Networks Unlocked

Enabling networks to deliver whole system, societal and economic value in an era of energy system transformation.

Contents

How to use this document:

Green bold underlined text Hover mouse over for additional information

CONTENTS Each new **section** has a button to click to return to the contents page

Networks Unlocked: responding to the challenge

Building on **Energy Networks for the Future** paper, the central premise of the **Networks Unlocked** paper is that during a time of rapid transition to net zero, networks could deliver more value, both to the energy system and to the wider economy and society, if they were enabled to do so.

To test this proposition, Regen has engaged with industry stakeholders to understand where additional value could be created, and what barriers and enablers need to be addressed to make this happen.

The paper begins with a summary of the current regulatory arrangements and an analysis of why the existing model may inhibit long-term investment and value creation. The paper considers whether current policy reforms could be the basis of a new framework, or whether more radical change is needed.

The paper then assesses the more fundamental implications for future network policy, including the regulatory model, the allocation of risk and reward, governance and oversight and the potential for a new partnership model between networks, their stakeholders and consumers of energy.

Finally, the paper takes a broad view across the main pillars of network value creation and explores how networks could be tasked to create additional value, with a deeper dive into the six potential value creation areas that emerged from stakeholder interviews and industry workshops.

> Value creation isn't just about regulation and performance measurement, but also how networks are enabled to apply whole system thinking, collaborate with other system actors and their stakeholders, manage risk, make investment decisions and develop new capabilities. It's also, fundamentally, about the new roles and new forms of governance that will be required to transform the GB energy system.
>
> **Johnny Gowdy,** Director, Regen

> Electricity networks are vital to deliver societal and economic value as we drive to meet net zero. Society's use of electricity will radically transform in the coming decade as electric vehicles and low carbon heating systems become the norm, just like the internet did in the late 90s. Which is why the UK government has estimated that up to £140bn of additional network investment will be required by 2050.
>
> Current price control arrangements have ensured that the cost to the consumer of building and operating the electricity grid remains low at around 35p per day. Spreading the cost of future investment over a long period, while delivering much more power through the network, will help to keep costs down. Meanwhile, reinforcement on this scale will directly support up to an additional 130,000 jobs and contribute up to £11bn of value to the economy.
>
> But we know that networks can deliver more, and therefore we welcome Regen's independent review of ways to harness the full value that networks deliver for our customers and communities as a valuable contribution to future policy development.
>
> In addition to the policy ideas covered in this paper, we believe more radical and constructive change is required in our planning and consenting regimes and in the supply chains that service the UK electricity industry. Electricity networks stand ready to support this economic growth and to embrace cohesive, coordinated and efficient changes to make this happen.
>
> **Stephanie Anderson,**
> Head of Regulation & Policy
> SP Energy Networks

Introduction – networks and the energy transition

CONTENTS

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Networks in an era of energy transformation

The combination of net zero, an energy security crisis and the rapid technological and commercial changes that are happening across the energy industry constitutes the greatest transformation for electricity networks since the era of privatisation and arguably represents an even greater challenge.

From high voltage transmission lines that will integrate large-scale offshore wind farms and the next generation of nuclear generators, to the upgrade of the low voltage network that will allow businesses and householders to adopt electric vehicles and low carbon heating solutions, a massive investment in infrastructure, enhanced capability and flexibility is required.

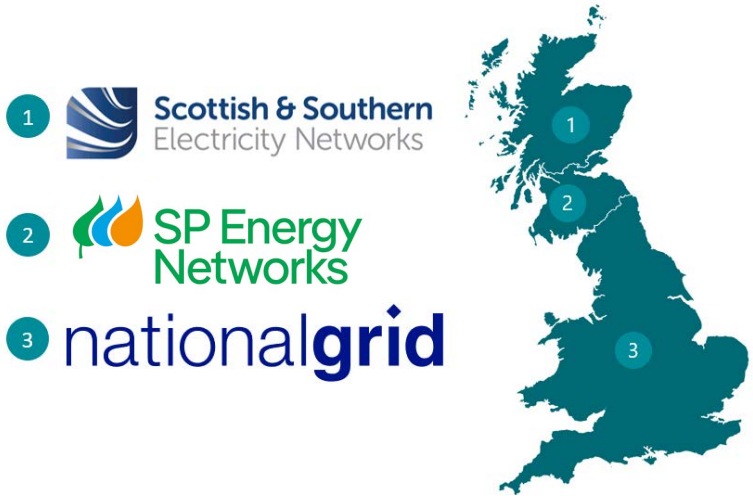
The experience of the pandemic and current energy crisis has made it clear that the rapid transition to a cost-efficient and resilient net zero energy system will be essential to support economic growth and the adoption of new technologies. A net zero delivery strategy must also achieve a range of wider societal goals from tackling fuel poverty and creating sustainable communities, to improving our environment, health and well-being.

If the energy system is critical for the UK economy and society, the provision of services and infrastructure by electricity networks is critical for that energy system to deliver the UK's net zero and energy security strategy. There is a strong argument that investment in networks will be the single most important factor that will either enable or potentially derail the UK's future energy goals.

This is why infrastructure investment has moved to the top of the energy policy agenda.

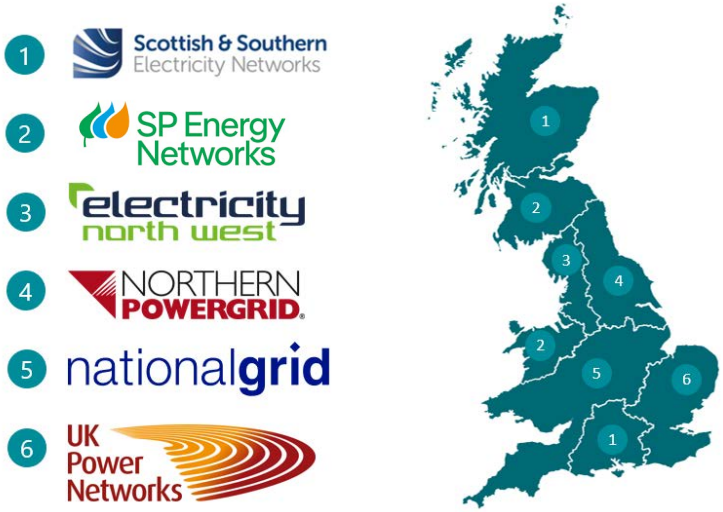
Jump to report conclusions

GB electricity networks



Electricity transmission

Figure 1: Electricity transmission licence areas and operators.



Electricity distribution

Figure 2: Electricity distribution licence areas and operators.

The GB electricity network consists of a high-voltage onshore and offshore transmission network and a lower-voltage distribution network. The onshore electricity network consists of approximately 20,000 km of high voltage transmission cables, and approx. 800,000 km of lower voltage distribution lines. Distribution networks serve approximately 29 million domestic households and business customers **(1)**.

- The onshore transmission network is owned by three transmission operators (TOs): National Grid Electricity Transmission (NGET), Scottish and Southern Energy Networks, and SP Energy Networks
- The distribution network comprises 14 Distribution Network Operator (DNO) licence areas, operated by six companies.
- The TOs and DNOs are regulated regional monopolies and are responsible for operating, maintaining, reinforcing, and extending the networks in their region to serve their customers.
- Network costs, plus an allowed return on capital (assets) employed and other incentive payments, are recovered from customers through network charges. These charges are set by the networks in accordance with a periodic price control agreement with the regulator.

There are also around 15 independent distribution network operators (IDNOs) and around 20 companies operating offshore transmission connections, mainly to offshore wind farms.

A further 20 companies hold licenses to operate, or to develop, interconnector links to neighbouring markets in Ireland and Europe. The GB energy network and the GB energy system do not include Northern Ireland, which is part of the Island of Ireland energy system

The UK's net zero transition

The UK government has set a target to decarbonise the UK's electricity supply by 2035. The net zero transition, and the security imperative to move away from imported fossil fuels, will require a massive increase in the capacity of electricity networks.

In 2021, the regulated networks delivered around 275 TWh of electricity to GB consumers with a peak winter evening demand of just under 50 GW.

In net zero future energy scenarios:

- GB demand for electricity is expected to almost double to 400-500 TWh (with an additional 50-100 TWh of net exports) by 2035 as heat, transport and industrial processes switch to low carbon electricity.
- Peak electricity demand is also expected to rise to between 70 and 80 GW.

The overall electricity system will be much larger. To meet this demand with low carbon electricity, generation capacity (including storage and interconnectors) will need to rise from around 100 GW today to between 160 and 200 GW in 2035.

The mix of generation technologies may vary, but in all net zero scenarios much of the added capacity will be from variable wind, solar and other renewable energy sources. There will also be a rapid expansion of energy storage and interconnector capacity.

Electricity to manufacture green hydrogen is expected to become a major new source of demand, while hydrogen itself it expected to become an important balancing fuel to generate electricity during peak demand periods.

Electricity demand is expected to almost double by 2035

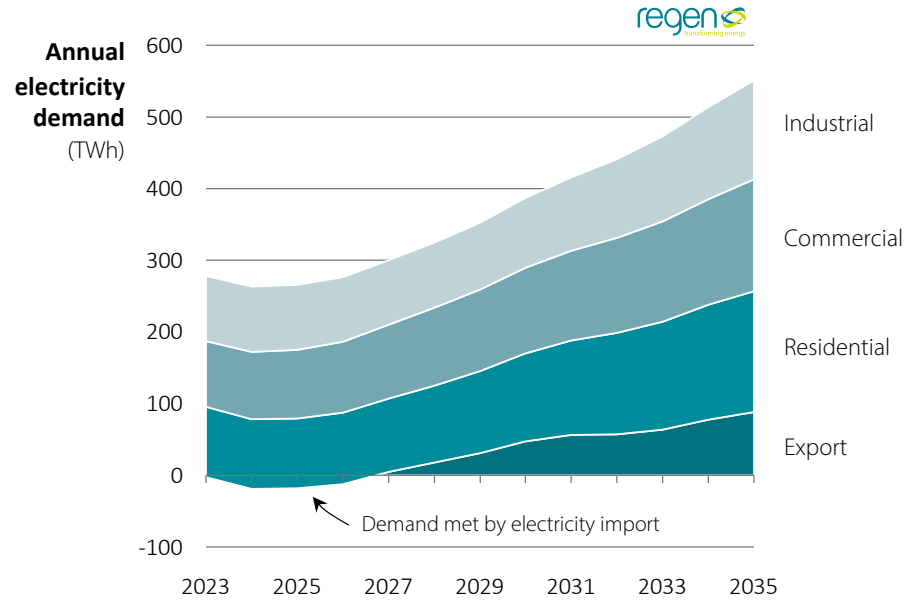


Figure 3: ESO Future Energy Scenarios 2022, Consumer Transformation scenario.

The importance of electricity from renewable and indigenous sources

GB electricity demand could double by 2035 and triple by 2050

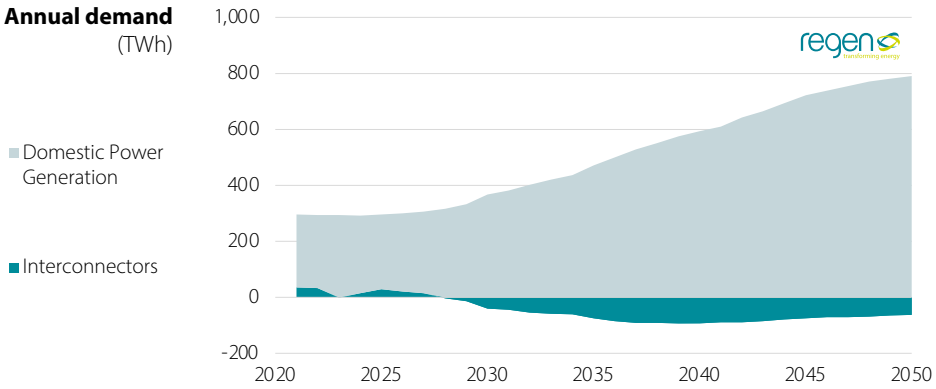


Figure 4: National Grid's Future Energy Scenario 'System Transformation'.
Source: **ESO Future Energy Scenarios** supporting workbook.

Increasing indigenous electricity production could enable the UK to become a net energy exporter by 2040

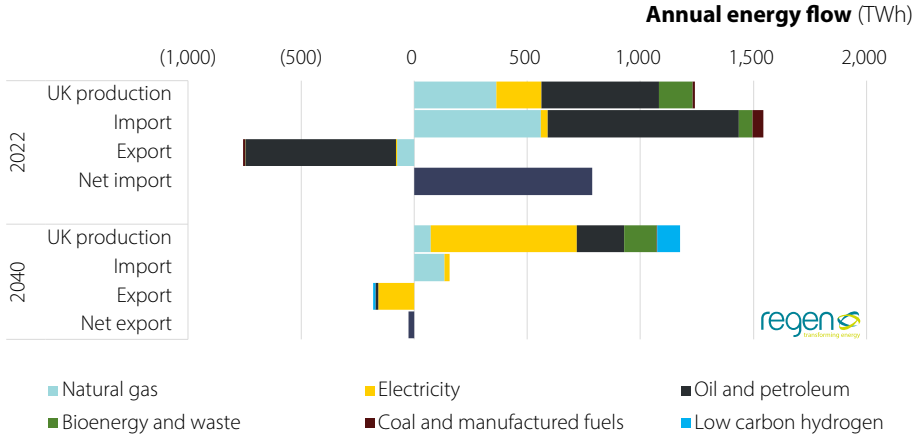


Figure 5: **Regen Analysis** - A Net exporter of energy by 2040.

As transport, heating and many industrial processes are electrified, electricity networks will deliver a far greater proportion of our energy demand.

The higher efficiency of electric solutions will cause primary demand to fall, whilst the amount of electricity delivered by networks will triple by 2050.

Although the UK will rely on imported electricity for energy security, overall the UK is predicted to become a net exporter of electricity in the 2030s.

In a net zero energy system, indigenous sources of energy will significantly increase as a proportion of energy demand by 2040, reducing the UK's import dependency and improving the UK's energy security.

Regen analysis has shown that by 2040 the UK could become a net energy exporter.

Most of this indigenous energy supply will come in the form of low carbon electricity from renewable energy sources, including offshore and onshore wind and solar. Consequently, electricity networks will be even more critical to the UK's prosperity in the coming decades.

Scale of investment

Investment of over £700bn is needed by 2037 to meet net zero according to Treasury analysis

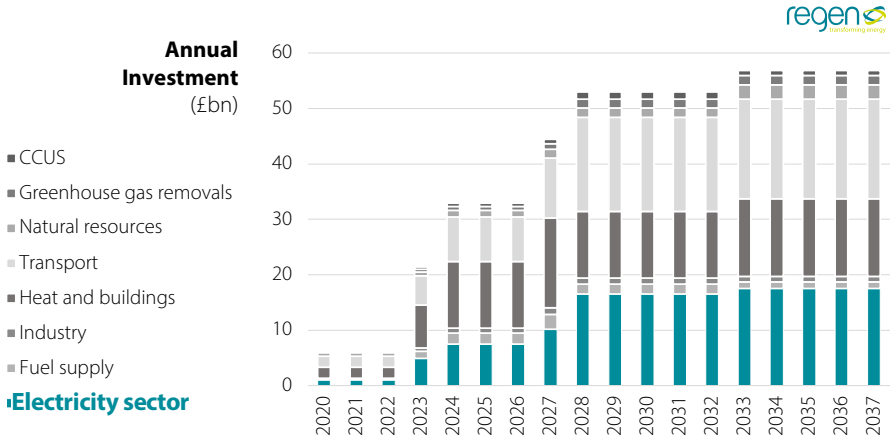


Figure 6: Additional annual investment required to reach net zero 2020-2037 excluding network investment (£bn, undiscounted 2020 prices). Source: **BEIS Net Zero Strategy** – Build Back Greener supporting workbook, using mid point average investment in each carbon budget period.

The BEIS Net Zero Strategy (2021) included a Treasury estimate that £721bn would be spent by 2037 to decarbonise the UK economy.

£210bn of that total is in the power sector; including new generation capacity digitalisation and building capability across all aspects of the electricity system.

Note - this figure does not include the investment required in transmission and distribution network infrastructure (see Figure 7).

Preparing the grid for net zero will require between £100-140bn of additional investment

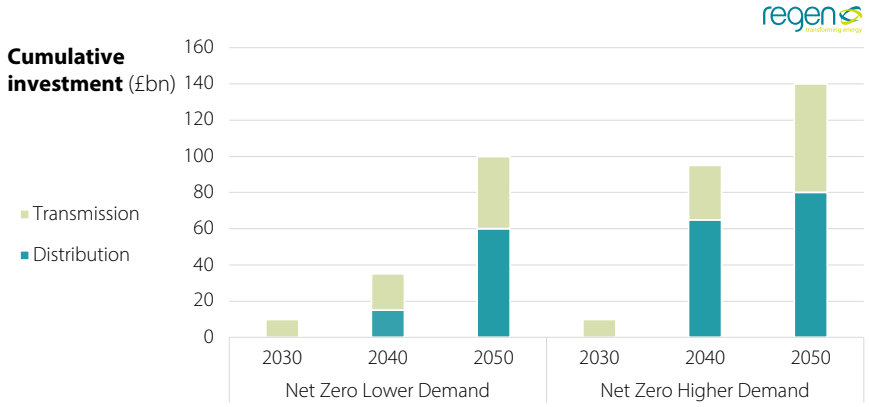


Figure 7: Cumulative onshore network investment required under two electricity demand scenarios (PV 2021-2050, 2020 prices). Source: Electricity Networks Strategic Framework **Appendix I** (BEIS/Ofgem).

The Electricity Networks Strategic Framework (2022)) estimated between £100-140bn of transmission and distribution network investment would be required to meet net zero plans, in addition to the baseline required regardless of net zero plans.

This estimate is, however, subject to a high level of uncertainty, especially in regard to the reinforcement of low voltage (LV) distribution networks. In a scenario where the entire LV network has 50% less capacity than currently understood, the cumulative investment could increase by £100bn by 2050 to £240bn.

Rising expectations that networks can deliver more

Since privatisation in 1990, priorities for the networks have largely been determined by the outputs and incentives set by the national regulator (Ofgem) working within the framework of the price control mechanism with centralised oversight and governance arrangements.

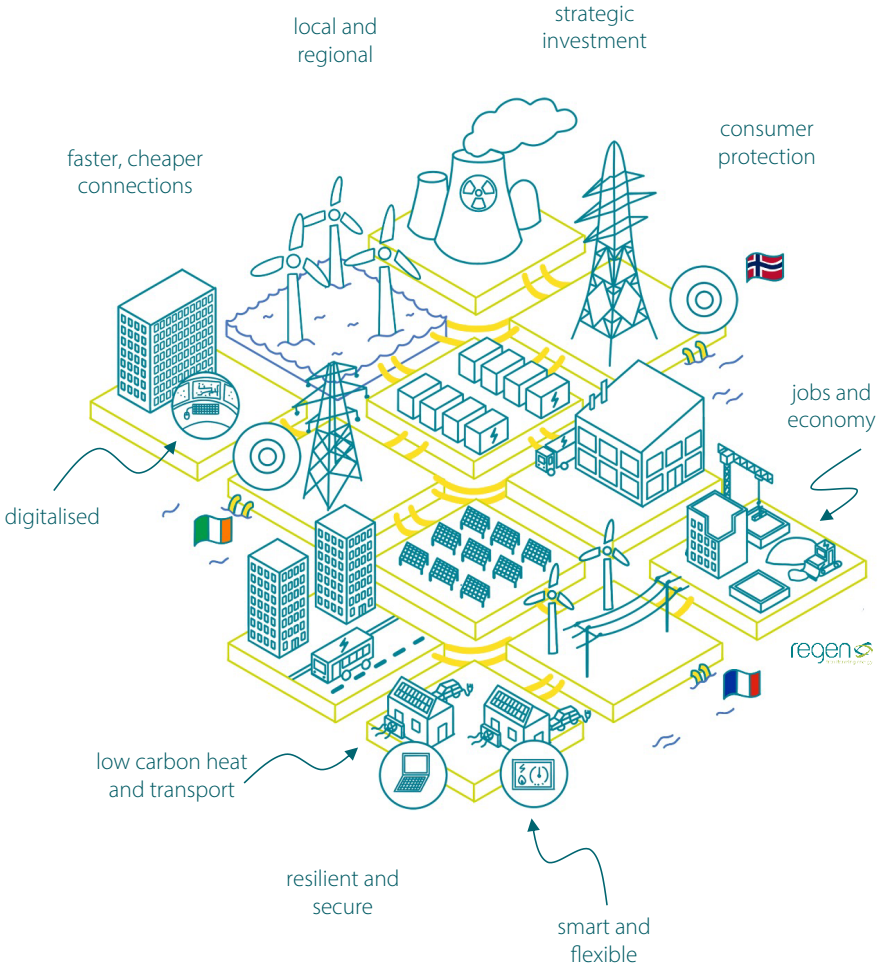
The regulatory model has an overarching objective of limiting the increase of network costs to the consumer while maintaining customer service levels. This has incentivised the networks to control operating costs and capital expenditure while minimising customer interruptions and measures of customer minutes lost (CML).

