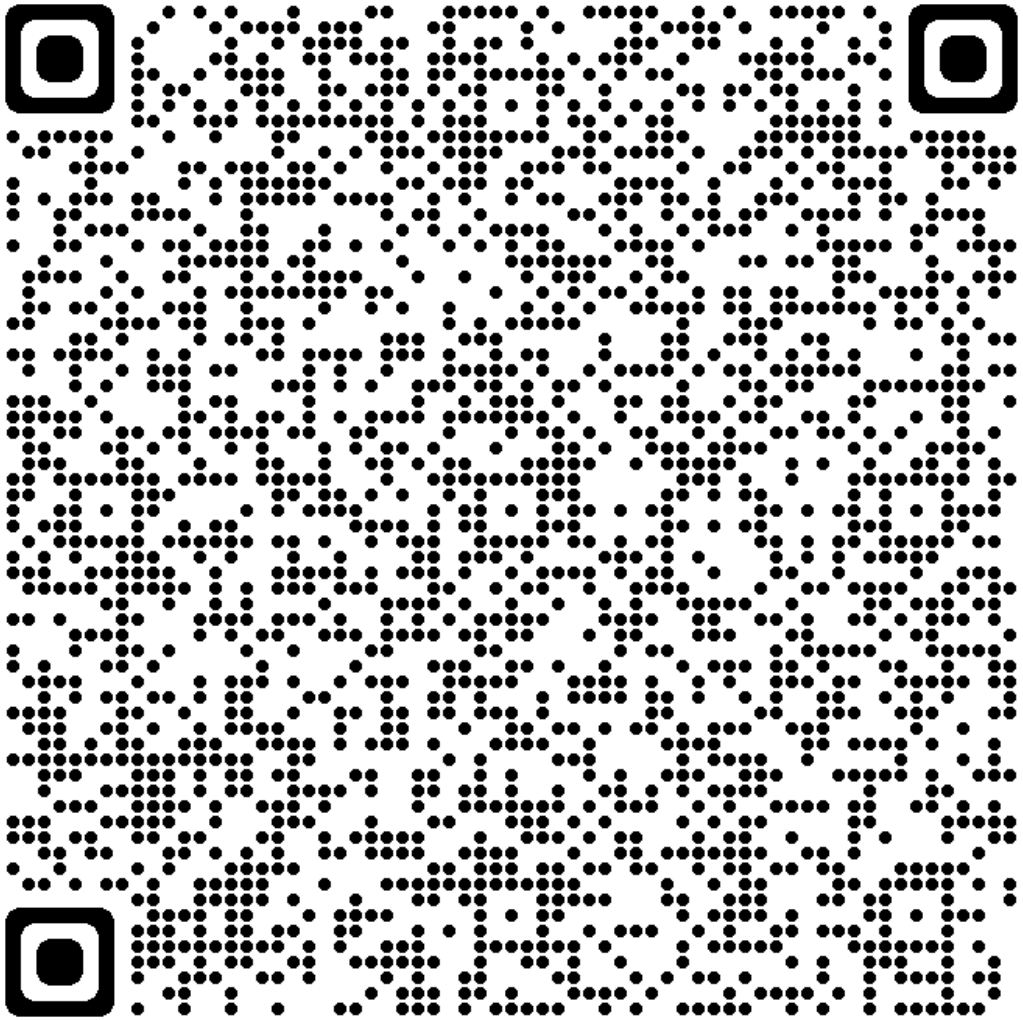
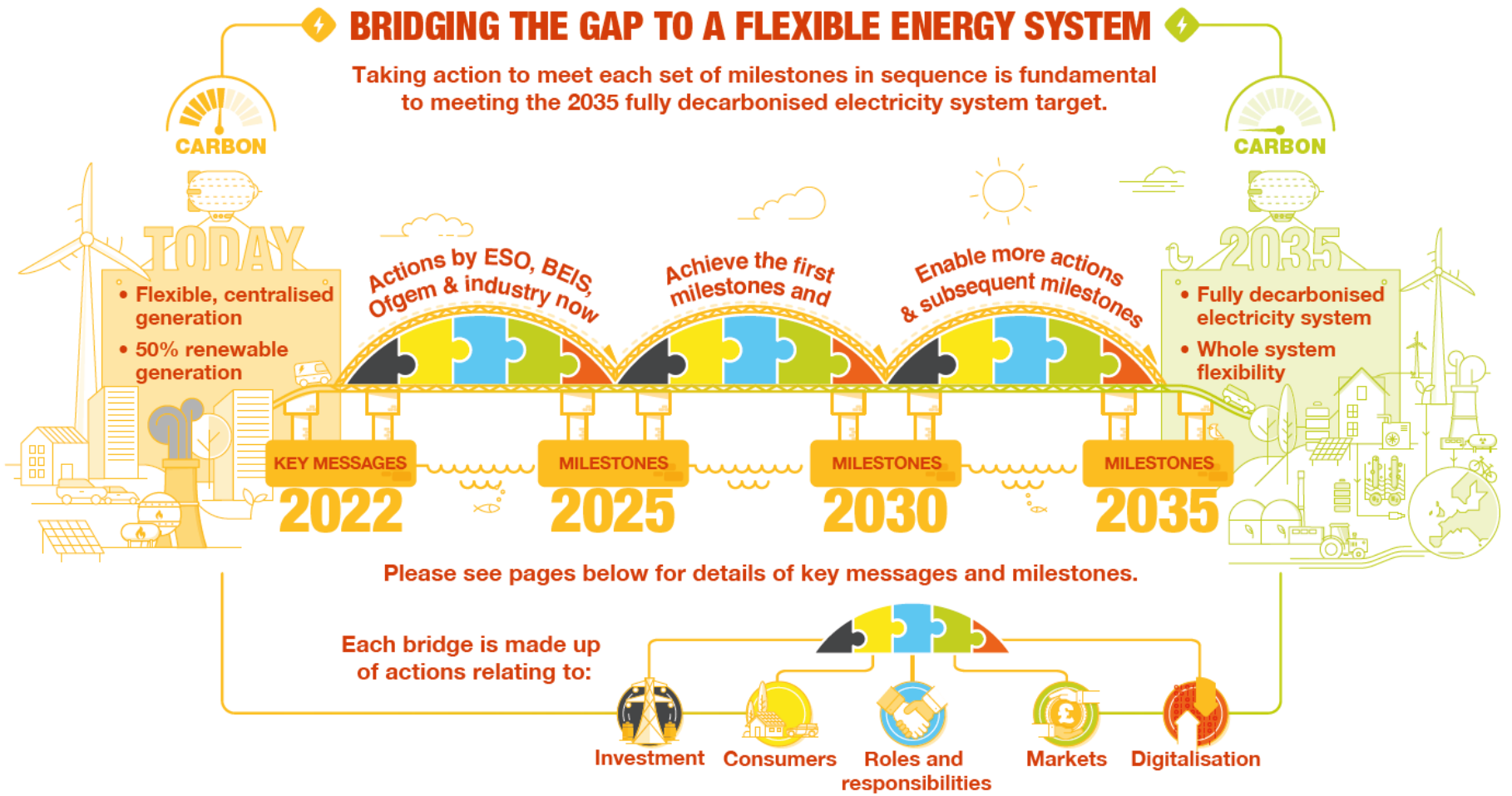
Bridging the Gap to Net Zero

Our previous work



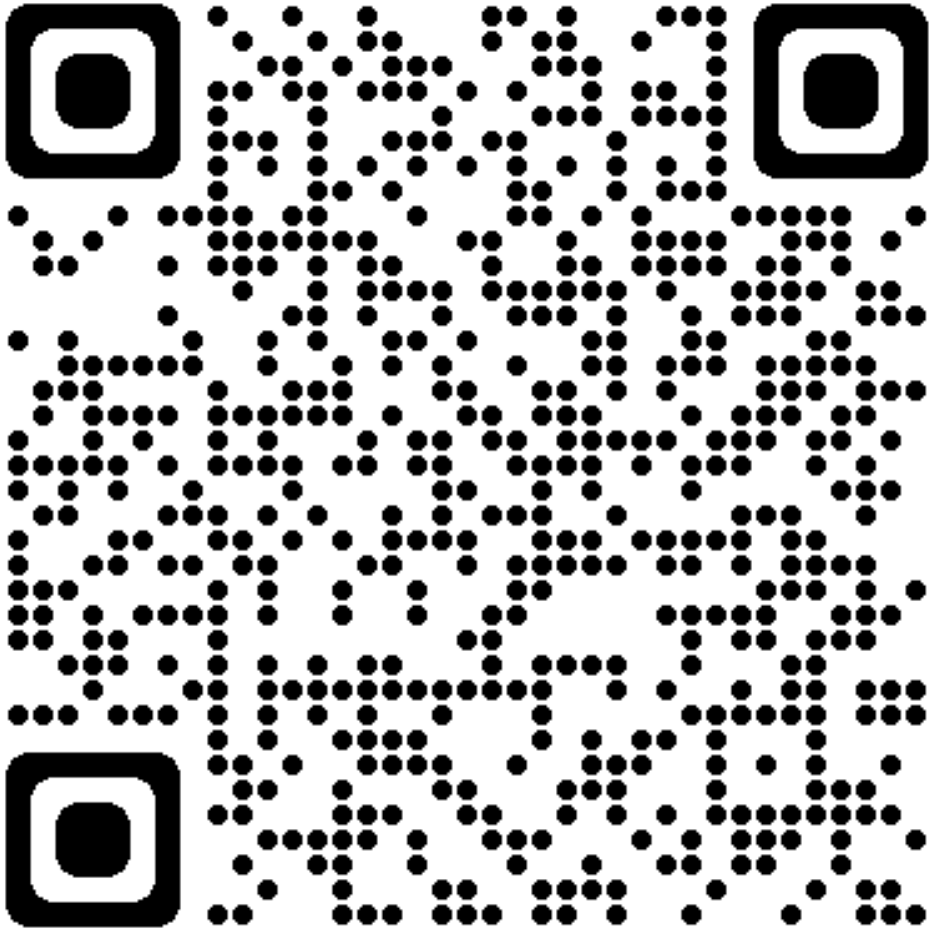
Flexibility timeline



What is Bridging the Gap?

Exploring areas of uncertainty concerning Net Zero delivery through engagement

Sign up to this year’s events



Milestones

2025 PRIORITY MILESTONES

Investment

Strategic flexibility infrastructure projects are underway, e.g. long duration storage, electrolysis.

Consumers

More flexibility enabling, end-consumer products and tariffs are on offer.

Roles and responsibilities

Clarity on who is doing what in the future, flexible energy system.

Markets

Revenue streams will be more certain for investment in flexible assets.

Digitalisation

Interoperability and resilience across the energy system is possible through greater digitalisation.

2030 PRIORITY MILESTONES

Investment

Whole energy system approach is used to make strategic decisions about infrastructure.

Consumers

Consumer facing businesses enable consumers to provide flexibility.

Roles and responsibilities

Codes and standards in place to support different Net Zero roles and responsibilities.

Markets

Reformed markets create incentives for flexibility.

Digitalisation

System balancing and stability actions are automatically deployed.

2035 TARGET MET

Investment

Whole system flexibility infrastructure is in place to enable decarbonised system operation.

