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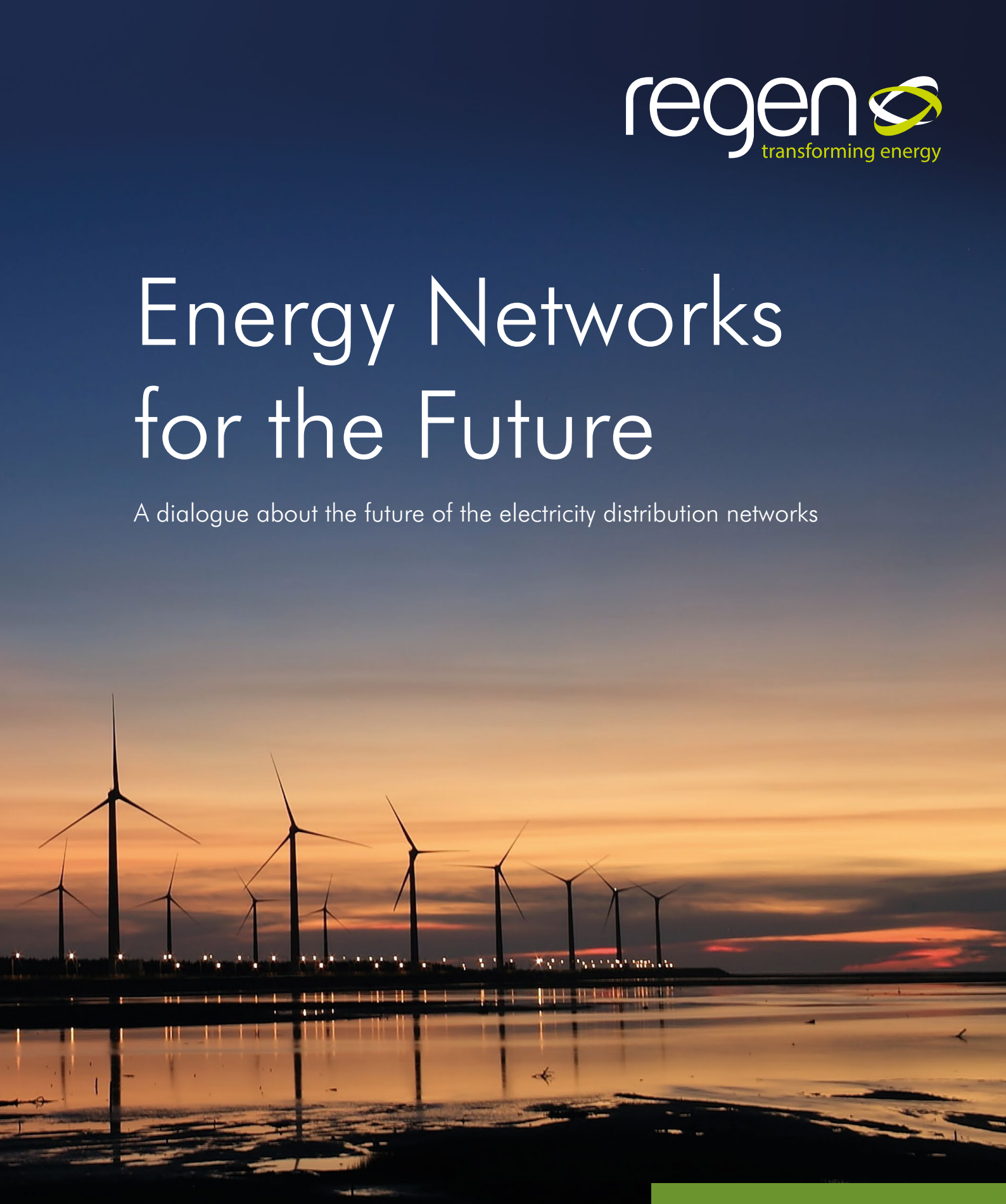
Energy Networks for the Future