However, in the new era of energy transformation, expectations about the role that networks should play, and what they should deliver, have become more expansive and ambitious. The requirement that networks should be more proactive and take a broader "whole system" approach has partly been driven by the decentralisation of energy, and the greater devolution of energy planning and decision-making to communities, cities and regions.

This has led to calls for networks to deliver more value, invest more, and be at the vanguard supporting the energy transition. In stakeholder interviews and workshops, the rise in expectations coalesced around a number of key asks for the energy system, including:

- Accelerating and increasing levels of strategic/anticipatory investment
- Speeding up and reducing the cost of network connections
- Ensuring best use of existing capacity and non-asset solutions like flexibility
- Supporting decarbonisation and net zero ambitions at a regional and local level, including community energy, electric vehicle charging and low carbon heating
- Support for vulnerable consumers, including those at most risk from the energy crisis and the longer time impacts of the energy transition
- Providing infrastructure to enable economic growth and the levelling up agenda.

The biggest changes are expected to be in the way networks manage the connection process and a shift towards strategic anticipatory investment.



Network regulatory model

CONTENTS

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Current regulatory model for networks

How networks are regulated and incentivised is central to unlocking their value-creation potential.

Electricity networks are a form of natural monopoly. A natural monopoly, which is allowed to maximise profits, will tend to underinvest, limit services, and exploit its market position to increase profits.

Strong market regulation is therefore needed to ensure that networks deliver on the promise of greater investment, better services and lower costs. Hence the creation of a regulatory agency (Ofgem) and the development of a comprehensive regulatory model that has evolved over several price control periods.

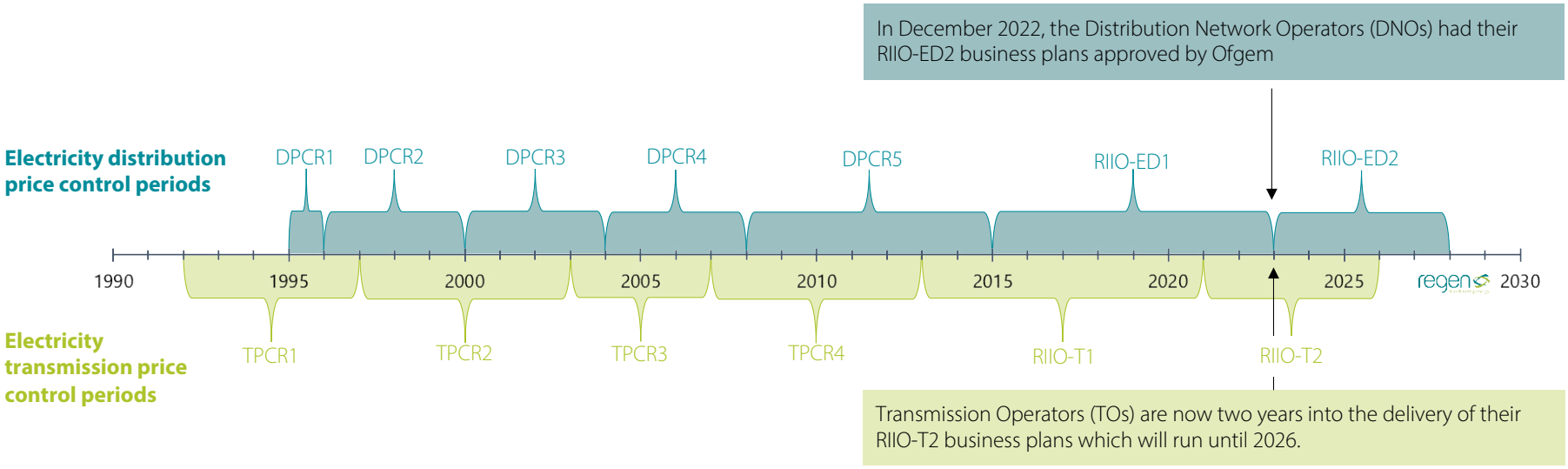
In summary, each price control period (5-8 years) has set the budget allowances for capital and operating expenditure, and the allowed return on the network's **regulated asset base**. This determines the cost budget revenue allowances, and therefore the network charges ultimately paid for by consumers.

Post-Privatisation price control periods

Early Price Control Reviews (PCRs) were geared towards cost management, and a formula of budget allowances based on inflation minus an element of efficiency cost reduction, known as an 'RPI-X' formula.

The current regulatory model known as **RIIO (Revenue = Incentives + Innovation + Outputs)**, which is now in its second price control iteration, was heralded as a new way to regulate and incentivise networks to efficiently deliver a **range of outputs** and better overall performance.

Although complex and administratively burdensome, **RIIO** is internationally regarded as one of the most progressive, robust and cost-effective regulatory models. It does, however, have some challenges; for example, the many months taken to set and agree on price control budgets.



Strengths of the current model

Interruptions in distribution have fallen

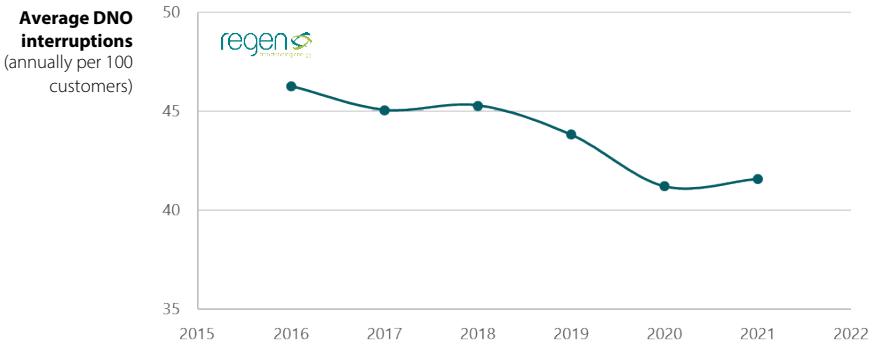


Figure 8: Annual interruptions per 100 customers (DNO average). Source: Ofgem RIIO ED1 & T1 annual reports 2020-2021.

Satisfaction scores across both transmission and distribution have steadily improved over the recent price control period

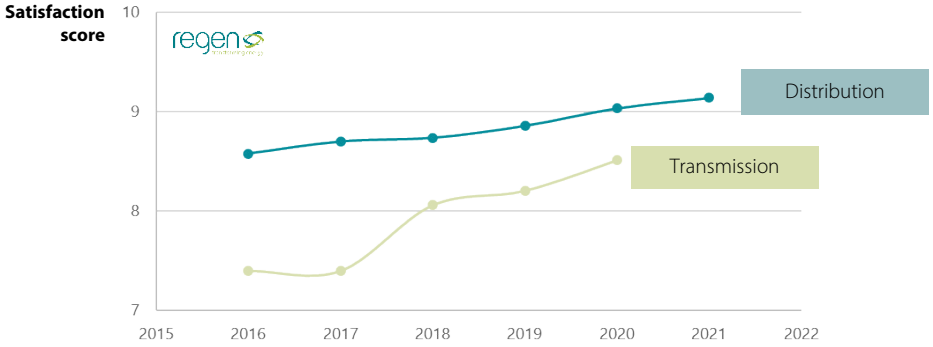


Figure 9: DNO and TO satisfaction scores. Source: Ofgem RIIO ED1 & T1 annual reports 2020-2021, average Customer Survey Score (CCS, Distribution) and Stakeholder Satisfaction Output (SSO, transmission).

In key areas, the RIIO model has performed well. Customer service and network reliability have improved, and GB has very low rates of network interruptions and customer minutes lost. Distribution network costs have remained fairly constant at around £100 per year per consumer and will continue at this base level under the ED2 price control period to 2028.

RIIO has introduced a number of important design **features and concepts** which incentivise networks to think in terms of Total Expenditure (Totex) and whole system benefits, and to invest in innovation and smarter solutions.

For example, the Totex model invites networks to focus on flexibility and optimising the use of existing assets, rather than just building new assets, with a Totex Incentive Mechanism (TIM) to share the cost savings between the networks and consumers.

RIIO includes a number of other incentive schemes based the delivery of broader **'outputs' and performance measures**. It also offers potential rewards to networks that can add additional value through initiatives and Consumer Value Propositions (CVPs) that go beyond their regulated outputs.

So, within the RIIO framework, there is scope to bring forward areas of additional value and to look more holistically at network performance and system benefits.

The business planning process for the current price control period, RIIO-2, has placed more emphasis on whole-system thinking, stakeholder engagement, approval from Customer Engagement Groups (CEGs), and the use of an evidence-based approach to defining future network requirements.

Network costs fell significantly after privatisation and have since increased slightly per MWh as electricity demand has fallen over the past decade

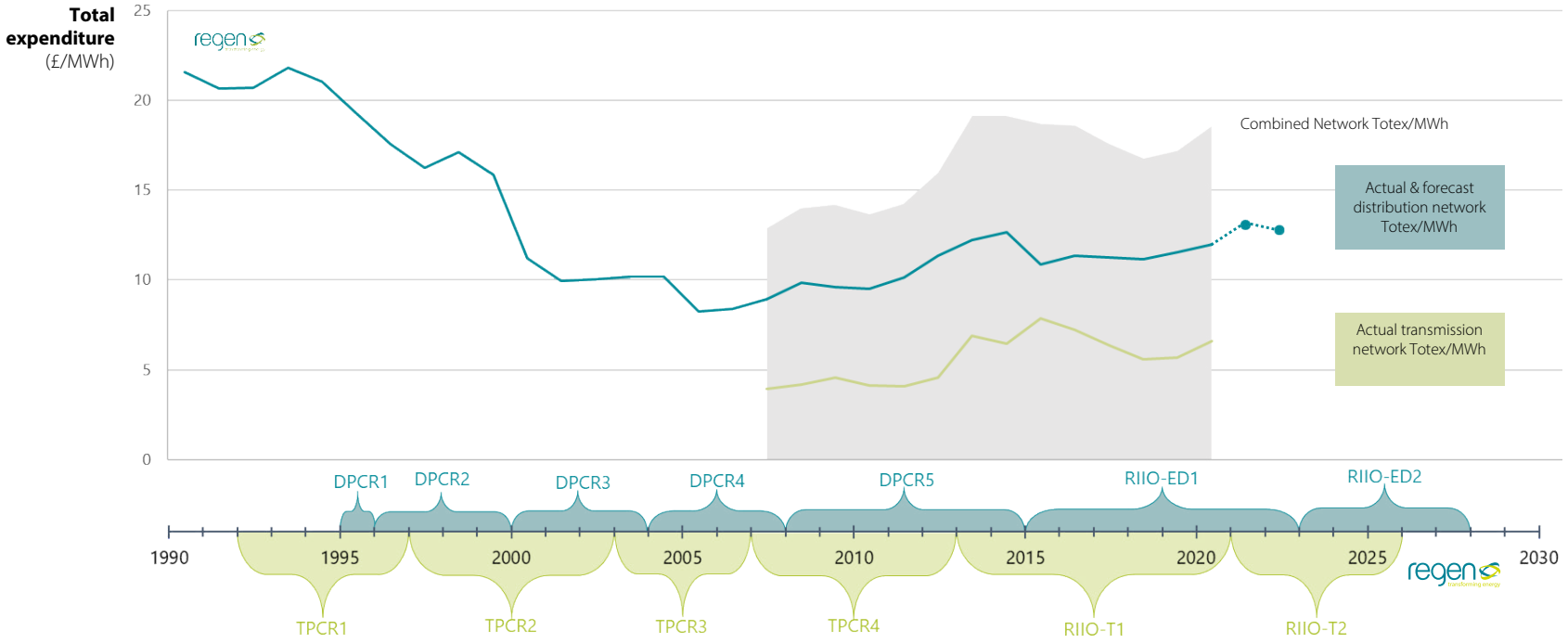


Figure 10: Network operators' total expenditure per MWh of electricity delivered, 2020-21 prices. Sources: Distribution networks - pre-2015 data provided by Ofgem to NERA consulting & 2020-2021 RIIO-ED1 annual report (Totex figure here excludes network faults). Transmission networks - Ofgem TPCR4 closedown report & 2020-2021 RIIO-ET1 annual report.

Network costs fell rapidly after privatisation but have since levelled out. In recent years, Ofgem has reported that costs per customer served have remained relatively stable at £90-100 per domestic customer for distribution network costs and £35 per domestic customer for transmission network costs. The costs per MWh of energy delivered (see Figure 10 above) have increased slightly since around 2005, as the overall demand for electricity has fallen. As electricity demand begins to increase – through electrification of heat and transport – the network cost per unit delivered is expected to fall in the longer term.

Investment has fluctuated significantly across price controls and a 'saw-tooth' profile has emerged

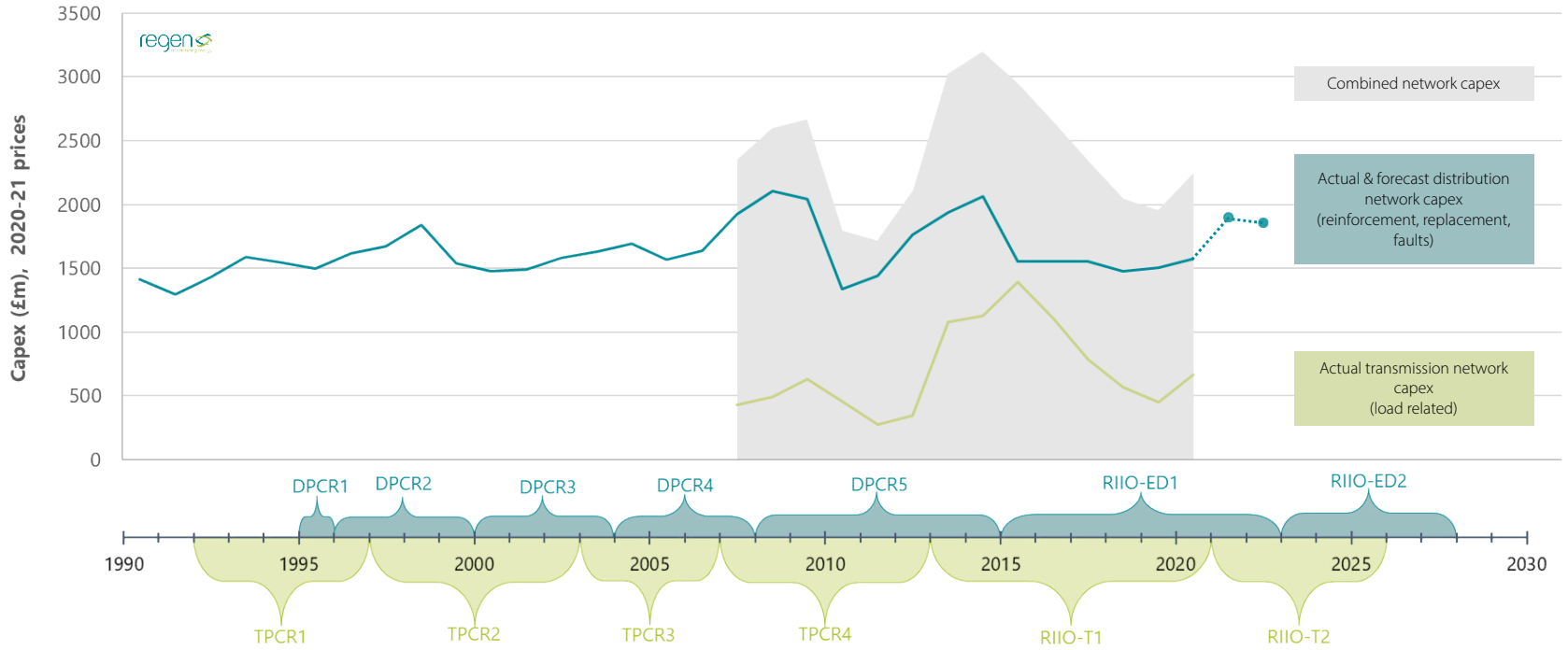


Figure 11: Network operators' capital expenditure on network reinforcement and replacement. Sources: Distribution networks - Pre-2015 data provided by Ofgem to NERA consulting & 2020-2021 RIIO ED1 annual report (TOTEX figure here excludes network faults). Transmission networks - Ofgem TPCR4 closedown report & 2020-2021 RIIO ET1 annual report.

Changes to the price control model have made it difficult to track and compare levels of investment. Investment data for the distribution networks suggest that average investment on reinforcement and replacement (the two main capex spend categories) has remained relatively constant, in real terms, since privatisation.

The "saw tooth" profile of investment expenditure – with lower expenditure at the start of each price control period ramping up as the control period comes to an end – suggests some inefficiencies that may be caused by the regulatory process. During RIIO-1 average capital investment has been significantly below budget allocation, with wide discrepancies between different network operators.

Adding value within the RIIO framework

The RIIO framework provides a number of opportunities for energy networks to go beyond the minimum regulated outputs to propose additional sources of value through, for example, bespoke Output Delivery Incentives (ODIs), Price Control Deliverables (PCDs), and Consumer Value Propositions (CVPs).

Consumer Value Propositions

The RIIO-2 price control has introduced Consumer Value Propositions, which are **defined** as "ways in which the plan goes beyond the minimum requirements and beyond the functions typically undertaken by an energy network company as business as usual and how this will lead to (quantifiable) benefits for consumers".

Each CVP was assessed by Ofgem to determine whether it should be **a)** accepted and rewarded, **b)** accepted as part of the business plan with a budget allocation, or **c)** **rejected without a budget**.

CVPs are intended to incentivise networks to think more holistically about their role and to work with stakeholders to identify additional sources of value. **The results** were mixed, with only 4 of the 46 transmission CVPs accepted by Ofgem. Distribution CVPs have fared better, with 11 of the 24 CVPs accepted at final determination. This was perhaps because they were better evidenced but also potentially better targeted, having learned from the previous experience of transmission. Network stakeholders indicated that the process was resource intensive. With less than a third of propositions being accepted, there is a risk that networks will put less effort into this important process at the next price control.

Of the themes proposed, environment and biodiversity, support for local energy planning, smart solutions and support for vulnerable customers featured among the accepted CVPs.

A key issue with the CVP process is that there is competition to propose successful CVPs but little incentive to collaborate or build on existing CVPs. Successful CVPs are then not adopted across all networks, leading to disparities in the level and type of services provided. This tension between collaboration and competition amongst networks is a feature of the RIIO model.

