Power of flexibility

Tom Luff
Senior Advisor

16 May 2023

Contents

About Energy Systems Catapult

Mission: **Unleash innovation and open new markets to capture the clean growth opportunity**

200 Innovation experts

Based in Birmingham

We work with Innovate UK

Established, overseen and part-funded by Innovate UK. Independent from Government. Not for profit

Bridge the gap between stakeholders in the sector

Supporting innovators

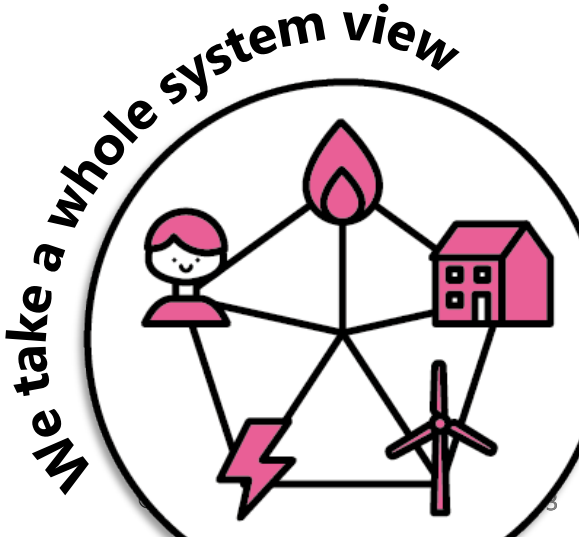
Research

Trials

Systems engineering

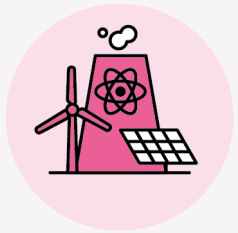
Digital

Modelling and simulation

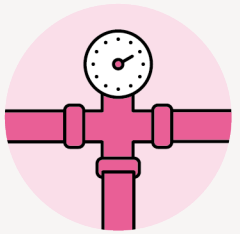


Whole-systems thinking

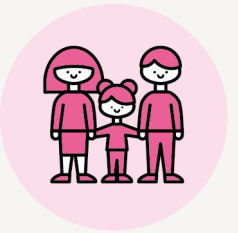
Joining up the system from sources of energy to the consumer


Generation


Transmission


Distribution


Buildings


Consumer

Breaking down silos between different parts of the energy system


Electricity


Heat


Transport

Joining up physical requirements of the system, with policy, market and digital arrangements


Physical System


Digital System


Market System


Policy

Capabilities

Modelling

National Energy System Modelling
Local Area Energy Planning & Modelling
Building Energy System Modelling

Energy System Modelling Environment (ESME)
ESME Flex
ESME Transport
ESME Networks
EnergyPath Networks™
Home Energy Dynamics

Digital & Data

Data Science
Data Systems

Living Lab

Consumer Insight

Research
Design
Trials

People Lab
Home Truths®

Systems Integration

Systems Engineering and Integration
Dynamic Energy System Simulation
Dynamic Energy System Architecting
Business Model Innovation
Energy System Integration Guides

EnergyPath Operations™
Whole Energy Systems Accelerator (WESA)

Markets, Policy & Regulation

Policy & Regulatory Knowledge
Economic Appraisal

Rethinking Electricity Markets (REM)

Infrastructure & Engineering

Networks and Energy Storage
Renewables
Transport

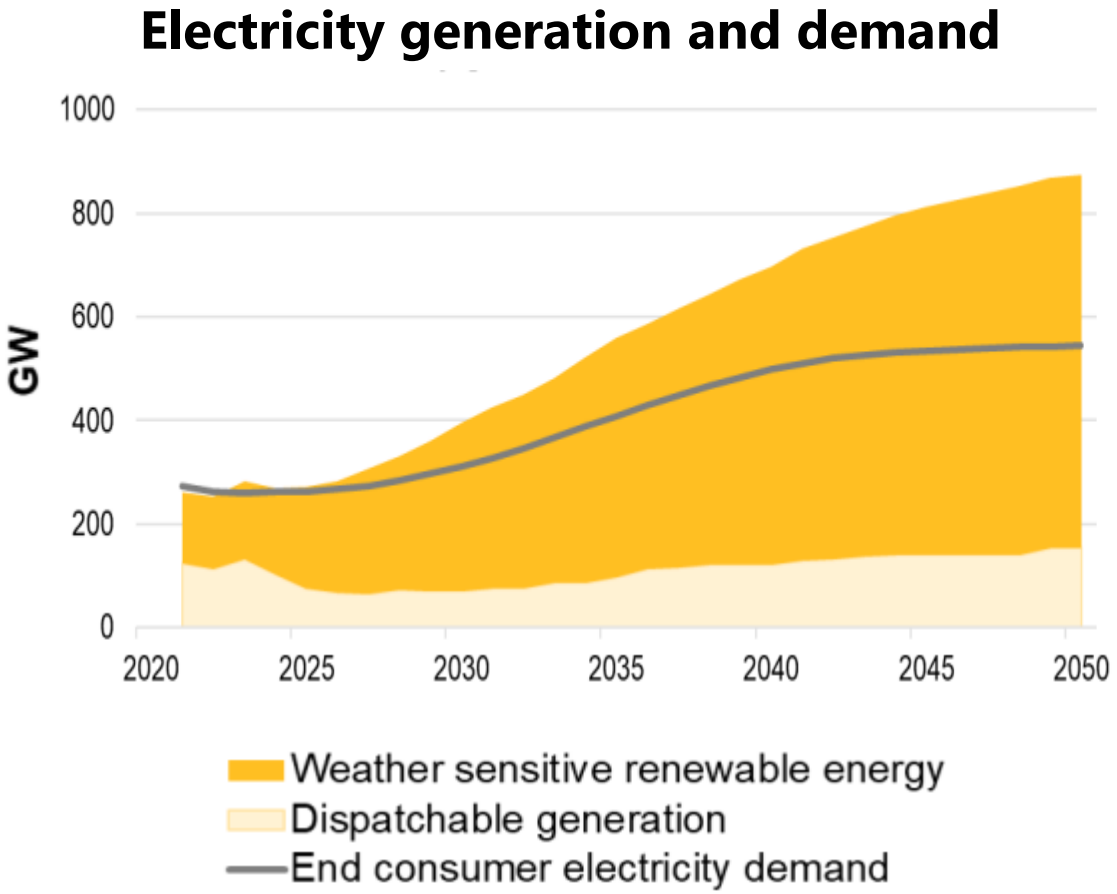
Carbon Capture and Storage, Industry and Hydrogen

Bioenergy

Contents

- Introduction
- Context
- Challenges
- Solutions
- Looking ahead

Four major shifts are needed in the power sector across all potential transition pathways



Source: Future Energy Scenarios 2022, National Grid ESO

1. **Rapid growth in clean electricity generation**, of which a large proportion will be intermittent, to meet the rising demand from electrification of heat and transport.
2. **Widespread installation of low carbon technologies** (heat pumps, EV chargers, solar PV, storage, etc.) to enable households to decarbonise.
3. **Enabling greater flexibility from consumer demand**, both behavioural and technological, to ensure a more cost-effective net zero transition.
4. **Enabling digital and data transformation**, to ensure that the right organisations have access to granular data about the system, demand and generation.

