Whole Energy Markets Coordination

Executive Summary

Enhancing the coordination of markets across the whole energy system

July 2025

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Foreword | Enhancing the coordination of markets across the whole energy system

We are at a crucial stage in the energy transition. 2024 was the UK's cleanest year of energy since records began, but the challenges continue to evolve. Accelerating progress towards a greener future requires diverse energy resources and emerging technologies, to enable decarbonisation across the whole economy.

Energy markets play a critical role in influencing both the investment in, and operation of, energy resources. We have therefore started to look at energy markets as a whole instead of considering different energy vectors in isolation. By engaging key stakeholders across different vectors, we can start to plan not just how each market can play a role in sustainable energy generation, but how markets can come together to realise a single vision.

The first step towards this vision is identifying opportunities for cross-market collaboration. Our initial findings indicate there are multiple areas where greater coordination across different energy markets could support our ability to meet climate change targets affordably, while maintaining security of supply. For this to be successful, the energy industry needs to work towards these common goals together. We are just at the start of the conversation on whole energy system coordination and are looking forward to continuing to engage and collaborate widely to refine these ideas and to discover more. Together, we can re-design whole energy markets that ensure clean, secure and affordable energy for generations to come.

Rebecca Beresford
Director of Markets
National Energy System Operator

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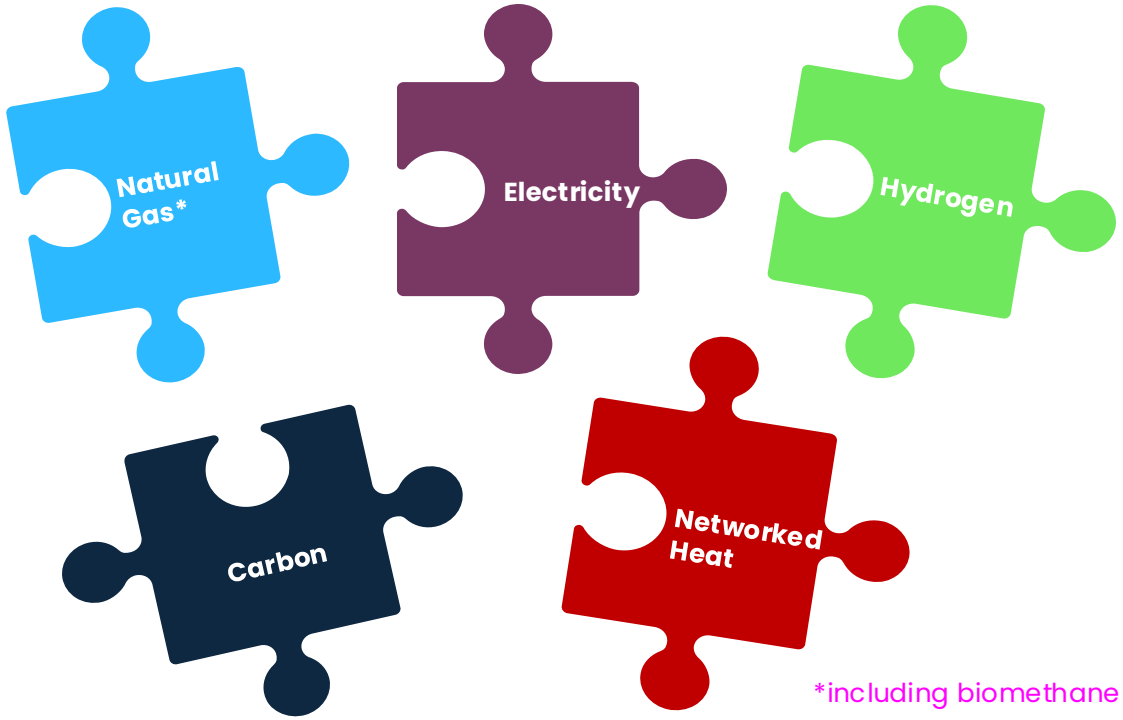
Context | NESO's remit in whole energy markets

1. NESO continues to function as the **system operator** for electricity
2. NESO acts as a **system planner** providing strategic direction for electricity, gas and future systems
3. NESO serves as an **independent advisor**, providing analysis and information to Government and Ofgem
4. **A whole energy market approach** is central to achieving the following objectives:
   - A clean, secure and affordable energy future for Great Britain
   - Development of competitive and efficient markets across energy vectors by improving coordination and addressing inefficiencies in existing design.

Our first phase focuses on enhancing the coordination of markets across the whole energy system. This effort is part of our broader role in market development, aiming to shape and drive the creation of competitive and efficient markets that interact seamlessly across multiple energy vectors. This programme will complement many of the key publications by NESO:

Purpose | NESO's role includes exploring how energy markets can work better together

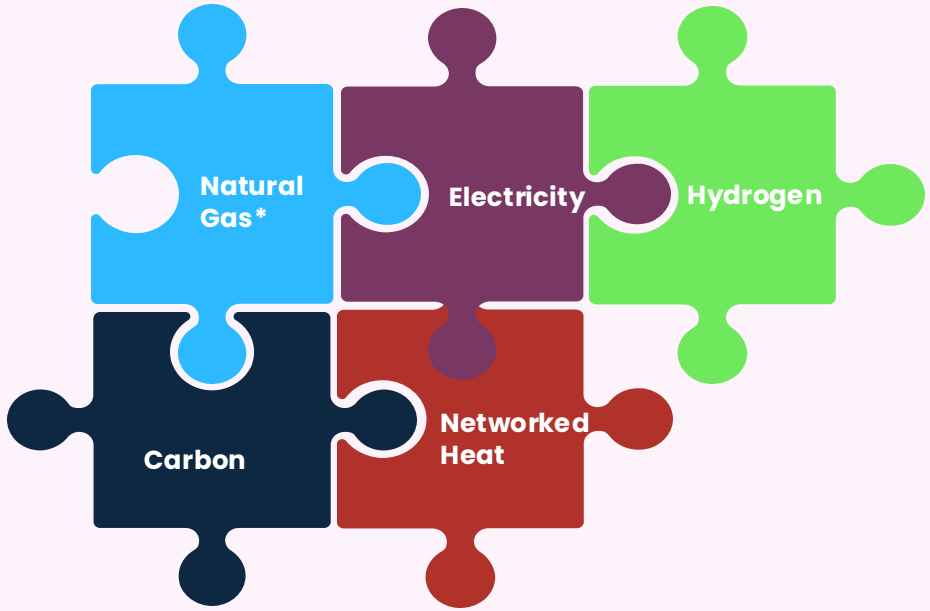
Currently, energy markets are designed independently of each other, in a fragmented approach



*including biomethane

Transitioning to a clean energy system requires an exploration of how these markets can work better together to support decarbonisation in an affordable and secure way

Whole Energy Market Coordination



For the purpose of this project, our scope includes 5 'vectors', which we define as distinct networked energy or waste carriers: Electricity, Natural Gas (methane / biomethane), Networked Heat, Hydrogen and Networked Carbon

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Market Design Categories: We identified the key components of as-is market design across the 5 vectors in our scope using the below categories:

Economic regulation

Structure of the energy market across vectors, value chains and market participants

E.g. Licenced activities, Codes, Standards

Investment policy

Market interventions employed to achieve specific policy objectives

E.g. Decarbonisation support mechanisms

Operational market design

The structure of wholesale and short-term operational energy markets to match physical supply and demand

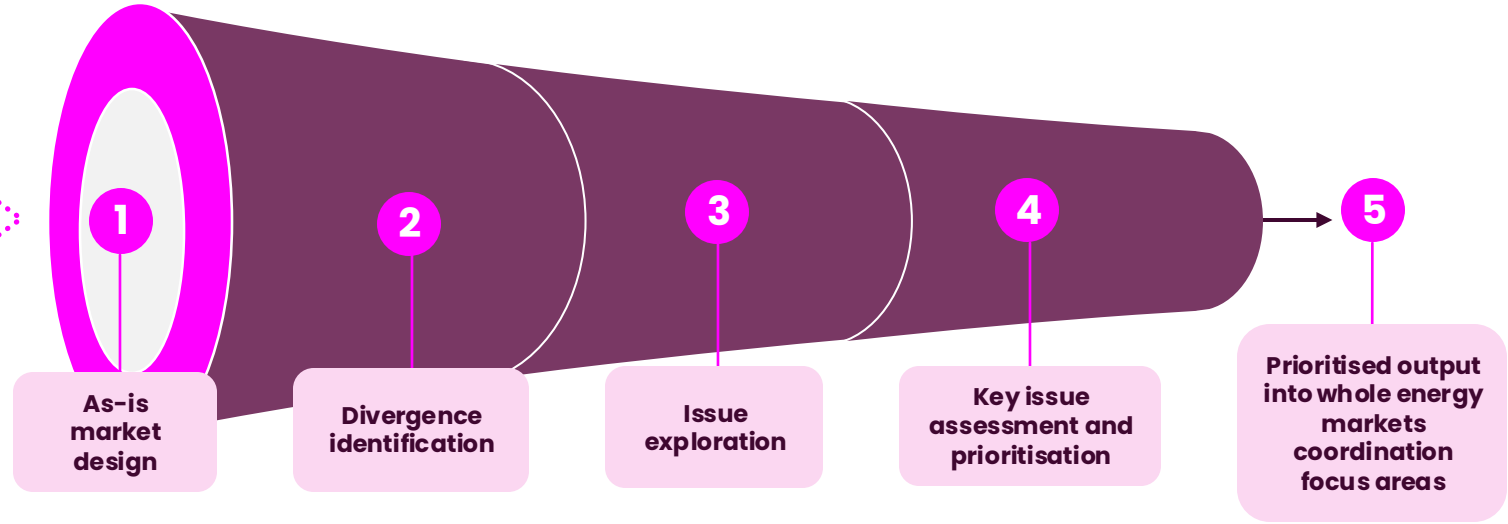
E.g. Energy balancing mechanism design, ancillary services

Cost allocation

Cost recovery for networks and investment policy

E.g. Investment policy cost allocation, network cost allocation

Market design comparison | Our analytical framework was applied to identify focus areas that could benefit from greater whole energy market coordination



1. Market design categories were used to develop comprehensive representation of as-is market design (across over 100 sub-category market design elements for each of the five vectors).
2. Comparing the current market design of the five vectors, we identified where there are differences (divergences).
3. We then explored potential issues as a result of these market design divergences.
4. We then considered the key issues according to our assessment framework, using this to prioritise them.