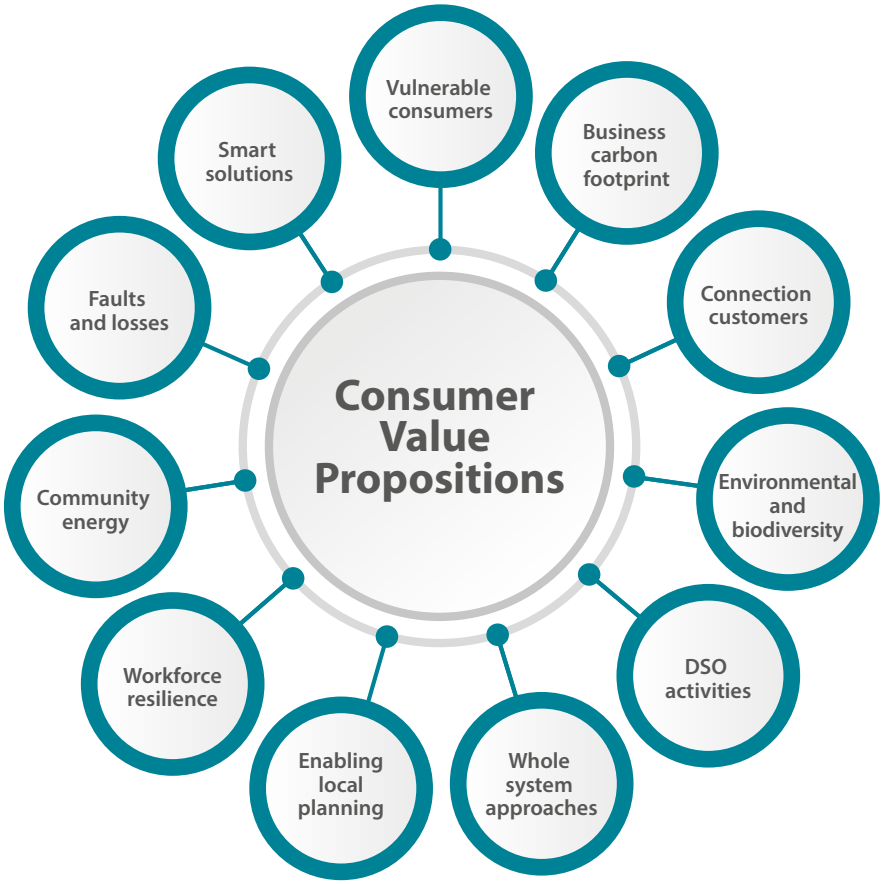


Figure 12: **Key themes** in the RIIO-T2 and RIIO-ED2 consumer value propositions.

RIIO-ED2 final determinations

Ofgem's final determinations on the ED2 business plans were published in November 2022 amid the cost-of-energy crisis, which has increased the focus on value for money for consumers.

Expenditure and investment budgets

An 11.8% reduction was made in allowed Totex, from £25.2bn in submitted plans to £22.2bn in the ED2 final determinations. Ofgem announced in a stakeholder webinar that they believed they had "got the balancing act about right" between affordability and delivering net zero.

On the question of network investment, there were some mixed messages, with an uplift on ED1 budget allowances but by significantly less than networks had requested in their budget submissions. For example:

- The average annual budget allocation for Load-Related Expenditure (LRE), which is the main investment budget for new distribution network capacity, has increased by around a 39% compared to ED1 allocations
- However, the budget final determination of £2.62 billion is 17% less than the £3.15 billion in submitted ED2 plans.

Increased use of uncertainty mechanisms (UMs)

Ofgem has said that it is confident the reduction in allowed expenditure budgets will not be a barrier to the rollout of low carbon technologies, as they have put in place Uncertainty Mechanisms (UMs) as a contingency to allow additional investment budgets to be released.

The increased reliance on UMs and contingency planning within the price control period marks a shift away from a rigid budget. The intention is that many UM budget allocations could be triggered automatically if certain growth conditions are met.

There are now 37 common UMs and five bespoke UMs. Ofgem has said that strategic or anticipatory investment will be considered in the context of smart optimisation and will need to be evidenced using monitoring data and connectivity models, plus local area energy plans and emerging flexible technologies and services.

The greater use of UMs will require additional planning, engagement, evidence gathering and cost-benefit analysis, which may prove difficult to achieve within a relatively short five-year price control period.

Stakeholders have, however, questioned whether these will be agile enough to allow timely investment and to mobilise network resources and supply chains to deliver the work. A lot depends on the resource and capability of the networks and Ofgem to submit and approve UM budget allocations.

RIIO-ED2 Consumer Value Propositions

Of the 11 accepted CVPs only three received a reward. This was an interesting exercise to identify what both the companies and Ofgem believed to be within a DNO's remit and going beyond business as usual. The three propositions that received rewards were:

- Offering Priority Service Register customers a bespoke smart energy action plan (NGED)
- Improving biodiversity in the seas around its island communities (SSEN)
- Offering the medically vulnerable access to a battery backup (SSEN).

There were more CVPs to support vulnerable customers and local network planning than any other area, which suggests these are areas both the networks and their stakeholders felt they could be doing more. But they were not consistently funded, which came down to the specifics of each proposal.

More for less and cost of capital determinations

A further highlight of the ED2 determination process has been the downward pressure across all expenditure budgets, and a further tightening of the allowed return on investment which has, in part, been achieved by a reduction in budget assumptions made around the cost of capital.

This has allowed Ofgem to claim that the ED2 determination offers "more for less" with a headline zero increase to consumer bills, albeit that bills may indeed increase if uncertainty mechanisms are enacted.

Regulatory model challenges

Despite its robustness and due diligence, there is a recognition that the existing RIIO framework and investment incentives must change and evolve to achieve the UK's decarbonisation and energy security strategy.

Points raised in stakeholder interviews and workshops highlighted challenges to the current regulatory model, including:

1. **Periodic price control budget allocations,** creating an artificial stop-start investment cycle and **a 'saw tooth' investment profile** which does not support long-term investment planning, efficient delivery or capacity building.
2. **Enabling anticipatory or strategic investment,** even when there is a clear strategic imperative to enable growth and/or future decarbonisation.
3. **Investment delay and underspend**, partly a result of Totex incentives combined with Ofgem's imperative to avoid regret costs, which is now manifesting in the rising costs of **network constraint management** and delays to new connections.
4. **How risk is recognised, allocated and rewarded** within a Regulated Asset Base model, and whether the returns on capital employed will bring forward the level of investment needed if there is investment risk or uncertainty.
5. **Responsiveness and flexibility of the RIIO budget cycle,** and a concern about whether the Uncertainty Mechanisms, introduced to deal with a changing energy and policy landscape, will be adequate or timely.
6. **The gap between the level of stakeholder engagement and the increased expectation that this will lead to real impacts, ownership and governance.** The regulatory model is still highly centralised, and its methodology and processes are largely opaque to wider stakeholders.
7. **Inconsistency between rhetoric and practice.** For example, the RIIO framework guidelines call for ambitious whole-system approaches and collaboration, yet, in practice, the regulatory model rewards competitive behaviour and a narrow focus on key outputs.
8. **Complexity and rigidity.** In a simplified summary, the current model is considered:
   - Very complex, because it is trying to incentivise a range of different outputs
   - Relatively static and rigid, because it is designed for incremental changes based around a set-piece periodic review and budget allocation.

Case for change

In summary, the RIIO model has the advantage of providing the regulator with a high degree of control and oversight, while network companies have clarity on their expected expenditure, revenue and capital requirements.

But overall, the regulatory model has struggled to fully support strategic investment and respond to the rapid transformation required to achieve net zero and the UK's energy security needs, or to meet the increased aspiration of stakeholders.

> *The regulatory system must facilitate investment in a strategic way to address these challenges effectively. And public and political confidence in the regulatory system must be improved.*
>
> **National Infrastructure Commission: Strategic Investment and public confidence 2019**

> *Current regulatory approaches are not fit for purpose for the existing activities, and they are inadequate for the challenges ahead of digitalisation and the emerging impacts on the energy sector.*
>
> **Dieter Helm,** Cost of Energy Review 2018

1 Ofgem RIIO-ET1 Annual Report 2020-21
2 Ofgem RIIO-ED2 Annual Report 2020-21

Unlocking the potential of networks

CONTENTS

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Extending and enhancing the RIIO framework

The RIIO framework has strengths and weaknesses. While there are differences in perspectives, there is a general agreement that it has introduced a higher degree of robustness and performance measurement, and that this has helped to improve customer service and contain costs.

There is also a recognition that regulating natural monopolies to deliver wider policy objectives is difficult. Even without net zero, regulators must deal with the conflicting tensions of trying to optimise investment, reduce costs and limit excess returns. This requires a positive and trustful relationship between the regulator and the industry, without getting so close to the point of being 'captured'.

The biggest area of challenge, as identified in interviews and roundtables, is the extent to which the regulatory model can respond to:

- The need for far greater levels of investment, innovation and smarter solutions to transform the UK energy system
- To meet the rising expectations of regional and local stakeholders at a time of increased energy devolution.

This has led to an active debate as to whether the whole RIIO framework needs to be redesigned or a more incremental approach can be taken. In March 2023, Ofgem issued a **consultation on frameworks on future network regulation**.

Across the industry stakeholders who participated in this study, the sense was that the RIIO model and approach could be adapted and enhanced to provide a more holistic and progressive regulatory model. This would, however, require a significant broadening of how value is measured and the development of wider and more targeted regulatory objectives.

Meanwhile, it is important to recognise that both the industry and policymakers have begun to embark on reform and make changes from within the existing model.

Network response to stakeholder engagement and whole system planning

Networks have increased their levels of stakeholder engagement and their commitment to support wider societal objectives, such as net zero. This is most notable through the future energy scenario and network planning processes, connections processes and various customer and community forums, as well as the Customer Engagement Groups that were established as part of the RIIO process.

RIIO-2 business plans now present a far more holistic vision of the networks' role and their commitment to support the transition to net zero. The challenge, however, will be to deliver on these commitments within the confines of the networks' regulatory framework and business model.

Policy response: multiple policy initiatives

Recognising the transformational changes required to achieve decarbonisation and meet the UK's energy strategy, policymakers have shown a willingness to review the ways in which the electricity networks are regulated, governed and incentivised.

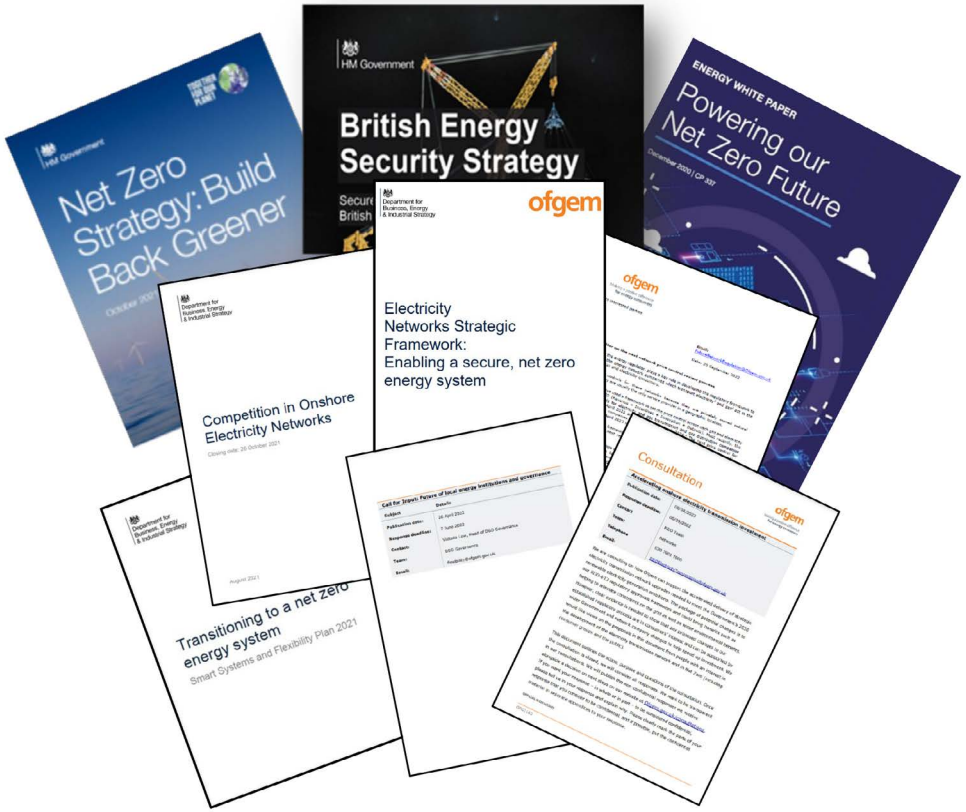
Three key strategy papers; **The Net Zero Strategy, British Energy Security Strategy** and **Energy White Paper** - have identified networks and network investment as critical enablers of the UK energy transition.

Alongside these core papers, there has been a flurry of policy consultations and 'open letter' calls for evidence on a range of network-related issues, including:

- network charging and future network governance;
- the role of the DSO
- future role and structure of the ESO
- increasing levels of competition; accelerating network investment
- reform of network connections
- holistic network design and the delivery of offshore transmission networks.

Several recent papers and policy documents relate directly to network objectives and value creation, and the way that networks are regulated:

- **Electricity Networks Strategic Framework**
- **Ofgem's Open Letter on the network price control process**
- **Accelerating Strategic Transmission Investment**
- **Future of local energy institutions and governance**
- **Frameworks for future system and network regulation**



It is not yet clear how radical Ofgem and DESNZ intend any review and reform of the strategic framework and regulatory model to be. Taken together, these papers do suggest that there is now a window of opportunity to look at the strategic framework for network regulation and that the direction of travel is towards more strategic planning and greater coordination between networks and a new system operator.

A new strategic framework?

Two key documents were issued in 2022, which could mark the start of a new discussion about the role of networks and the way they are regulated and incentivised to deliver a wider set of benefits:

Electricity Networks Strategic Framework

BEIS & Ofgem, Aug 22

The Strategic Framework document issued by BEIS and Ofgem sets out a broad vision of the future role of networks, noting that they are "fundamental to net zero and reducing dependence on fossil fuels" and that they "need to be transformed at an unprecedented scale and pace to accommodate decarbonisation and demand growth."

Whilst it introduces no new policies, it sets out a framework that future policy should align to and identifies a number of key priorities for networks to:

- Be strategically planned
- Provide cost effective and timely connections
- Be smart and digitalised
- Support the build back greener agenda
- Accelerate and efficient infrastructure build
- Reflect the cost of the changing energy system.

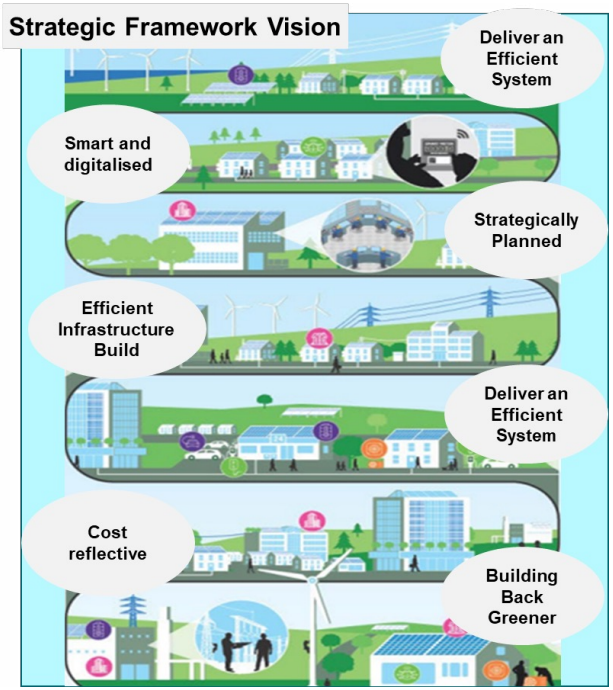


Figure 13: Graphic adapted from BEIS/Ofgem Strategic Framework.

Open Letter on the network price control process

Ofgem, Sept 22

Ofgem's open letter, and subsequent **"Frameworks for future system and network regulation"** consultation, looks ahead to potential reform of the regulatory model for the RIIO-3 price control period.

It acknowledges that "the RIIO framework… may not be the most appropriate model for the energy system we need to build" and that it may inhibit the delivery of "whole system transformation".

The letter identifies sources of uncertainty; the increase of distributed variable generation, the rate of electrification of industry and transport and heating, the scale and impact of electricity storage, and the wider use of demand-side flexibility.

The consultation document seeks views on a future framework, suggesting that fixing budgets and plans at the beginning of a period (Ex ante) may not enable the movement towards faster, coordinated decision-making based on the latest information available.

> *Government and Ofgem to work with network companies to facilitate anticipatory investments in grid infrastructure… Develop by 2025 a long-term cross-sectoral infrastructure strategy by 2025, to adapt and build respectively the distribution of liquid and gaseous fuels, electricity and CO_2 networks over the next decade.*
>
> **Chris Skidmore,** Mission Zero: Independent Review of Net Zero 2023

Accelerated grid investment

Accelerating Strategic Transmission Investment (ASTI)

In perhaps the most significant indication of a changing approach to network investment, in December 2022, Ofgem **responded to its consultation** on accelerating transmission network investment.

The Ofgem response proposed a new framework for large infrastructure investment, including measures designed to streamline the regulatory approval process, provide exemptions from competition requirements and introduce stronger incentives/penalties for timely project delivery.

Taken together, these measures are intended to accelerate the delivery of around £20 billion of network investment (the 26 ASTI projects) which, if delivered on time by 2030, would provide a net consumer benefit of £2.1 billion.

The ASTI project list includes most of the projects identified as part of the **Pathway to 2030: Holistic Network Design** (see figure 14).

The ASTI response, and the decision to approve network investment at scale, is a significant step that has been welcomed across the industry. It could point to a new approach whereby transmission networks work with the System Operator and other agencies, such as the Crown Estate, to develop holistic plans, which can then be fast-tracked through the regulatory approval process.

While the focus has been on the transmission network, a similar proactive and fast-track approach could be applied to major investment in the distribution networks. A shift towards integrated planning coupled with strategic investment with delivery incentives seems to be inevitable.