Consumers

The majority of consumers are able to deliver the flexibility needed seamlessly via automated products and services.

Roles and responsibilities

A coordinated approach to whole energy system operation is achieved through clarity of roles and responsibilities for Net Zero.

Markets

Markets enable flexibility of all durations through the right long-term investment and short-term dispatch signals.

Digitalisation

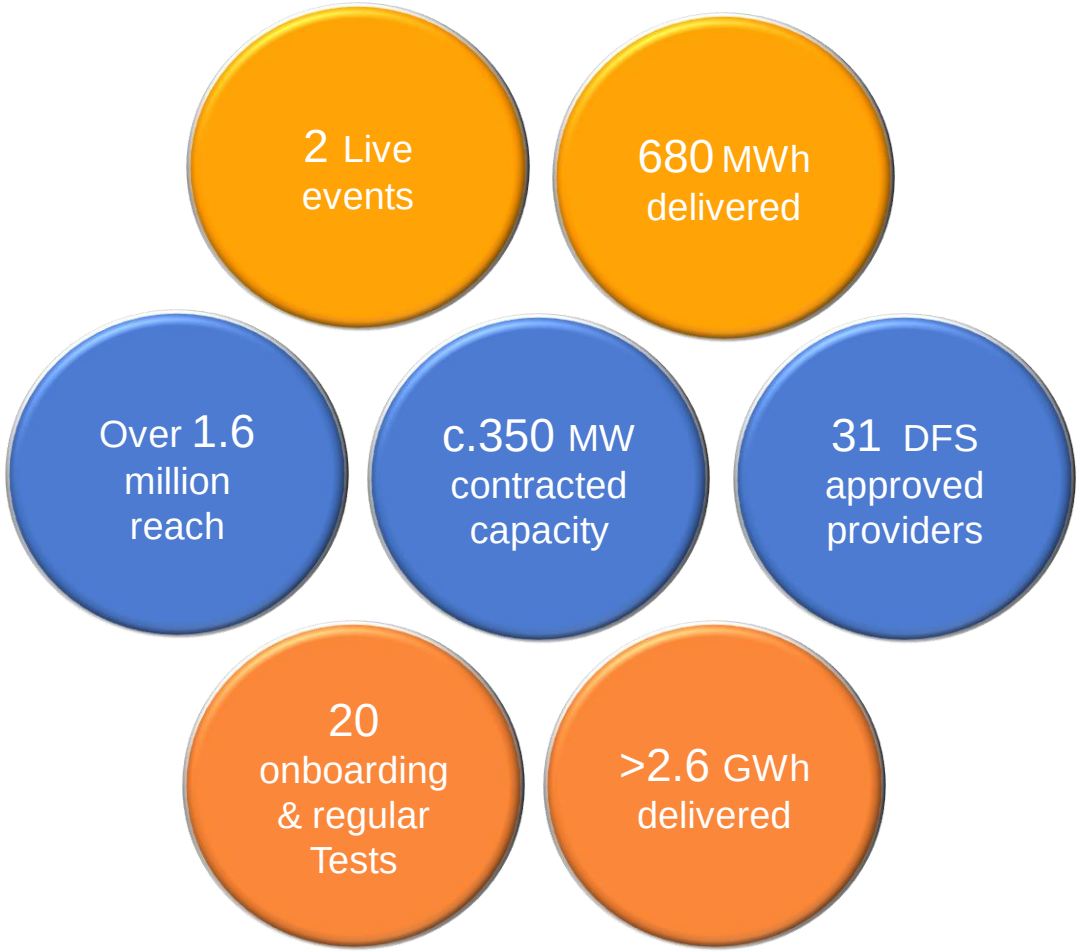
Digitalisation is a fundamental part of the whole energy system as it enables greater market facilitation of flexibility actions.

CONSUMER FLEXIBILITY

DEMAND FLEXIBILITY SERVICE

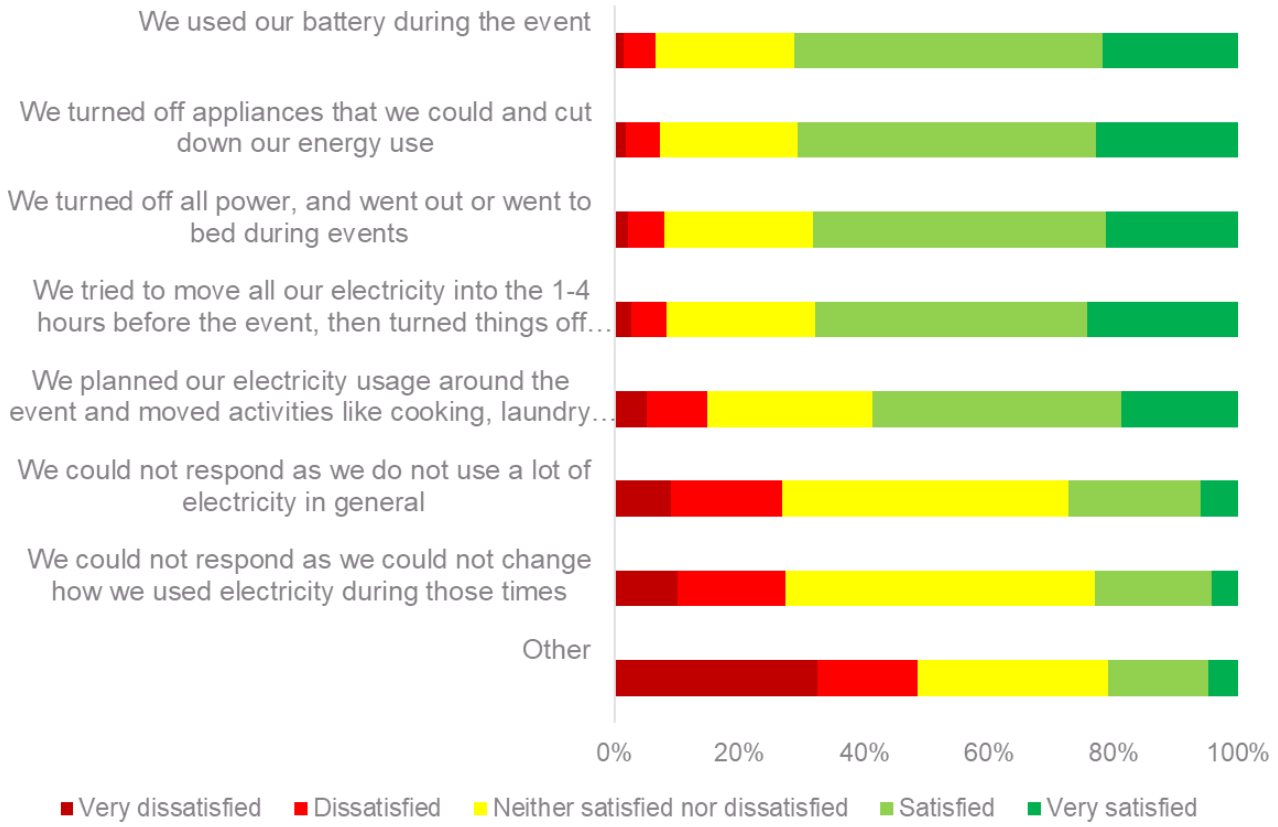
A nationwide demonstration of a demand reduction service, enabling domestic consumers, industrial and commercial users to be incentivised for shifting demand to avoid the peak