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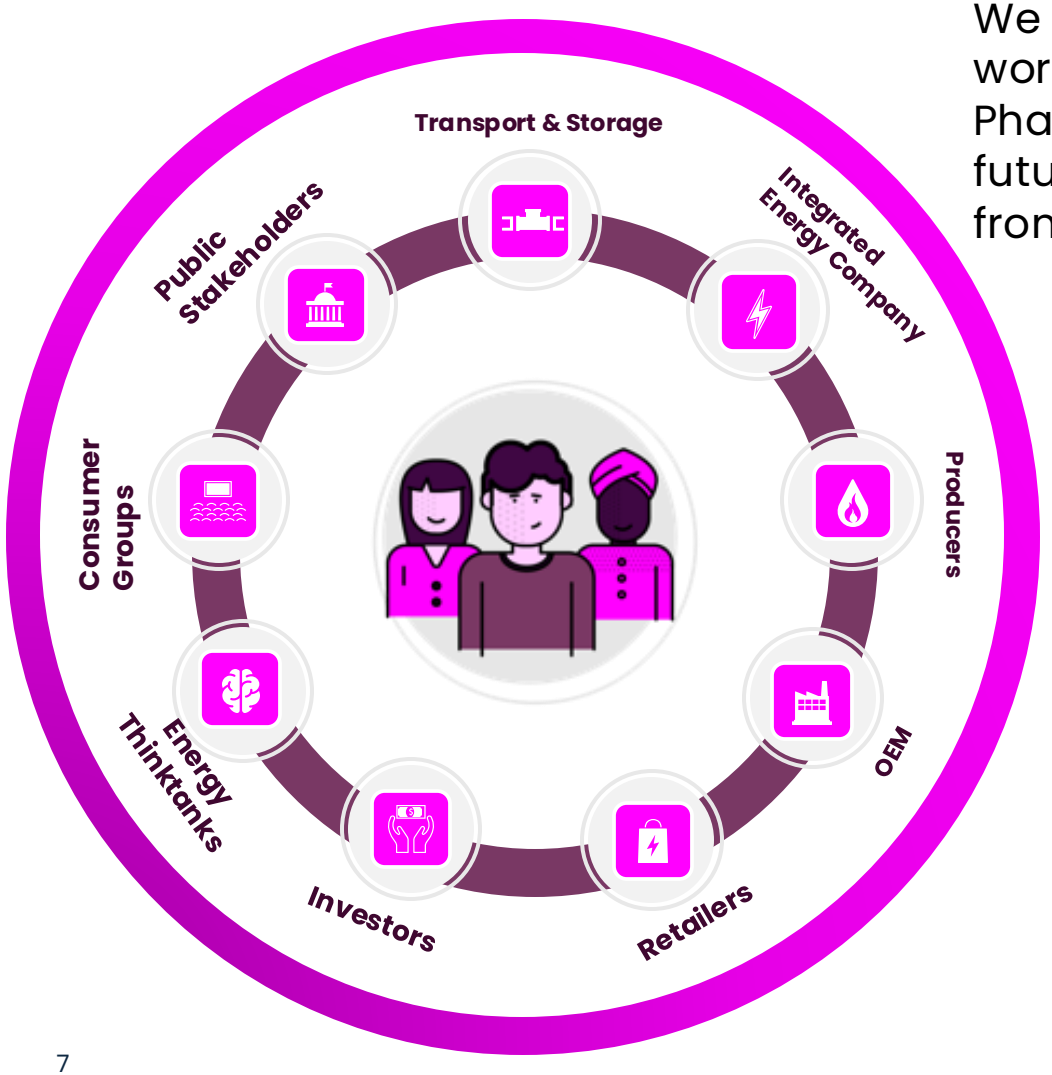
Stakeholder overview | We engaged with a wide range of domestic and international stakeholders across the energy sector



We have leveraged insight from stakeholders working across the energy landscape as part of Phase 1. Engagement will continue to be central to future phases. We will continue to draw insights from forums including:

Markets Advisory Council

Markets Forum

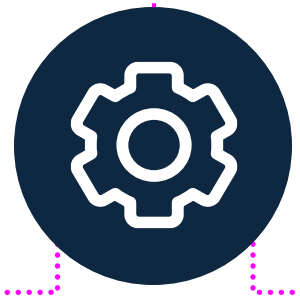
Industry Conferences

Industry Round Tables

Focus areas | Based on our analysis and stakeholder insight, we have grouped the initial opportunities for improved coordination across energy markets within three focus areas

Unlocking clean heat

How we heat our homes is one of the biggest challenges we face on the path to net zero. The pace and scale of new heating methods required to decarbonise heat requires co-ordinated market signals.



Integrating greater strategic planning into holistic market design

There is a need to coordinate greater strategic planning with market signals and investment policy to support the UK's net zero transition.

Ensuring energy security in a more complex energy system

GB's energy landscape is increasing in complexity, with emerging new low carbon energy markets and technologies, and a growing role for energy consumers to balance energy supply with demand. This calls for enhanced coordination across markets to secure the overall energy system.

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Focus Areas | We identified areas of cross vector market design that could benefit from greater whole energy market design coordination

Market Design	Unlocking clean heat	Ensuring energy security in a more complex energy system	Integrating greater strategic planning into holistic market design
Economic regulation	1 Time of Use Tariffs (ToUT) have a critical role in enabling price responsive demand across vectors 2 A regulated investment model for district heating could further support its deployment		
Investment policy	3 Aligning heat decarbonisation funding across technologies and regions could accelerate the rollout of clean heat		
Operational market design			
Cost allocation	4 Rebalancing environmental costs across consumer bills could incentivise fuel switching to lower carbon alternatives 5 There is a need to strategically consider the timeframe over which we pay for energy infrastructure		

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Focus Areas | We identified areas of cross vector market design that could benefit from greater whole energy market design coordination

Market Design	Unlocking clean heat	Ensuring energy security in a more complex energy system	Integrating greater strategic planning into holistic market design
Economic regulation			
Investment policy		6 Long-term incentives specifically to reward the contribution of energy supply assets to overall energy security could be considered for all vectors 7 Long-term incentives to support investment in assets with the ability to reduce demand to contribute to overall energy security could be considered for all vectors	
Operational market design		8 Greater coordination of system operation across vectors could generate greater operational and cost efficiencies	
Cost allocation			

Please note, these focus areas are not ranked in order of prioritisation.

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Focus Areas | We identified areas of cross vector market design that could benefit from greater whole energy market design coordination

Market Design	Unlocking clean heat	Ensuring energy security in a more complex energy system	Integrating greater strategic planning into holistic market design
Economic regulation			9 Holistic market design should ensure coherence of strategic planning and investment policy at national and regional levels
Investment policy			
Operational market design			10 Stronger operational locational signals in electricity markets could unlock the ability for other vectors to harness low-cost low carbon electricity, and highlight the need to consider cross-vector locational incentives
Cost allocation			11 The delivery of national and regional strategic targets could be influenced by the extent to which investment policy takes into account locational network charges

* This opportunity considers cross-vector interactions after a specific potential change to market design, rather than under existing market design.

Please note, these focus areas are not ranked in order of prioritisation.

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Opportunities | Other geographies have been considering ways to improve coordination across markets

Netherlands

Unlocking clean heat

Heat decarbonisation in the Netherlands: The Netherlands has put in place consumer cost protection mechanisms like the "not-more-than-others" principle. This means consumers connected to district heating networks will not pay higher tariffs than the cost of being connected to the gas network.