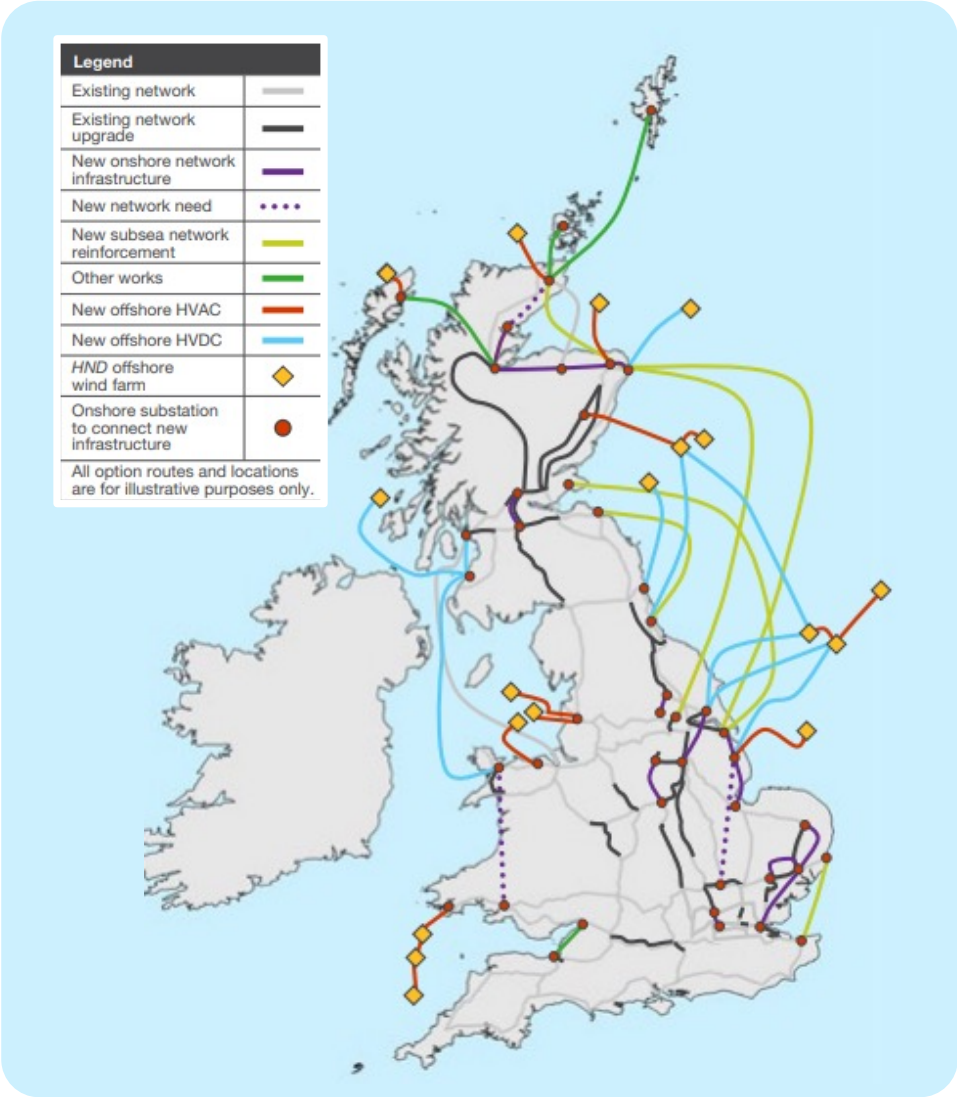


Figure 14: Holistic Network Design Pathway to 2030, project map.

Identifying value and setting objectives

A value based balanced scorecard

It is beyond the scope of this paper to try to redesign the RIIO framework. However, it is important to begin the discussion about what a reformed RIIO framework might look like.

The Ofgem regulatory framework consultation presents a number of theoretical models: "Plan and Deliver", "Ex Ante", and "Freedom and Accountability". However, the ability of stakeholders to engage with these theoretical models is a challenge.

An alternative, or complementary, approach would be to consider in the broadest terms what value we want networks to deliver and then to develop a set of objectives, output performance measures and incentives that will enable networks to deliver those outcomes.

Recognising that within those objectives there may be trade-offs, and even conflict (investment versus consumer cost, for example), the framework could be considered as a "balanced" scorecard.

This is not a radical departure from the RIIO framework, which already has elements of a scorecard and scope to include different output incentives, which can be both financial and non-financial.

The key extension would be to widen the scope and definition of value creation to explicitly include and incentivise the UK's energy policy goals, like net zero, and wider societal ambitions.

And to ensure that the balanced scorecard is shared by both the networks and Ofgem. In other words, they become part of Ofgem's statutory remit.

Building blocks of the value based balanced scorecard

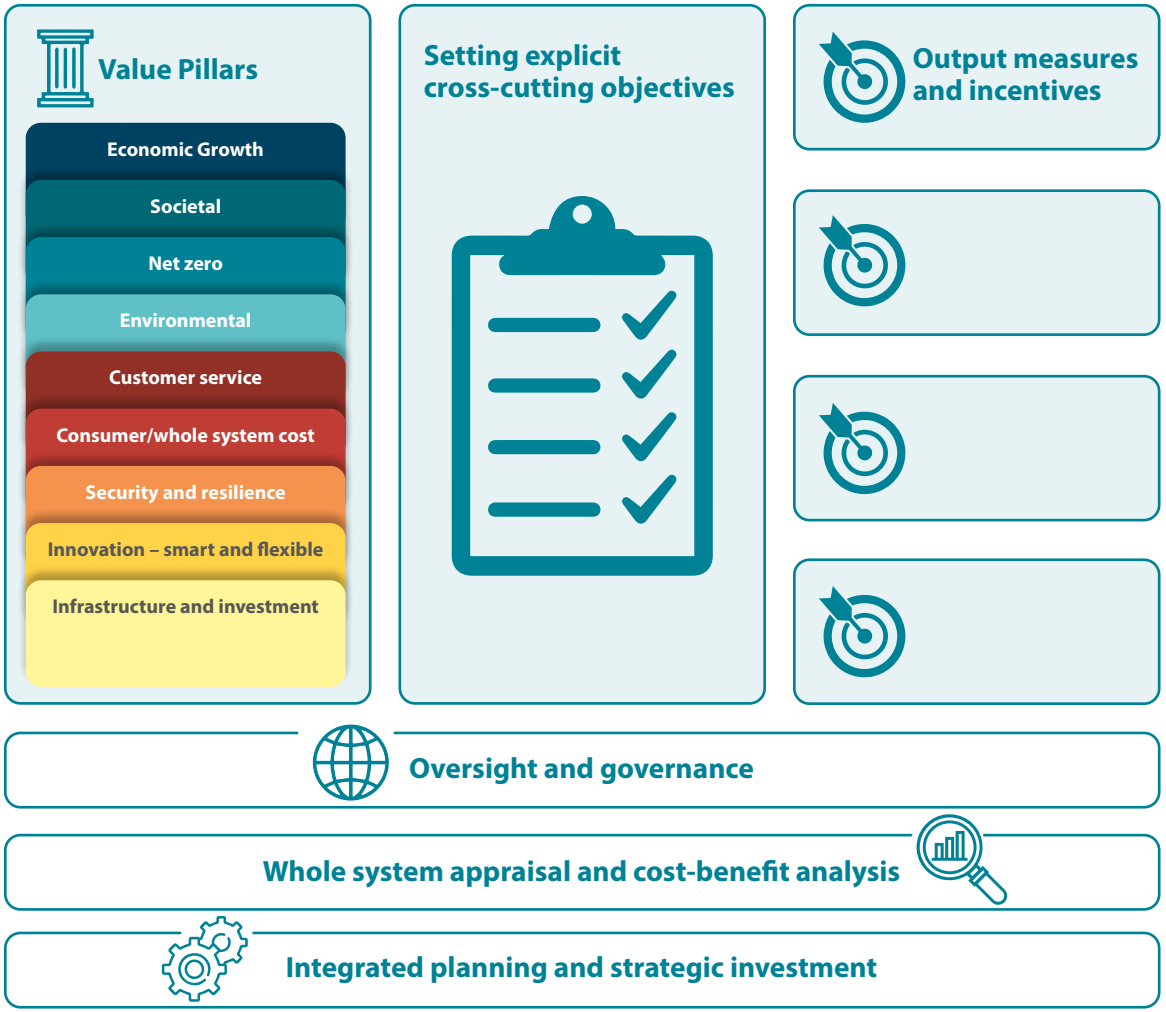


Figure 15: Elements and building blocks of a value based scorecard approach for network regulation and performance management.

Value pillars *(illustrative)*

Figure 16: Set of value pillars emerging through the workshop and discussions with industry stakeholders organised for this paper.

A framework based on value pillars

Developing a new model and a new regulatory framework will be extremely challenging and will require significant stakeholder input.

A useful starting point could be to reconsider the points of value that networks can bring and then align the objectives and outputs that we want networks to deliver.

To help think about this in a holistic, whole-system way, we have called these **Value Pillars**.

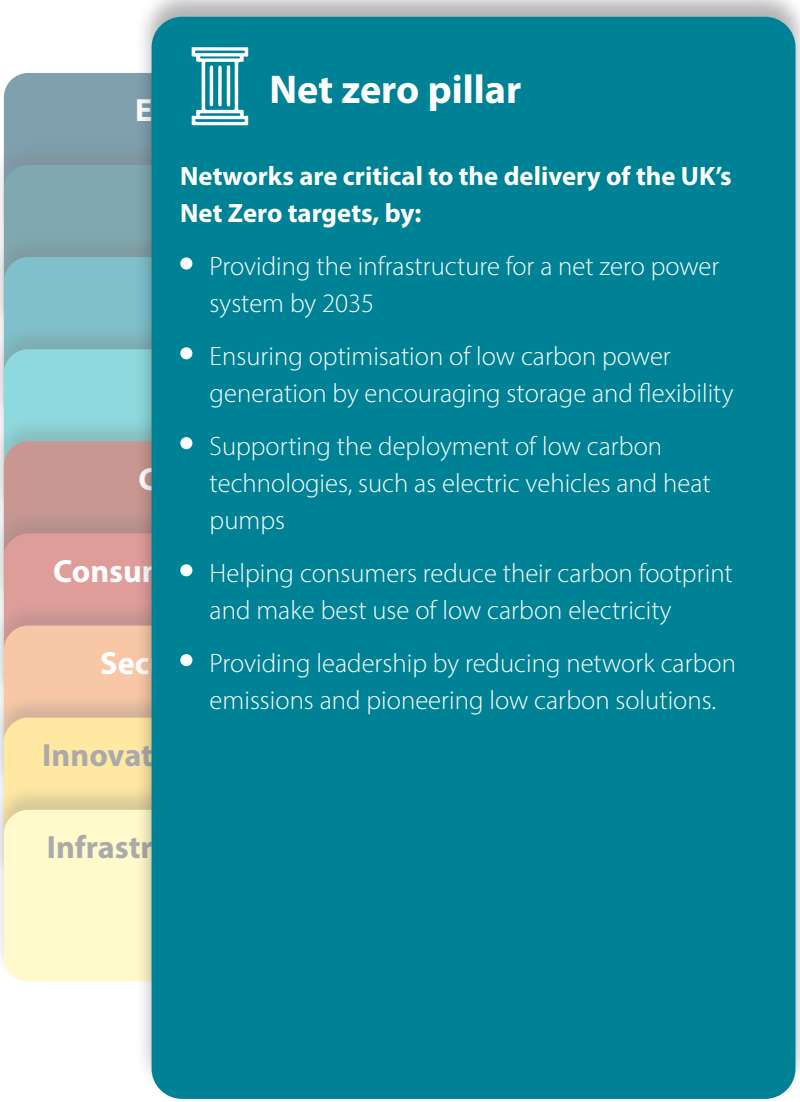
Value Pillars would include the broadest categories where we might expect energy system, societal and economic value to be created. These might be considered the highest-level headings on a whole system scorecard or cost-benefit analysis, and they would form the foundation of an enhanced regulatory framework.

They would also represent the broadest remit of where it is expected that the networks, regulators and stakeholders will work together to create value.

Defining the set of value pillars produced a lot of debate and discussion in our workshop and interviews. The set that emerged, as shown in Figure 16, is just an illustration and a possible starting point for further discussion.

There will be a high degree of overlap and synergy between the different value pillars, and we would expect many objectives to be cross-cutting. There may also be points of tension and trade-off, particularly around cost.

Building wider value objectives into the regulatory framework – net zero as an example



Net zero pillar

Networks are critical to the delivery of the UK's Net Zero targets, by:

- Providing the infrastructure for a net zero power system by 2035
- Ensuring optimisation of low carbon power generation by encouraging storage and flexibility
- Supporting the deployment of low carbon technologies, such as electric vehicles and heat pumps
- Helping consumers reduce their carbon footprint and make best use of low carbon electricity
- Providing leadership by reducing network carbon emissions and pioneering low carbon solutions.

Example: Regulation and net zero

Net zero features across all network business plans as a key area of focus and as a broad objective but its delivery has not been set as an explicit output of the regulatory framework.

Ofgem's **strategic vision** now includes "Working with Government, industry and consumer groups to deliver a net zero economy at the lowest cost to consumers" as an overarching objective. This could, however, be interpreted not as the proactive delivery of net zero, but more about ensuring that, if net zero happens, it is done in a cost-effective way.

Setting explicit net zero objectives:

- Delivery of a decarbonised power sector by 2035, subject to security of supply (as stated in UK Net Zero Energy Strategy 2022)
- "Ensure sufficient capacity to support new demands, particularly from the decarbonisation of transport and heat" - BEIS and Ofgem Networks Strategic Framework 2022
- Minimising the carbon footprint of network investment and operations, including direct emissions, losses and fossil fuel use
- Supporting regional and local stakeholders to plan for, and deliver, a net zero economy

Example output and reporting measures:

- Reduction in grid carbon intensity within the licence area (gCO2 per kWh)
- Other metrics, such as % increase homes and businesses with low carbon heating
- Business carbon footprint
- Fossil fuel use/carbon intensity – for key system operations, flexibility and losses

3 www.regen.co.uk/riio-ed2-and-net-zero-an-open-letter

4 assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/943755/letter-to-jonathan-brearley.pdf

Adopting whole system approaches and cost benefit analysis

The adoption of 'whole-system' approaches and appraisal methods features in the **Ofgem guidelines** for RIIO-2 business planning, which requires networks to set out **their whole system thinking**.

The scope of 'whole-system' could be defined very widely to include value creation approaches that span across:

1. **Electricity networks**, e.g. integration of transmission and distribution
2. **The wider energy system**, including gas and heat networks, generation, flexibility and markets
3. **Other utilities and systems**, including waste, water, transport, communications
4. **Wider sources of social and economic value** in health, education, social care, equality, diversity and the natural environment etc.

However, **Regen's 2021 analysis** of whole-system projects and initiatives showed that, in practice, most whole-system approaches were still confined to value creation within electricity networks or, in some cases, within the energy system.

There were few examples of initiatives that spanned non-energy utility systems or wider economic and societal value systems. There were almost no examples of "value transfer" between system actors, with the notable exception of budget transfers between distribution and transmission network operators with respect to Scottish island interconnectors.

The direction of travel is, however, towards more integrated and holistic use of whole system approaches, including the standard use of whole system cost-benefit analysis and investment appraisal tools. If fully adopted, this could open the potential for increased collaboration and partnership between networks, other system actors, and regional stakeholders.

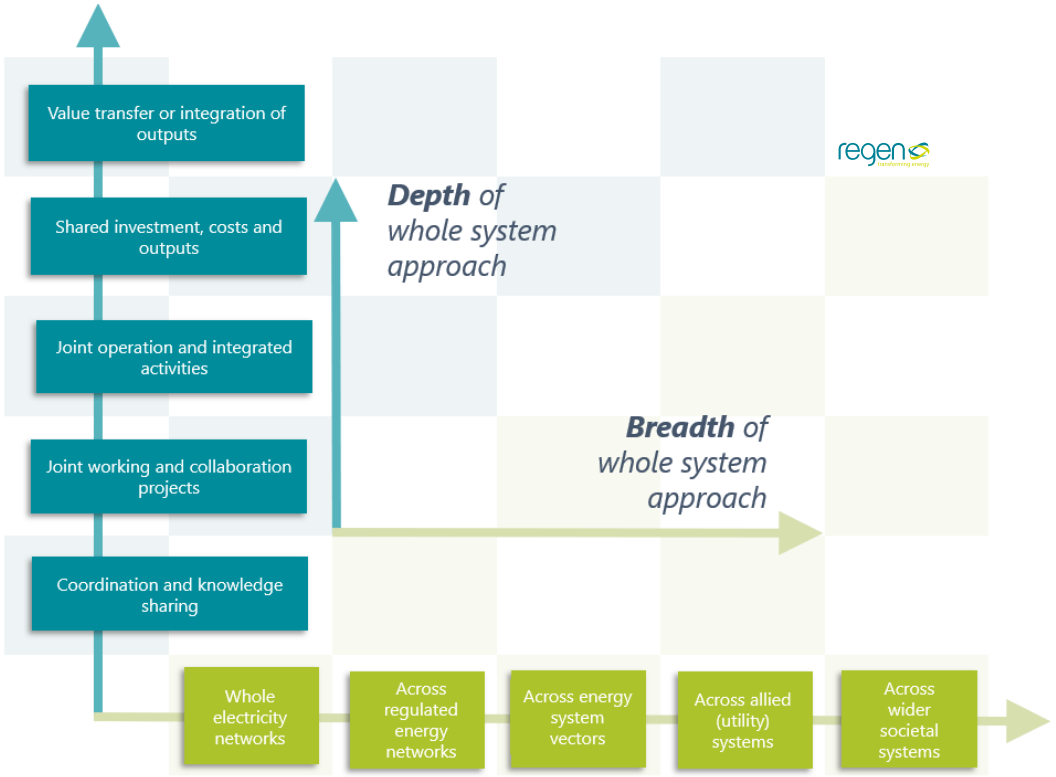


Figure 17: Whole System Matrix.

- **Breadth** refers to the scope of whole-system thinking within networks, the energy system or across wider utility and economic value systems
- **Depth** refers to the degree of integration and value sharing between actors

Applying whole systems approaches – SP Energy Networks example

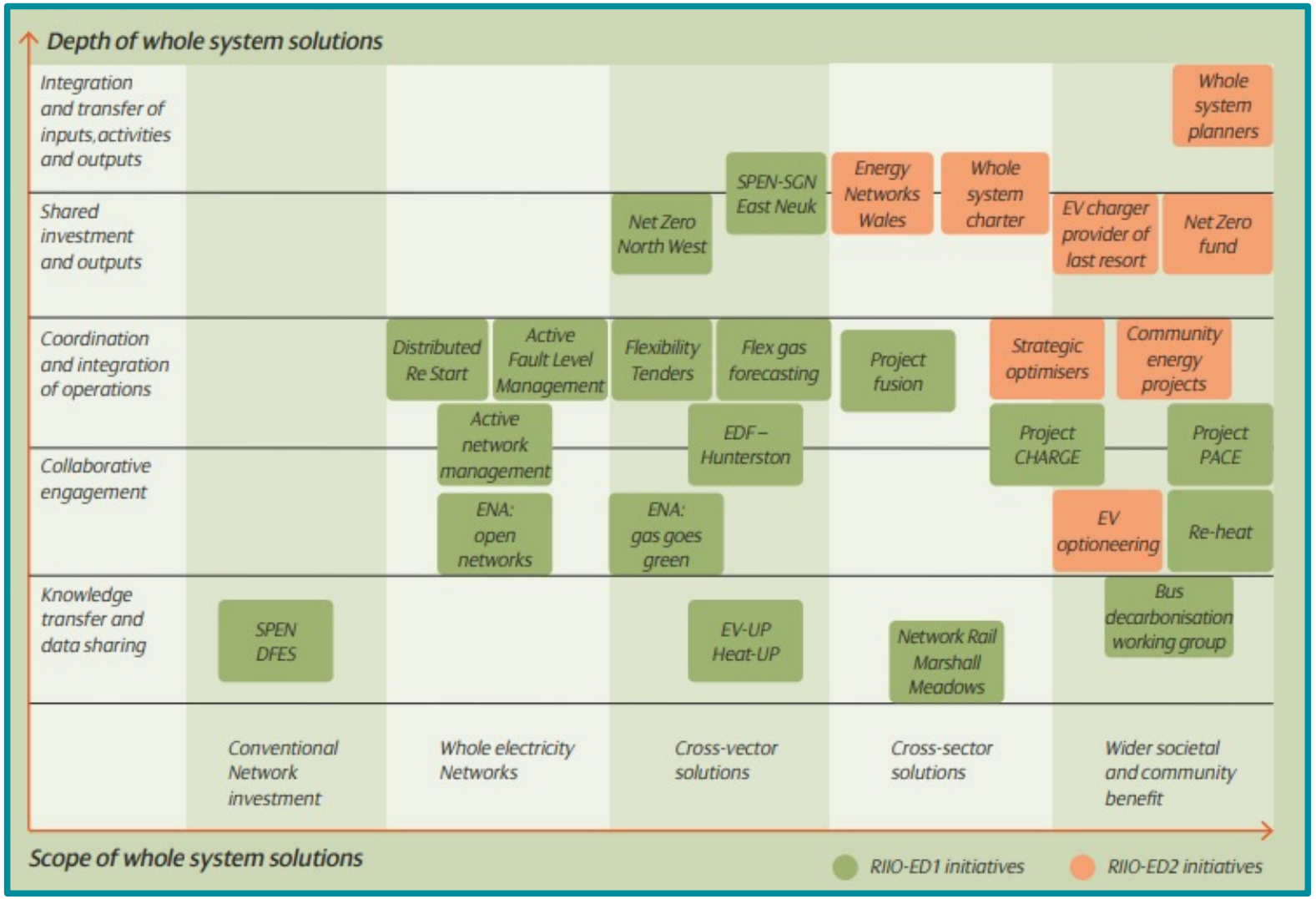


Figure 18: Whole System Matrix, SP Energy Networks - ED2 Business Plan 2022.