A dialogue about the future of the electricity distribution networks



November 2019

SP ENERGY NETWORKS

Electricity transmission

Britain's electricity transmission network transmits high-voltage electricity (440 kV and 275 kV)[1] from where it is produced to where it is needed throughout the country. It is owned and maintained by regional transmission companies, while the system as a whole is operated by a single System Operator (SO). This role is performed by National Grid Electricity Transmission plc (NGET) - it is responsible for ensuring the stable and secure operation of the whole transmission system.[2]

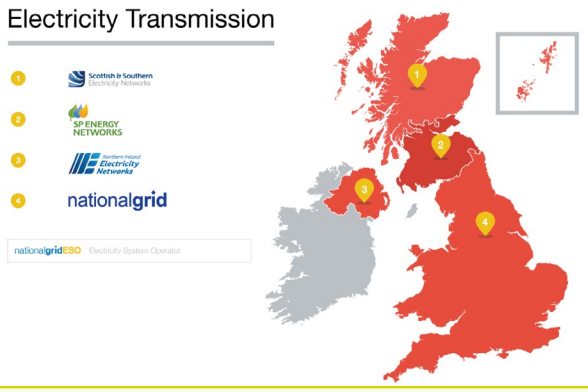


Image: Energy Networks Association

Electricity distribution networks

Distribution is the operation and maintenance of the assets which transport electricity from grid supply points to individual customers. It incorporates a network of overhead lines, underground cabling, switches and transformers that operate at voltage from 132 kV down to 240 V[3]. There are 14 licensed distribution network operators (DNOs) in Britain and each is responsible for a regional distribution service area. The 14 DNOs are owned by six different groups. In addition, there are also a number of smaller networks owned and operated by Independent Network Operators (IDNOs).

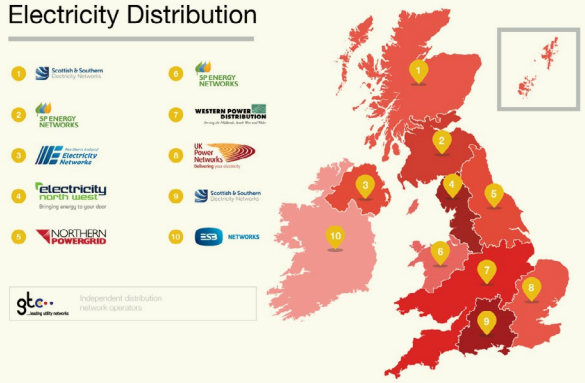


Image: Energy Networks Association

Gas transmission

Britain's gas transmission network, the National Transmission System (NTS), is the high-pressure gas network which transports gas from the entry terminals to gas distribution networks, or directly to power stations and other large industrial users.[4]

Gas distribution

The gas distribution networks (GDNs) are the medium and low pressure delivery systems that supply to the consumers.

The gas distribution network is covered by four different gas distribution licences including SGN, Northern Gas Networks, Cadent and Wales and West Utilities.

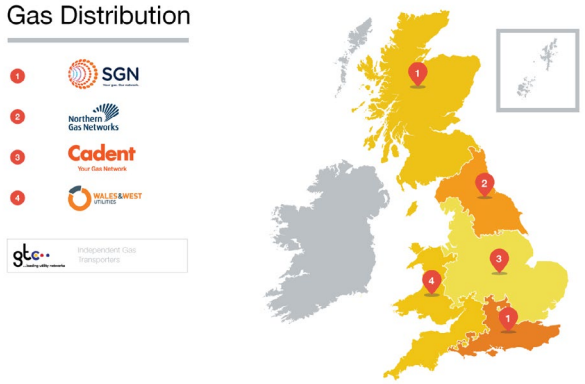


Image: Energy Networks Association

The focus of the paper is the role of the electricity distribution networks, currently delivered by six companies across fourteen licence areas. Many of the paper's findings and conclusions are, however, applicable across the transmission and gas networks and to the new integrated and multi vector energy system that is emerging.

1 Transmission voltages in Scotland are 132 kV, 275 kV and 400 kV. In England, 132 kV electricity lines are part of the distribution network.
2 www.ofgem.gov.uk/electricity/transmission-networks/gb-electricity-transmission-network
3 In Scotland, distribution is up to 33 kV
4 www.ofgem.gov.uk/gas/transmission-networks/gb-gas-transmission-network

Energy Networks for the Future

The climate emergency has provided the biggest catalyst for change in the global energy system since the industrial revolution. It has motivated millions of protestors, from school children to pensioners, to campaign for our planet's future and to ask governments, industry and policy makers to take urgent action.