European Union

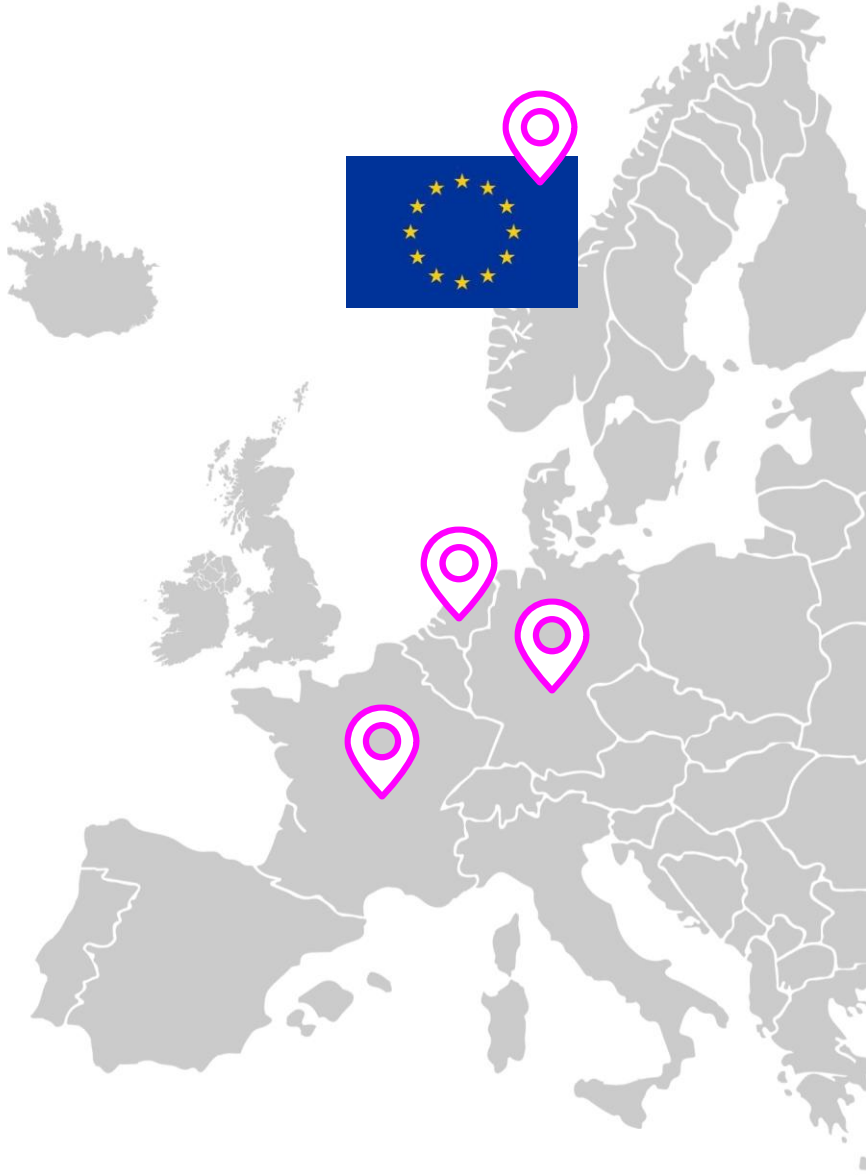
Ensuring energy security of supply in a more complex whole energy system

Securing long-term LNG contracts: European countries such as Germany have secured multi-decade LNG contracts from global suppliers to support their overall energy security of supply.

Germany/ France

Integrating greater strategic planning into holistic market design

Different countries employ a range of approaches to the staging of investment decisions for Offshore Wind project development. Germany and France both bundle investment decisions on property rights, consenting, connections and subsidies together to reduce uncertainty and expedite development. This approach can improve coherency of investment policy with strategic planning for all vectors, given that the location of these assets can dominate overall whole system energy flows (although it does so at the expense of pipeline optionality).



Next steps | This report is the first step in a multi-phased project towards coordinated, whole energy market design

July 2025

1

Phase 1 publication

Whole Energy Markets Coordination

- **Map context** of evolving GB energy system and relevant market trends
- **Identify major divergences** across vectors within as-is market design
- **Identify opportunities** to improve cross-vector coordination
- **Gather learnings** from other markets with similar risks & opportunities

Autumn/Winter 2025

Sharing output and seeking feedback

- **Publish full report** in Winter
- **Launch webinar** to share outputs and share opportunity for broad stakeholder feedback
- **Harness industry feedback** from open invitation Whole Energy Market Forum
- **Targeted feedback** sought through industry roundtables and bilateral discussions

Winter 2025

2

Phase 2: Scoping future whole energy market activities:

- Pending feedback, **our planned approach for phase 2** could include:
- **Development of selection criteria** for future Whole Energy Market Coordination projects
- **Prioritise Whole Energy Market projects** to be taken for further assessment in collaboration with industry
- **Detailed analysis** on prioritised areas to **inform policy recommendations**

2026

Future Phases

- To build on our findings in **collaboration with our customers and wider industry**

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Supporting Analysis

Our approach to exploring emerging opportunities for market coordination:

Market design comparison

Focus Area Summary | Unlocking clean heat

Focus Area Summary | Ensuring energy security in a more complex system

Focus Area Summary | Integrating greater strategic planning into holistic market design

Clean heat

Energy security

Integrating strategic planning into markets

Emerging opportunities for market coordination have been explored through our market design comparison and identified through inputs from stakeholder interviews

Market design comparison

Through our analytical framework we have identified differences in market design across energy markets and prioritised the output into focus areas that could benefit from greater whole energy coordination. Using this framework, we have explored some initial concepts to mitigate the impacts of market design divergences.

Stakeholder inputs

Numerous energy industry stakeholders from GB across vectors, consumer group and investors were interviewed and voiced a broad range of opportunities for a whole energy market approach.

International examples

Other geographies (e.g., Netherlands, USA, Denmark, Australia) have acknowledged the need for more coordinated market design across vectors and started to implement several opportunities. We have highlighted several examples that complement the outputs of our analysis.

Feedback loops between 3 sources to test opportunities

Opportunities in this report are not based on quantitative analysis and are illustrative of potential areas that could benefit from enhanced whole energy market coordination

Emerging list of opportunities for greater whole energy market coordination

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Focus Area Summary | Unlocking clean heating

How we decarbonise GB residential heating is a multifaceted challenge:

Heating our homes is a major challenge on the path to net zero. We need to change not only 'how' but also 'when' we heat our homes and reduce energy consumption for heating. Providing greater consumer choice across low carbon heating technologies through more coordinated market signals will help the UK meet its climate change targets and provide opportunities to increase flexibility in the energy system.

Current home heating energy sources in the UK (FES 2024):

- 83% of homes use a gas boiler
- 8% use direct electric heating
- 3% use district heating
- 1% use a heat pump
- 5% use other sources

Examples of consumer challenges transition to clean heating:

- The cheapest energy is the energy that is not used, energy efficiency can be improved through initiatives such as upgrading insulation and window glazing, however this will also incur cost and disruption for consumers
- Consumers who rent their home may not have a direct say in how their properties are heated
- Replacing heating systems often happens when they fail, typically in winter. Installing lower carbon technology like heat pumps can take longer to install than like-for-like replacement, increasing the likelihood for consumers to choose quick resolution options like replacement boilers, which locks them into another ~15 years of gas use.

Cost exposure of consumers to clean heating:

- There are multiple technology choices to decarbonise residential heat including electric heat pumps, connecting to (low carbon) district heat systems, hybrid heating systems (typically a combination of gas boiler with electric heat pump), and the potential option for hydrogen boilers. Different technologies have varying costs profiles, with some having substantial initial investment cost, and others with higher operating costs.
- The spark spread (i.e., the difference between the cost of electricity vs gas), among other factors has a large impact on the economic feasibility of different decarbonisation options for heat. Looking internationally where the spark spread is low (i.e., similar gas and electricity prices), there is a high uptake of heat pumps. Conversely, in countries where the spark spread is high (i.e., electricity is typically more expensive than gas), such as the UK, there is a reduced incentive for consumers to fuel switch from gas to lower carbon alternatives[1]

In the following slides, we explore how coordination across markets could unlock clean heating.

Source: European Hydrogen Backbone, European Heat Pump Association

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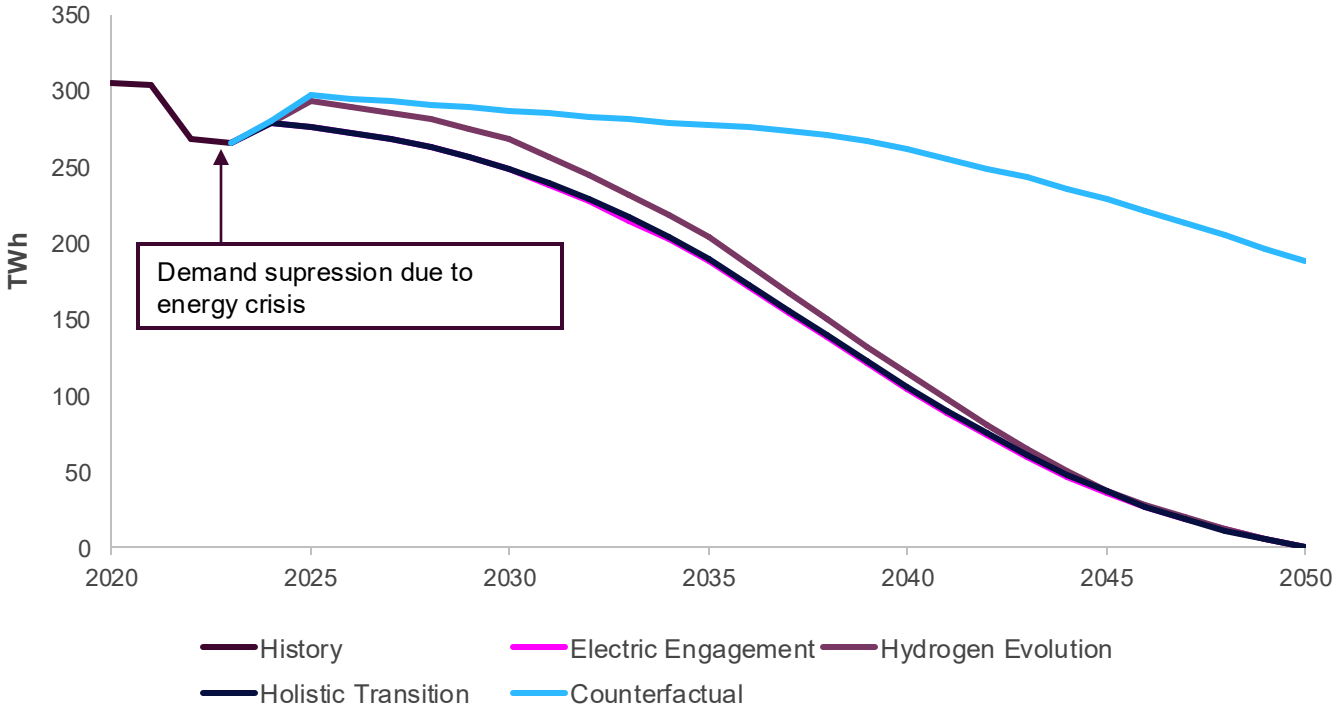
Focus Area Summary | Unlocking clean heating