Government's 2012 Electricity Market Reform was successful in scaling up renewable power…

Three objectives…	… four policies
1. Ensuring a secure electricity supply 2. Ensuring sufficient investment in sustainable low-carbon technologies 3. Maximising benefits and minimising costs	1. Contracts for Difference 2. Capacity Market 3. Carbon Floor Price 4. Emissions Performance Standard

Massive scale up in deployment of renewable power – especially offshore wind

Significant reduction in cost of renewables

Important first stage of the transition to net zero power

… but now we must modernise our systems to introduce greater flexibility and *integrate* renewables onto the grid

- The rapid growth of renewables creates new issues and risks under the current framework, which we now know more about:
  - Variable renewable resource
  - Distributed energy and consumer assets

- Development of demand-side response and storage has not kept pace, despite new technology, including potential of digital

- New goal of Net Zero greenhouse gas emissions to be achieved by 2050
  - high variable renewables share in all possible pathways
  - consumer engagement will be critical, but high uncertainty

- **A new phase of reform – or EMR2 – is needed to introduce greater system flexibility so we can integrate renewable power onto the grid**

Contents

- Introduction
- Context
- Challenges
- Solutions
- Looking ahead

ESC's Rethinking Electricity Markets programme identified fundamental challenges faced by the current market arrangements

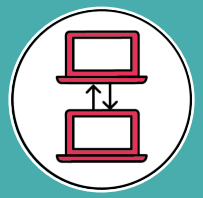
Price signals are not sufficiently granular by space and time and do not accurately or fully reveal the value of flexibility to the system

Contracts for Difference focus on generating as much as possible… regardless of *where/when* is best from a wider system perspective.

The Capacity Market dampens wholesale market signals for flexible technologies

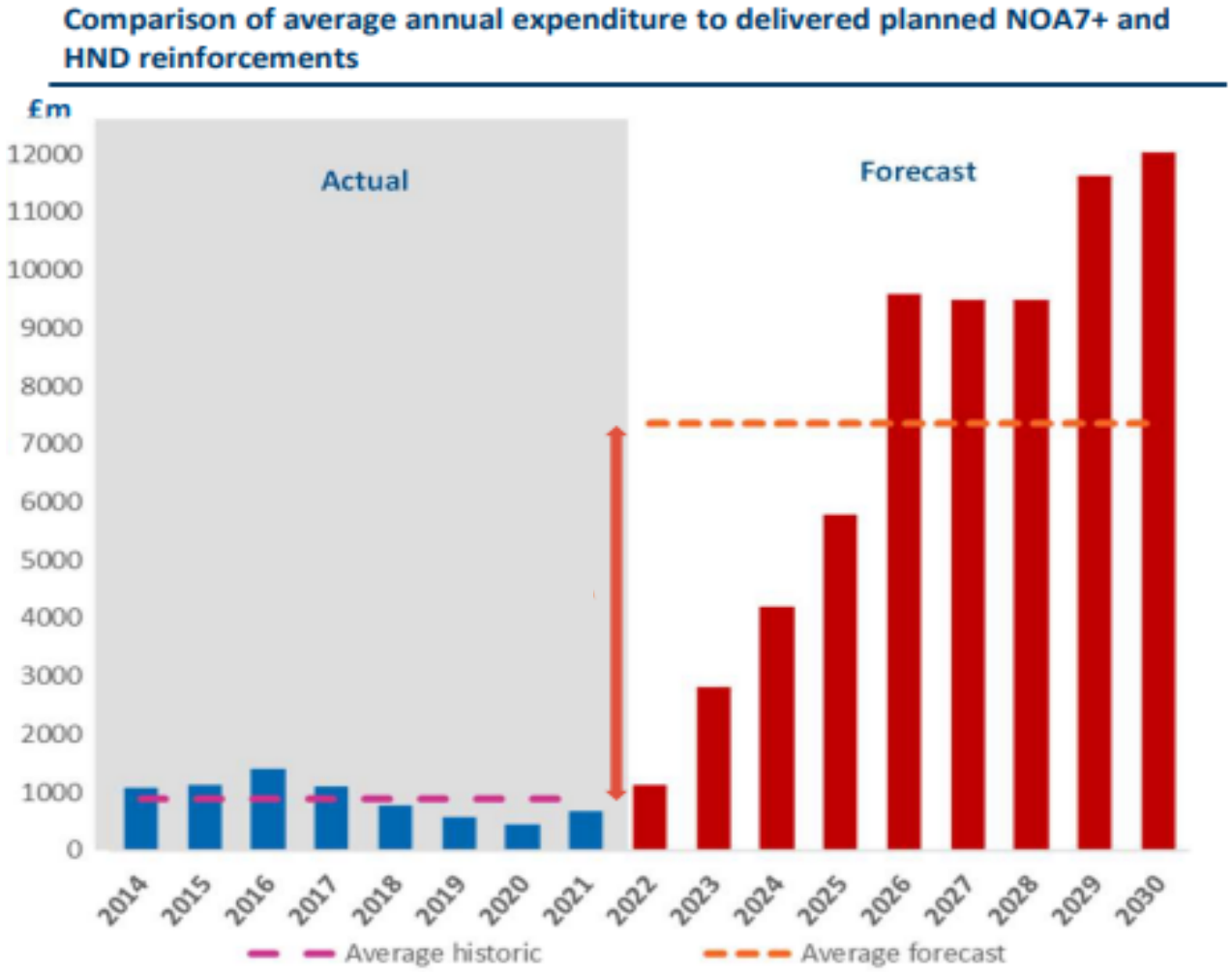
Incoherent carbon price signals across vectors

Lack of strategic planning and coordination



Data and digitalisation needed to enable more efficient operation and coordination of electricity systems

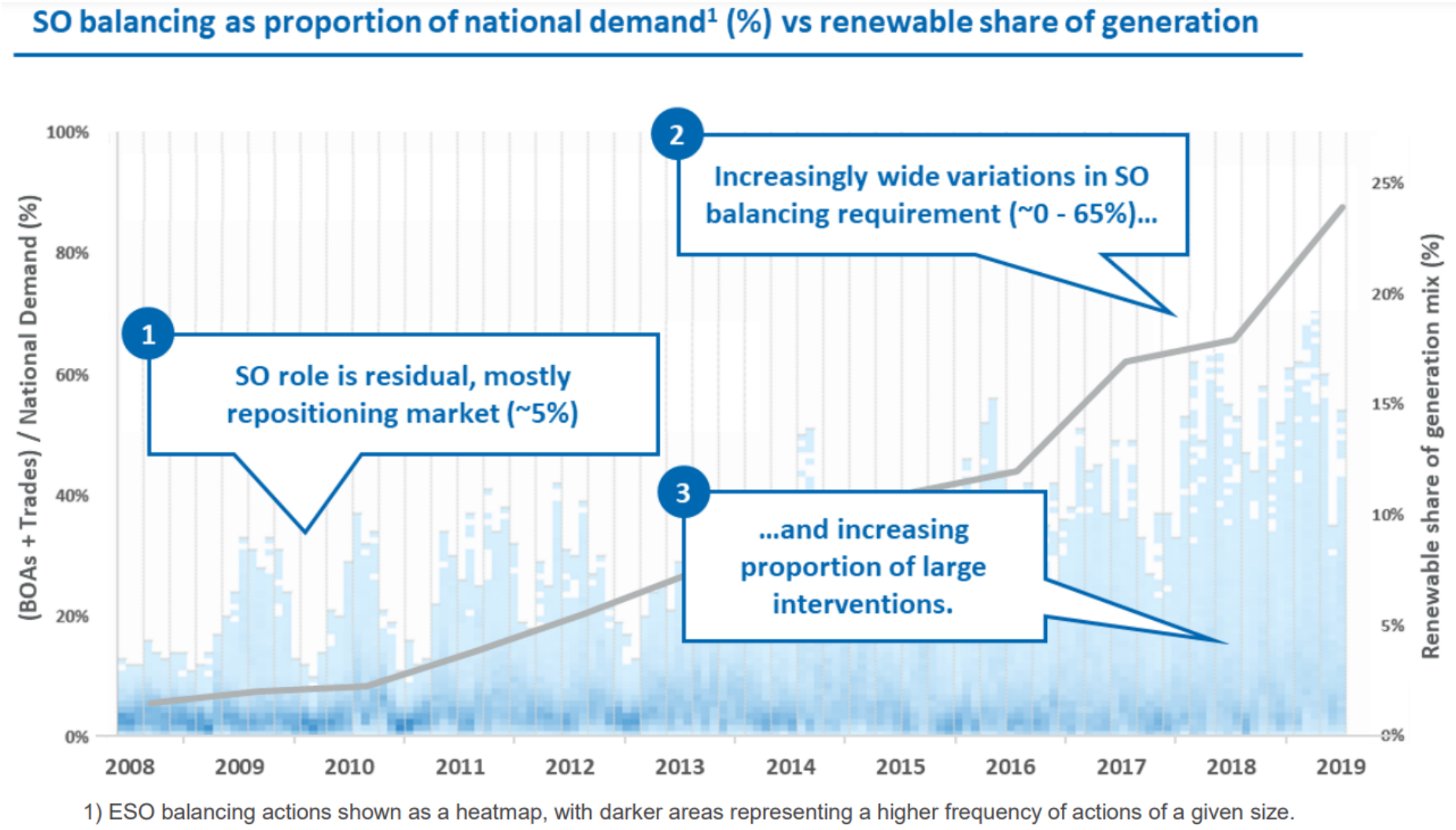
Net zero requires an eight-fold increase in large transmission reinforcement by 2030…