SP Energy Networks mapped projects and initiatives onto a matrix based on the depth and breadth of their whole system approach.

While initiatives undertaken during ED1 have tended to be limited, there is a definite shift towards wider and deeper whole-system thinking coming forward in ED2.

Enabling the energy transition – increased devolution of oversight and governance

The current regulatory model is still highly centralised, with virtually all oversight, performance monitoring and governance vested in the national regulator, Ofgem.

Customer Engagement Groups (CEGs) were introduced to provide a degree of challenge to networks as they developed their business plans. However, CEGs do not have a mandated ongoing governance role.

This centralisation has led to two main criticisms:

1. Ofgem does not have the resources and level of detailed (local) knowledge to provide effective oversight and governance across all networks, all regions and all outputs. This is especially true in areas like environmental outputs, vulnerable customers and investment delivery
2. Despite higher levels of engagement and how critical networks are for their net zero and economic growth goals, regional and local stakeholders are excluded from the network oversight and governance process. This includes city regions, devolved governments and local authorities who, in many other respects, are being asked to lead the net zero transition.

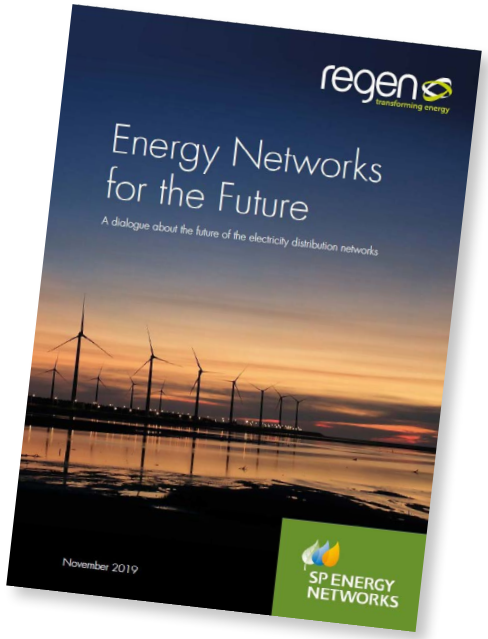
Inevitably, there have been calls for greater levels of energy devolution, including from the Scottish and Welsh Governments and combined authorities such as Greater London, West Midlands and Greater Manchester.

This has put networks in the impossible position of trying to meet the rising expectations of local stakeholders while still reporting exclusively to a central regulator. It has also put Ofgem in an untenable position.

Various governance models have been suggested, including some that would limit the role of Ofgem to one of cost control and market regulation, while a new system architect would take responsibility for system planning and investment.

Regen's 2019 paper, "**Energy Networks for the Future**", proposed a new governance model with:

- An **'Office of Net Zero',** working with the UK government departments, devolved governments, cities and regions to set energy strategy and decarbonisation policy
- **Ofgem** to focus on its core role to regulate markets, competition, consumer protection and cost/performance control
- **Regional energy governance bodies** to provide day-to-day oversight of network performance, including investment delivery, planning and wider stakeholder engagement.
- Whether the 'system architect' role would sit within an Office of Net Zero or an enhanced System Operator (SO) was not clear as, at that time, it was not decided how independent the SO would be.



Since this paper was written, there have been a number of new developments, including the decision that the future SO will be a fully independent public agency. The future SO role could then include a number of strategic planning and system architect functions.

Likewise, the role of the Distribution System Operators (DSO) has also progressed with a focus on integrated network planning, capacity optimisation, whole system coordination (with transmission) and flexibility.

Energy devolution and what it might look like

Ofgem has issued a call for evidence to begin a conversation about both the role we expect (distribution) networks to play and the future governance arrangements. The **Future Local Energy Institutions and Governance** calls for evidence regarding the sub-regional functions that the energy system should provide, especially with respect to the DSO function, and what governance arrangements should be put in place.

While not committing to a more devolved arrangement, the call for evidence suggests there is a need to consider whether greater regional governance is required, especially with respect to the delivery of infrastructure and network services to support economic growth, local area energy plans (LAEPs) and local heat and energy efficiency strategies (LHEES).

Ofgem's key proposal has been to establish a **"Regional System Planner"** function to provide a higher degree of coordination and consistency of planning at a regional level. The degree to which the RSP would deliver sub-regional plans and engage directly with local stakeholders is still to be determined. The RSP function is likely to work in partnership with networks rather than duplicate or cannibalise their planning and engagement role.

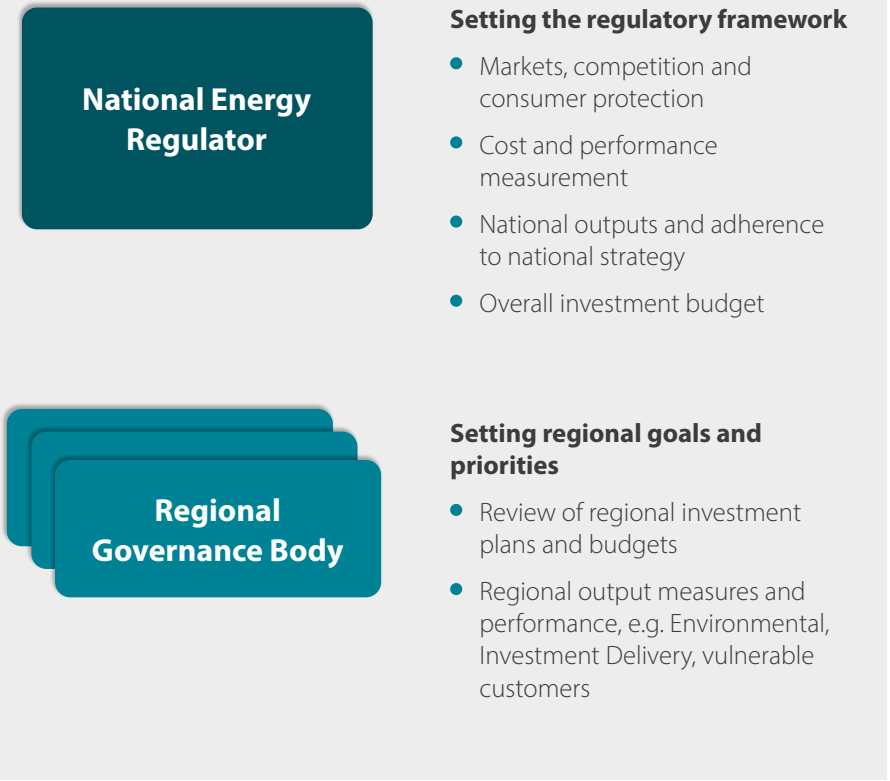
Going further, it has been argued that unlocking the full value of networks and enabling them to work in partnership with regional stakeholders requires a new governance model with greater accountability and oversight given to democratically elected local and devolved authorities.

This point about regional accountability goes beyond energy networks; it also applies to other centrally regulated infrastructure providers, including water companies and rail networks.

The topic of regulatory devolution has moved up the policy agenda and is likely to feature in discussions about the future role of Ofgem, the ESO and the overall shift towards greater devolution for Scotland, Wales and cities/regions. It also features in a host of other policy areas, including the levelling up agenda, transport, housing, fuel poverty, innovation and industrial strategy.

A future governance model for energy networks is likely to have a hybrid structure with some elements defined and retained within a national regulatory framework and other elements devolved to regional bodies.

Whether these regional bodies consist only of a Regional System Planner, potentially sitting within the SO, or are aligned with devolved governments, combined city and local authorities – or a new regional energy governance body is an open question.



Current and Future Models of Oversight and Governance

Current Model Characterised by:	Future Model Characterised by:
Narrow view of network value based primarily on network cost and service levels	Broader view, based on whole system value and benefit to society
Centralised budget, governance and oversight arrangements assigned within a national regulator	National standards and regulatory framework, but increased devolution of oversight and governance, environment, net zero delivery, social goals, investment and connections
Periodic price control as part of a root-and-branch budget submission and review process	Periodic, but with a rolling medium-term budget and long-term outlook, especially for network planning and investment
Risk avoidance or limited within defined uncertainty mechanisms	Risk acceptance within strategic investment planning with mitigation and risk sharing arrangements
Regulated asset-based return offering a high degree of certainty but with limited risk reward	Less certainty of budget allocation, capital and investment, but greater use of risk/reward

Priority areas for network value creation

CONTENTS

regen
transforming energy

Priority areas for network value creation

Through the industry round table, workshops and interviews, the project focused on six areas where it was identified that networks could be enabled to add significant value. To a large extent, these also corresponded to areas of recent policy reform and to areas where networks have been actively developing CVPs and other value propositions.

1	**Strategic and integrated planning for future energy**	Integration of network plans with wider delivery plans at a national and local level
2	**Connections for growth**	Reforms to accelerate new connections, reduce connection costs and optimise capacity utilisation
3	**Capacity optimisation**	Using flexibility and other non-network solutions to complement infrastructure investment and create whole-system value
4	**Consumers in vulnerable circumstances**	Fulfilling a social contract to support those in positions of vulnerability, and ensuring a just energy transition
5	**Enabling consumers to be smart and efficient**	Enabling consumers to improve energy efficiency, adopt smart technologies to reduce consumer bills and network costs
6	**Building delivery capability**	Building capacity and capability within network organisations, supply chains and across the industry to deliver net zero and the UK's energy strategy

Value area 1:
Strategic and integrated planning for future energy

Value potential: Strategic planning for energy infrastructure

The need for the UK to have an integrated strategic delivery plan for net zero has been highlighted in several recent reports and publications, including, for example, the **Day in the Life of the electricity system 2035** and the Climate Change Committee Net Zero progress reports. It also featured in our industry workshops and interviews as the single biggest success factor for the UK to achieve its energy system objectives for net zero, affordable energy and security of supply.

While there are already plans for some elements of the energy system, an overarching and integrated delivery plan, which includes network infrastructure and capacity adequacy, is essential to secure future investment and delivery.

Local energy planning for decarbonisation and economic growth

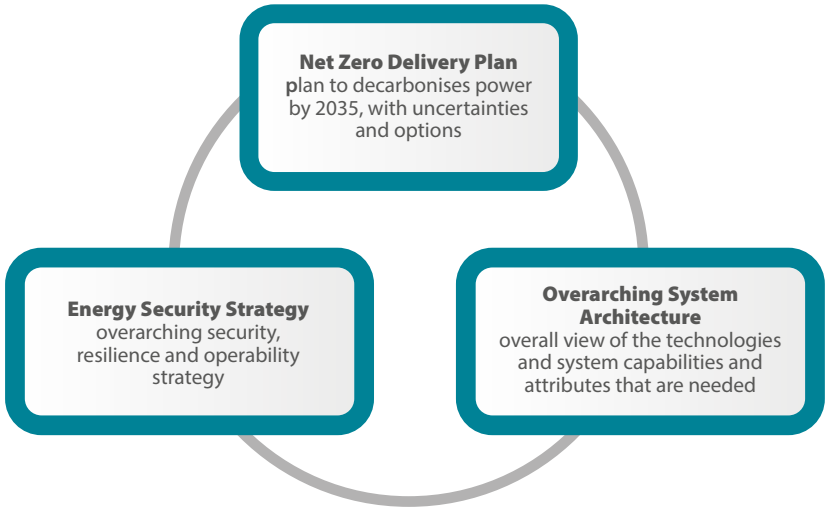
Another critical aspect of energy planning is to support local authorities and cities/regions to deliver projects at a local level. This might include strategies to decarbonise heat and transport or support low carbon energy generation and storage, as well as new housing, industry, transport and fuel poverty initiatives.

Many local authorities have already developed a decarbonisation strategy and are working on more detailed **Local Area Energy Plans** and **Local Heat and Energy Efficiency Strategies**.

Both at the strategic level and at the local level, networks are essential to develop and deliver integrated energy plans. There are also significant opportunities to optimise and improve network investment by taking an integrated and holistic approach across transmission and distribution and with other energy actors.

Investment ahead of need: The Electricity Networks Strategic Framework compared investment outcomes from investment delivered 5-20 years ahead of need. The results showed that earlier investment can reduce the number of reinforcement interventions required by DNOs by between 23-54%, compared to the five-year baseline. **(INV03)**

Net Zero and Energy Security Delivery Plan



Network planning elements
• Network capacity investment
• Holistic Network Design (HND) approach
• Capacity adequacy planning
• Use of flexibility and capacity optimisation
• Joined up and integrated Regional Development Plans (RDPs)
• Resilience strategies
• Operability planning

Value area 1:
Strategic and integrated planning for future energy

Networks' role

Networks are in a unique position to support the development of net zero delivery planning at both a national and a local/regional level.

The integration between network investment planning, energy and economic planning is a key area in which networks can provide significant assets and capabilities, for example:

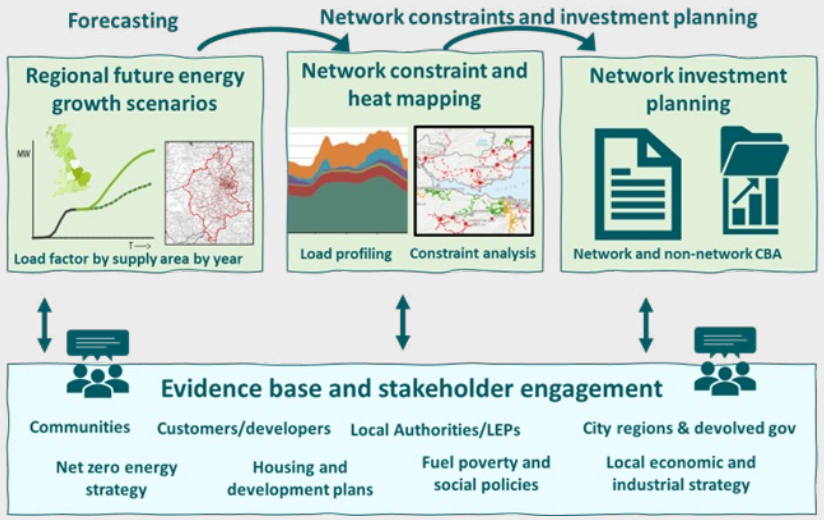
- Future Energy Scenario analysis at both a national and regional/licence area level
- Datasets of existing consumers, generators and flexibility assets
- Projections based on future connections data
- Analysis of demand and generation profiles and trends
- Forecast and distribution models for key technologies
- Teams of network planners with appropriate modelling skills and market insight
- Access to engage with developers, asset operators, consumers and businesses
- Ability to form collaborative partnerships with local authorities and regional bodies

> A new arrangement is needed which gives the networks more power to integrate their connections and planning processes. This should prioritise whole systems value while allowing them to deliver on their own, and wider, long-term network investment plans.
>
> **Chris Skidmore Mission Zero:** Independent Review of Net Zero 2023

Integration of network planning at a regional and local level

Transmission and distribution networks are already engaging with local and regional stakeholders to complete their **network investment plans**.

Distribution networks, for example, complete an annual Distribution Future Energy Scenario (DFES) process that involves data gathering, workshops and other forms of engagement with stakeholder partners. The DFES analysis then feeds directly into the development of network constraint analysis and investment planning. An obvious source of value would be to feed DFES data into the baseline of local area energy planning and local heat and energy efficiency plans that are being developed by local authorities.



By 2035 power sector carbon intensity should fall to c.10 million tonnes of CO_2 emitted annually, or less than 20g of CO_2e per kWh of electricity. At an expected carbon price of £109 per tonne in 2035, the carbon saving in the power sector would be worth over £5.4bn per year. **(NZ01)**

Value area 1:
Strategic and integrated planning for future energy

Enabling networks to add value

Integrated planning is a key area for network capability building and innovation. It has also featured in a number of consumer value propositions which would enable networks to support local authorities to develop their local area energy plans.

Enabling networks to plan holistically

At the transmission level, the adoption of a Holistic Network Design (HND) approach for offshore wind is a significant first step towards a more whole-system and proactive approach to network planning. Going further, Ofgem has indicated that it would like to see a new process for planning the electricity transmission network resulting in a **Centralised Strategic Network Plan (CSNP)** and for regulatory approval to accelerate investment delivery (**ASTI Framework**).

How big a shift this is from the existing Network Options Assessment process and how it fits with the RIIO budgeting process is still to be addressed. So too is the split of responsibility for planning and delivery between the new national system operator, transmission operators and distribution operators.

Enabling networks to work with and support local stakeholders

Over the course of RIIO-ED1, networks have increased the level of engagement with local stakeholders, and many are now actively participating in local energy planning initiatives; for example, by providing network asset and planning data to local authorities and other parties. Further innovation in this area is allowing networks to share even larger datasets and to do so in forms that are more user-friendly, graphical and interactive.

Providing data and resources that can engage with over 300 local authorities and other regional and city bodies is a challenge. Digitalisation and the use of new data platforms will be key. Most networks have also sought to address this by proposing an **additional consumer value proposition** that would help to fund the network to provide additional planning support resources.

Unlocking the value potential

There are lots of potential initiatives and innovation projects in the area of integrated planning that could help networks to deliver more value to the energy system and local partners.

Key initiatives highlighted through this study included:

- Providing an overarching net zero delivery plan within which networks, and other stakeholders, can develop their own delivery plans
- Extending the concept of holistic network design and regional development plans to ensure the onshore and offshore electricity transmission networks, including interconnection, are planned holistically together
- Streamlining the regulatory process and incentivising timely project delivery for both transmission and distribution networks (Building on the ASTI framework approach)
- Ensure that new planning processes (such as the CSNP) allow the proactive delivery of strategic anticipatory investments and the co-optimisation of multiple load sources/connections (see also Connections for Growth)
- Better integrating the network planning and investment appraisal process with local area energy planning, including through two-way digital data exchange
- Ensure that LAEP and LHEES outputs are appropriately reflected in network planning processes
- Ensure networks are sufficiently resourced and empowered to engage with local area planning
- Provide clearer information to planning authorities and local communities on the benefits and impacts of electricity network projects and how environmental and community factors have been considered in the design.

Value area 2: Connections for growth

Value potential

Providing grid connections to generators and consumers of energy in a cost-effective and timely way is a fundamental network service and a key measure of network performance.

Fast and affordable connections allow new generation and storage capacity to be added to the energy system and enable a wide range of economic activities, from new housing developments, new industries and businesses, hospitals, schools, EV charging locations, data centres and much more.

The cost, timing and availability of grid connections featured as a priority area in discussions with all stakeholders. Across both distribution and transmission networks, there has been a trend towards longer lead times for new connections, and, in some parts of the network, connection delay has become a major risk to both decarbonisation and economic growth.

Three main causes of connection delay have been highlighted:

- thermal constraints or, in other words, lack of capacity
- delays in the processing of connection applications, especially where connection applications require an assessment across both transmission and distribution network boundaries
- the queue of projects that hold a connection agreement and how this queue is managed.

In a recent example, **in west London**, an increase in network capacity reserved for planned data centres led to a significant delay for connections for new housing. While it is not unusual to face trade-offs between different network users, the speed with which new technologies are connecting to the network is challenging the existing connection management process.

As well as speed of connection, networks can add significant value by designing and delivering the most **cost-effective connection option**. There are significant engineering and economies-of-scale cost savings that can be achieved by combining connections and by "co-optimising" different load factors.