KEY STATISTICS

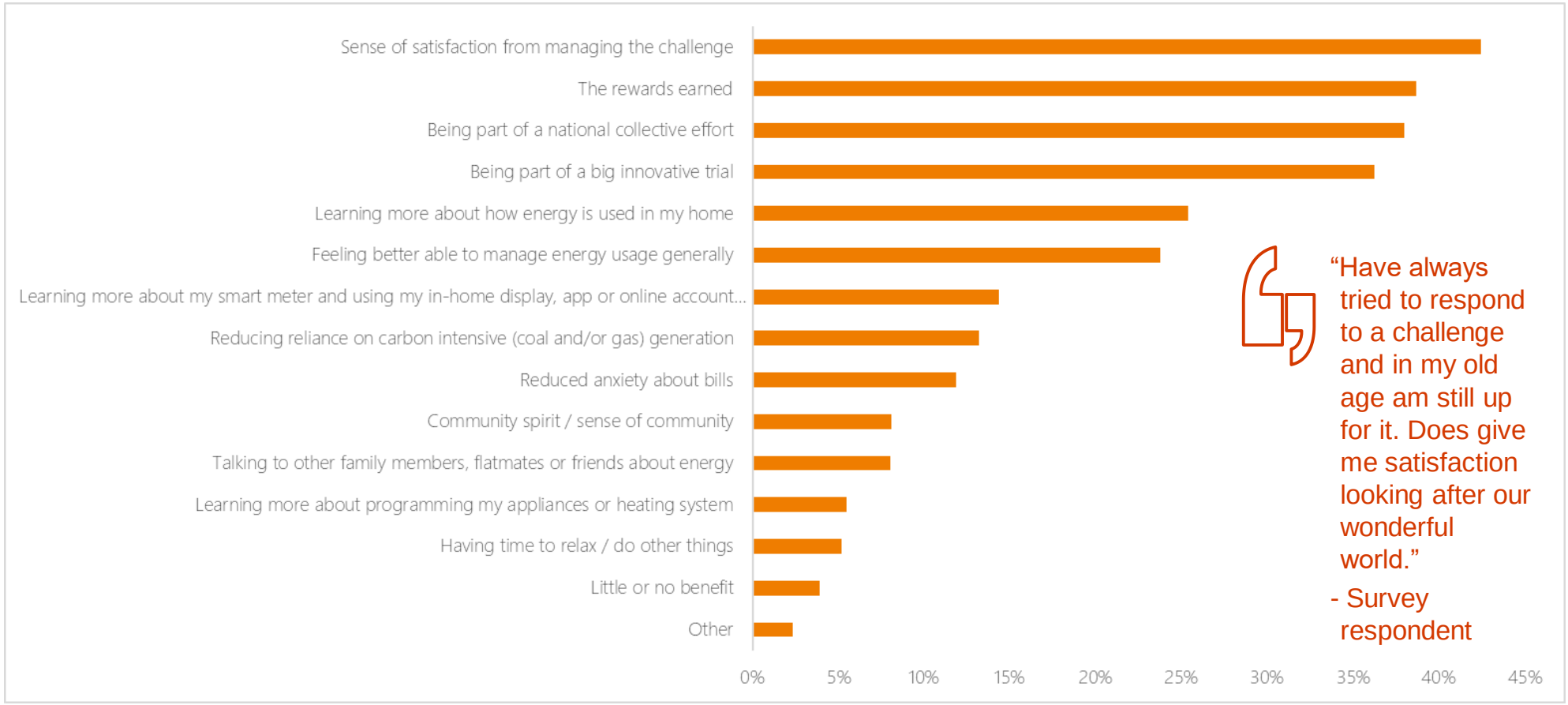


EXPERIENCES

Satisfaction levels were high but differed according to strategy



MAIN PARTICIPATION BENEFITS



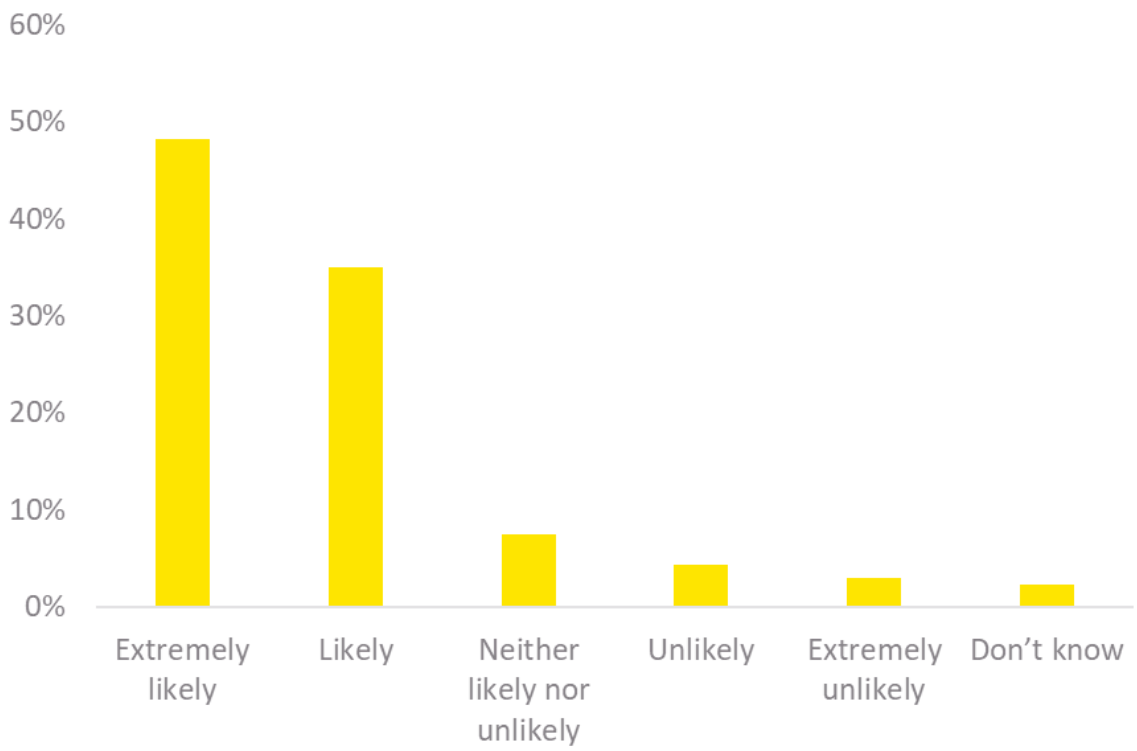
"Have always tried to respond to a challenge and in my old age am still up for it. Does give me satisfaction looking after our wonderful world."

- Survey respondent

FUTURE PARTICIPATION

High willingness to participate again

83% of survey respondents are likely or extremely likely to take part in the scheme again



Future System Operator

The FSO over time

Now

ESO today

‘Day 1’ of the FSO

2024

We will introduce the **whole energy system capability** for:

- **Gas Strategic Planning** and **Whole Energy Planning**
- **Gas Markets Strategy** and **Whole Energy Markets Strategy**
- The **Advisory** role to support BEIS/Ofgem in decision making
- **Office of Energy Resilience & Emergency Management**

The new capabilities will be empowered by two separate licences and the Strategy and Policy Statement, with **new statutory duties** to ensure security of supply for electricity and gas

- A new **Electricity System Operation** licence
- A new **Gas Strategic Planning** licence

Setting up enabling services to serve a standalone organisation

Future of the FSO

2024 - 2030

Future responsibilities may extend to the following:

- **Hydrogen**
- **Heat**
- **Transport**
- **CCUS**

Transforming enabling services

New roles

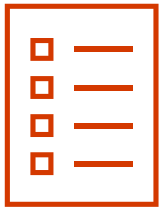
Whole Energy Networks

Why are we doing this?

Co-ordinate across the energy system to provide insights and translate policy into immediate strategy to facilitate ‘net zero’.

What are we looking to achieve?

Working across whole energy system solutions, providing strategic and investment recommendations so infrastructure is an enabler of the transition to net zero.



How will we deliver this role?

Recruiting expertise in strategy development and system planning whilst utilising business capabilities and processes to meet net zero more efficiently.

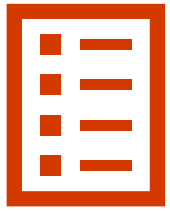
Whole Energy Markets

Why are we doing this?

Create a holistic view of energy markets across multiple vectors to provide clear direction, increase efficiency/accessibility and give insights on how codes could be modified to facilitate improvement.

What are we looking to achieve?

Drive value by bringing industry experts together to collaborate on whole energy market challenges and develop holistic energy market strategies to drive innovative solutions.



How will we deliver this role?

Building a range of capability including business planning to data analysis to facilitate whole market participation and identify future challenges, trade-offs and routes for increased efficiency.

New roles

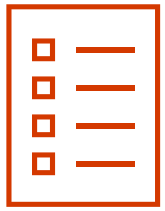
Advisory

Why are we doing this?

To provide strategic advice, information and analysis to the Gas and Electricity Markets Authority (GEMA) and Ministers of the Crown.

What are we looking to achieve?

Responding to requests for advice on the energy trilemma, energy strategy/policy and give awareness of new developments across the industry.



How will we deliver this role?

Creating a multi-disciplinary team aligned to the energy trilemma, spanning the whole energy system, to develop advice and facilitate engagement with stakeholders.

Office of Resilience and Emergency Management

Why are we doing this?

Responsible for cross-vector energy resilience, emergency preparedness and response coordination, to move towards a whole energy system response.

What are we looking to achieve?

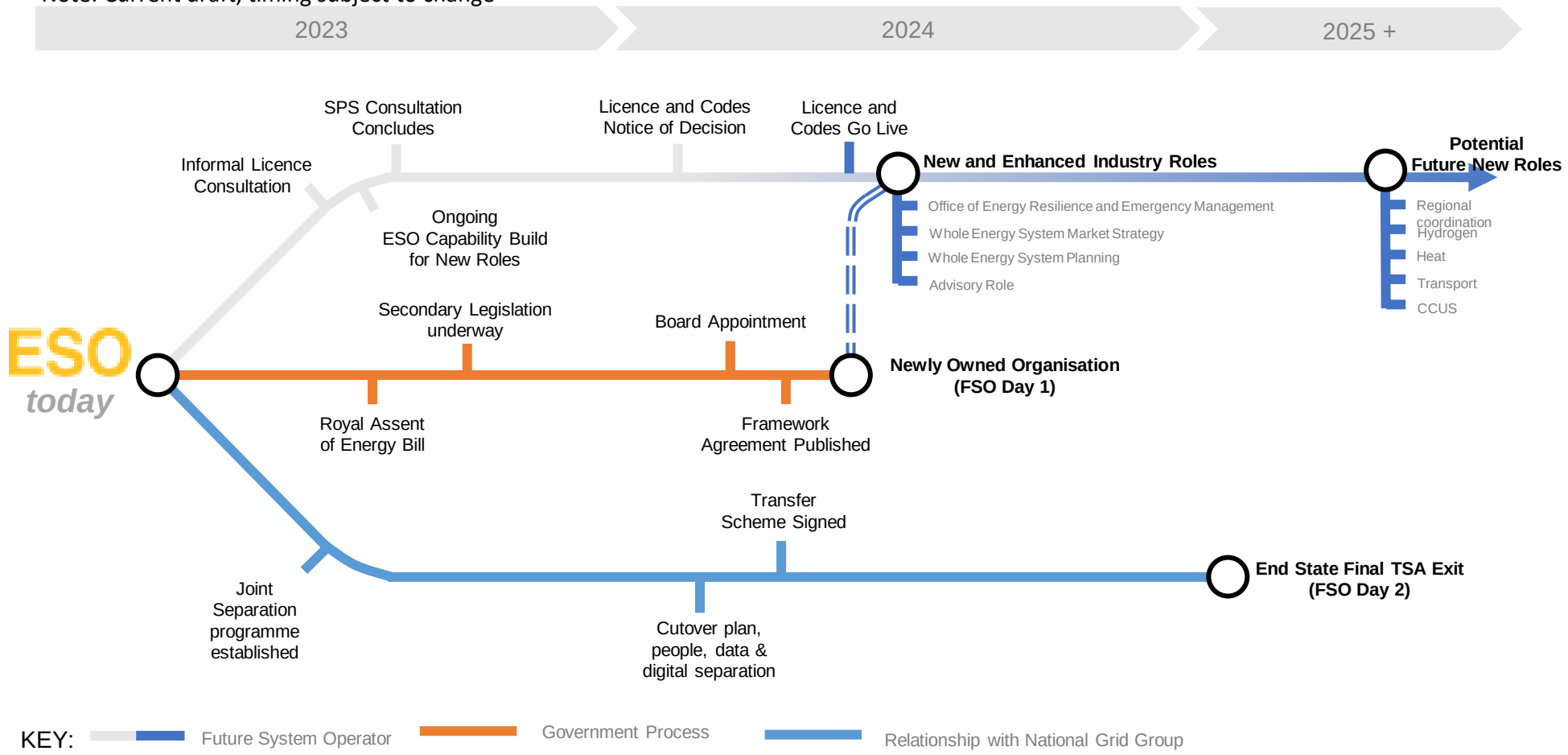
Identify resilience interactions and opportunities, addressing vulnerabilities and, in time, providing whole energy system co-ordination during an energy emergency.

How will we deliver this role?