Sources: Ofgem-RIIO Performance report; RIIO T2 PCFM; ESO-Pathway to 2030 Holistic Network Design and NOA Refresh; FTI analysis.

8x increase in average spend required to deliver reinforcement planned under Holistic Network Design (HND)

… creating huge challenges if we can't increase flexibility

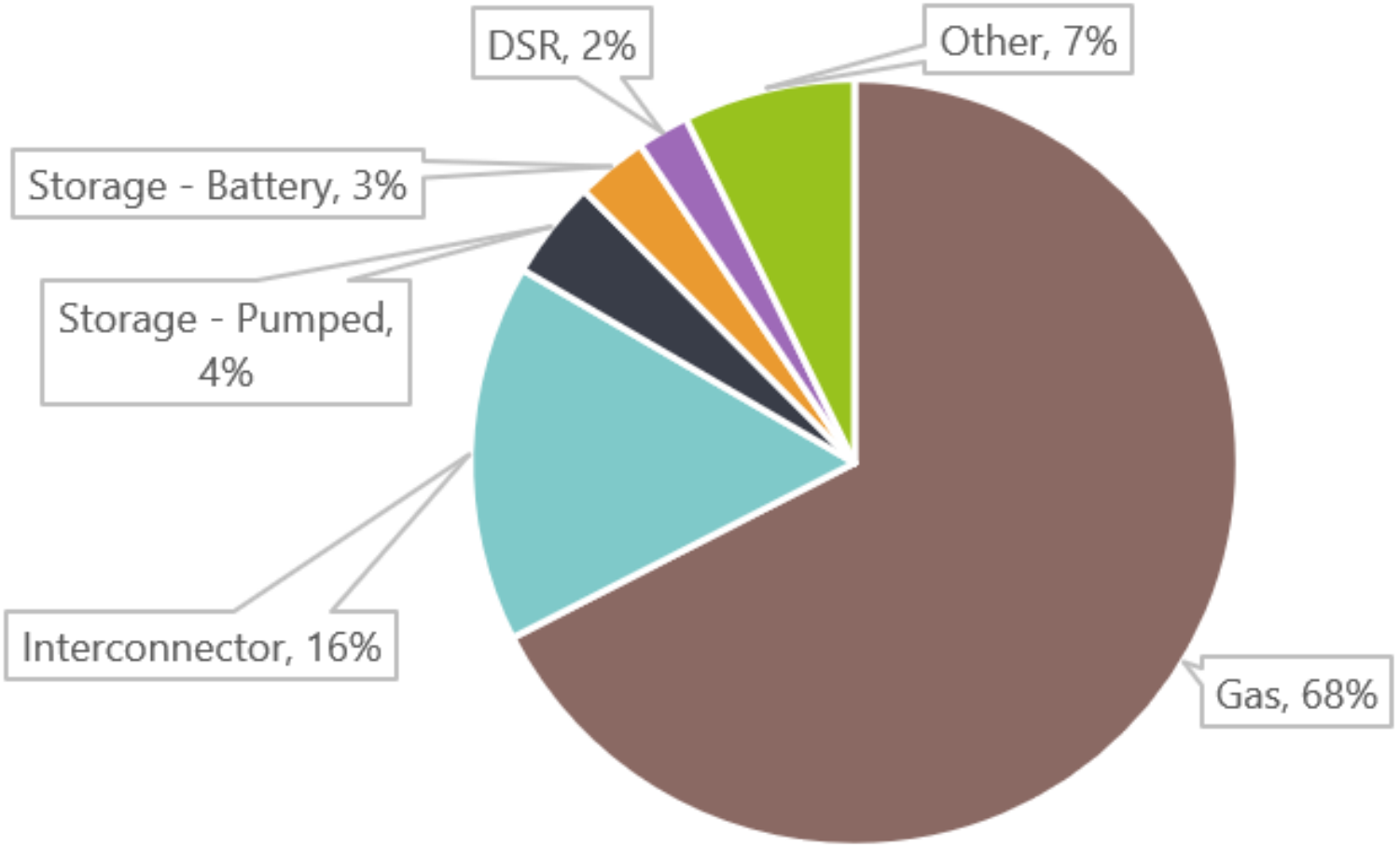


1) ESO balancing actions shown as a heatmap, with darker areas representing a higher frequency of actions of a given size.

- The rapid change in *how* and *where* electricity is generated has shifted the requirements of the ESO.
- NGESO is no longer acting as a *residual* rebalancer; balancing actions now regularly exceed 50% of national demand.
- NGESO spent £2.64 billion in balancing costs in 2021.

EMR schemes undermine incentives for flexibility

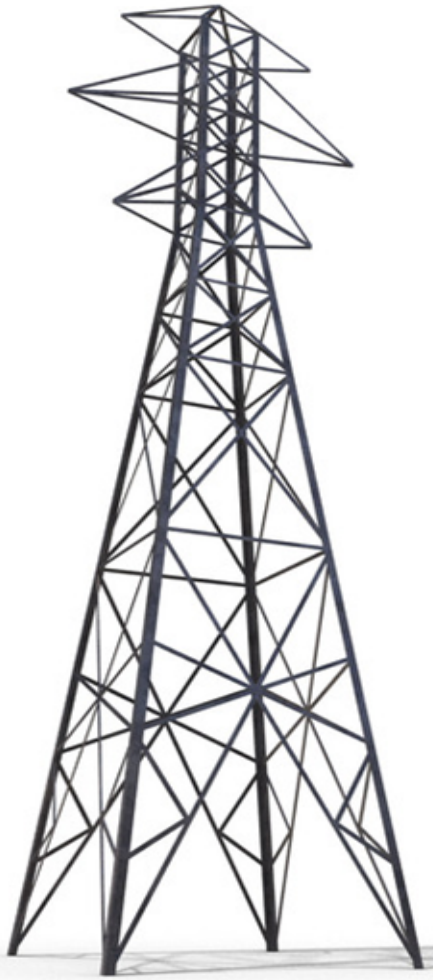
Capacity awarded by Primary Fuel Type in T-4 auction for delivery year 2026/27 (Total capacity procured = ~43GW)



Source: EMR Delivery Body

- CFDs encourage generators to produce electricity even when it's not needed by the system – instead of incentivizing them to store that excess power.
- The Capacity Market – which helps reduce the risk of outages – is heavily stacked in favour of gas generation.