Need to accelerate the uptake of clean heating technologies to replace natural gas

Residential annual gas demand for heat

Source: NESO FES 2024



Pending reforms to the UK domestic heat landscape:

- Natural gas: There is no timeline to cease the use of natural gas as a source of heat in existing homes.
- Electrification of heat: The government has a target to reach 450,000 installations of heat pumps by 2030, this will require a ~4.5x increase from the 98,000 heat pumps sold in 2024.
- District heat provides ~3% of UK heating requirements today, Government ambition is to increase this to ~20% by 2050.
- Hydrogen : Government will consult in 2025 on the role of hydrogen in home heating.

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Focus Area Summary | Unlocking clean heating

1 Time of Use Tariffs (ToUT) have a critical role in enabling price responsive demand across vectors

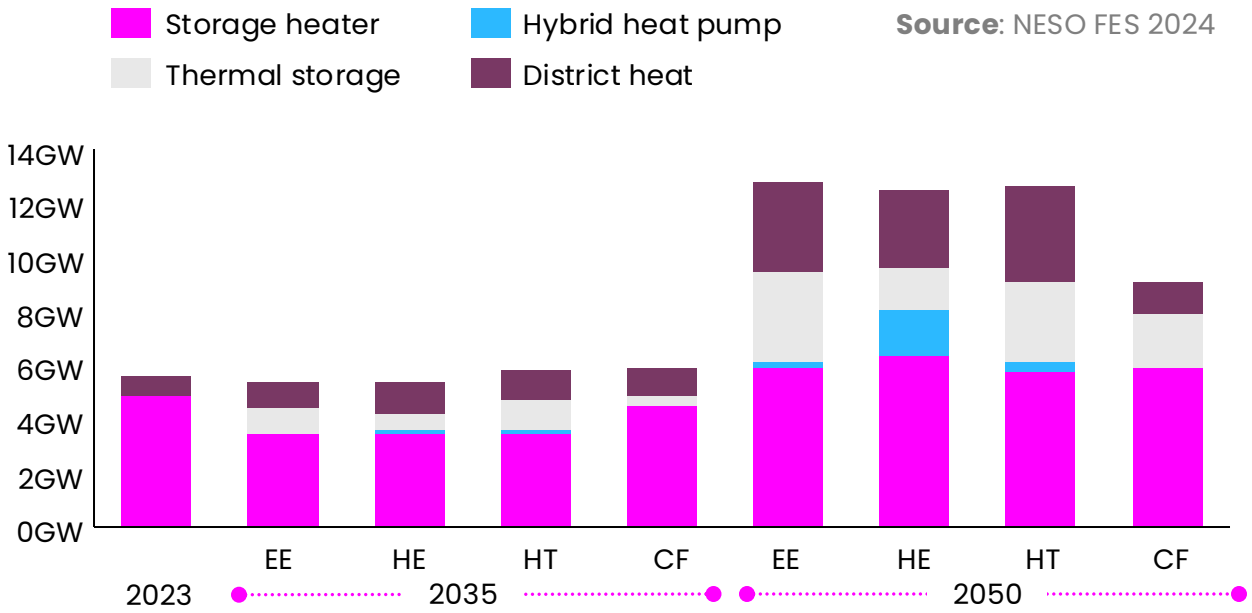
Why it matters

Participating in Time of Use Tariffs (ToUT) enables consumers to be rewarded for flexible energy consumption, thereby supporting to balance energy supply with demand. To fully unlock this flexibility, advancements in metering, the granularity of settlement periods, and the evolution of retail market incentives are necessary. However, current market design does not allow consumers across all vectors to be rewarded for flexible energy consumption, which impacts the broader energy system.

NESO's Future Energy Scenarios (FES) outline credible pathways to decarbonise the UK's energy system by 2050, the chart on the right illustrates the growing role for flexible energy technologies. Achieving a greater role for flexible energy technologies will require adequate incentives, including rewarding flexible energy consumption through mechanisms like dynamic tariffs or ToUT with short-term price setting periods. These mechanisms can help unlock clean heat as they have the potential to greatly improve the financial incentives.

Illustration of focus area in current energy landscape

Overall heat flexibility by technology from FES 2024 (GW)



Illustrative opportunities to unlock benefits from focus area

Introduce incentives for retailers to accelerate the development and uptake of **ToUT tariffs** across vectors, **enabling consumers to respond to price signals.** Given the increasing importance of end-user participation in balancing the energy system, clear price signals are essential.

Focus Area Summary | Unlocking clean heating

2 A regulated investment model for district heating could further support its deployment

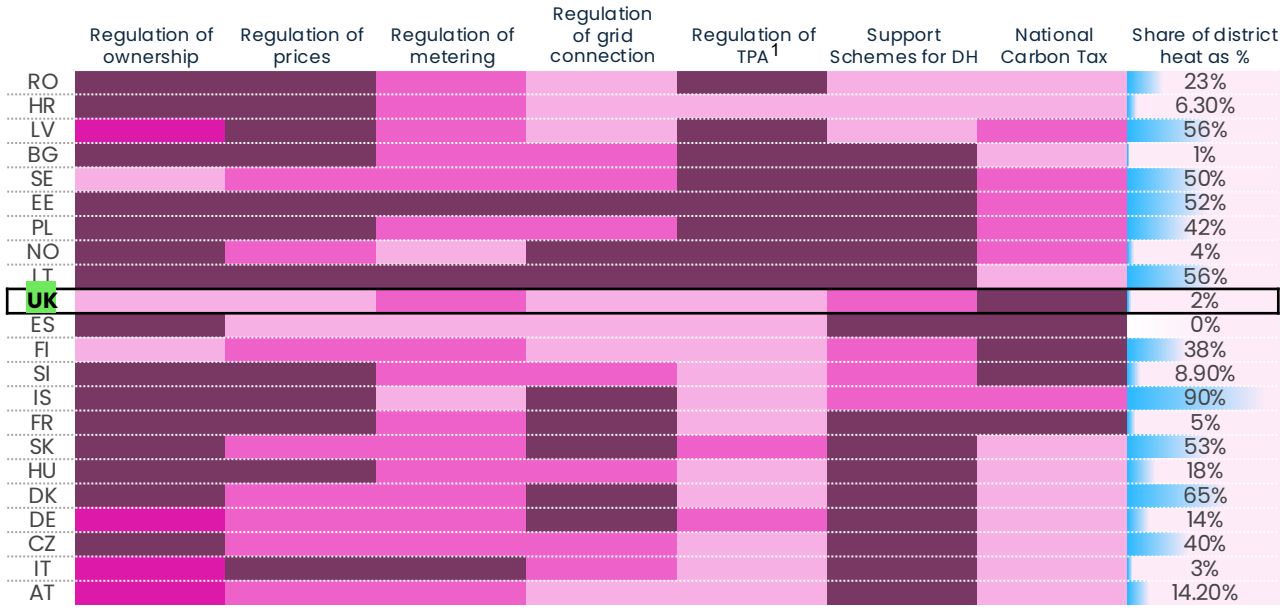
Why it matters

Government ambitions to decarbonise heat include district heating which could provide up to 20% of our residential heat demand by 2050, up from approximately 2% today. Introducing a regulated model, such as a regulated asset base (RAB) as used in other vectors, would guarantee a rate of return on investment and could reduce risks for district heat network projects, potentially accelerating their deployment.

The absence of a comprehensive regulatory framework for heat networks may increase uncertainty for investors, limiting attractiveness of such projects. The illustration on the right shows that countries in Europe with high levels of regulation for district heating tend to have a higher share of district heat as a heat source. In contrast, the UK, with low levels of regulation, has a correspondingly low share of district heating today.

Illustration of focus area in current energy landscape

Policy intensity by region per theme



Source: A. Billerbeck et al. Policy frameworks for district heating:

Illustrative opportunities to unlock benefits from focus area

A Regulated Asset Base regulatory framework for heat networks could reduce investor uncertainty and avoid a potential slow-down in rollout of district heating systems.