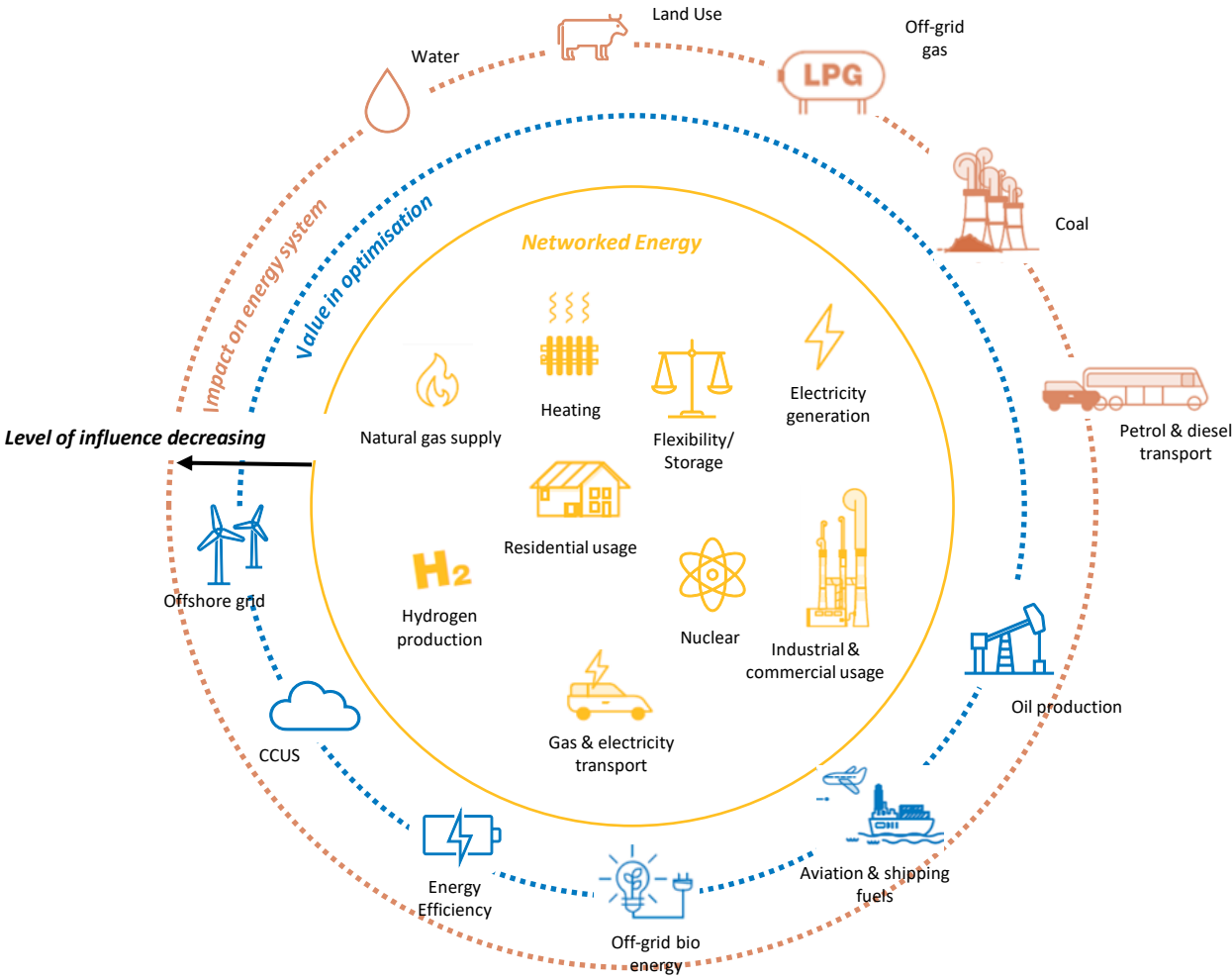
Recruiting cross vector expertise and whole energy system resilience knowledge, building on existing resilience and emergency activities as the role extends to the whole energy system.

High Level FSO Roadmap

Note: Current draft, timing subject to change



Whole Energy Thinking



There are many different areas which could be considered when thinking about the whole energy system.
Thinking to date is to focus on the central yellow areas as the FSO first goes live which could develop over time

Evolution of the FES

Where we have come from and where we are going

Where we have been

- Originally designed to feed the Electricity and Gas 10 Year Statements
- A flagship publication for over 12 years
- Constantly evolving to provide new insights and serve more customers
- At the heart of ESO activities from network planning to security of supply
- Exploring uncertainty and managing risk through our scenarios

What's coming next

- Through the CSNP Ofgem's aims to enable coordinated strategic planning of a wholistic future energy system
- The FES process will evolve to form the foundation for the CSNP
- The focus of our analysis will expand from what could happen to explore what should happen
- By doing this the FSO will take an active role in steering the future of energy

FSO and Advisory Role

- In 2024 the ESO will become the Future System Operator
- The FSO will be in the public sector, with operational independence from government
- Utilising our expertise built on years of experience, as well as our analytical tools and techniques, we will provide impartial advise to government on decisions on the route to net zero
- Scan the QR code to find out more about the FSO

From Scenarios to Pathways

Scenarios

- Informed through extensive research and stakeholder engagement
- By varying sets of input assumptions the FES explores and models different ways we might use and generate energy in the future
- By seeking out credible yet distinct outcomes we provide a wide range of possible futures to our downstream customers to allow them to asses risk

Pathways

- An evolution of our scenarios
- Continue to explore what could happen through the same rigorous process
- Go one step further to determine the routes to net zero that provide the highest consumer value
- Use our analysis to present what could happen, what should happen and where our current trajectory is heading

Ofgem Consultation

- Ofgem consulted on how the future of supply and demand modelling (FES) should evolve to fulfil the requirements of the CSNP
- Their consultation closed on 23rd June 2023
- Scan the QR code for a link to Ofgem's consultation

Let us know what you think

We would love to hear what you think about the future evolution of the FES process

Please let us know and ask us any questions, we are here to chat

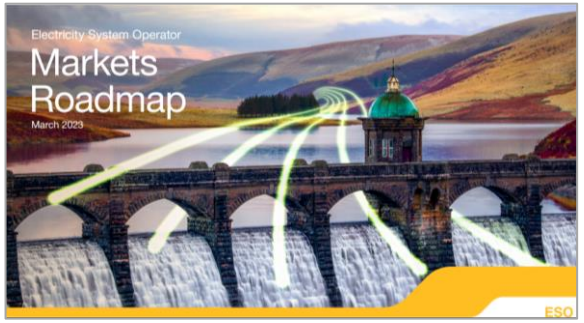
Markets Roadmap

Reforming our markets

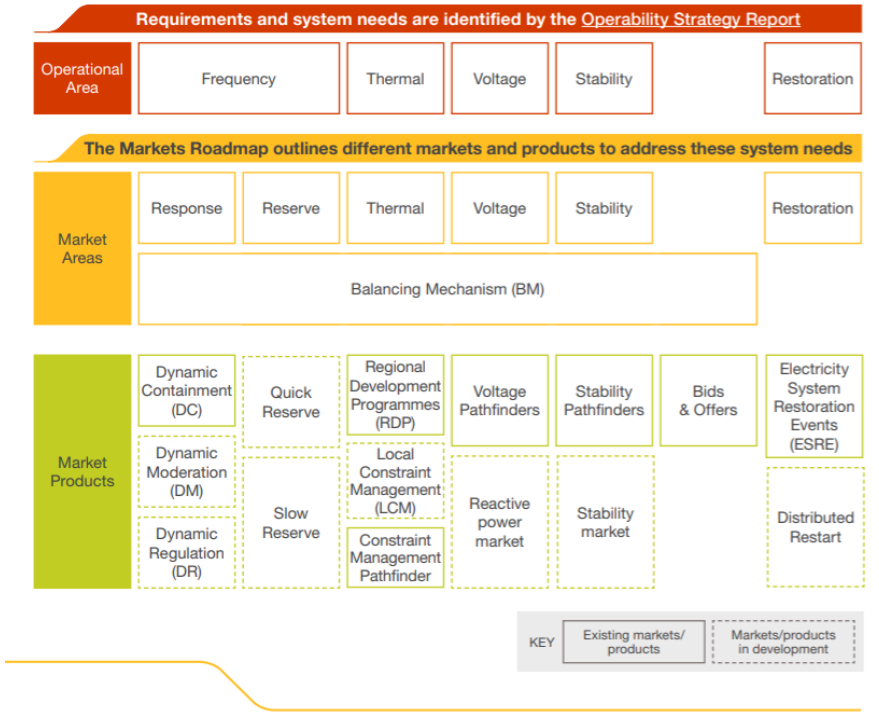
The Markets Roadmap outlines the ESO's plans to reform our markets to enable zero-carbon operation by 2025 and fully decarbonise by 2035

The markets roadmap also:

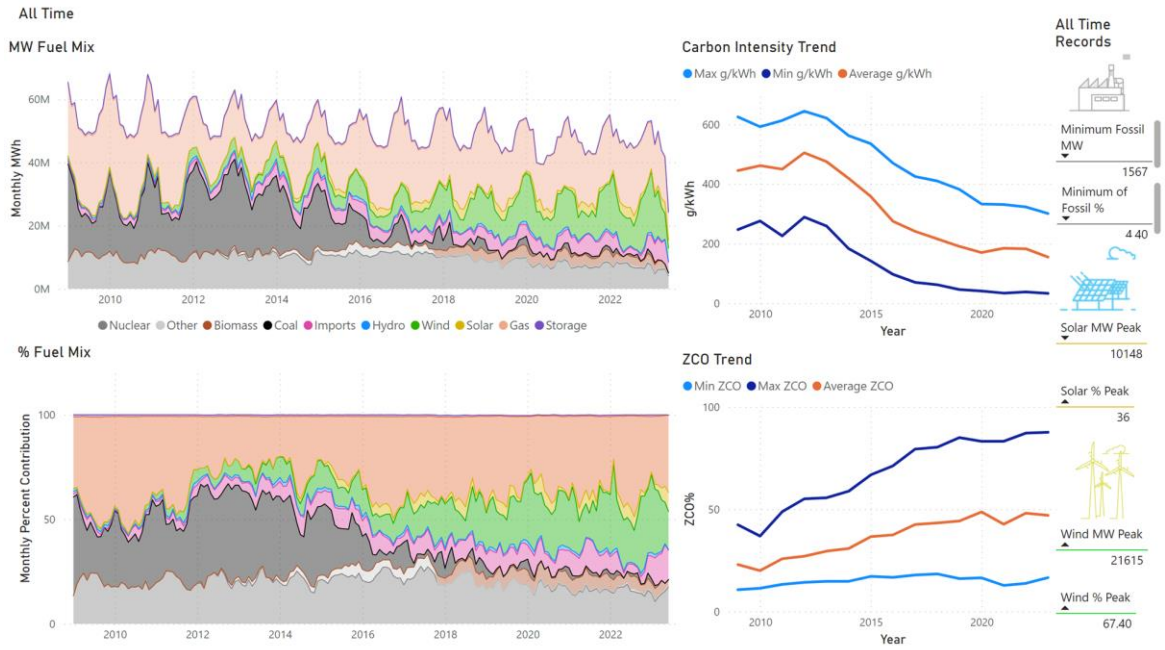
- Provides key insights into the different ESO markets as well as the key drivers for reform.
- Gives stakeholders confidence that we are making the right market reform and design decisions.
- Shares strategic questions we are currently tackling and signposts how industry can work with us to answer them.



Our product suite



2025: Zero carbon ambition



- By 2025, our target is to operate the electricity transmission system for at least one settlement period with 100% zero carbon generation.
- We need the market to deliver a 100% zero carbon position, but we also need the right ancillary services.
- This includes fast-acting response products, zero-carbon stability and voltage support.
- Our new Dynamic Frequency Response products and Pathfinders will be crucial to achieve zero carbon operation.