Renewables and storage projects are driving a huge increase in generation connections

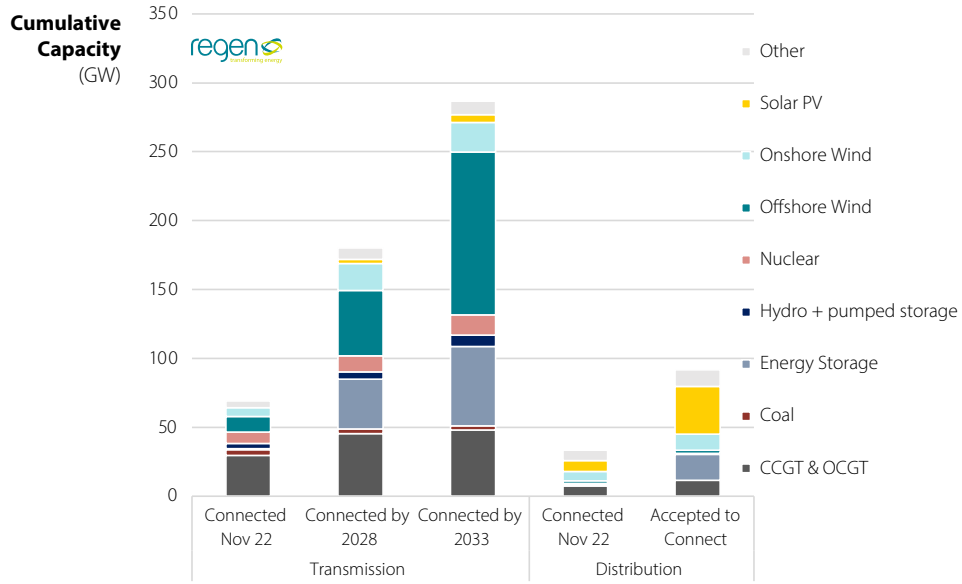


Figure 19: Regen Analysis of the Transmission Entry Capacity Register and the DNOs' Embedded Capacity Registers (data accessed November 2022).

The government's 2022 British Energy Security Strategy recognised the crucial role that the electricity networks will play to support the shift away from imported fossil fuels. Regen's analysis has shown that **by 2040 the UK could turn around the current import dependency of 800 TWh to a net 12 TWh export by 2040. (SR01)**

Value area 2: Connections for growth

Connection process under extreme pressure

Networks are expected to provide connections in a cost-effective and timely way. They are also expected to manage the connection queue in a way that is fair and transparent. At present, this is done on a first-come-first-served basis, which allows customers to reserve network capacity by accepting a connection agreement.

There are, however, significant differences between transmission and distribution network connection arrangements.

- Transmission networks have operated under a 'connect and manage' approach, with **'shallow'** connection charges; networks offer connections, albeit sometimes with a significant lead-time, and deliver network upgrades, which are recovered through use-of-network charges.
- Distribution networks have been able to charge customers more for the upfront cost of connection, including a proportion of the cost of network upgrades, which can be prohibitive for some projects. This arrangement has changed in 2023 as distribution networks have shifted to **'shallower'** connection charging.

The current arrangements have come under increasing pressure because:

- There has been a massive increase in connection applications, seen first on the distribution network and now at transmission level
- Connection lead times have been extended, sometimes by as much as 10-15 years, especially in constrained parts of the transmission network
- The interdependency between distribution and transmission networks has become a critical new factor
- Connections have become significantly more complex and higher risk for customers if they are in an area that may require transmission upgrades and are subject to a 'statement of works' by the system operator
- The queue of new projects applying for connections has increased significantly, especially for new solar, storage, data centres, EV charging and other high-growth technologies.
- The operation of the queue has become a blocker for new projects, with capacity now reserved for what may be highly speculative projects.

Connection lead-times on the transmission network have increased significantly in the last 5 years

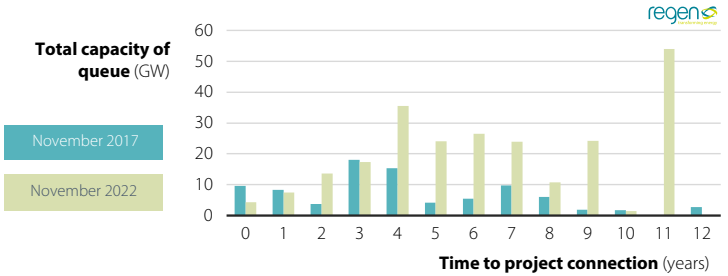


Figure 20: As the volume of projects has grown, so has the average lead time to connect to the transmission network. The percentage of projects with a connection date within five years has decreased from 80% to 70%. Source: ESO Transmission Entry Capacity (TEC) Register.

Connection improvements and reform

Improving the network connection process features in the new **Electricity Networks Strategic Framework** highlights three key objectives:

- Improving the affordability of connections and customer experience
- Reducing timescales to connect
- Improving consistency between distribution network operators.

Distribution and transmission networks are taking steps to improve the **queue management process**. This includes tightening up the requirement for projects to meet milestones and the periodic use of 'amnesty' windows for customers to amend or hand back their connections and release capacity.

Several innovations relate to the use of flexible connection agreements, from simple time-of-use or voltage limits to more sophisticated Active Network Management (ANM) solutions. The **SP Energy Networks Dunbar ANM scheme** used network monitoring technology to optimise capacity utilisation, to enable energy generation projects to be built ahead of a planned network upgrade.

Value area 2: Connections for growth

Enabling networks to add value

There are several **connection-related initiatives**, including a **GB Connections Reform** programme, that are in progress. Industry stakeholders have, however, called for a more fundamental review of the connection process and reform of the underlying commercial and regulatory arrangements.

1 Queue management based on project readiness

A more radical change would be to move away from a strict 'first to book capacity' queue towards a connection queue that reflects when projects are actually 'ready to connect', with robust enforcement of milestone rules. This would be difficult to implement within the current connection agreement terms and regulatory codes but would help to reduce capacity blocking, which is holding up other connections and potentially leading to unnecessary capacity building.

2 Two-stage connection process

A second complimentary option would be to move towards a two-stage process for certain types of connection. A two-stage process has already been used for new offshore wind projects that are subject to the **Holistic Network Design** process, whereby an initial connection offer is made but is then subject to a design review. This allows the networks and system operator to look more holistically at generation and demand across several projects to develop a better overall network design (and possibly shorten lead times for the connection customer).

A similar concept, with some differences, could potentially be extended to certain onshore connections. This would give networks the opportunity to review background load assumptions, 'co-optimise' different load sources, design the most cost-effective connection solution, assess strategic investment options and consider the use of flexibility solutions.

A current proposal, which is subject to approval by Ofgem, is to introduce a two-stage process as a **temporary measure** to allow networks to effectively deal with the current high volume of transmission connections and distribution connections that have been caught up in the 'statement of works' process.

An advantage of a two-stage approach is that it could lead to better connection outcomes, but it could also risk adding further delay before a customer receives a full connection agreement and could increase project risk, especially for smaller projects with shorter development timescales.

A lot of detailed work needs to be undertaken before a two-stage could be adopted more widely on a permanent basis. It is also clear that this approach would not be suitable for all connections and across all network areas.

3 Greater use of non-firm and flexible connection agreements

This paper has already highlighted the benefits of Active Network Management solutions to enable earlier connections. More broadly, flexible connection agreements can allow networks to be less risk-averse in their network planning which can then free up significant capacity. Ofgem has also supported the use of non-firm connection agreements, although with the proviso that they are time-limited and do not penalise the customer as a means to acquire low-cost flexibility.

As an example, National Grid ESO is planning to use new assumptions to model battery storage projects alongside a new non-firm offer and updated Holistic Network Design analysis to help reduce connection delays for storage.

4 Co-optimisation, holistic design and strategic investment

Networks could achieve significant cost savings if they were better able to co-optimise multiple connections, exploit economies of scale and to better design solutions for strategic investment.

This is, however, not an easy approach to implement within the current regulatory model. If the cost-benefit for an investment proposal relies on multiple projects going ahead, this will require a change in the treatment of investment risk between the network, regulator, customer, and other stakeholders.

Value area 2: Connections for growth

Enabling networks to add value

5 Alignment and integration of distribution and transmission processes

Connection reform requires greater integration and alignment of processes between transmission networks, distribution networks and the system operator.

- Consistent connection processes, in part to avoid disparities and distortions that may determine where connections are made
- Joined up and integrated Regional Development Plans across networks
- Transparency and clarity, especially where distribution customers may be subject to transmission constraints and vice-versa
- Seamless processes that work across voltage and geographic boundaries
- Alignment of the roles and interface between networks, Ofgem and the system operator

6 Linking connection priorities to local area energy plans/strategies

At present, networks are obliged to be technology and customer neutral. There is no link between connection offers and the priorities set by Local Area Energy Plans, energy justice concerns, net zero or any other regional strategy.

If networks were, however, to give priority to certain types of connection customers for a non-technical reason, they would require some form of overarching authority to justify their prioritisation. This could, for example, come from a local energy plan or national/regional net zero delivery plan.

Allowing networks more discretion may encourage better whole-system planning but would also require network governance to be strengthened to ensure networks did not exploit discretion for their own gain.

7 Appropriate use of competition

All networks have committed to increase and support competition within the industry and to allow competitors access to provide network services where this is appropriate.

Competition comes in a number of forms:

- Connection customers can challenge the cost of network connections and can seek an independent quotation from a third-party contractor for certain elements of the connection works, known as 'contested works'.
- Many connection customers also contract their own connection consultants to review the proposed connection design and to challenge cost estimates. Anecdotally, the use of an independent network consultant can result in significant cost savings.
- Large-scale network investment can be open for competitive tender, although competition requirements may also then delay network investment.
- Customers, or groups of customers, may elect to apply for an Independent Network Operator Licence to set up and manage their own network area.

The challenge for the networks and Ofgem is to introduce competition where it adds value to the consumer over the long term.

> The Review heard from hundreds of innovative companies eager to bring new technologies to market but being hampered by slow, ponderous bureaucracy and an antiquated approach to grid connections not suitable for a modern 21st century electrified economy.
>
> **Chris Skidmore Mission Zero:** Independent Review of Net Zero 2023

Value area 3:
Capacity optimisation and use of flexibility

Value potential of flexibility

The development of a **smart and flexible energy system** is a central pillar of the UK net zero and energy security strategy and underpins much of the industry's policy and market reform initiatives.

Flexibility comes in many forms and includes, such as short and long-duration storage, consumer demand side response, dispatchable generation, new flexible demand from hydrogen electrolysis and EV charging, and the operation of GB interconnectors to neighbouring energy markets.

For this study, the focus has been to look at the role that networks can play as users of flexibility, to facilitate flexibility markets, and encourage investment in new flexibility solutions.

The value potential of flexibility is enormous. Flexibility can provide a range of network and energy system services, including:

- Network capacity optimisation
- Capacity constraint management and curtailment avoidance
- Local energy supply and use of low carbon generation
- System balancing
- Frequency regulation and other ancillary services

As well as services that are of direct value to the networks, flexibility also provides wider energy system benefits by helping to reduce consumer bills, increase security of supply and support the transition to net zero.

The UK could become a world leader in the development of flexibility and network optimisation solutions, markets and enabling technologies, which would, in turn, create significant export opportunities for **UK businesses that are innovators** in the sector.

Ofgem and DESNZ have therefore encouraged networks to make full use of flexibility and have called for networks to adopt "flexibility first" approaches and to harness the value of "**Full Chain flexibility**".

5 smarter.energynetworks.org/energy-networks-innovation-strategy-2022/
6 www.smartergridsolutions.com

Technologies that could provide energy flexibility in 2035

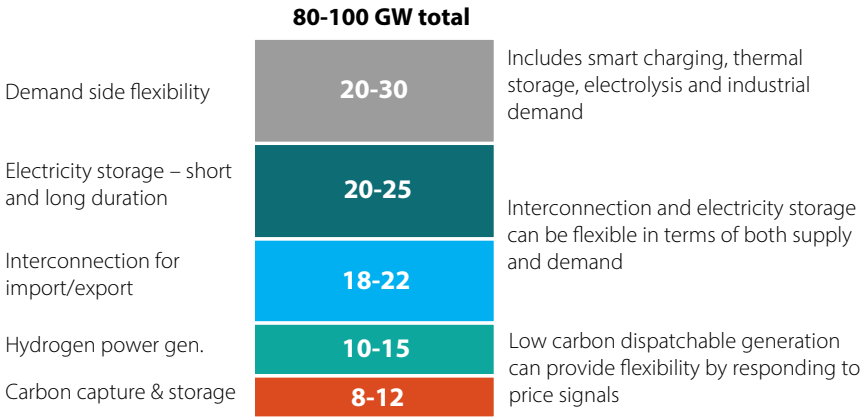


Figure 22: For further analysis of flexibility requirements in a net zero energy system see, for example, The Day in The Life of the Electricity System 2035.

> We define flexibility as modifying generation and/or consumption patterns in reaction to an external signal (such as a change in price) to provide a service within the energy system.
>
> Our vision is for a secure, affordable, net-zero system where all connected resources can flexibly respond to available energy and network capacity.
>
> A more flexible energy system could reduce future system costs dramatically. It will also help reduce the amount of new generation, storage and network infrastructure that has to be built.
>
> **Ofgem:** Full Chain Flexibility 2022

Value area 3:
Capacity optimisation and use of flexibility

Flexibility on the distribution networks

Except in a few specific areas of energy security, networks do not own energy storage and flexibility assets, but they have been mandated to encourage the development and use of flexibility wherever this provides a positive network benefit, for example, as an alternative to investment in network assets.

This 'flexibility first' mandate is supported by the Totex Incentive Mechanism (TIM), which allows networks to share the value of saved (or delayed) capital expenditure from the use of flexibility where there is a clear cost benefit.

For the distribution networks, the use of flexibility to optimise capacity utilisation and network investment is at the heart of the Distribution System Operator (DSO) role. As a result, all distribution networks have started to publish **detailed maps** of their flexibility requirements and to procure flexibility via a range of flexibility auctions, to manage network constraints and delay the need for network investments.

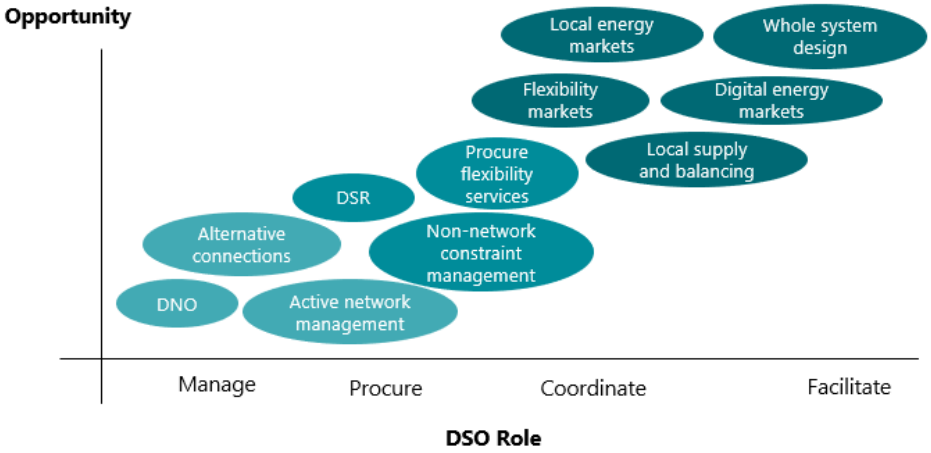


Figure 23: The Distribution System Operator (DSO) role has evolved from network management to include the procurement of flexibility services.

The Electricity Network Association has reported that over the last four years, distribution networks across GB had tendered for over 7 GW and awarded 3.4 GW of contracts (see Figure 21). **SP Energy Networks** has, for example, launched a range of flexibility products with regular Spring and Autumn tenders.

To date, most distribution flexibility tenders have related to demand-side constraint management, restoration of supply and reactive power. There are, however, now some tenders coming through to provide **flexibility for generation constraints**.

While the use of flexibility has grown, there is still a question about whether flexibility can provide long-term solutions for network constraints on the **low voltage (secondary distribution) networks** where flexibility provision is likely to be limited and much harder to harness.

Distribution network flexibility services have grown

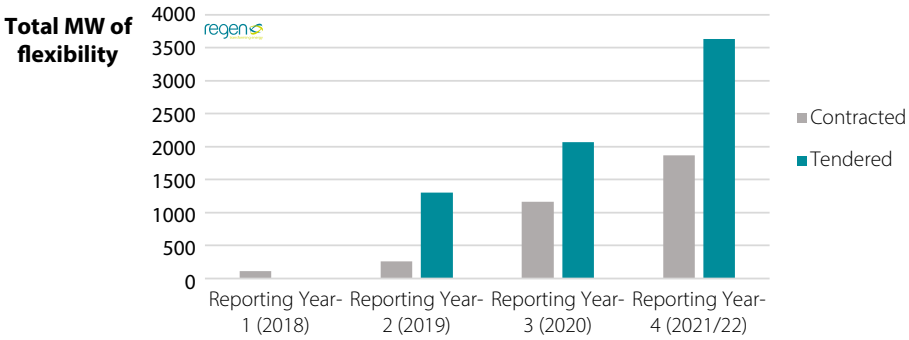


Figure 24: The ENA has tracked over 7 GW of flexibility tenders from 2018 to 2021/22. Source: ENA analysis.

Value area 3:
Capacity optimisation and use of flexibility

Flexibility on the transmission networks

Battery storage has been used extensively to provide **frequency response** services, including the new Dynamic Containment service, and this has been a major drive for investment in over 1.8 GW of battery storage capacity.

Transmission networks and the ESO have also recently begun to utilise flexibility assets for other network services, including system balancing and constraint management. This wider use has the potential to significantly scale up both short and long-duration flexibility solutions.

The balancing mechanism (BM) market, for example, is now open to new participants and has the potential to provide a significant revenue stream for flexibility providers. This market is developing rapidly; however, it is still the case that the majority of BM actions continue to be awarded to large CCGT plants while flexibility assets are regularly "skipped" for a variety of operability reasons, including resource and IT limitations within the Control Room.

In other areas, the ESO and transmission operators have begun to trial the use of flexibility in more innovative ways. For example:

- Working with energy supply companies, the ESO now runs regular '**Demand Flexibility Service**', which incentivises domestic customers to reduce demand during tight supply periods. This has been trialled on a number of occasions during winter 2022/23.
- Trialing the use of **forward contracts for flexibility services** for constraint management.
- Working more closely with DSOs to develop local flexibility "hubs" and to develop and integrate local flexibility markets.
- Investing in the development of new markets and new capabilities to enable the value of flexibility to be fully exploited.
- Investment in IT, digitalisation and automation to make better use of many more flexibility assets and service providers.

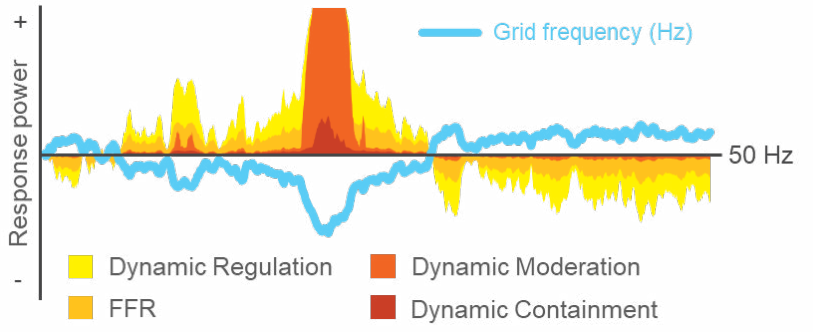


Figure 25: Frequency response to maintain grid frequency at 50 Hz has become an important network service for flexibility providers.