1. TPA: Third Party Access

Focus Area Summary | Unlocking clean heating

3 Aligning heat decarbonisation funding across technologies and regions could accelerate the rollout of clean heat

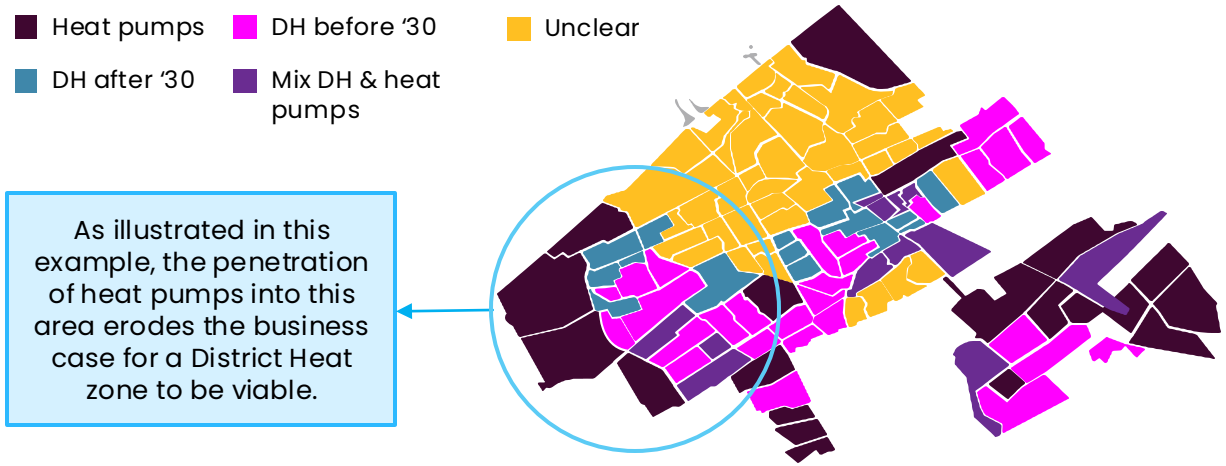
Why it matters

While the national Boiler Upgrade Scheme has accelerated progress towards the UK's heat decarbonisation targets, without coordinated efforts across various decarbonised heating technologies and their locations, funding for decarbonised heating—including investments in energy networks, heat pumps, and district heating— could be deployed inefficiently. There is an opportunity to lower consumer bills and further accelerate the heat decarbonisation transition through both local and national coordination efforts.

To support optimal business cases for networked systems like district heating, especially in dense urban areas, levelling support and enhancing coordination between technologies, in tandem with existing policies such as heat network zoning, could accelerate the rollout of clean heating technology.

Illustration of focus area in current energy landscape

The Haag's (Netherlands) heat transition vision shows opportunities for further district heating development



Source: Transitievisie warmte Den Haag

Illustrative opportunities to unlock benefits from focus area

Developing **technology-agnostic low carbon heating investment grants** could support a broader range of technologies and align national strategies, such as the heat pump grant, with regional planning efforts. This approach could help avoid or reduce unnecessary reinforcements of energy transportation systems.

Focus Area Summary | Unlocking clean heating

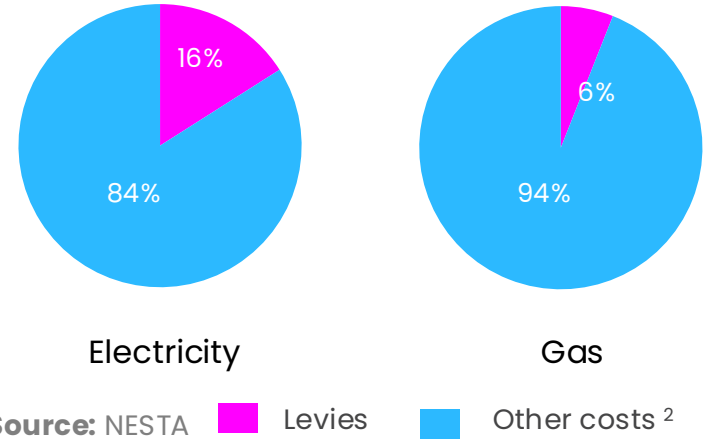
4 Rebalancing environmental costs across consumer bills could incentivise fuel switching to lower carbon sources

Why it matters

Environmental costs, including investment policy costs for renewable electricity generation funded through the Contract for Difference scheme, are incorporated into UK electricity bills. Additionally, emissions penalty costs are applied to electricity generated from natural gas, as these generators are required to pay under the UK Emissions Trading Scheme (ETS). In 2023, these generators incurred nearly £2.6 billion in emissions costs through the UK ETS. With these driving up wholesale costs, and environmental costs increasing consumer bills, this weakens the incentive for consumers to switch from higher carbon energy sources to low carbon energy sources such as low carbon electricity.

Illustration of focus area in current energy landscape

Breakdown of environmental levies on consumer bills



The pie charts shows the (2024) breakdown of consumer energy bills. As illustrated, for Electricity ~16% of consumer bills were composed of environmental levy costs[1] (not including ETS charges), with only 6% for Gas.

Illustrative opportunities to unlock benefits from focus area

Rebalancing environmental policy costs could provide stronger consumer incentives to adopt low carbon heating technologies. There are many different models for how and the extent to which environmental costs could be rebalanced. These would need to consider decarbonisation benefits as well as energy affordability, protecting vulnerable consumers and other impacts such as any interactions with other cost drivers.

1. Environmental levy costs for Electricity are Warm Home Discount, Energy Company Obligation, Renewables Obligation and Feed in Tariff. Environmental costs for Gas are Energy Company Obligation and Warm Homes Discount. 2. Other costs refers to wholesale costs, transmission costs etc., i.e. those which are not environmental policy

Focus Area Summary | Unlocking clean heating

5 There is a need to strategically consider the timeframe over which we pay for energy infrastructure

Why it matters

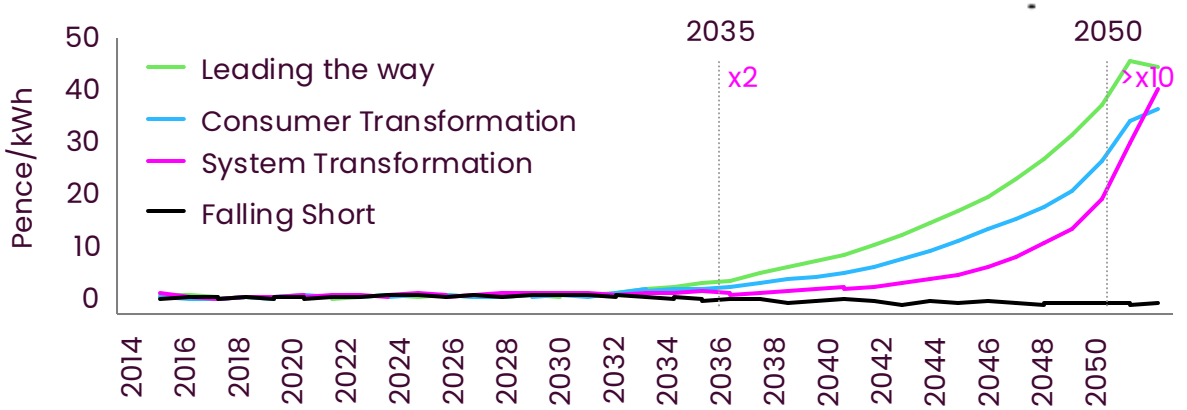
There is an opportunity to strategically consider delaying or accelerating the cost burden on consumers from energy infrastructure to find the most efficient and affordable options for decarbonising heating (and other energy uses). The energy transition requires maintaining existing infrastructure while developing new systems, and the timing of network cost recovery is crucial to ensure affordability for consumers.

For example, as we move away from natural gas, a shrinking natural gas user base will face higher prices to maintain existing networks. The chart to the right illustrates a potential tenfold increase in consumer gas bills if we continue under the current charging model, i.e. where network costs are recovered over the full expected lifetime of the asset. Ofgem has committed to depreciating the gas distribution networks by 2050 and is considering whether to depreciate the entire gas distribution network (GDN) or only new additions under the upcoming RIIO-GD3 price control. Forecasts provided by GDNs suggest a price increase of approximately £7-£27 per annum, depending on the region, if Ofgem chooses to depreciate the entire gas distribution network by 2050.

Similarly, the timing of cost recovery for emerging vectors like hydrogen or carbon should be examined, including options to delay costs, in order to reduce the burden on initial users until a larger user base is established.

Illustration of focus area in current energy landscape

Estimated gas distribution charge evolution for consumers in GB under the current charging model



Source: Ofgem analysis

Illustrative opportunities to unlock benefits from focus area

Sharing the costs across vectors of both **declining old networks**, e.g. gas and **development of new networks**, e.g. hydrogen, to ensure that consumers aren't unfairly burdened.