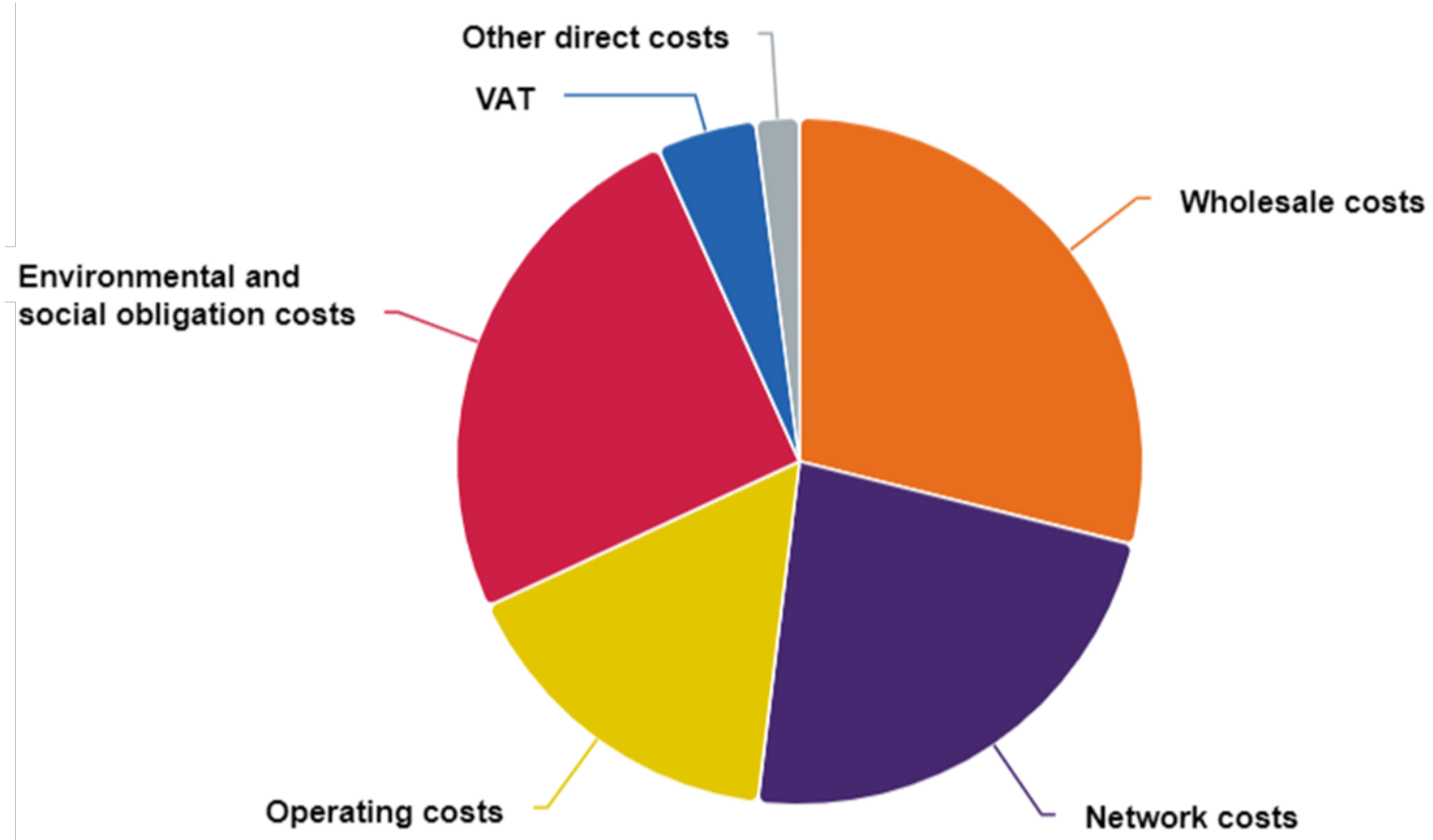
Despite reforms, there remain limited signals for flexibility with the network charging regime



- Network charges increasingly based on *capacity* of connection (weakens incentives for turn up/down signals).
- Locational signals are weak and don't reflect local conditions (often single tariff for entire licence area).
- RAG time bands are blunt and may not reflect future system constraints (particularly in a system dominated by variable renewables and electrified heating/transport).
- Increasing socialisation of reinforcement costs.
- The main reforms which could unlock greater value for flexibility (e.g. TNUoS/DUoS reform) have been consistently pushed back, descoped, and paused.

Current arrangements limit the opportunity for consumers to benefit from their flexibility