Transforming the UK economy to become net zero carbon will be an immense challenge. Our future net zero pathway is not certain, but we know that low carbon electricity will be a fundamental building block and will require billions of investment in strategic infrastructure, as well as new innovations and the utilisation of smarter non-network solutions.

The electricity networks, therefore, have a critical role to play in our decarbonisation journey, by distributing low carbon electricity and by enabling regions, cities, communities, businesses and consumers to play their part in an energy revolution. It is understandable therefore that there is renewed interest in who owns the networks, how they are governed and the method by which they are regulated and incentivised.

Based on Regen's research, and interviews with a wide range of industry leaders and stakeholders, the Energy Networks for the Future paper examines how the regulatory and governance model for the energy networks should change to accelerate the decarbonisation and democratisation of energy, while continuing to deliver a secure low cost service for the consumer, and a range of wider societal and economic goals.

We hope this paper will promote a constructive discussion and debate about what we want the energy networks to deliver, and how we can create a new strategic partnership between the industry and its stakeholders to achieve a net zero energy future.

Johnny Gowdy
Director, Regen

Today's climate emergency means the need to deliver against net zero targets is now greater than ever. The UK's electricity networks are key to driving this for the country, and we at SP Energy Networks are uniquely placed to lead on that journey; delivering value for money, a secure and stable supply, and ensuring our most vulnerable customers won't be left behind.

Our flagship projects see us bringing traditional network operations into the modern world with digital innovation and smarter, more agile network management, and we're already extending our services to support other industries such as heat and transport - enabling the increased uptake of electric vehicles and new electric heating devices. We're also committed to a tailored and locally focused approach that helps to prioritise the needs of our customers and stakeholders, whilst ensuring we continue to deliver a reliable and sustainable network. That's why we've been clear on our ambition to become a Distribution System Operator (DSO), and in highlighting the critical role the DSO has in preparing our network for the future.

The pace of change and radical transformation required across the industry means we cannot stand still. Net zero needs to be at the heart of energy policy, and we need more local decision making capabilities to meet the unique needs of every community. In order to build the smarter networks of tomorrow, we need a fair regulatory regime that reflects the investment required, the risk associated, and the incentives necessary to meet net zero.

That's why I'm delighted we've had the opportunity to support Regen in this timely report which arrives at a pivotal moment in our sector. The proposals outlined would create the environment we need to plan, invest and respond to the needs of *all* of our customers.

Scott Mathieson
Network Planning and Regulation Director, SP Energy Networks

Executive Summary

Energy will be at the heart of the UK's transition to becoming a net zero carbon economy. That transition has already begun with the growth of renewable electricity generation and the demise of coal, but this is just the beginning of a much more profound and radical transformation of our whole energy system which must happen if the UK is to fully decarbonise.