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Focus Area Summary | Ensuring energy security in a more complex energy system

How can we ensure energy security in a more complex energy system

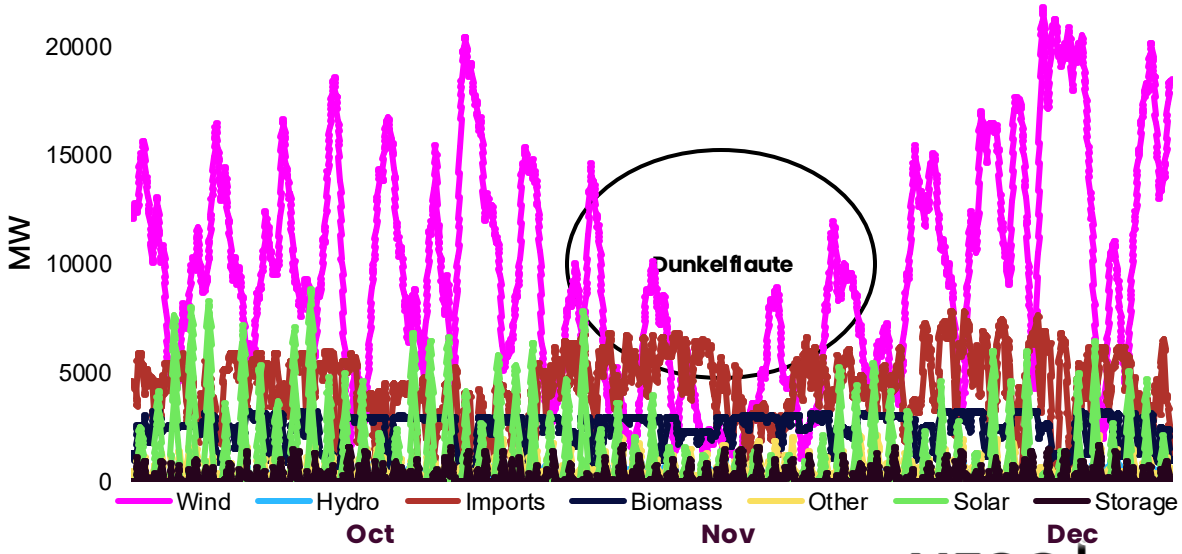
Context to GB Energy Security for mature energy vectors:

- Security of supply traditionally refers to the availability of energy sources to meet peak demand
- By the 2010's, GB's electricity generation had started to shift away from fossil fuels towards more intermittent generation sources. The country had experienced the rapid closure of older, more polluting power plants. As a result, there was a significant risk that the market might no longer provide a reliable electricity supply as it did in the past. This was mainly due to potential revenues in the energy-only market, i.e. peak prices during times of system stress, not being high enough to encourage investment in new capacity. To address this challenge, Electricity Market Reform in 2011 brought in a policy mechanism (the Capacity Market) that would ensure energy security by encouraging enough investment in capacity to maintain a stable electricity supply.
- In 2000, natural gas supply in the UK was predominately procured from domestic natural gas supplies from the North Sea. Domestic natural gas supplies have since declined, and currently only provide approximately a third of UK overall gas supply. However, security of gas supply is still left to the short-term market, where market prices incentivise delivery of gas. Unlike in electricity, there is no dedicated policy mechanism to support security of gas supply.

In the following slides, we identify opportunities to improve whole energy security via enhanced whole energy market coordination.

Security of Supply in a more complex, integrated energy system:

- As more renewables are integrated into GB's energy system, this increases the potential for extended periods where there is low electricity generation from renewable assets due to limited wind and solar energy, known as a Dunkelflaute event. As these type of events become more likely, means to ensure security of supply will need to evolve.
- For example, during Dunkelflaute events, there is an increasing need for flexible generation available for long periods of time. Given the interconnected nature of the future energy system between multiple vectors, this will have significant implications across energy markets.



Source: NESO

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Focus Area Summary | Ensuring energy security in a more complex energy system

6 Long-term incentives specifically to reward the contribution of energy supply assets to overall energy security could be considered for all vectors

Why it matters

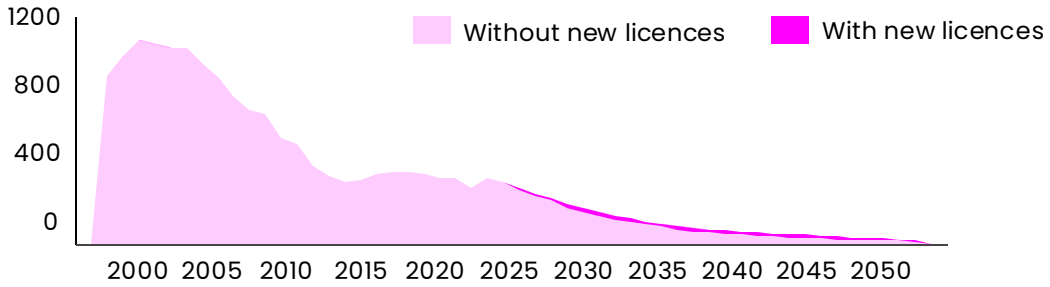
The emergence of new vectors, such as hydrogen and networked carbon, interacting with existing vectors of electricity, natural gas and networked heat, will lead to a growing number of interactions between vectors, thereby increasing the complexity of the UK's energy system. It is currently difficult to assess what the relative contribution to overall whole energy security is for each vector.

To enhance overall energy security, it may be beneficial to implement policy mechanisms that provide long-term incentives specifically to reward the contribution of energy supply assets to overall energy security. Recognising the benefits in diversity of energy sources, such measures could improve the efficiency of securing the whole energy system. While long-term support mechanisms do already exist for energy supply in some vectors, most of these are not targeted to remunerate assets for their contribution to energy security.

Illustration of focus area in current energy landscape

Although Clean Power by 2030 aims to limit gas to be used in the power sector to less than 5% by 2030, NESO's Future Energy Scenarios includes a broad range on the role of gas used in the wider UK economy out to 2050.

With the reduction of domestic UK natural gas supplies via the North Sea, this generates the need to consider further measures to support natural gas security of supply, especially when considering the integrated nature of natural gas into overall energy security.



Source: North Sea Transition Authority

Illustrative opportunities to unlock benefits from focus area

Introduce **supply adequacy** (i.e. availability of assets to support energy security at times of system stress) **incentive mechanisms across all energy vectors** to reflect contribution of multiple vectors to overall energy system security.

Focus Area Summary | Ensuring energy security in a more complex energy system

7 Long-term incentives to support investment in assets with the ability to reduce demand to contribute to overall energy security could be considered for all vectors

Why it matters

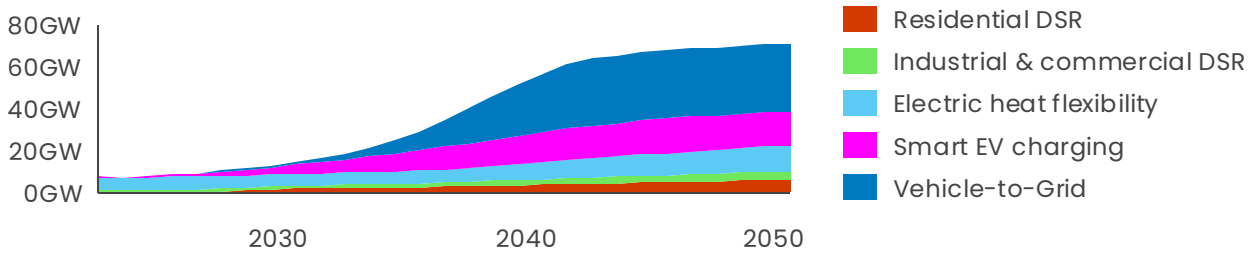
With the emergence of new vectors and a growing number of interactions between emerging and existing vectors, the UK's energy system is becoming increasingly complex. End-users, including both residential and industrial consumers are poised to play a more significant role in supporting to balance the energy system during periods of stress.

To facilitate this, long-term incentives could be a tool to encourage users to invest in technologies that can assist the system in such critical times. At present, only the electricity sector has the Capacity Market in place, allowing demand side assets to be contracted to support balancing supply with demand.

Illustration of focus area in current energy landscape

As we can see from the Future Energy Scenarios data in the chart below, the potential for Demand Side Response (DSR) moving forward is huge (all categories represent DSR potential).

Source of demand side response, Holistic Transition Pathway



Source: NESO Future Energy Scenario 2024

Illustrative opportunities to unlock benefits from focus area

Introduce an explicit, but voluntary, **incentive for energy consumers across all vectors** to **invest in the ability to contribute to energy security** by changing behaviour during whole energy system stress events (i.e. for consumers to increase or reduce demand at times of system stress).

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Focus Area Summary | Ensuring energy security in a more complex energy system

8 Greater coordination of system operation across vectors could generate greater operational and cost efficiencies

Why it matters

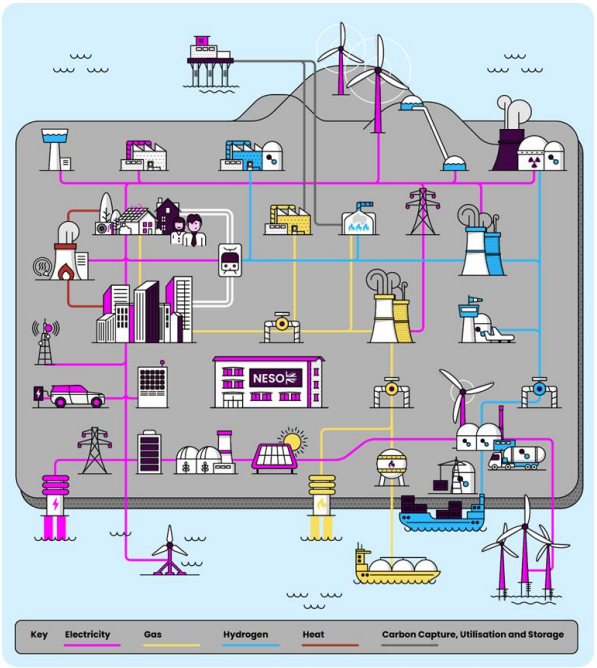
As we observe a rise in the number of energy vectors such as hydrogen and networked carbon, the interactions between these vectors will increase, leading to a more complex energy system. Each vector will have its own systems and governance structures to manage its operations effectively. However, with the growing number of interactions, there is significant potential for value creation through enhanced understanding of each vector's operations. This can be achieved through information sharing and ensuring that control rooms are well-informed about the requirements of the vectors they interact with most frequently. Such collaboration will enable better planning and contribute to delivering a system that is both affordable and efficient.