Large CCGT plants have dominated the balancing mechanism

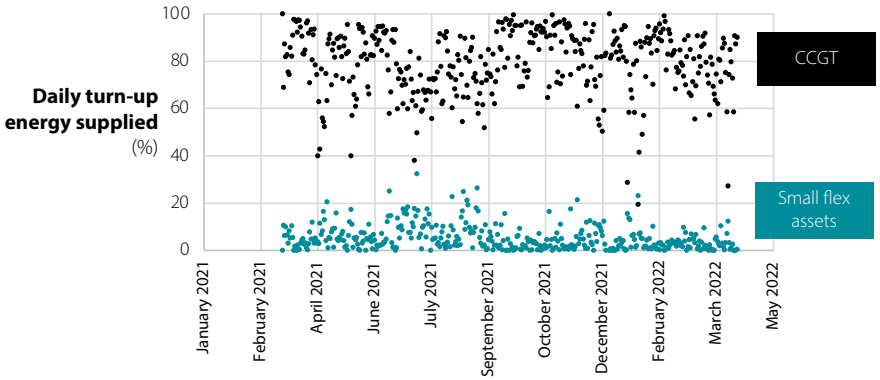


Figure 25: The Balancing Mechanism offers huge potential but has proved to be a very difficult market for flexibility providers who are often "skipped" in favour of large CCGT plants. Source: ESO Balancing Mechanism Dispatch Data.

7 www.nationalgrideso.com/industry-information/balancing-services/frequency-response-services
8 regensw.wpenginepowered.com/wp-content/uploads/Regen-Insight-Managing-Constraint-Costs.pdf

Value area 3: Capacity optimisation and use of flexibility

Enabling networks to add value

There is a significant amount of innovation and market development activity which is helping to increase the use of flexibility within the GB energy system.

In many respects, however, the use of flexibility is still at an early stage of development. Getting storage and demand flexibility to the next stage, where it is ubiquitous, at scale, and can supplant fossil fuel technologies, will require a step-change in the way the networks and energy system operate.

In terms of the value that networks can add, some key themes have been identified:

1 Enabling and incentivising networks to make appropriate choices between capacity investment, optimisation and flexibility

The regulatory model provides a broad incentive for networks to use of flexibility. It is also true, however, that while flexibility has a clear role to play, there is also a need to invest in physical network infrastructure. Getting the balance and timing right between these strategies is critical.

To do this, the basis of the cost-benefit analysis between asset investment and flexibility needs to be clearly defined and transparent. Consideration also needs to be given to the whole system value trade-off between long-term investment and short-term solutions. This is not a simple calculation since short-term solutions may themselves provide 'optionality' that enables a better long-term outcome.

2 Investment in supporting technologies and capabilities will be critical

Data digitalisation, the use of visualisation tools, Artificial Intelligence, automation, control and monitoring software and general IT investment will be critical to help improve network processes and provide additional customer services.

The Balancing Mechanism is a good example of a market in which flexibility providers could play a major role but where investment is needed in IT solutions, data digitalisation, Control Room functions and capabilities for this to happen.

The same capability challenges exist for the distribution networks, especially in the low voltage network and in the interface between distribution and transmission.

3 Proactively supporting and facilitating market development

Apart from some limited innovation funding, flexibility providers have not received revenue support subsidies, and so their investment case must be based on market revenue models.

It is not the role of networks to increase revenue for flexibility providers. However, there is a recognition that, for the benefit of the whole energy system, networks and the system operator have an important role to play to develop flexibility markets and encourage investment in flexibility solutions. This may mean proactively designing new markets and services that allow flexibility providers to compete and being prepared to move away from strictly technology-neutral and short-term cost criteria.

Ofgem's consultation on the **future of local energy institutions and governance** has proposed giving the future System Operator a coordination and facilitation role to support the development of flexibility markets.

4 Adding net zero and carbon intensity as a key criterion

To align the objective of decarbonisation and net zero, it is important that new flexibility markets (or other forms of capacity optimisation) include carbon as an overarching criterion. This may require a change to industry regulation to allow networks to differentiate between technology types or build carbon cost criteria into procurement processes. In the meantime, industry stakeholders have called for the carbon intensity of network services to be reported transparently and performance to be monitored with targeted reductions.

The Government and Ofgem's central net zero scenario shows that:

- **£100-140bn network investment** by 2050 to support net zero power demand would only result in an increase in domestic consumer network charges of **£4-5 per MWh** (0.4-0.5 pence per kWh).
- Network charges per unit of energy would then fall from 2040 onwards and would be less than the baseline scenario without net zero. **(C01)**

Value area 4:
Consumers in vulnerable circumstances

Value potential

Access to a reliable and affordable energy supply is fundamental for all aspects of modern life, supporting people to be healthy, comfortable, and better able to participate in work and wider society. The transition to a net zero energy system, and the digitalisation of the economy, are making consumers more dependent on their electricity supply.

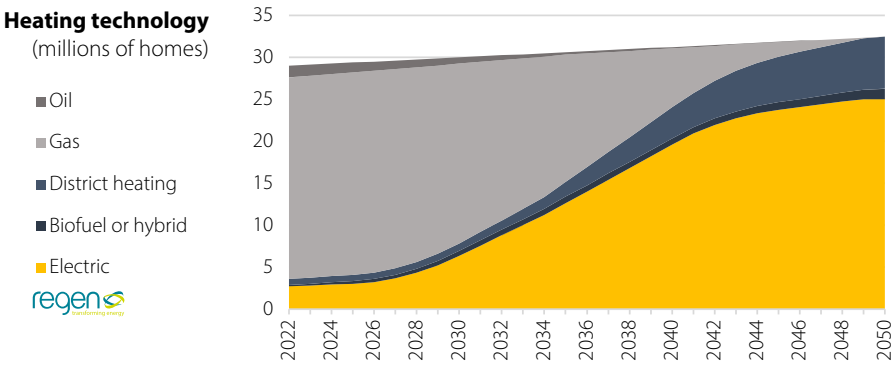
Interruptions to electricity supply have significant economic and social consequences and can cause severe distress and hardship for people. Some groups are impacted more than others, and as the energy system changes, new forms of vulnerability will emerge. Adding to the challenge, the number of consumers considered to be in vulnerable circumstances is growing due to an ageing population, more people with diagnosed disabilities, smaller households, and the increase in the cost of living.

Enabling a just transition

Beyond wider vulnerability and ensuring those at the highest risk from loss of supply get the support they need, energy consumers and stakeholders have indicated that networks have a role to play in addressing fuel poverty and ensuring everyone can benefit from the energy transition. There is a growing awareness that people already in low-income or vulnerable circumstances are at risk of exclusion from the benefits of low carbon technologies and smarter services due to a range of financial and social barriers. Because more affluent groups are more likely to be able to afford new technologies, there is also a risk that investment in infrastructure is targeted in those areas specifically, creating physical as well as social and economic inequality.

By 2035, 80% of vehicles on the road could be electric vehicles, so households will be relying on the networks to charge and provide the energy for their transport needs. This will deepen the dependency of consumers on the networks and increase the importance of providing a reliable and resilient service. **(CS01)**

Uptake of electric heating and transport will increase the importance of a secure and affordable electricity supply



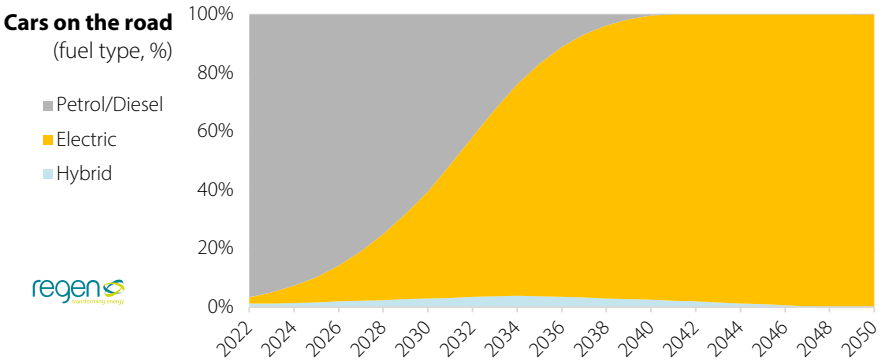


Figure 27: Source ESO Future Energy Scenarios data workbook, Consumer Transformation. This net zero compliant scenario is most aligned with the UK government's heat pump installation target and the Climate Change Committee's Balanced Pathway.

Value area 4: Consumers in vulnerable circumstances

The role for networks

How networks should provide support to consumers in vulnerable circumstances and the range of vulnerabilities that should be considered for support have evolved over the course of the ED1 price control period. For ED2, Ofgem has invited networks to expand their role by creating a new principles-based licence obligation that widens the range of vulnerabilities networks must consider, referring to three **principles**:

1. Consumers most at risk during a loss of supply (no change from ED1)
2. Consumers in or at risk of fuel poverty
3. Consumers most at risk of being left behind in the energy system transition towards net zero

Core responsibility to those at-risk during loss of supply

Networks' core responsibilities have been focused on providing vulnerable people with preparation advice in advance of supply interruptions and providing practical support to those that need it during a power cut – including hot food/drinks and, in some cases deploying backup generation to particularly vulnerable households.

The use of Priority Services Registers (databases with details of customers and their specific needs and vulnerabilities) has been a key tool enabling networks to give support where and when it is needed. The use and maintenance of PSRs is a core requirement of the network licence conditions (**licence condition 10**, special services), and networks have been focused on both improving the quality of the PSR data and increasing customer awareness of the services on offer.

There has also been a consistent drive to better understand the nature of vulnerabilities and needs of vulnerable customers by working with expert partner organisations, training staff to recognise the signs of vulnerability and championing a vulnerability-first approach throughout their working cultures.

Networks have been innovating in this space; for example, SPEN's **Security of Supply for Vulnerable Consumers** project, funded through the Network Innovation Allowance, aims to develop a new tool to aid decision-making in loss of supply incidents.

Fuel poverty

Prior to ED1, stakeholders were already making the case that as well as focusing on those at-risk during loss of supply, networks also had a role in tackling the issue of fuel poverty. Networks did recognise this role, and networks made commitments to refer customers to support available, publicise information campaigns and form partnerships on show-case projects. For ED2, networks' core commitments on fuel poverty are still centred around advice such as tariff switching support, energy efficiency measures, how to maximise income and debt advice.

Enabling a just transition

There is a growing awareness that the energy transition is not yet working for all in society, and networks are now expanding their role to consider those at risk of being left behind and support people everywhere to make the transition and benefit from the opportunities on offer.

The commitments in ED2 are mostly focused on educating customers so they are aware of the opportunities available to them, from installing LCTs and carrying out research studies to understanding the barriers to participating in a smart and flexible energy system. There were a few notable CVPs that proposed to go further than providing advice:

- **SPEN:** Direct low carbon transition support for 40,000 vulnerable customers to reduce energy bills and carbon emissions by funding demand reduction technology and increasing the uptake of smart meters.
- **SSEN:** Targeted, personalised and proactive personal resilience support to a total of 420,000 new and existing PSR customers, providing up to 21,000 battery packs to new and existing PSR1+ customers.
- **NGED:** Offering smart energy action plans to 600,000 customers per year. The plans will explain how customers can install smart meters, change their behaviours to save energy and switch to time-of-use tariffs.

There is an ongoing discussion around the range of vulnerabilities networks should be considering and the level of support that should be made available.

Value area 4: Consumers in vulnerable circumstances

Enabling networks to add value

1 Clarifying the role of the networks

The networks have a clear and established responsibility to those at risk of loss of supply. However, their role on fuel poverty and enabling a just transition is less clear. Whilst Ofgem has invited networks to consider a wider range of vulnerabilities, it is being quite restrictive about what it sees as an appropriate role for networks, and there is still debate around where the boundaries of their responsibilities lie. Some stakeholders have argued that networks should be able to pay a premium for alternatives to traditional network reinforcement where there are clear additional social benefits.

2 Shift towards a more collaborative CVP process

As noted in the **CVP analysis**, the development of consumer value propositions for ED2 encouraged competition rather than collaboration between networks. An alternative process that developed CVPs via collaboration between networks and Ofgem might help to clarify the level of support networks are expected to deliver, as well as ensuring that consumers get a consistent level of service regardless of which licence area they live in. For example, only PSR customers in the NGED licence area will be eligible for "smart energy action plans".

3 Enabling a more collaborative and ambitious whole-system approach

Community-level resilience is key to ensuring vulnerable customer groups get the support they need during outages. One way that networks can build local resilience is through local energy planning engagement and supporting the development of local resilience hubs. Practically this might involve partners arranging community centres to operate off-grid during outages and could be the hub for the provision of existing services such as hot food and drinks.

If networks are going to develop tighter partnerships with a wider range of organisations, such as local authorities and third-sector organisations, they will need to develop sufficient resource capacity with relevant expertise and relationships. Strong working relationships will be necessary to develop integrated projects with shared investment and outputs.

4 Embedding fairness into network planning and investment

Ensuring communities are not excluded due to a lack of infrastructure is an important consideration for networks. Currently, modelling such as Distribution Future Energy Scenarios (DFES) may use affluence as one of the factors in planning for the uptake of EVs and low-carbon heating systems, because more affluent groups are more likely to be able to afford their own new technologies. However, planning and investing on these lines alone could lead to investment only in those areas, leaving less affluent areas behind in both uptake of low-carbon technologies and the infrastructure required to support them down the line.

Ensuring equitable infrastructure and access to new technology is thus a key area for networks to consider as part of each network's stakeholder engagement and local area plans. Investing ahead of need with priority for vulnerable people and places, coupled with ongoing LCT support and building this into DFES and other planning work, could help to fundamentally enable a fairer transition. Projects such as **PACE**, which assessed the benefits of a network-led approach to EV charger roll-out in rural and deprived locations in Scotland, are important for piloting this more ambitious role.

Value area 5: Enabling consumers to be smart and efficient

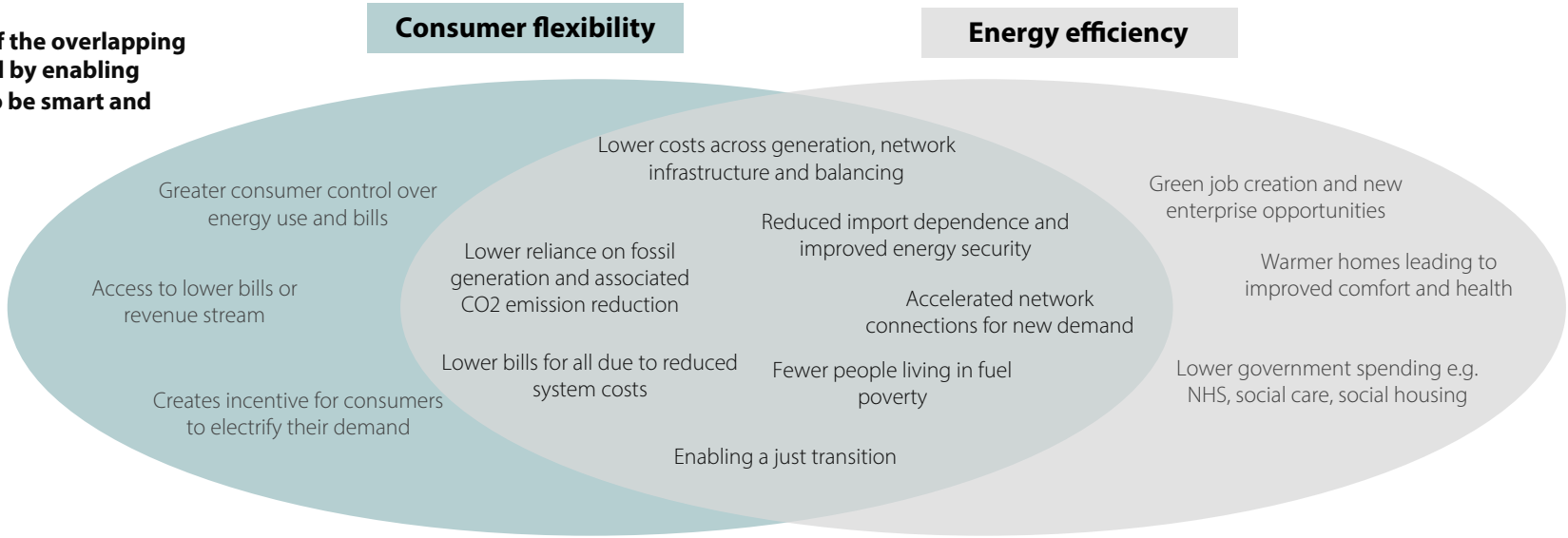
Value opportunity

Widespread consumer participation in demand-side flexibility will be a key element of the net zero energy system, curbing demand at times of peak electricity loads and enabling better local and national balancing. Improved building thermal energy efficiency will be important to ensure that electrified heating solutions are cost-effective. Both consumer flexibility and energy efficiency can reduce and, in some areas, delay the need for network development; in the 2021 **Smart Systems and Flexibility Plan**, Ofgem and BEIS estimated that a smart and flexible system would reduce system costs by up to £10bn by 2050.

Consumer flexibility and improved energy efficiency can also be deployed to unlock wider value inside and outside the energy system. This value ranges from economic value achieved via improved energy security and more affordable energy bills to the social value of living in a warmer home (the wider value is explored in the diagram below).

DNOs are already required to consider flexibility when meeting future network demands, and a new licence condition requires the promotion of energy efficiency measures where they can cost-effectively alleviate the need for network reinforcement. It is, therefore, important that electricity networks explore their role in creating and targeting wider value created.

Illustration of the overlapping value created by enabling consumers to be smart and efficient



Value area 5: Enabling consumers to be smart and efficient

Networks' role

To date, enabling consumers to be smart and efficient has not been a core responsibility of the networks. The delivery of smart metering has and continues to firmly sit with energy suppliers, whilst **ECO**, the government's main energy efficiency scheme, has also been the responsibility of suppliers rather than networks.

Consumer participation

The Ofgem 2021 **innovation vision** identified that achieving decarbonisation would involve greater consumer participation in the energy system and more active involvement in decision-making. For consumer demand-side flexibility to work at scale, consumers will need to be willing participants; they will need to understand the benefits of either allowing the smart operation of their devices or actively turning down or moderating their energy consumption.

Networks have been making advice available via expert organisations to enable consumers to make more informed energy choices and to better understand how their behaviours relate to the energy transition. For example, NGED is supporting the **Energy Saving Trust**, and SSEN has partnered with third-sector organisations in both its licence areas to provide **energy advice**.

Enabling and supporting access to low carbon technologies

Networks have a responsibility to enable consumers to access low carbon technologies. This means ensuring that there is the network capacity to allow the installation of heat pumps and EV chargers enabled by DFES and local area planning activities. It also means providing the necessary resources, interfaces and tools for installers to efficiently make connection applications.

Energy efficiency

One model piloted in projects such as the Scottish DNOs' **re-heat project** would see networks developing partnerships to enable energy efficiency projects to be considered as an alternative to traditional network reinforcement by stacking funding from a range of sources such as local authorities, social housing providers, government energy efficiency programmes as well as network budgets. This would involve networks developing strong partnerships with local organisations as well as developing a clear understanding of the complex funding landscape (which includes ECO+, the Boiler Upgrade Scheme, Minimum Energy Efficiency Standards and the Social Housing Decarbonisation Fund) to ensure their funding for energy efficiency does not overlap with what is available from existing schemes.

Licence condition **31E** now requires DNOs to consider energy efficiency as a cost-efficient alternative to network investment. However, in the RIIO-ED2 final determinations, Ofgem made it clear that they would not accept vulnerability strategy proposals to install energy efficiency measures. The DNO role should be limited to 1) the use of referral channels to signpost customers to existing energy efficiency support available to customers, e.g. Government grant schemes, and 2) utilising their network of partnerships to enable referrals where energy efficiency advice can be provided to customers from consumer bodies, charities and local organisations **(paras 5.87 – 5.95)**. In summary, networks are right to be considering energy efficiency but only where there are direct network benefits, such as in areas with constraints.