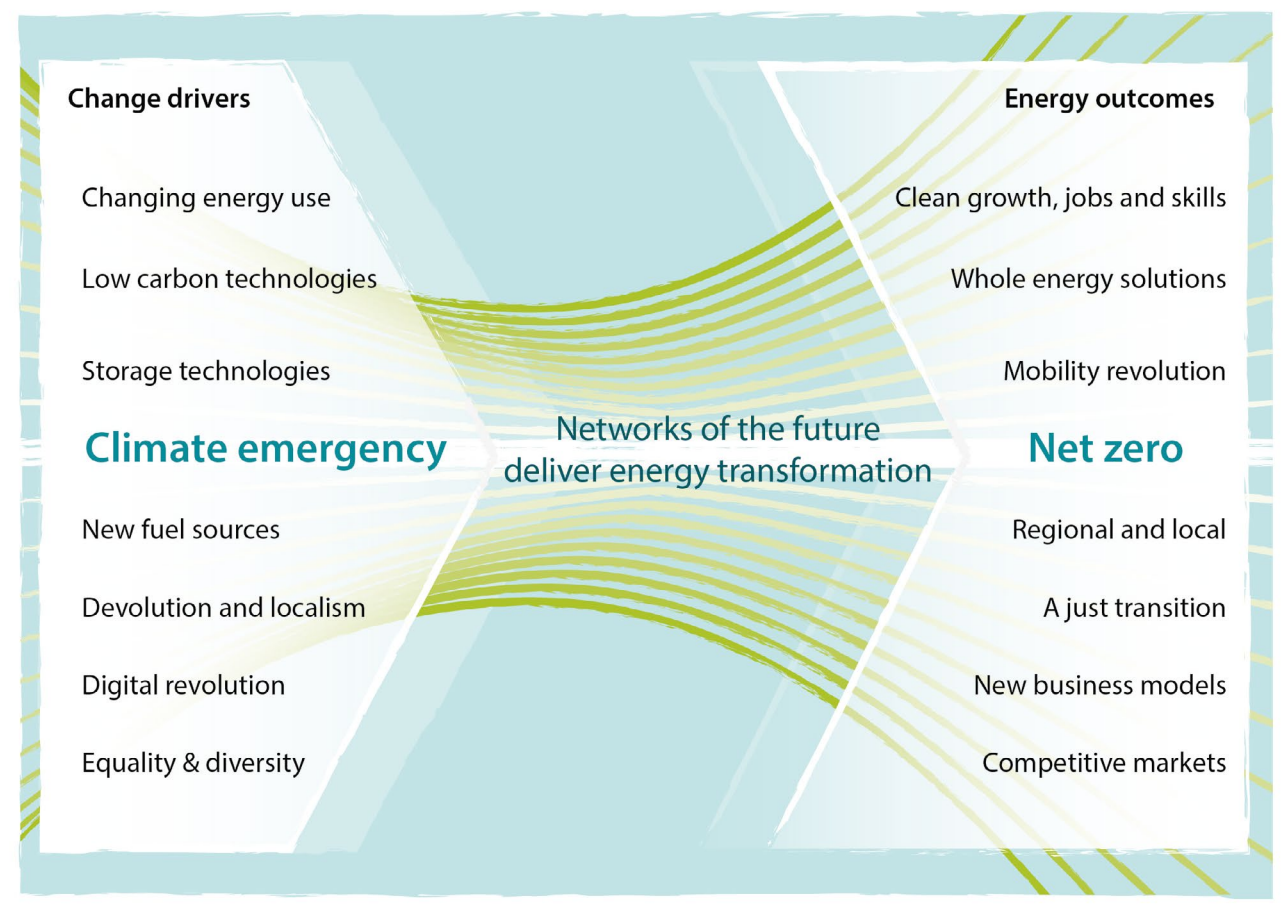
Alongside the climate emergency, other disruptive factors will revolutionise how we generate, distribute and consume energy. Significantly, new digital technologies and innovative business models are enabling a smarter and more flexible energy system with a far greater degree of cross energy vector[5] integration, decentralisation and the provision of local energy solutions.

The transformation of the energy system has introduced new challenges and new opportunities for the networks for gas and electricity, and for the new energy networks that will be created for green gases, hydrogen, carbon, heat and transport.

A significant amount of investment in new technology, innovation and new infrastructure will be needed. The Committee on Climate Change modelling suggests that annual capital investment in the power sector infrastructure may rise to £20 billion per year to achieve net zero by 2050, almost double the current investment[6]. However, it is also clear that simply increasing expenditure, and therefore consumer bills, cannot be the answer. The networks need to become smarter, more integrated, more flexible and crucially open to new business models in order to increase productivity and optimise the use of both network and non-network assets to deliver a system that is both affordable and resilient.

5 Cross energy vector – interchange in use of energy fuels and sources for power, heat, industrial process and transport.

6 Committee on Climate Change www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming



Given how critical the networks are to the energy transformation, it is positive that a debate has begun about the role that they will play and whether the current regulated industry model is still fit for purpose.

> 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 October 2019** [7]

One proposed approach[8] to deliver this transformation is to renationalise the networks into a form of public ownership where they can be directly financed and managed for the public good. At the other end of the policy spectrum there have been calls for the radical deregulation and liberalisation of the energy sector[9], with less focus on societal outcomes, to unleash the power of the free market. Proponents argue this would allow competition and the market to dictate levels of investment and service delivering a more cost-efficient energy system.