Breakdown of an electricity bill*

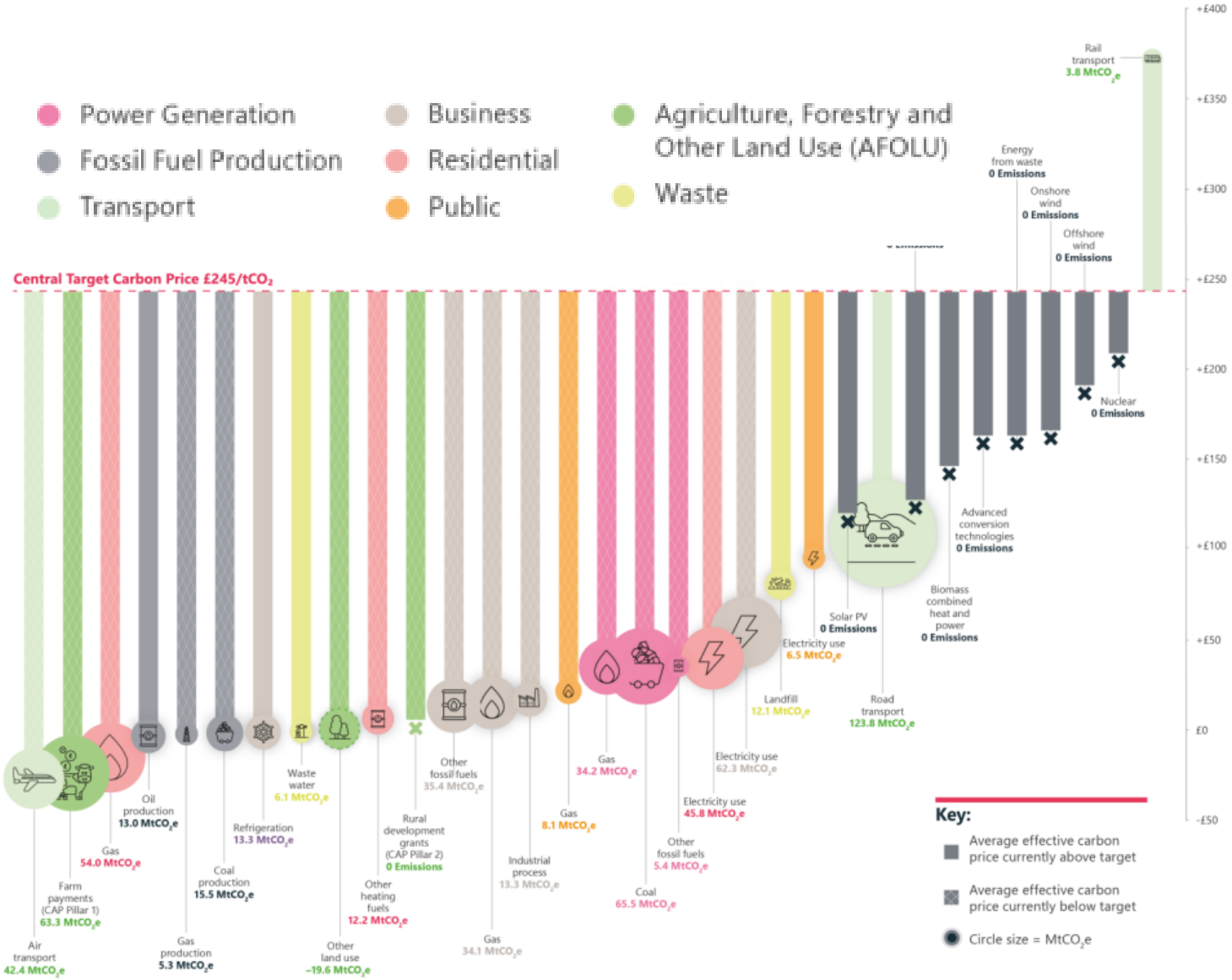


Source: Ofgem; August 2021. *NOTE: due to the energy price crisis from 2022, wholesale costs have increased significantly both absolutely and as a proportion of the bill.

- Proportion of the electricity bill that can be flexed is small.
- Few flexible tariff positions on the market; concern about their commercial sustainability
- Value of flexibility remains fragmented across multiple siloed markets, with numerous barriers:
  - Wholesale market, Balancing Mechanism, Capacity Market, Ancillary Services, NGESO Local Constraint Markets, DNO flexibility markets etc.

Carbon price signals across vectors are incoherent

Effective carbon prices and emissions in the UK by sector



- Uneven / ineffective carbon prices
- Relative prices often incentivise high carbon choices:
  - e.g. gas vs electricity for heating homes

Contents

- Introduction
- Context
- Challenges
- **Solutions**
- Looking ahead

The reform landscape is busy…

Ofgem's Targeted Charging Review (TCR) Significant Code Review

•Launched 2017. Closed (2019). Reforms to be fully implemented April 2023.

✓

BSUoS Task Force

•Launched 2019. Closed (2020). Reforms implemented April 2023.

✓

Ofgem's Access and Forward-looking Charges (AFLC) Significant Code Review

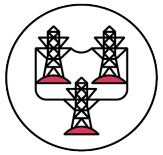
•Launched 2018. Closed (2022). Reforms implemented April 2023.

✓

DUoS Significant Code Review

•Launched 2022. Restarted Spring 2023.

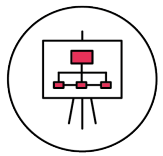
?



TNUoS Task Force

•Launched 2022. Had been paused. Ofgem letter on 3rd March 2023 noted it will be reinstated in April 2023.

?



Ofgem's March 2023 consultations/calls for input

•The Future of Distributed Flexibility (call for input)
•Future of local energy institutions and governance (consultation)
•Future price controls consultation (RIIO3)

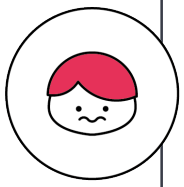
?

Review of Electricity Market Arrangements (REMA) + Retail Strategy Refresh

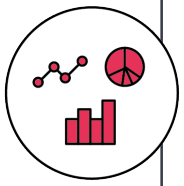
•Decisions will have implications for future network charging arrangements.

?

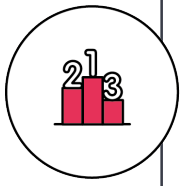
Review of Electricity Market Arrangements (REMA) came to some similar conclusions as ESC analysis



- *"The current market framework **does not maximise the potential for the full range of flexible technologies to deploy or operate flexibly**:*
  - *a lack of sufficiently granular time-and location-based operational signals to incentivise flexible operation of assets,*
  - *limited investment signals,*
  - *and limited signals for flexible assets to hold back energy for periods of system stress, for example long-duration storage."* REMA Page 85.

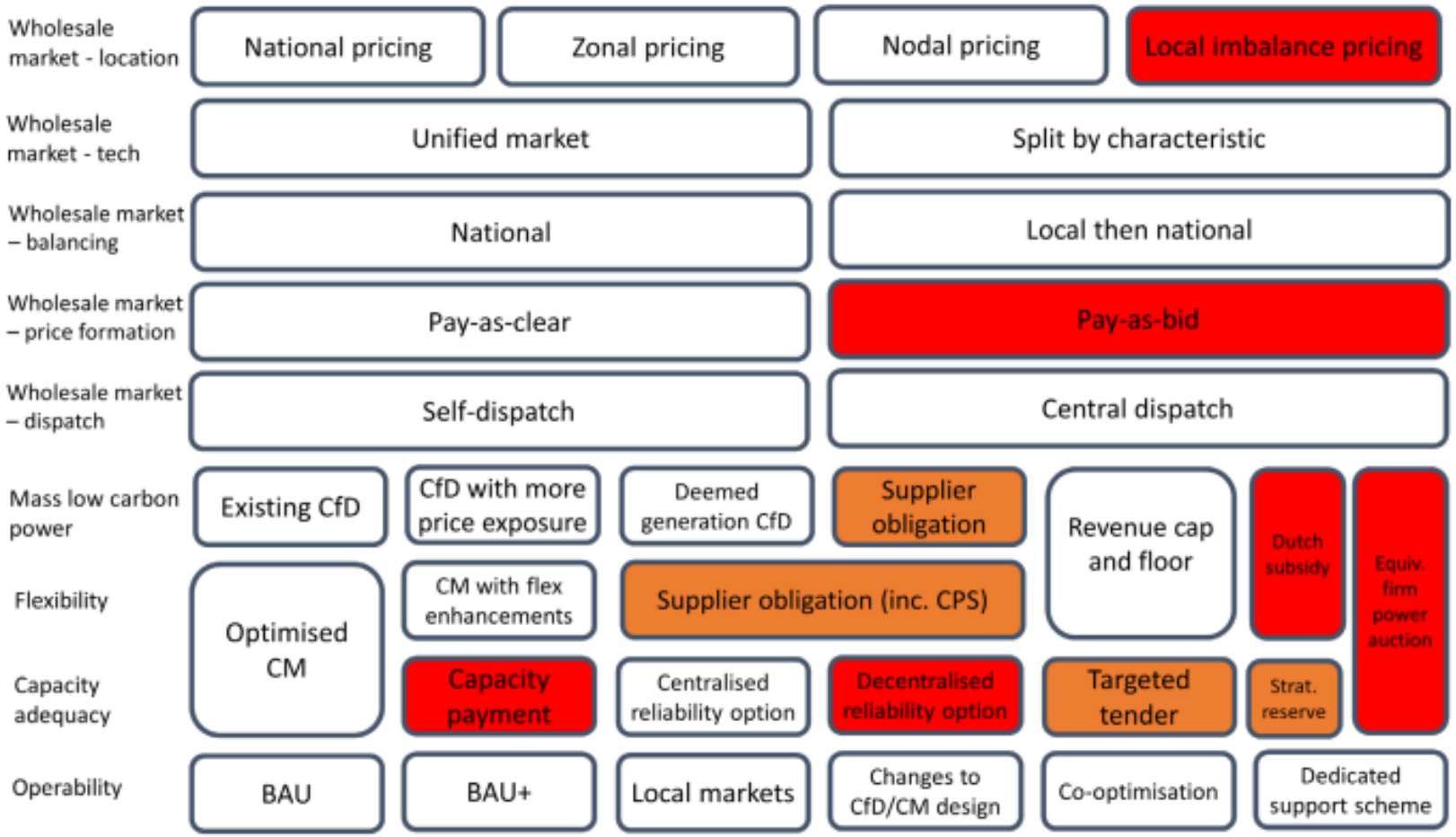


- *"the **signals** in these markets [wholesale, capacity, balancing and ancillary services markets] **are not fully reflective of system needs**, reducing incentives to act flexibly at different times or across locations, and in particular removing signals to enable local, distributed flexibility."* REMA page 86.