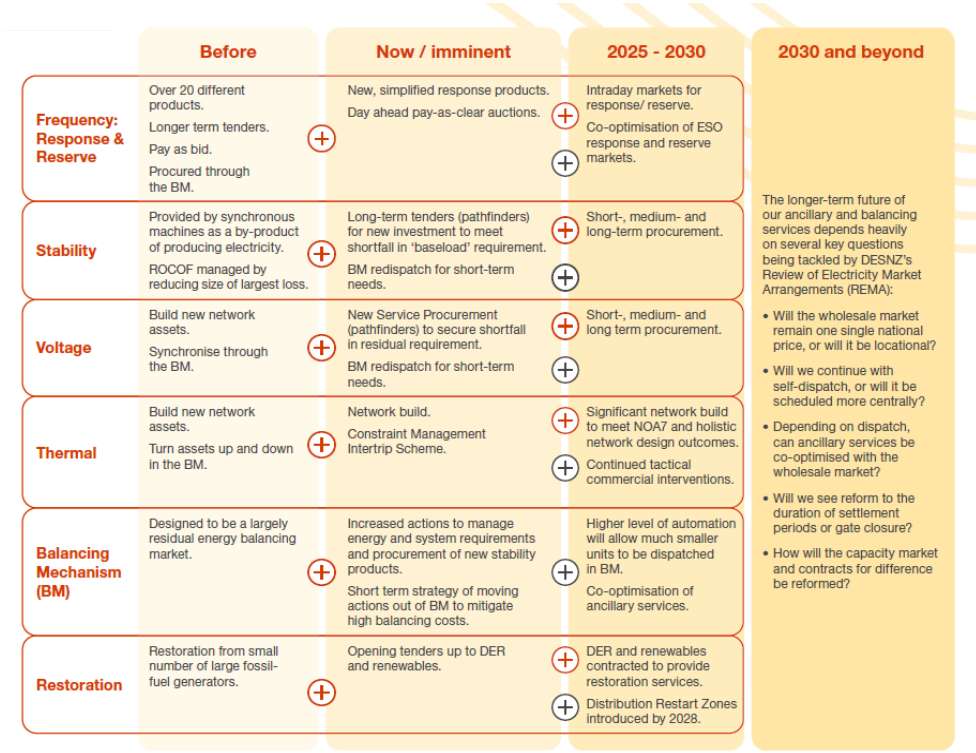
Scope of the Market Roadmap

In the roadmap, we:

- Outline the drivers for reform and planned changes to improve the markets in the near term.
- Demonstrate how we're looking for market solutions, which are cost-effective for the consumer as well as ensuring system operability.
- Provide more clarity on the strategic direction of travel for 2025-30 and how we're thinking about the wider market changes.

If you have feedback/suggestions for improvement, please get in touch:

market.dev@nationalgrideso.com

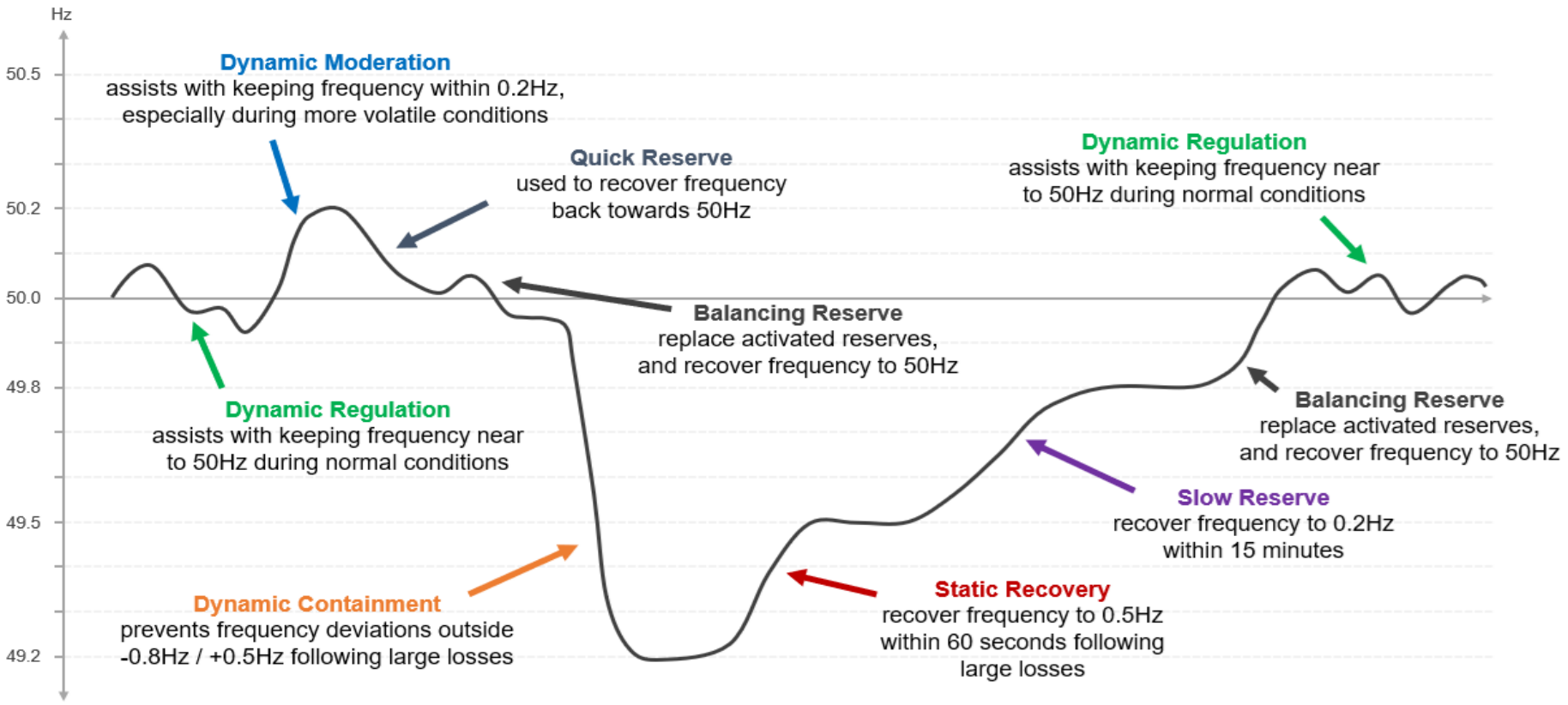


	Before	Now / imminent	2025 - 2030	2030 and beyond
Frequency: Response & Reserve	Over 20 different products. Longer term tenders. Pay as bid. Procured through the BM.	New, simplified response products. Day ahead pay-as-clear auctions.	Intraday markets for response/ reserve. Co-optimisation of ESO response and reserve markets.	The longer-term future of our ancillary and balancing services depends heavily on several key questions being tackled by DESNZ's Review of Electricity Market Arrangements (REMA): • Will the wholesale market remain one single national price, or will it be locational? • Will we continue with self-dispatch, or will it be scheduled more centrally? • Depending on dispatch, can ancillary services be co-optimised with the wholesale market? • Will we see reform to the duration of settlement periods or gate closure? • How will the capacity market and contracts for difference be reformed?
Stability	Provided by synchronous machines as a by-product of producing electricity. ROCOF managed by reducing size of largest loss.	Long-term tenders (pathfinders) for new investment to meet shortfall in 'baseload' requirement. BM redispatch for short-term needs.	Short-, medium- and long-term procurement.	
Voltage	Build new network assets. Synchronise through the BM.	New Service Procurement (pathfinders) to secure shortfall in residual requirement. BM redispatch for short-term needs.	Short-, medium- and long term procurement.	
Thermal	Build new network assets. Turn assets up and down in the BM.	Network build. Constraint Management Intertrip Scheme.	Significant network build to meet NOA7 and holistic network design outcomes. Continued tactical commercial interventions.	
Balancing Mechanism (BM)	Designed to be a largely residual energy balancing market.	Increased actions to manage energy and system requirements and procurement of new stability products. Short term strategy of moving actions out of BM to mitigate high balancing costs.	Higher level of automation will allow much smaller units to be dispatched in BM. Co-optimisation of ancillary services.	
Restoration	Restoration from small number of large fossil-fuel generators.	Opening tenders up to DER and renewables.	DER and renewables contracted to provide restoration services. Distribution Restart Zones introduced by 2028.	

Market Roadmap in 5 minutes

Market Area	Volumes	Costs	Summary of reforms / key points to note
Frequency Response	↑	↘	Co-optimisation of existing products, phase out of FFR, development of Static Recovery.
Reserve	↓	↑	Development of new Quick & Slow Reserve products, revised plan to launch Balancing Reserve, future co-optimisation opportunities.
Thermal Constraints	↑	↑	Delivery of Constraint Management Intertrip Service (CMIS), Local Constraints Market launch, MW Dispatch, longer-term wholesale change through REMA.
Restoration	N/A	→	Embedding learnings from Distributed ReStart, feasibility and economic assessment of 3 new tenders launched in 2022.
Stability	↑ ↓	↑	Go-live of all Phase 1 Stability Pathfinder units, design of 3 new stability markets through innovation project, indication to launch Y-1 market as a priority.
Voltage	↑	↑	Reactive power market design innovation project, new Network Services Procurement tender for 2026, harness new capability through CSA.
Balancing Mechanism	↑	↑	Removing actions from BM through new specific markets, lowering barriers to entry (e.g., operational metering), Balancing Transformation.

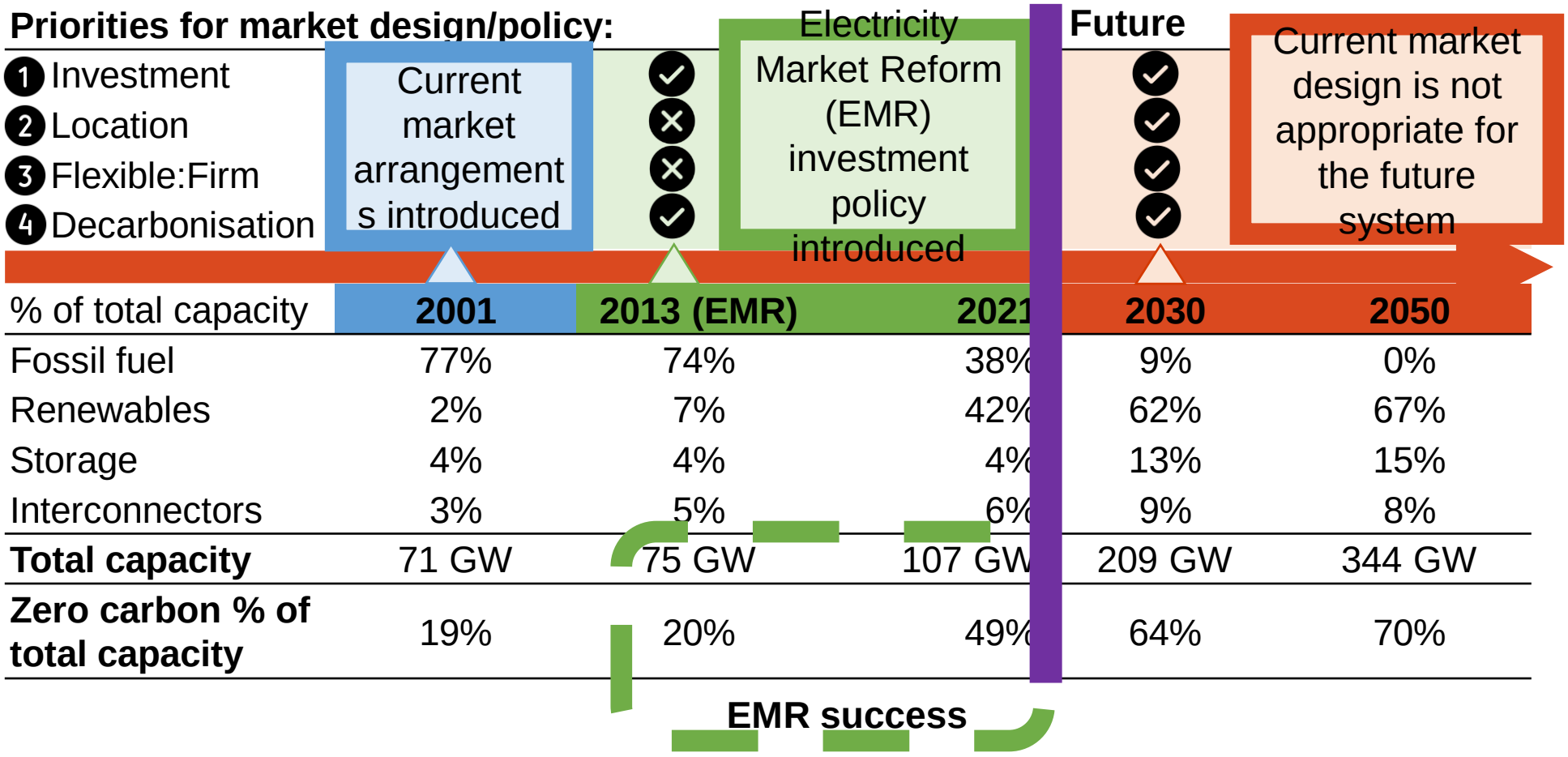
Managing system stability



Net Zero Market Reform

Current markets require reform

Our current market was not designed for a high-renewable, flexible, low carbon system, and requires reform for net zero