When vectors establish systems to support their operations, processes for managing emergencies will already be in place, facilitating cooperation during critical situations. This is exemplified by the annual emergency exercises conducted between gas and electricity control rooms. While these events are meticulously prepared for, our focus here is on ensuring the ongoing security of the system on a daily basis, outside of periods of stress, through efficient and collaborative practices.

Illustration of focus area in current energy landscape

As we move to the energy system of the future, there will be an increased number of vectors at play, and an increased number of interactions between them, making the system a lot more complex than it is today. We can see a glimpse of this in the diagram to the right.

As the number of interactions increases, and the system becomes more complex, it will be paramount to consider how best each vector can play a role in securing overall energy security.



Source: NESO

Illustrative opportunities to unlock benefits from focus area

Ensure strong links between system operators across vectors (e.g. electricity & hydrogen) to improve security of supply and **minimise operational blind spots** (i.e., through information sharing and widening operational coordination responsibilities across vectors) **ensuring full use of flexibility across energy vectors**, optimising vector operations at whole system level and **avoiding biased decision making towards single vectors**.

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Focus Area Summary | Integrating greater strategic planning into holistic market design

Full decarbonisation requires a combination of greater strategic planning and efficient operational energy markets

The role of energy markets in allocating resources and how they have evolved to achieve decarbonisation

Managing energy resources involves two basic decisions: 1) What (and where) to build and 2) When to use it. Since privatisation of the energy markets (from the 1980s), markets have been used to make both types of decision.

When the UK committed to reducing emissions in the early 2000s, policies were introduced to adjust market outcomes to achieve the "energy trilemma", a framework of three objectives that policymakers need to balance (decarbonisation, minimising costs for consumers, and securing energy supplies). Throughout, markets have been central to delivery.

Why more strategic planning is required for full decarbonisation

The next phase of decarbonisation on the path to net zero emissions by 2050 must progress at a greater pace and scale than ever before. It must extend from the electricity sector across all energy use and beyond. And completing the job of decarbonising electricity will involve new challenges within a complex and uncertain picture. These demand a greater role for strategic planning:

- An increasingly dominant share of energy assets will rely on supportive government policy for delivery in the context of high uncertainty on costs and energy demand.
- Low carbon energy sources are typically capital intensive and therefore particularly benefit from clear signals and a supportive investment climate.
- Coordination is needed between the required strengthening of energy networks and the rapid deployment of clean energy sources, as well as across vectors and between demand and supply.

At the same time there is a clear ongoing need for market mechanisms. Operational dispatch may be increasingly complex to forecast and manage, with significant uncertainty as to the locations and supply/demand profiles of assets. Real-time price signals will be important given the inflexibility and intermittency of the renewable generation. Uncertainty over the future implies a need to retain the responsiveness provided by markets. Continued competitive discipline and innovation can also help to manage costs.

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Focus Area Summary | Integrating greater strategic planning into holistic market design

As the National Energy System Operator (NESO), we have taken on new responsibilities for strategic planning. Critically, these extend beyond the ESO's previous planning role which was limited to electricity network planning.

Strategic Spatial Energy Plan (SSEP) will help accelerate and optimise the transition to clean, affordable and secure energy across Great Britain by providing greater clarity to industry, investors, consumers and the public on the shape of our future reformed energy system. It will achieve this by assessing the optimal locations, quantities and types of energy infrastructure required to meet our future energy demand, helping enable the clean, affordable and secure supply we need.

Centralised Strategic Network Plan(CSNP) will build on the SSEP to provide an independent, coordinated, and longer-term approach to wider network planning across electricity, gas, and hydrogen vectors in GB to help meet the government's net zero ambitions.

Regional Energy Strategic Plans (RESPs) will help ensure that local areas get the energy infrastructure they need to meet local net zero and growth ambitions. The RESPs will form part of NESO's wider strategic energy planning activities, ensuring a joined-up approach between national, regional and local levels.

Energy policy and markets are very complex with lots of interacting parts, and to meet the ambitious targets of the energy transition they are changing in some fundamental ways. This creates a new challenge of ensuring that strategic planning, investment policy and markets are working together coherently across the whole energy system.

The critical ongoing role of markets in efficient energy system operation:

We need markets to continue to provide signals for which assets to run when. There is room for improvement in market design for it to do this more effectively. These include making sure markets accurately reflect:

- Differences in the value of energy across time and space
- When and where it is most difficult to reduce emissions
- How willing consumers are to reduce or increase demand depending on price
- The incremental costs of transforming energy from one vector to another, avoiding distortions by subsidy design

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Focus Area Summary | Integrating greater strategic planning into holistic market design

9 Holistic market design should ensure coherence of strategic planning and investment policy nationally and regionally

Why it matters

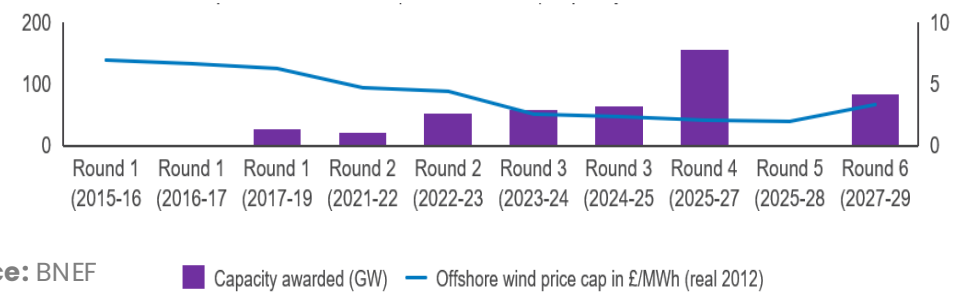
As set out in the Clean Power 2030 Action Plan, the Government has ambitions to rapidly reach target levels of multiple low carbon generation technologies, requiring unprecedented scale and pace of investment (~£40bn p.a.). It is therefore critical to ensure that market price signals and investment policy are fit for purpose to deliver these.

The Government has committed to consulting on targeted reforms to the Contract for Difference (CfD) mechanism for upcoming allocation rounds, including improving transparency and predictability in the timing and scale of future CfD allocation rounds. Consideration must also be given to how existing investment policy, historically designed to be agnostic on location, may require reform to deliver spatial plans.

Illustration of focus area in current energy landscape

To meet the Clean Power by 2030 target, approximately 6 GW of offshore wind capacity needs to be added annually. The Government's sixth allocation round (AR6) increased the budget by 50%, totalling £1.5 billion, securing contracts for 3.8 GW of offshore wind. This represents considerable progress, yet it still falls short of the required annual additions. Previous experiences underscore the challenges faced: the fifth allocation round (AR5) saw no bids due to unviable strike prices resulting from sharp cost increases, while only two offshore projects from the fourth round (AR4) have advanced to construction to date. These experiences demonstrate that achieving high targets will require coordination between strategic planning, auction design and budgets.

BNEF Offshore wind allocation round results (GW)



Source: BNEF

Illustrative opportunities to unlock benefits from focus area

Build upon the commitments in the Clean Power 2030 Action Plan to further **improve the stability of the regulatory environment**, and increase investor confidence, for example via **greater forward visibility of subsidy allocation rounds.**

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Focus Area Summary | Integrating greater strategic planning into holistic market design

10 Stronger operational locational signals in electricity markets could unlock the ability for other vectors to harness low-cost low carbon electricity, and highlight the need to consider cross-vector locational incentives

Part One: Stronger operational locational signals in electricity markets could unlock the ability of other energy vectors to harness low-cost low carbon electricity

Why it matters

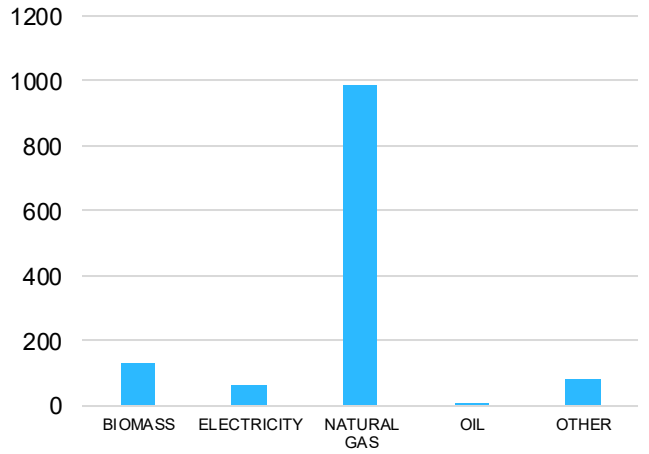
Operational locational signals in the context of a national wholesale electricity price can take various forms, such as local flexibility markets, which provide location specific incentives for demand assets to turn up or down with the objective of resolving locational constraints on the system.