- *"**in the long-term having multiple technology-specific mechanisms could create a fragmented market and risk distorting competition between technologies**. We will not prematurely expose developing technologies to cross-technology competition; however, we do need to consider how to incorporate them into our broader electricity market arrangements when the time is right."* REMA page 87.

There is consensus on the need for change but division on which package of reform to adopt

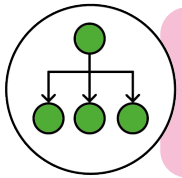


- "Summary of Responses" publication showed that most responses (83%) agreed with the vision presented.
- Consensus (80%) that current market arrangements would not deliver the change necessary to achieve decarbonisation by 2035 and that it was right to consider market design changes.
- The scale of the challenge means radical reform is needed.

RED = DESNZ has decided not to take forward into the next round of assessment;
ORANGE = discounted as standalone mechanisms but to be considered in conjunction with other reforms.

ESC is pushing for a package of measures to support investment in flexibility

***1.** Make electricity markets work more accurately in time and space*

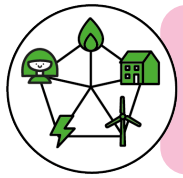


***2.** Introduce outcome-based policy mandates*

The following slides will focus on parts 1 and 2

***3.** Evolve policy to support financial market development and contracting for investment*

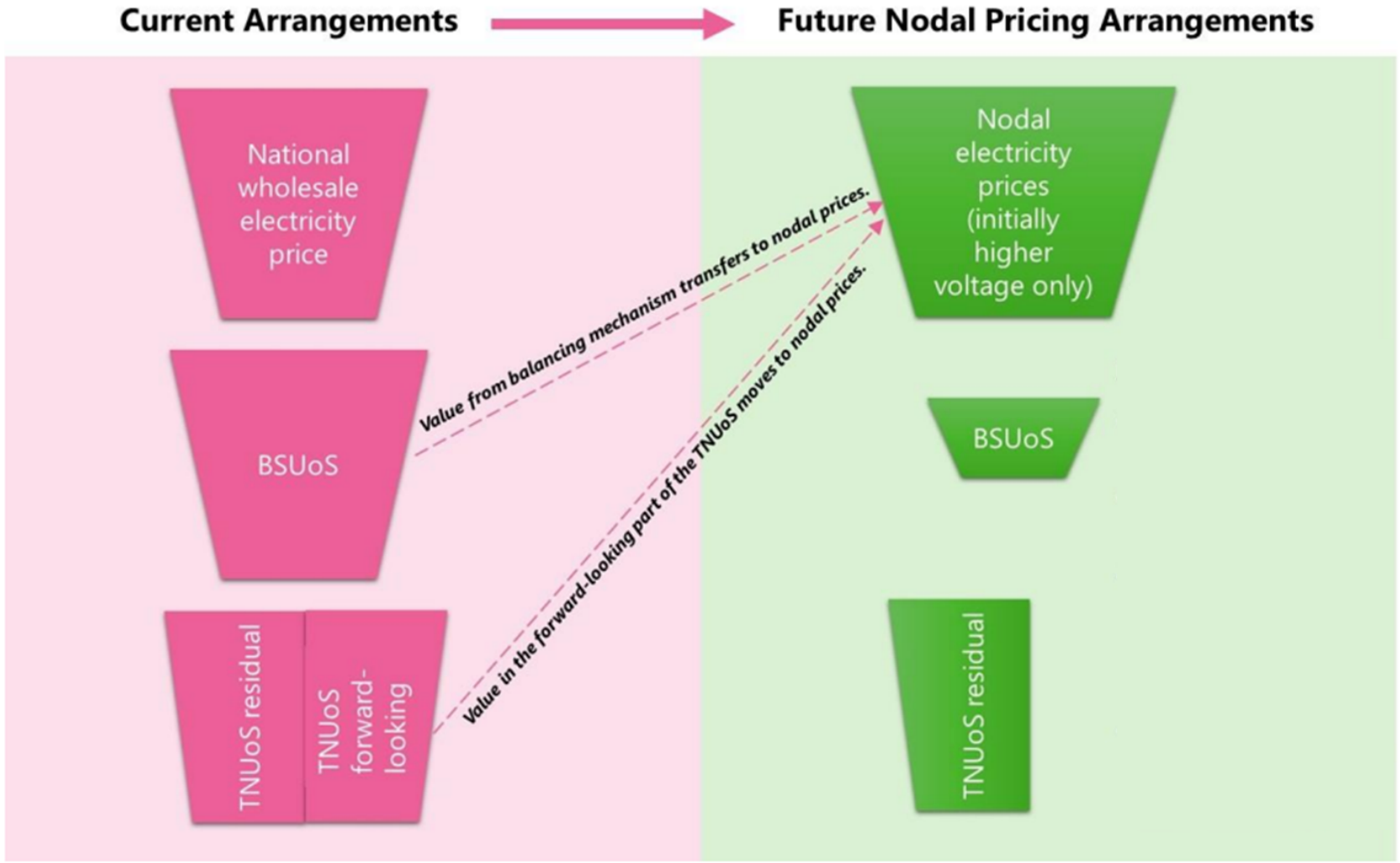
***4.** Redesign support for immature technologies to avoid distorting markets*