% of total capacity	2001	2013 (EMR)	2021	2030	2050
Fossil fuel	77%	74%	38%	9%	0%
Renewables	2%	7%	42%	62%	67%
Storage	4%	4%	4%	13%	15%
Interconnectors	3%	5%	6%	9%	8%
Total capacity	71 GW	75 GW	107 GW	209 GW	344 GW
Zero carbon % of total capacity	19%	20%	49%	64%	70%

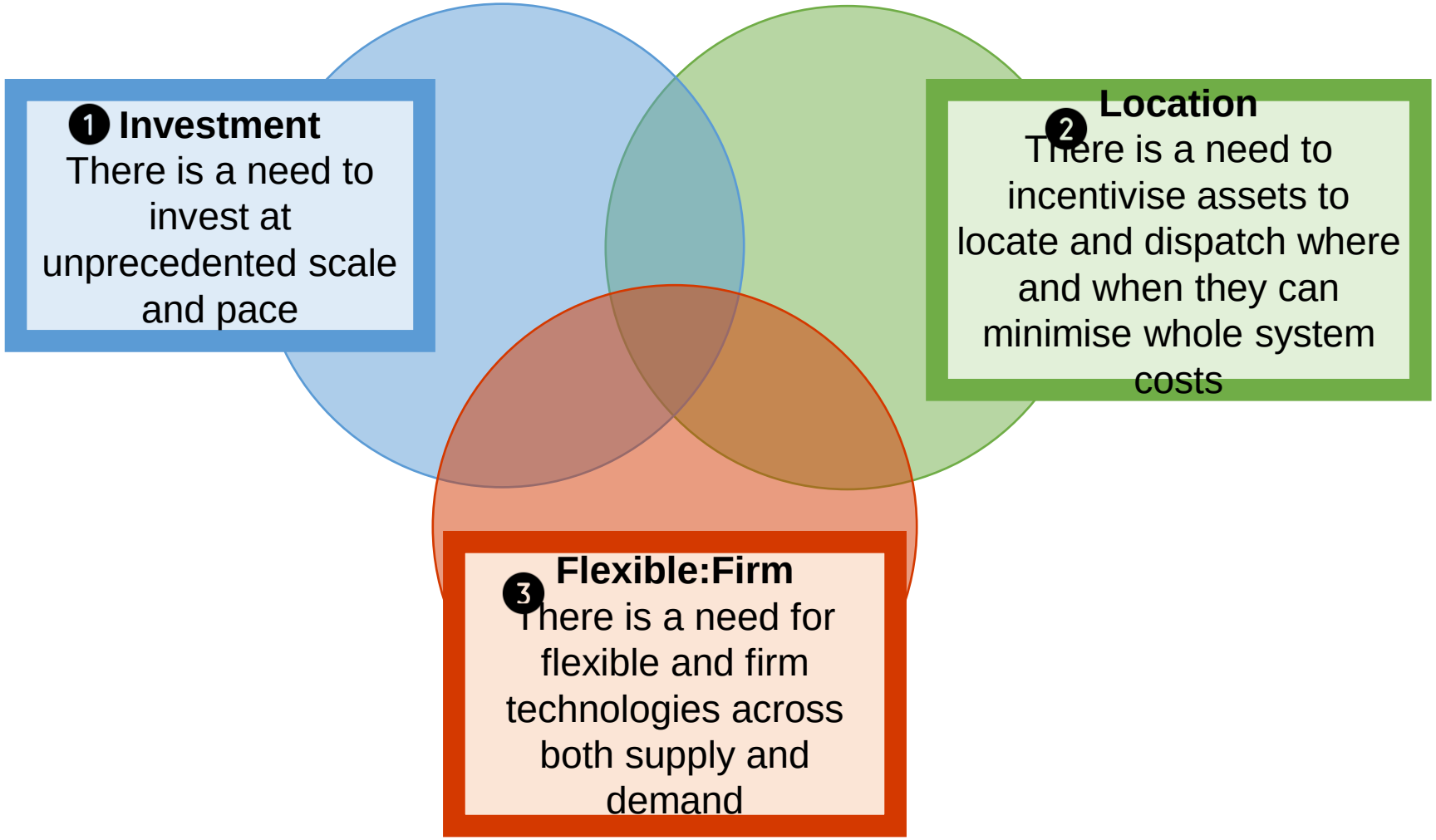
EMR success

Note: Fossil fuel = coal, gas and oil; Renewables = wind, solar and other renewables (e.g. tidal etc); Zero carbon includes nuclear and renewables, but not storage and interconnectors

Source: DUKES 5.8 for all 2001 and 2014 data expect interconnector data from Ofgem; FES2022 for all 2021, 2030, 2050

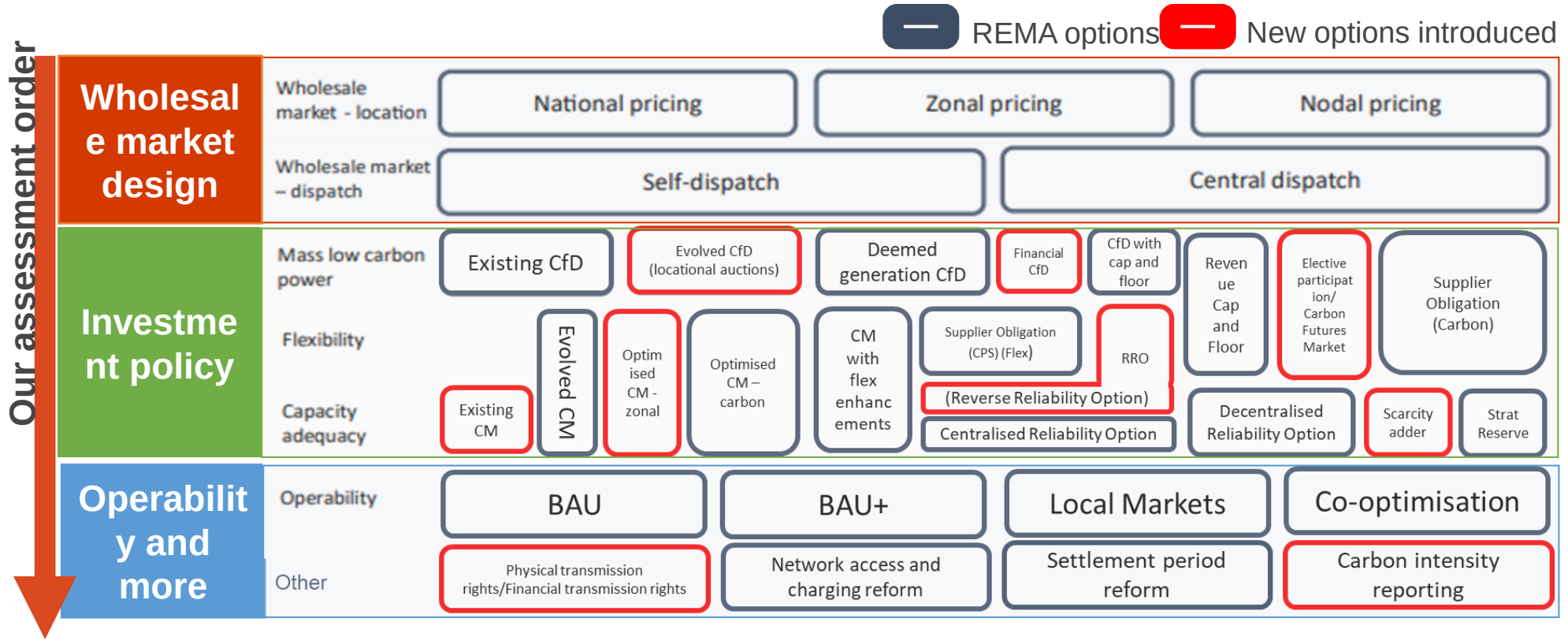
Challenges to be addressed

Our ‘Case for Change’ identified three key challenges facing the GB electricity market that need to be addressed by reform



Assessment of reform options

We first assessed wholesale market design when considering options for reform from both an operational and investment perspective



Our assessment of wholesale market design options (phase 3)

Baringa's independent assessment of reform options

Summary of our assessment

Market reform must be implemented with clear transitional pathways to retain investor confidence in order to achieve net zero at lowest cost

Our market reform priorities

- Re-establish link between wholesale market incentives and real-time system needs, by introducing locational energy pricing
- Retain investment policy but reform to address distortions and ensure participants' incentives align with market signals

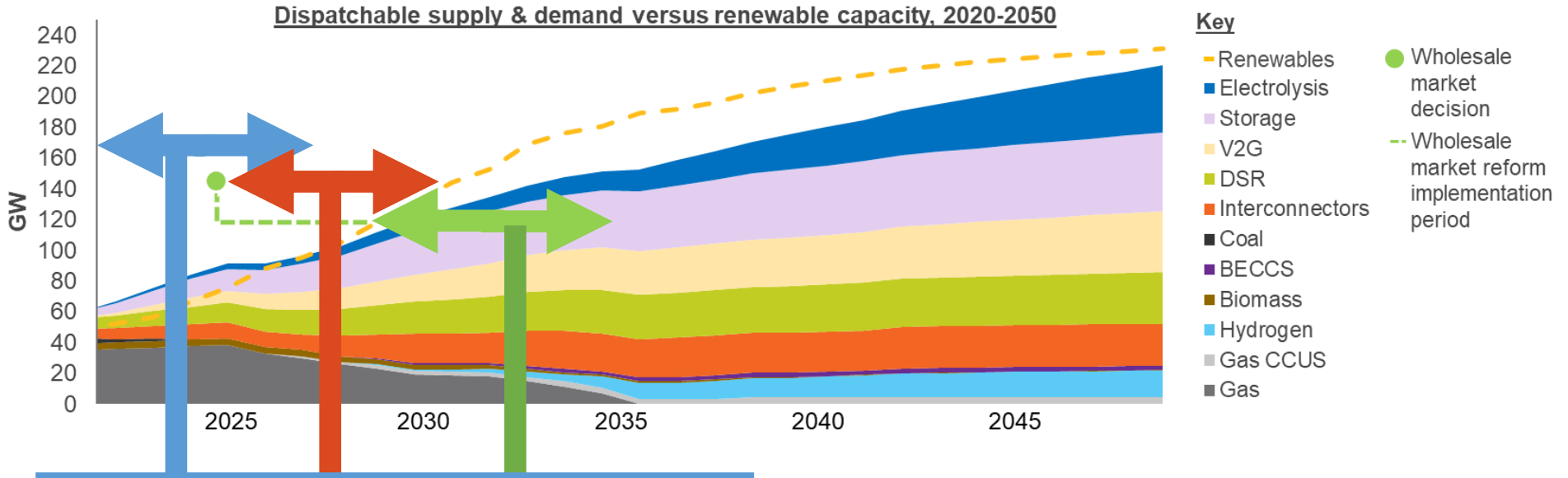
Implementation considerations

- Enduring investment reforms should be coherent with future wholesale market design
- Potential short-term reforms, to *partially* address emerging issues, must be carefully considered due to additional disruption and potential for unintended consequences
- Reform pathways which set out how the package of reforms are phased in over time are critical to minimise regulatory risk and ensure investor confidence
- Need to coordinate with complementary strategic transmission network build