Stronger operational locational signals in electricity markets would provide an opportunity for growth in two crucial energy vectors; hydrogen and networked heat, by improving their economic viability in regions like Scotland, where wind output is abundant and demand is relatively low.

Illustration of focus area in current energy landscape

The Heat Networks (Scotland) Act 2021 sets a target for the combined supply of thermal energy of 6TWh by 2030. Whilst district heating networks can use a variety of primary energy sources to generate their heat, electrically powered heat pumps (air or ground source) should be an economic option in Scotland given the abundance of (currently curtailed) wind output. However, due to high electricity prices, a very small minority of existing and planned heat networks in Scotland use electricity as their primary energy source'

Networked Heat by fuel type in Scotland (kW)



Source: Scottish Government, June 2024

Illustrative opportunities to unlock benefits from focus area

We are exploring options to provide stronger locational operational signals within a reformed national wholesale electricity market.

Focus Area Summary | Integrating greater strategic planning into holistic market design

Clean heat | Energy security | Integrating strategic planning into markets

10 Stronger operational locational signals in electricity markets could unlock the ability for other vectors to harness low-cost low carbon electricity, and highlight the need to consider cross-vector locational incentives

Part Two: Stronger operational locational signals in electricity markets could highlight the need to consider cross-vector locational incentives holistically

Why it matters

Differences in how energy markets reflect the value of energy across locations could result in inefficient decisions on which assets to run when.

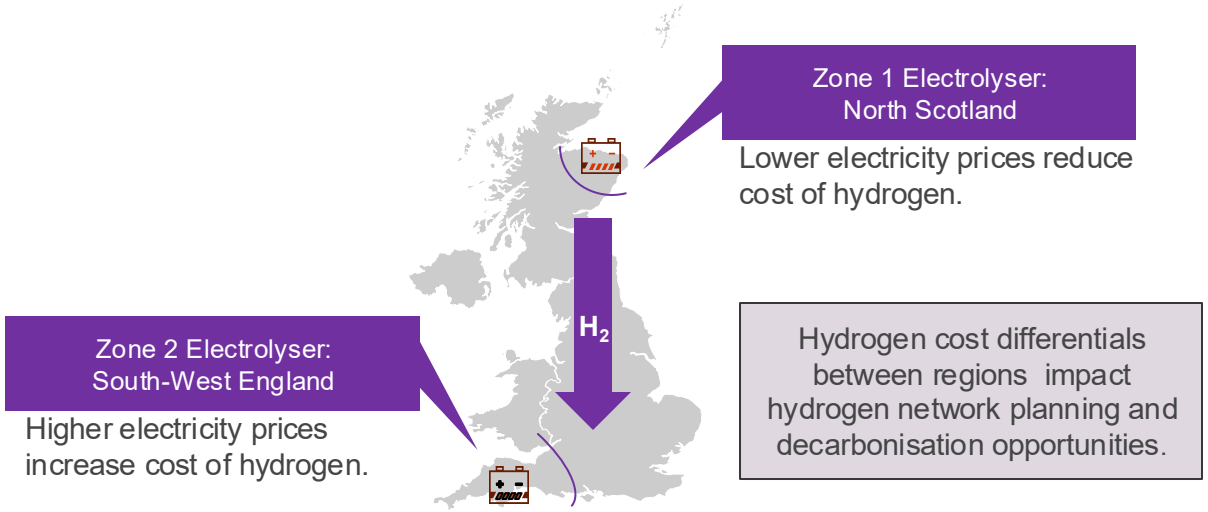


Illustration of focus area in current energy landscape

The economics of green hydrogen production via electrolysis is highly sensitive to the price of electricity. Although an electrolysis plant can access some locational value via the Balancing Market, this is difficult to hedge and therefore cannot be used to underpin investment. Stronger operational locational signals in electricity markets would therefore act as a catalyst for electrolysis development.

Illustrative opportunities to unlock benefits from focus area

Stronger operational locational signals in electricity markets could help unlock hydrogen cost reductions and related decarbonisation opportunities in key industrial sectors by incentivising the location and operation of electrolysis in areas of relative abundance

1. Assumes variable OPEX of > £10/ MWh;

Focus Area Summary | Integrating greater strategic planning into holistic market design

11 The delivery of national and regional strategic plans could be influenced by the extent to which investment policy takes into account locational network charges

Why it matters

A key consideration in the strategic planning of energy assets across vectors is the geographical distribution of assets across the country. The assumed locational spread of assets in one vector can significantly impact the optimal locations of assets, and the required network, for other vectors.

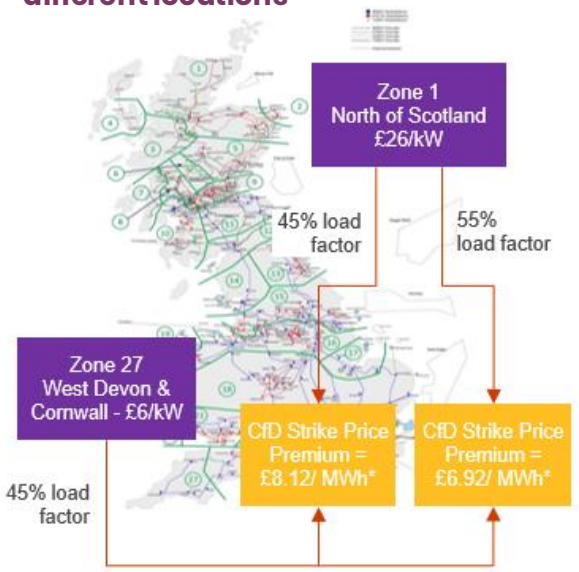
For example, how much wind capacity is located in the north of GB is likely to impact how much hydrogen capacity would be optimally located in the north, and therefore how much network capacity may be required to transport hydrogen to demand centres in the south.

The ability of investment policy to deliver assumed plans in one vector is therefore critical to assure the optimal combination of assets across the whole energy system.

Currently, electricity investment policy is agnostic to the location of supported capacity. For example, measures such as Contracts for Difference (CfDs), are auctioned nationally, such that all projects receive the same strike price regardless of location.

Illustration of focus area in current energy landscape

Illustrative impact of differential TNUoS tariffs[1] on required CfD Strike Prices in different locations



To provide a case study based on offshore wind, projects located in the north of Scotland bidding into CfD auctions will face higher transmission network costs. However, these projects may still be as profitable as more southerly projects with lower transmission network costs, as northern offshore wind projects typically have higher wind speeds and hence greater output per unit of capacity.

For example, for an offshore wind farm with a 45% load factor connecting to Zone 1, its LCOE will be around £8/MWh higher than an equivalent asset connecting to Zone 27 with the same load factor. This reduces to under £7/MWh if we assume the Zone 1 asset has a superior load factor of 55%. Locational signals therefore rely on cost signals, including from other policy instruments such as TNUoS

Illustrative opportunities to unlock benefits from focus area

For investment policy to align with spatial plans, and therefore the optimal combination of assets across the whole energy system, **regional auctions with independent strike prices may be required**, to **reflect the impact of locational network charging** e.g. for electricity generation, regions where higher TNUoS is not outweighed by other locational advantages (such as higher wind yield) may require a greater subsidy.

[1] Based on 2024/25 Wider generation TNUoS tariffs (intermittent generation)
TNUoS: Transmission Network Use of System tariffs. LCOE: Levelised Cost of Electricity

Appendix – Stakeholder voiced opportunities

Additional whole energy opportunities | Stakeholders voiced further opportunities for enhancing coordination across markets

Integrating strategic planning & market design

Combine subsidy awards with network connection, to accelerate the pace of clean energy projects

"Given the long process of developing renewable assets, developers successful in receiving subsidies currently risk waiting to get connected to the network. This causes delays and increases costs. A solution could involve combining renewable development subsidy awards with network connections." [Energy producer]

Reduce complexity accessing the energy market, to accelerate local development of clean energy projects

"Simplify local energy trading, for instance, enable a wind farm near a housing estate to directly supply energy via the existing distribution network, without the complexities of transmission charges and code." [Equipment Manufacturer]

Unlocking Clean heat

Alignment of clean heat subsidy support across markets, to incentivise consumers to fuel switch to low carbon alternatives

"Customers should be extended subsidies (e.g. such as connection fee support) to balance the playing field for other clean heat opportunities, besides heat pumps, to incentivise consumers to fuel switch in areas where it is optimum for district heating. To boost customer acceptance and incentivise switching to district heating in areas where it is optimal, transitional funding schemes are useful. Such schemes would give customers an incentive, and reassure them that they will not be worse off by switching from gas" [Integrated energy player]

Ensuring Energy security

Long term contracts, to encourage investor confidence across energy markets

"Contracts should be long-term to support low carbon flexible generation play a larger role in overall energy security." [Integrated energy player]

"Create a central buyer to secure long-term energy contracts akin to models used in other countries, and in the UK prior to market liberalisation in the early 2000's. Long term contracts could stabilise long-term energy costs and secure energy supply." [Integrated energy player]

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