***5.** Overhaul governance for industry codes, system operation and energy data*

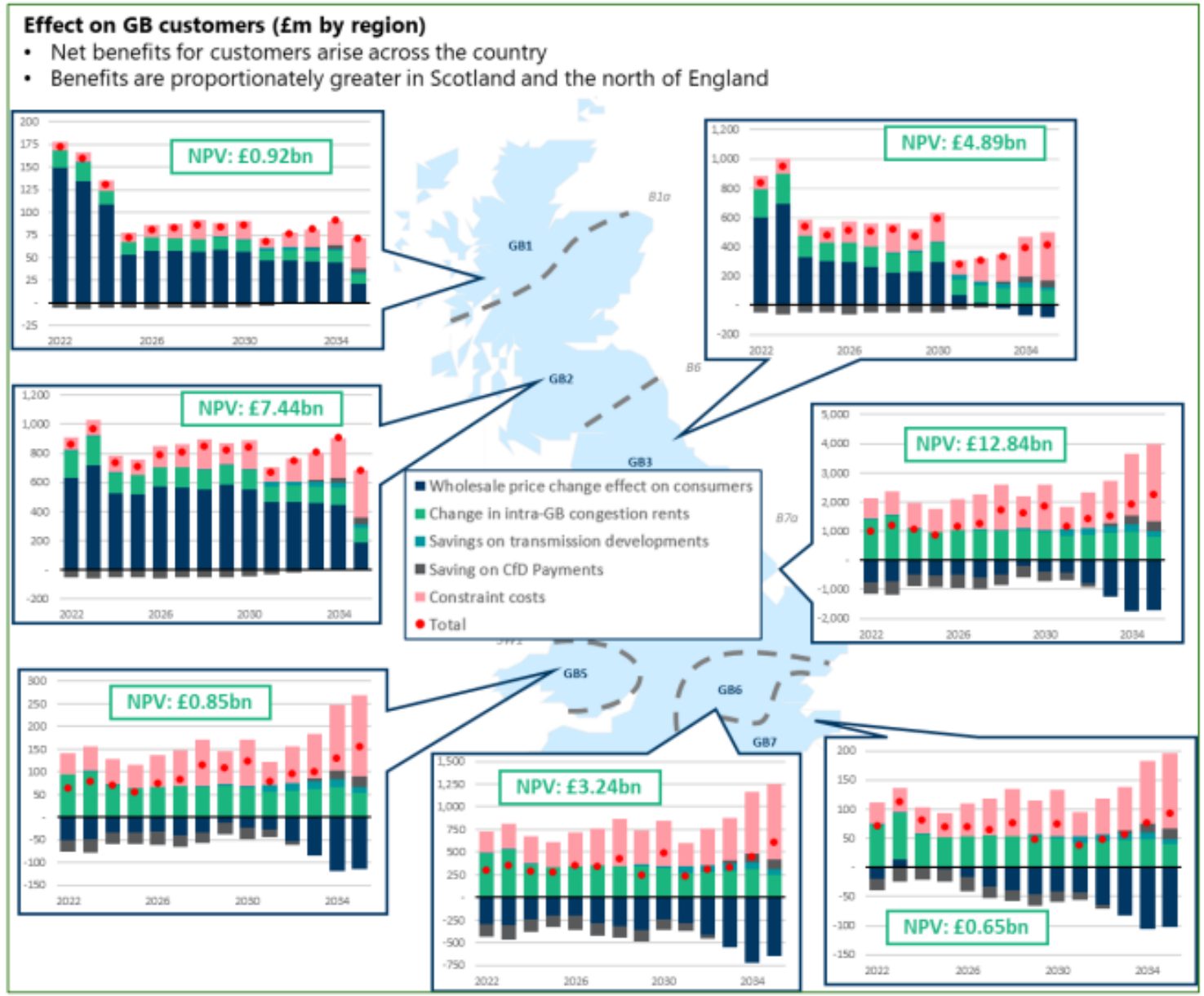
***6.** Align sector strategy and policy mandates with carbon budgets*

Nodal pricing would increase the value in the short-term wholesale power markets, reducing total system costs



- Total system costs reduce
- Value in spot electricity market increases
- System Operator balancing costs (and amount socialized through BSUoS) significantly reduce
- Costs collected through network charges limited to residual (initially transmission only)

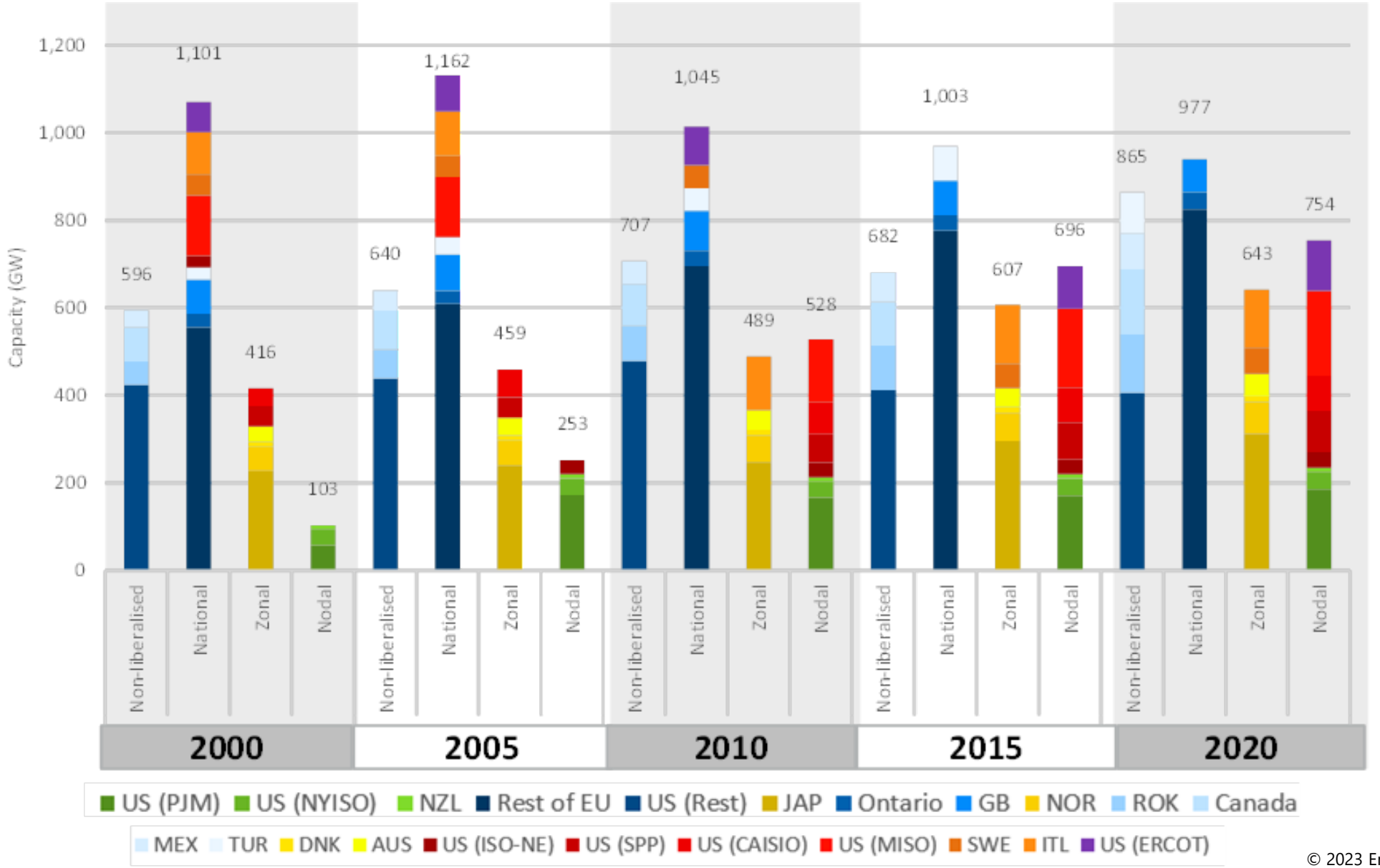
This could result in largescale benefits across the system