Our preferred pathway (next slide)

Our holistic vision for markets

Our holistic long-term vision for GB electricity market design emerges from three key implementation phases



1. Flex foundations (present to 2027)

2. Investment policy realignment (2025-2030)

3. Wholesale market transition (2028-2035)

More detail in our autumn report.
To keep up to date:

Network Reform

Connections Reform

We recognise the challenges currently facing our connections customers and the need to update the connections application process. As a result, we have launched the Connections Reform project to address these challenges and put our customers and stakeholders at the heart of this change. Our 5-Point Plan is helping to manage some of these immediate challenges.

1. TEC Amnesty
This was the first TEC Amnesty since 2013. We received a total of 8.1GW of applications and are currently working with Ofgem to allow the termination/reduction of TEC process from connection agreements.

2. Construction Planning Assumptions Review
We are reducing the assumptions around how many projects in the queue will connect. We expect this will allow some connection dates to be brought forward and reduce works in existing agreements.

3. Treatment of Storage
We are revising the way storage connections are modelled using insight resulting of a better understating of its behaviour. These changes will allow storage to connect quicker and support unlocking more capacity to connect others.

4. Queue Management
There is currently no mechanism in the CUSC to terminate projects that are not progressing. If changes are approved, it would allow us to terminate projects that are not progressing against their contracted milestones and agreed timescales.

5. Non-firm Offer Development
The policy aims to accelerate the connection of energy storage projects by removing the need for non-critical enabling works to be complete before they connect. We continue to look at the opportunity to roll out this approach to other connections.

How do we get there?

ESO 5-Point Plan

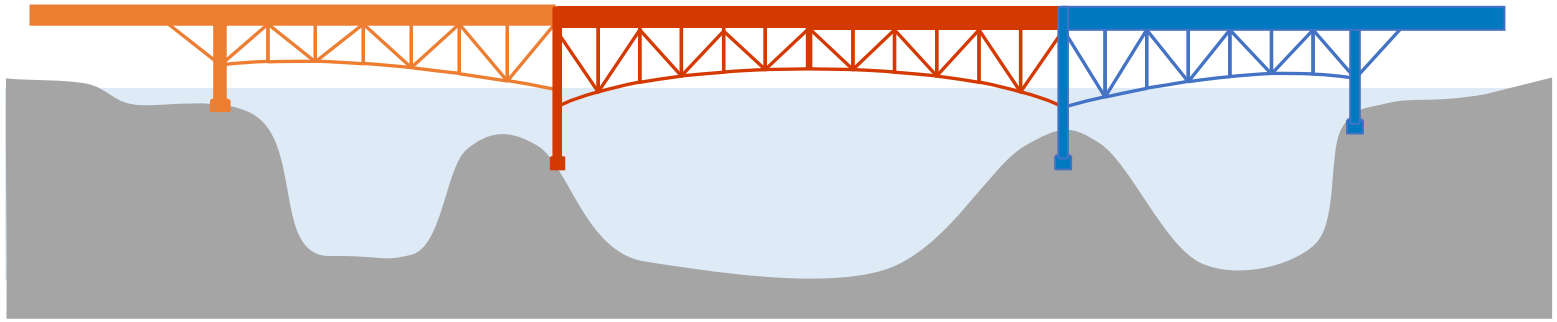
Tactical initiatives designed to alleviate as much of the pain as possible and introduce improvements, which are aligned initiatives coordinated by others e.g. SCG

Implementation and Transition

Implementation of the reformed process, including potential phasing / quick wins and any transitional activities required to move between the current and future process

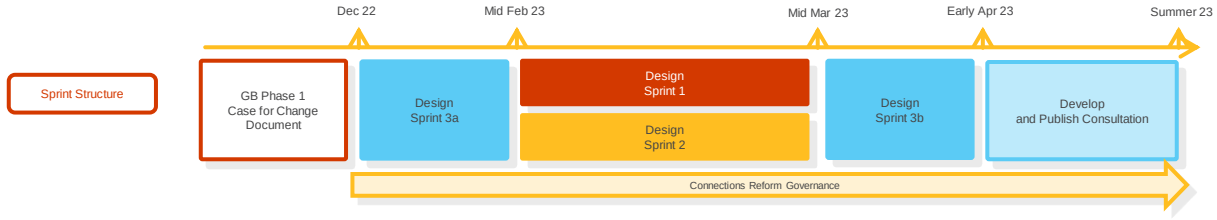
Reformed Process

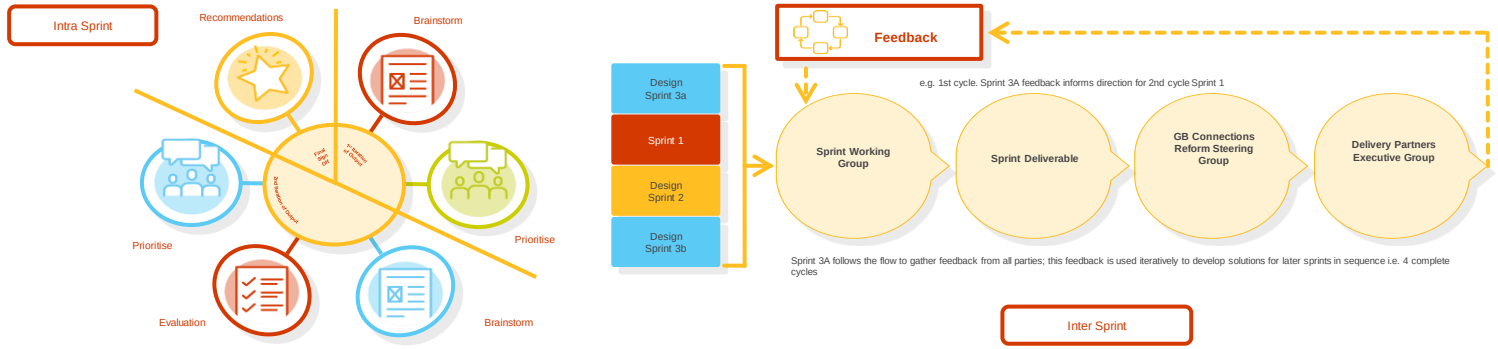
Ultimate solution in place fully reflected in relevant licences, codes, policies and procedures with steady state changes possible through enduring change mechanisms



Connections Reform

We started Phase 1 of the connections reform project in October 2022 to understand stakeholder needs and published our Case for Change in December. Phase 2, which commenced in January, was structured based on the work and learnings from the case for change.





We have now launched our Connections Reform Consultation to get industry views on our proposed recommendations.

The Connections Reform Consultation can be found on our website and will be open until **Friday 28 July** for formal feedback.

Email us

Box.connectionsreform@nationalgrideso.com

Get in touch to share your views!

Consultation Link

Summary Link

ESO

Future Of Network Planning

Net Zero will change how our energy is sourced, used and transported, with the energy network at the forefront of the transition. Evolution of the network planning investment is underway to support the delivery of the UK's net-zero ambition.

Centralised Strategic Network Plan will provide insights and direction across all system needs, under a single framework.

Focusing on system requirements in the short term whilst anticipating the network of the future.

The framework will have built-in ability to consider different fuel sectors.

Pathways identifying the long term direction of travel for Net Zero

Onshore and offshore ET networks (including interconnection), are planned holistically

Environmental and community factors considered alongside economic are considered in the high-level designs

The key building blocks for network investment will remain unchanged; how will they are delivered will evolve, requiring development of new tools and capabilities.

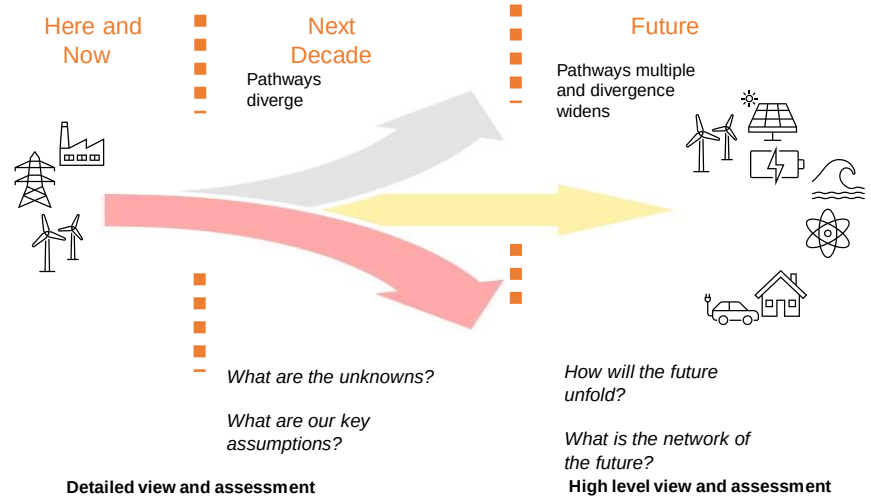
Agility, transparency, governance and robustness are key enablers for the new framework

The multiple pathways to Net Zero will require robust approach to determine the exact approach

Where are we today?
What do we know?