Network delivery of smart meters

Use of smart meters will be crucial for enabling consumers to be smart and efficient with their energy use. 86% of consumers with smart meters change their behaviour to save energy after their device is installed, according to **Smart Energy GB**.

Currently, the delivery of smart meters sits with suppliers – but so far, **only 45%** of domestic electricity meters are smart, and the installation rate is slowing. Stakeholders interviewed for this paper suggested there is a case for networks to take control of smart meter delivery to accelerate installation. The economist Dieter Helm has also recently **argued** that all metering should be managed by networks rather than suppliers.

Value area 5: Enabling consumers to be smart and efficient

Pilot studies

Networks have carried out a range of pilot studies looking at how they can enable consumers to be smart and efficient. Some studies have focused more on learning about the network impact of consumer electrification of heat and transport. For example:

- NGED's **Future Flex** study of the limitations of domestic flexibility, which found that energy efficiency could deliver £1000 of network value per home
- SPEN's **Heat-Up** project assessed the impact of heat pump domestic retrofits on their network
- SPEN and SSEN's collaboration Project Re-Heat is exploring how operators can react to high electricity demand caused by decarbonised heating systems, using the flexibility of heat pumps and storage to benefit the network
- Regen worked with SSEN to carry out a high-level **scenario analysis** of the impact of energy efficiency measures on demand at a regional level
- UKPN's **Energywise** project assessed to what extent social housing residents in London could engage with energy-saving campaigns and time-of-use tariffs.

Air pollution has an impact on human health, productivity and well-being, as well as the wider environment. Electrification of heating will reduce the costs associated with these impacts significantly. Currently, the annual air quality costs of the average household heating demand are £18 for gas and £5.04 for heat pumps. In 2035, the air quality costs will still be £18 for gas but only £0.67 for electric heat pumps. **(S01)**

Unlocking networks to add value

Expand from pilots to business as usual

For networks to enable all consumers to be smart and efficient with their energy use, they will need to expand beyond trials and pilot projects to make energy efficiency projects business as usual. As a relatively new area for networks, they will need sufficient resources with the necessary expertise and capacity.

Networks will also need to standardise the use of holistic, whole-system cost-benefit analysis and investment appraisal tools to enable the effective development of projects where value is transferred outside the energy system. This will include the effective quantification of social value, e.g. using social return on investment (SRoI) tools, which some stakeholders interviewed for this paper suggested can be challenging.

New role in smart meter delivery

For distribution networks to have a role in the delivery of smart meters, a change in position from Ofgem would be needed. Whilst the regulator would understandably be unwilling to halt the supplier-led roll-out, a network-led approach could be in addition to, rather than instead of, the supplier-led installation programme.

Value area 6: Building industry capability

Value potential

Delivery of net zero and the UK energy security strategy will involve £100-140bn of additional investment in the transmission and distribution networks by 2050, according to the Electricity Networks Strategic **Framework**. Investment in infrastructure, digitalisation and innovation will be required across all aspects of the energy system. A big question is whether the industry will have capacity to deliver such a transformation or whether there is a real risk that delivery capacity becomes a drag anchor on both economic growth and decarbonisation.

As well as a requirement for meeting the UK's strategic goals, capacity building creates jobs and skills, and it can promote diversity and economic activity. The expertise developed by engineers and energy system experts in-house at networks provides the skilled workforce needed by the rest of the industry to achieve net zero, and as such, networks are performing a crucial training service.

Networks won't be able to deliver their ambitious plans without increasing their own capacity and also ensuring that there is a healthy industry supply chain. There is an opportunity for networks to be more strategic and collaborative in their partnership developments to both reduce delivery costs and ensure the market can keep up.

> Government analysis suggests that reinforcing Great Britain's onshore electricity network to meet net zero could directly support an additional 50,000–130,000 FTE jobs by 2050, contributing an estimated £4-11bn of GVA for the UK. **(EG01)**

Value area 6: Building industry capability

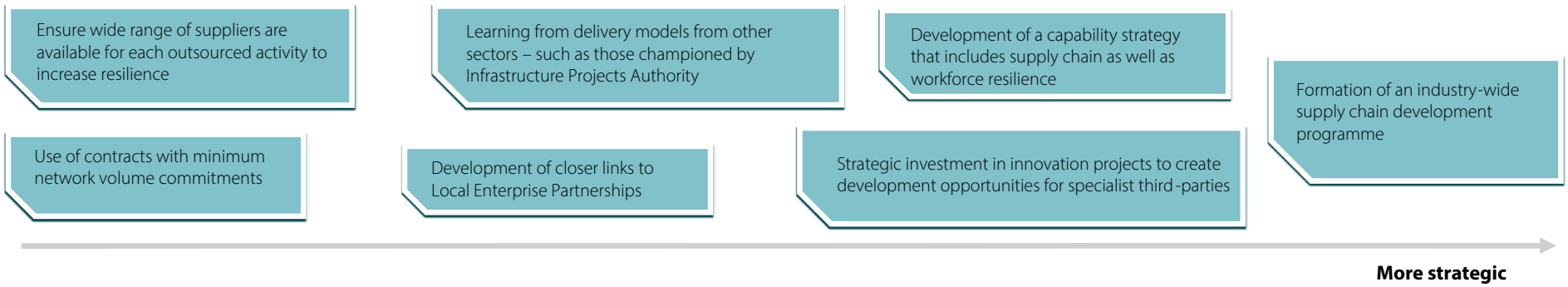
Networks' role

For the RIIO-2 price control, transmission and distribution networks were required to produce a workforce strategy detailing how they would develop a modern, diverse, high-quality, well-trained workforce fit for the future. This reflects the industry consensus that the resilience of human capital, as well as network assets, is crucial to achieving the objectives of the electricity networks. There was no requirement to produce a supply chain strategy, though distribution networks were required to consider the impact on their supply chain where they forecasted large increases in investment (two DNOs, NPG and SSEN, did publish separate supply chain-focused sections in their business plans).

The networks are making commitments on their internal workforces, from recruiting a representative workforce, addressing key skill shortages (such as data, digital, whole system engineering skillsets), and tackling the utilities-wide problem of an ageing workforce. Participants in the industry roundtable session highlighted network planning as a key area where networks must do more to train, attract and retain people.

Significant untapped value lies in more proactively developing the wider supply chain to de-risk the delivery of infrastructure required to meet net zero. Proactive supply chain development could involve greater collaboration with chambers of commerce and local enterprise partnerships to set up local or national supply chain development programmes with the aim of helping potential suppliers to understand the route to market and give the certainty needed to make investments. Networks are using their Network Innovation Allowances to develop their supplier network. A key principle of the **Network Innovation Strategy** is collaboration with stakeholders – which includes research and academia, industry associations, expert consultancies, and technology and equipment providers.

Networks also have a role to play in fostering innovation that can be exported to other industries and to electricity networks worldwide. For example, leakages of the electrical insulator SF6 (a greenhouse gas with a warming impact 23,000 times that of CO_2) is a significant problem for both transmission and distribution networks that will require alternative switchgear equipment to be brought to market. Similarly, whilst the networks do have ambitious plans to reduce their carbon footprints, there is an opportunity for networks to leverage their unique technical expertise and to forge a leadership role in electrification by stimulating markets for alternatives to fossil fuels for backup power and mobile machinery – creating both in-house knowledge and export potential in the supply chain.



Value area 6: Building industry capability

Enabling networks to add value

One of the key barriers to networks making anticipatory investments is the length and cycle of the price control period. Short five-year price controls are in favour across many regulated monopolies, perhaps because they reduce the impact of uncertainties on cost and output forecasts compared to longer price control periods. However, shorter periods do not encourage long-term planning. Investments in supply chain capacity development and workforce resilience have long payback periods, in many cases longer than five years, making them potentially unattractive from a simple financial cost-benefit viewpoint. Shorter price controls with fluctuating saw-tooth investment profiles create a challenge for the supply chain, as they struggle to cover their overheads in troughs and cannot keep up with demand at the peak, leading overall to higher delivery costs.

For ED2, Ofgem has expanded the use of uncertainty mechanisms to mitigate risks to both DNOs and consumers. However, these mechanisms encourage the networks to take a "wait and see" approach rather than rewarding successful anticipatory investment - inhibiting long-term supply chain development.

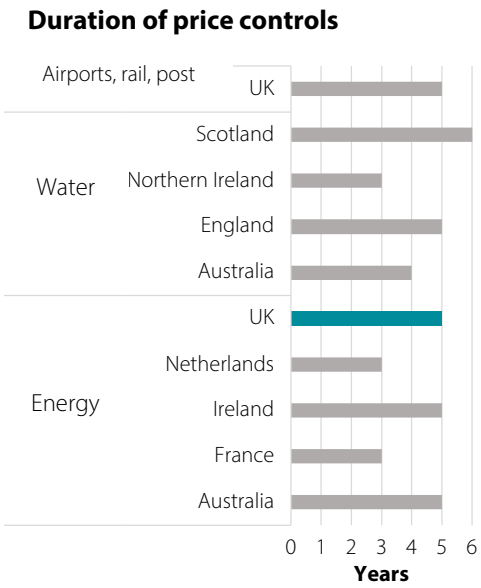


Figure 28: Price control comparison across utilities. Source: The duration of price controls

To some extent, the use of uncertainty mechanisms reflects the lack of a single net zero plan, as significant decisions remain on which decarbonisation pathways will be followed. Members of the trade association for energy infrastructure providers, BEAMA, have expressed **concern** that the lack of a consensus around a clear net zero pathway is creating uncertainty and stalling investment from suppliers.

Other sectors in the energy industry, such as **oil & gas** and **offshore wind**, have successfully used joint industry projects (JIPs) to co-fund and co-finance initiatives for the benefit of the whole sector. Electricity networks could be collaborating with JIPs to stimulate their supply chains in key areas where competition alone has not succeeded.

Supply chain development at Hinkley Point C

Participants at the industry workshop mentioned that anticipatory supply chain development was not something the networks were doing enough of. One attendee drew attention to the work done to prepare the local supply chain prior to the construction phase of EDF's nuclear reactor at Hinkley Point C in Somerset.

EDF worked with Somerset Chambers of Commerce and Local Enterprise Partnerships on a Supply Chain Development Programme with the aim of anchoring nuclear skills and capabilities in the South West region in advance of construction. The programme provided support to help businesses understand the nature of HPC, to prepare bids and get ready to deliver.

"The confidence of the businesses to invest and change is dependent on understanding the route to market, the size of the opportunity and the potential return on investment. The programme has aimed to uncover the opportunities and break them down into more 'accessible' components so that local businesses can better review and decide if the opportunity is suitable for them."

Hinkley Supply Chain Programme annual report, 2018.

The programme ensured UK businesses were able to compete and win contracts. For example, Bilfinger UK is leading the fabrication and installation of the Nuclear Steam Supply System with contracts worth £400m, and Osprey, a Somerset-based company, is providing marine and heavy logistics with contracts totalling £5m.

Summary and conclusions

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Networks Unlocked: Conclusions

The Networks Unlocked paper has explored how electricity networks can create additional value for the energy system and wider society at a time of rapid and radical energy transformation.

Based on interviews, workshops and discussions with industry stakeholders, it has sought to better understand the role of networks in supporting the UK's net zero and energy security strategy and the economic and societal challenges faced by local and regional stakeholders.

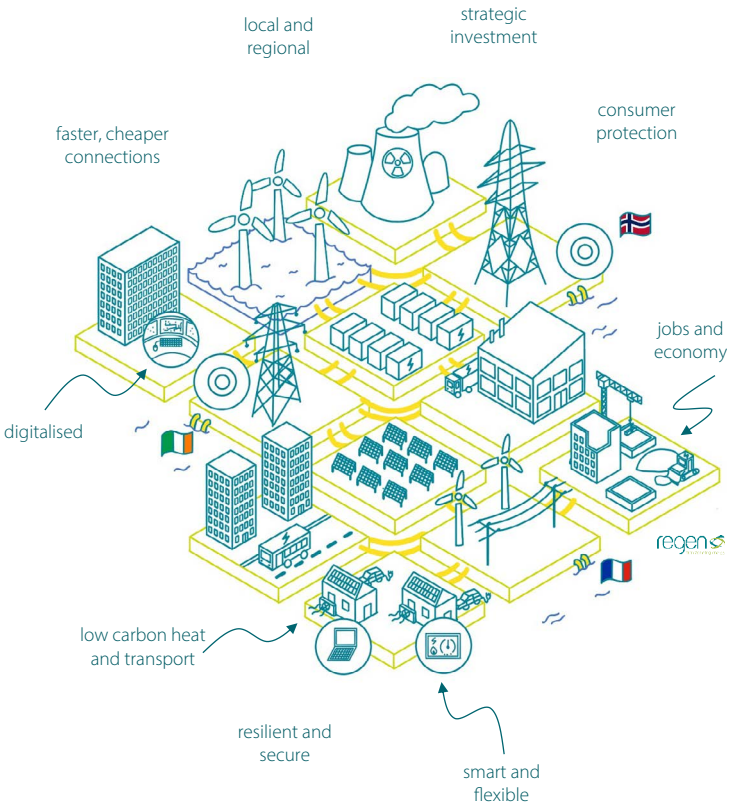
Taking a broad view, the study conclusions are that:

- Networks have a critical role to play in enabling the delivery of the UK's future energy system, both by providing infrastructure and by enabling other energy system participants to develop the technologies and services needed to deliver an affordable, secure and resilient net zero energy system.
- Networks can also play an important supporting role to ensure that the energy transition is fairer and more equitable across society, and that vulnerable and disadvantaged consumers are not left behind. They can do this by providing equality of service, ensuring better access to low carbon and smart technologies, and fulfilling their long-standing function to ensure all consumers have a resilient and secure energy supply.
- The increased devolution of energy matters, and the strong view that energy is a public good that underpins social and economic goals requires a new, enhanced relationship and governance model between networks and their regional partners.

Reform of the existing regulatory model could form the basis for an enhanced framework

- Electricity networks are a natural monopoly; it is therefore inevitable that the industry must be regulated and that the regulatory framework will be complex and multi-faceted.
- The current RIIO regulatory model has evolved to apply more rigour and broader performance measures to the regulatory process. Judged against its own priority objectives, centred on customer service and cost control, it has been broadly successful.
- The regulatory model is, however, under increasing pressure because of the speed and enormity of the energy transformation, and the increased expectations of energy system stakeholders
- The model is not fundamentally broken. It could form the basis of a more progressive and proactive framework, but it does require targeted reform both in terms of its design and the way in which it is applied and managed.

Regulatory reform will be led by Ofgem but requires support and input from national and regional stakeholders, networks and the wider industry. Reforms should be in place before the start of the ED3 price control period.



Networks Unlocked: Conclusions

Reforming the regulatory model for strategic investment

- The scale of investment and the need to invest in anticipation of future energy requirements are the biggest challenges to the current regulatory model.
- There has been positive movement in this area, signalled by the Holistic Network Design process and the new Accelerated Strategic Transmission Investment framework. There is still a tension between short-term cost control and long-term investment, which points to a need to enhance the framework under which investment decisions are taken.
- Long-term investment must be underpinned by a strategic delivery plan at a national/system level and by regional and local network development plans.
- The delivery of strategic investment will require changes in how networks are incentivised to deliver infrastructure projects and how the risks of non-delivery and potential regret costs are addressed.
- The role of flexibility and other system solutions should be embedded within the investment planning and 'whole system' appraisal process.
- Reform will lead to a change in objectives for the networks, system operator and regulator to prioritise investment decision-making and foster a greater degree of collaboration and partnership between them.

Adopting a value-based and more responsive model

- Building on the concept of incentivising a range of outputs and whole system thinking, the regulatory model could be enhanced by defining value pillars, objectives and outputs that are explicitly aligned with the UK energy strategy and with economic and societal goals, including decarbonisation.
- This approach would broaden the role and expectation of networks and would also allow them to be more proactive and holistic in their approach to value creation.
- Defining objectives which are aligned to a set of outputs and performance measures will require a much higher degree of engagement and consultation with network stakeholders.
- The nature of the price control period may itself change, moving away from a fixed periodic review and set budget allocation to something that is more responsive and dynamic.

Improving governance and oversight

- Energy is now a key part of the UK's devolution and 'levelling-up' agendas. As engagement and expectations increase, it makes sense to reform the governance model with a shift of emphasis away from centralised regulation towards more decentralised governance arrangements.
- The UK government's review of utility regulation should consider whether the role of Ofgem could be refocused on core regulation and performance monitoring, while oversight and budget accountability (including for investment delivery) could be shared with regional governance bodies.
- A common theme is to better align network reporting and performance measurement with wider energy system goals such as net zero, even if those goals cannot be delivered solely by the actions of networks.

National Energy Regulator

Setting the regulatory framework

- Markets, competition and consumer protection
- Cost and performance measurement
- National outputs and adherence to national strategy
- Overall investment budget

Regional Governance Body

Setting regional goals and priorities

- Review of regional investment plans and budgets
- Regional output measures and performance, e.g. Environmental, Investment Delivery, vulnerable customers

Networks Unlocked: Conclusions

Priority areas for network value creation

The study considered six key areas that were identified as critical for network value creation:

- Integration of network planning at a national and local level
- Reforms to accelerate new connections, reduce connection costs and optimise capacity utilisation
- Using flexibility and other non-network solutions to complement infrastructure investment and create whole-system value
- Fulfilling a social contract to support those in positions of vulnerability
- Enabling consumers to improve energy efficiency and adopt smart technologies to reduce consumer bills and network costs
- Building capacity and capability within network organisations, supply chains and across the industry to deliver net zero and the UK's energy strategy.

In each of these areas, networks could be enabled to deliver more value through a combination of innovation, adoption of new technologies, partnership and collaboration with other system actors, better use and digitalisation of data, integrated planning and capability building.

It is notable that in each area the study considered, significant innovation and reform are already in progress. This suggests that there is a good basis for alignment between the strategy and business plans of the industry and the objectives of their partners and stakeholders.

It's also fair to say, however, that the pace of change needs to be accelerated and that more radical and far-reaching reform may be needed, not just in how networks are regulated but also, for example, changes to the planning and consenting regime that would otherwise delay infrastructure investment.

Unlocking networks – agenda for future reform

There is now a far greater recognition of the important role that networks play and how essential they will be for the UK to achieve its net zero and energy security objectives. With greater recognition has come a much higher degree of expectation and, inevitably, calls for networks to deliver more.

Several reform initiatives have already been instigated by DESNZ, Ofgem and from within the industry itself. In the last year, there have been proposals in the areas of connection reform, network charging reform, network planning, scaling up the use of flexibility and steps to accelerate strategic investment. Ofgem has also invited the industry to begin to think about the sort of regulatory model that should be put in place for the next price control period.

While the range of initiatives and focus from policymakers is very positive, there is still a strong sense that the overall framework requires a more holistic review, including the wider objectives to embed whole system thinking, collaboration, competition and greater levels of energy devolution to regions and cities.

Inevitably, the most pressing issue is the delivery of network investment on both the transmission and distribution networks at a pace and scale that reflects the urgency to decarbonise and provide energy security. The framework for strategic investment must therefore be aligned with an overarching strategic delivery plan for the energy system, as well as with regional and local energy plans.

The reform agenda must also consider the needs of network users and the end consumer. Affordability, service and resilience will still be paramount. To those core objectives, networks now also have a key role to ensure the protection of vulnerable customers and those that might be left behind during a period of rapid technology and system change.

Finally, any reform agenda must put front and centre the goal of decarbonisation, which for the power sector must be complete by 2035.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