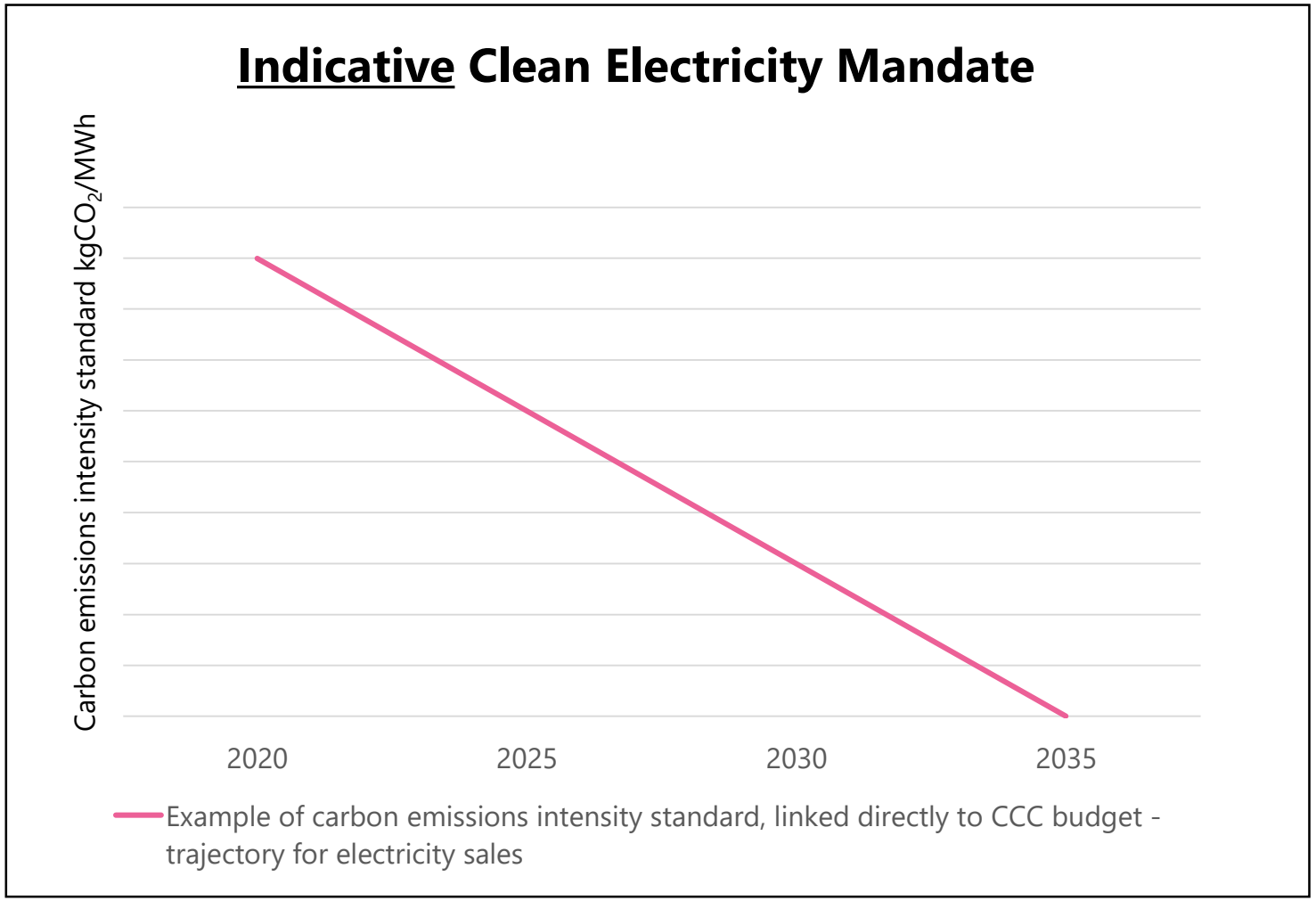
- Our *Location, Location, Location* report highlighted **£30bn of savings by 2035** from:
  - more efficient location & despatch of generation and storage
  - more efficient use of network infrastructure, including interconnectors to European markets
- Savings for users in all regions, but proportionately greater in Scotland & the North of England.
- More investment in grid scale storage
- Earlier investment in generation supported by carbon capture to complement renewables.

Note: Estimated benefits are based on *conservative* assumptions and *simplified* reforms. Further savings would be likely under a more refined market design (and modelling exercise – see FTI analysis).

Internationally, locational pricing is on the rise

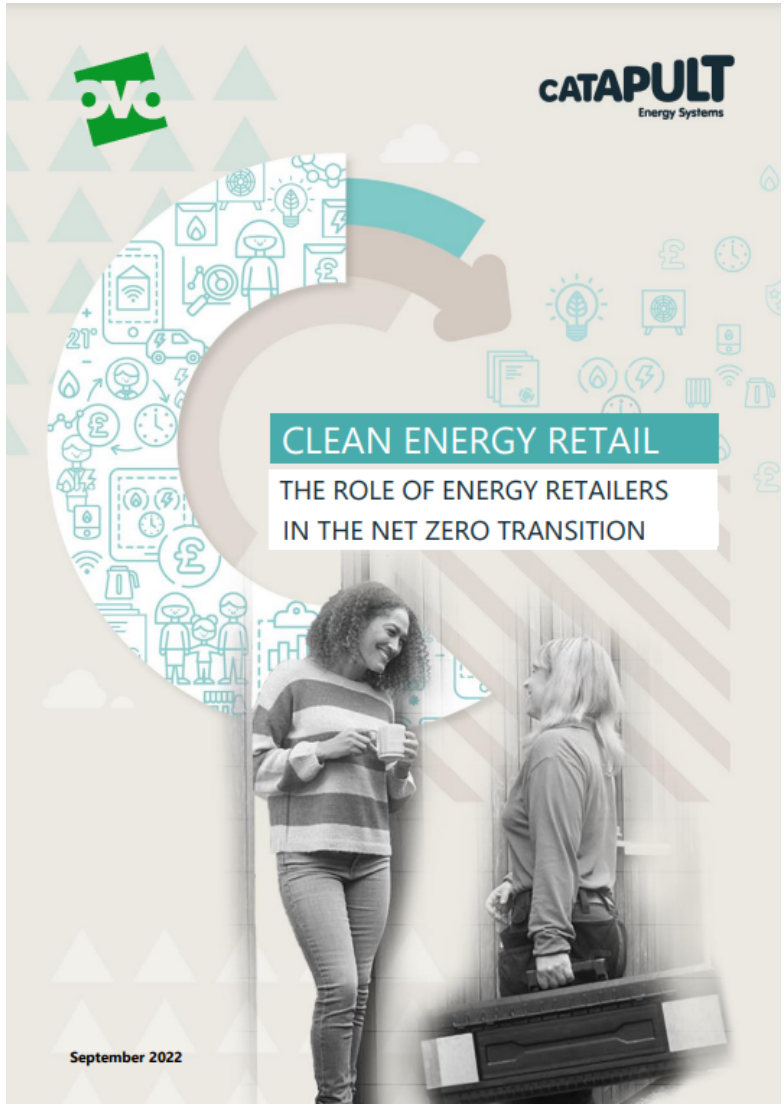


Outcome based policy, such as a Clean Electricity Mandate



- Carbon reduction trajectory linked directly to CCC budget – cf ban on ICE vehicles.
- Applied to electricity retailers / offtakers on sales of electricity.
- A minimum standard instead of of subsidies.
- Requires carbon tracking, registry, accounting, compliance options, reporting, enforcement tools.
- Highly visible to all market participants and investors.
- Phasing required.

Linking to the retail sector will be crucial to realise the benefits



- Net zero progress to date has been largely “invisible” to consumers but this will need to change.
- The retail framework should be built on an understanding of the underlying needs of consumers and translate them into objective choices.
- Current innovative retail propositions face challenges in relation to mass-market take-up, and innovation for the future must be unlocked.
- Policy reform is needed to unlock innovation; it should be considered alongside wider energy reform and be iterative to commercial developments.

Contents

- Introduction
- Context
- Challenges
- Solutions
- Looking ahead

Looking ahead

- There are a number of significant milestones in the coming months:
  - Retail Strategy Call for Evidence in “summer” (DESNZ)
  - REMA consultation 2 in “autumn” (DESNZ)
  - Follow up to Distributed Flexibility call for evidence later this year (Ofgem)

- Particular evidence gaps to focus on might include:
  - Consumer response to flexibility opportunties
  - Different models of locational pricing – eg shielding / phasing
  - Implementation of change (learnings from previous reform programmes)

Thank you

Tom Luff

Senior Advisor, Electricity Markets, Policy and Regulation

es.catapult.org.uk
@energysyscat