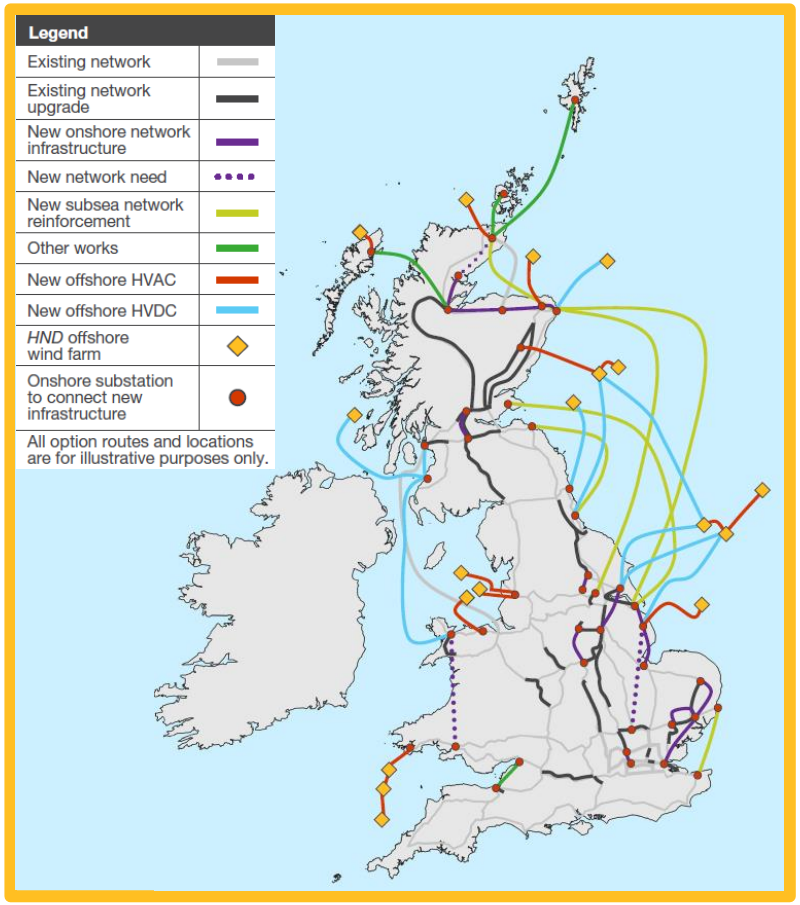
What is the gap?
How do we bridge the gap?

Where are we heading?
What are the unknowns?



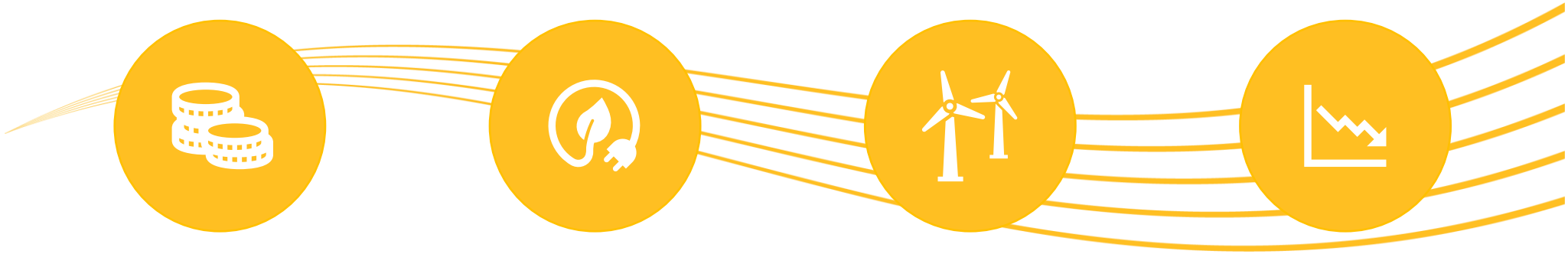
Holistic Network Design

- **Connects offshore wind** and **transports** the electricity generated to where it will be used.
- Helps to **unlock 50 GW of offshore wind by 2030** when combined with wind further advanced in its development.
- Moves towards a more **centralised, strategic network planning** that is critical for delivering affordable, clean and secure power, as we journey towards our net zero future.
- **A first of its kind, integrated approach** for connecting 23GW of offshore wind (18 offshore wind farms) to Great Britain and transporting the electricity generated to where it will be used.
- **Balances the four objectives** of cost to consumers, deliverability and operability and impact on the environment and on communities.
- We are finalising the **ScotWind HND Follow Up Exercise** for connecting an additional 20.7GW of offshore wind (16 offshore wind farms) to Great Britain.



Holistic Network Design

Key Benefits compared to the radial design



Save consumers £5.5bn in costs from 2030

£54bn network investment

Increases availability of offshore wind by 32 TWh over 10 years from 2030

2 million tonnes CO_2 equivalent savings between 2030 and 2032

Reduces the impact on the seabed by up to a third smaller footprint of cables coming to shore compared to the radial design

Resource Adequacy

Net Zero Adequacy Modelling

Key questions on ensuring security of supply in the 2030s

- What mix of supply, demand-side response, interconnectors and storage is needed to ensure security of supply, whilst meeting our net-zero 2035 target?
- What are the potential risks and how do we mitigate these?
- Which metrics are needed to measure security of supply?
- What policy changes and mechanisms are required?

Initial study

An initial study has been published in collaboration with AFRY.

This implemented a Europe-wide network model in order to assess the impact on resource adequacy of different future portfolios.

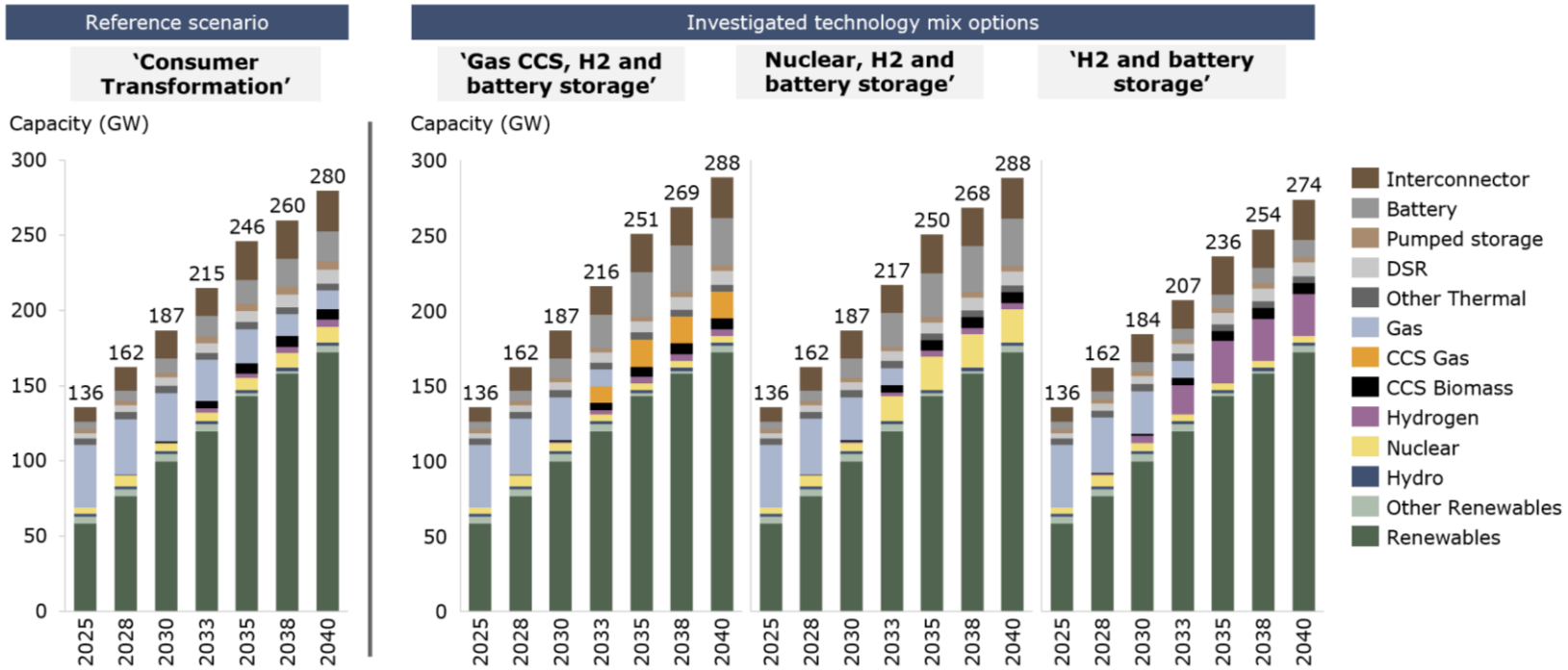
Initial Study with AFRY

Four key messages

1	There is no trade-off between adequacy and meeting net-zero but we need to **bring forward investment in clean, reliable technologies**.
2	Understanding **risks due to weather patterns** will become increasingly important to ensure adequacy in a fully decarbonised system with high levels of weather-dependent generation.
3	**New modelling approaches and metrics** will be required to assess risks to adequacy in a fully decarbonised power system.
4	It will become more important to consider adequacy in the context of developing the **right markets, the right networks and future operability challenges** to be confident that adequacy is ensured in a cost-effective way.

Future Supply Mixes

Similar Loss of Load Expectations (about 1 hour/year) were met by different technology mixes whilst also meeting our 2035 net-zero target.



Stress Events Durations

The duration of critical stress events in the GB system were found to increase over time, especially in scenarios using batteries to ensure security of supply.

	Year	Distribution of length of critically tight periods (hours)										Mean length of critically tight periods (hours)
		<3	3-4	5-7	8-15	16-25	26-50	51-75	76-100	101-150	>150	
'Consumer Transformation' (reference)	2025	15	31	6	8	0	0	0	0	0	0	5
	2028	10	28	2	10	2	0	0	0	0	0	6
	2030	5	24	3	9	0	1	0	0	0	0	6
	2033	1	8	2	3	0	5	1	0	0	0	17
	2035	1	5	1	2	1	6	1	0	0	0	21
	2038	0	0	0	2	0	5	4	0	0	0	45
	2040	0	0	0	2	0	5	4	0	0	0	44
'Gas CCS, H2 and battery storage'	2025	15	31	6	8	0	0	0	0	0	0	5
	2028	13	25	1	9	2	0	0	0	0	0	5
	2030	11	12	2	2	0	4	1	0	0	0	10
	2033	0	1	0	0	4	3	8	1	0	0	42
	2035	0	0	0	0	2	3	4	3	1	0	58
	2038	0	0	0	2	0	3	4	2	0	0	50
	2040	0	0	0	1	0	4	2	0	0	0	43
'Nuclear, H2 and battery storage'	2025	15	31	6	8	0	0	0	0	0	0	5
	2028	13	25	1	9	2	0	0	0	0	0	5
	2030	11	12	2	2	0	4	1	0	0	0	10
	2033	0	0	0	1	3	4	8	1	0	0	44
	2035	0	0	0	0	2	4	4	3	1	0	57
	2038	0	0	0	2	0	3	4	2	0	0	51
	2040	0	0	0	1	0	5	3	1	0	0	52
'H2 and battery storage'	2025	15	31	6	8	0	0	0	0	0	0	5
	2028	12	28	0	11	0	0	0	0	0	0	5
	2030	9	25	2	10	2	0	0	0	0	0	6
	2033	1	11	1	5	0	7	1	0	0	0	17
	2035	1	6	1	1	1	5	4	0	0	0	24
	2038	0	0	0	2	0	4	5	0	0	0	43
	2040	0	0	0	2	0	5	3	0	0	0	41

Project Plans

Demand	Extreme weather	Networks	Interconnectors
The impact of climate change on demand. Inclusion of Demand Side Response.	Wind and solar droughts, extreme summer heat. The impact on technologies.	The impact of increased renewables on network constraints. Potential locational pricing.	Low interconnection scenarios and Europe-wide stress events.

Metrics	Storage	New technology	Uncertainty
Potential alternatives to Loss of Load Expectation.	A range of storage durations and approaches. To include hydrogen.	Including build-rates and consideration of non-delivery risks.	The impact of uncertainty and stochasticity (e.g. in fuel prices) on our model outputs.

We plan to publish a **full resource adequacy study in 2024.**