7 National Infrastructure Commission : Strategic Investment and public confidence www.nic.org.uk/wp-content/uploads/NIC-Strategic-Investment-Public-Confidence-October-2019.pdf

8 "Bringing Energy Home" Labour Policy Paper May 2019 www.labour.org.uk/wp-content/uploads/2019/03/Bringing-Energy-Home-2019.pdf

9 See for example Britannia Unchained and to some extent Dieter Helm's Cost of Energy Review.

Between these two political positions there is a more nuanced and pragmatic discussion between the industry and its customers and stakeholders; about what we really want the energy networks to deliver and how this is best achieved. There is also a recognition that, while energy can never be treated as a free market, the question of ownership may be less important than the ability of the public and private sectors to work together to innovate, develop smarter solutions and secure long term strategic investment.

In the absence of a clear strategic direction there is a risk that the industry could stagnate around the defence of the status quo, or be distracted by largely political and academic arguments about ownership, creating an investment hiatus that would slow the transition to a zero carbon economy.

Building energy networks for the future

The paper's underlying conclusion is that, while there is certainly a case for radical change, the reform to the existing regulatory model should recognise the need for public leadership and collaboration with local regions and communities, while at the same time harness the power, capital and innovation of UK businesses and progressive investors.

Across the broad spectrum of policy options there is a large degree of consensus in terms of what outcomes and objectives the energy system of the future should deliver. As well as decarbonisation at least cost, there is a positive focus within the industry on questions of energy justice, equality, transparency and workforce diversity. Critically, there is a clear understanding that networks need the public to trust that they are not abusing a monopolistic position, but are acting in the interest of consumers and delivering wider social good.

A core finding of the paper is that the current regulated industry model for energy networks requires significant reform to meet the net zero challenge and to bring forward the scale of infrastructure investment, non-network solutions and innovation needed to ensure that decarbonisation is delivered within an affordable and resilient energy system.

Energy security and consumer value are recurring themes; feedback from the stakeholder interviews also identified a number of new priorities for reform of the regulatory model:

Embedding decarbonisation objectives

Explicit decarbonisation objectives, greater regional governance and accountability, incentives that work to bring forward the right investment while reducing costs, and a clear purpose to ensure a just transition and wider societal benefits will become critical factors for the successful delivery of net zero carbon.

Building a new public/private partnership based on regional and local governance

Creation of a new partnership between private networks and public stakeholders whereby the networks take a more explicit role to deliver decarbonisation, support regional economic growth and other societal outcomes, while also working with regional partners to improve local resource planning and reduce investment risk.

Incentivising strategic investment and cost efficiency

The current investment appraisal approach needs to be adapted to better manage risk and uncertainty, and to encourage long term strategic investment. Scrutiny needs to be maintained but further steps towards cost transparency, and better governance and accountability at a local and regional level is needed.

Image: Community Energy Wales

A new model for network governance and accountability

The net zero carbon amendment to the 2008 Climate Change Act, has put the UK in a leadership position in terms of its declared decarbonisation commitment. There remains, however, a significant "execution gap" between the UK's ambitious decarbonisation targets and the energy strategy, policies and investment needed to deliver them.

National agency or office for net zero carbon

Given the climate emergency there is a strong case for the creation of a new national "energy agency" or "office of net zero" with the political backing to drive net zero carbon delivery across government departments. Working closely with, and including, devolved governments, cities and regions, this body would develop and implement a long term energy and decarbonisation strategy to deliver policies set out by the government.

Regional energy governance

Energy and climate change have become local priorities for devolved governments, regions, cities and local communities. Further devolution and decentralisation of energy is essential to deliver the transformational change that is needed at a local level.

UK regions should have a more formal governance role over the future of critical infrastructure. Regional governance bodies, which could be defined by licence areas or based around the emerging city regions, would help build public trust and engage local stakeholders, and also allow the networks to leverage the investment potential of regional economic plans and industrial strategies[10].

Expanding the Distribution System Operator (DSO) role

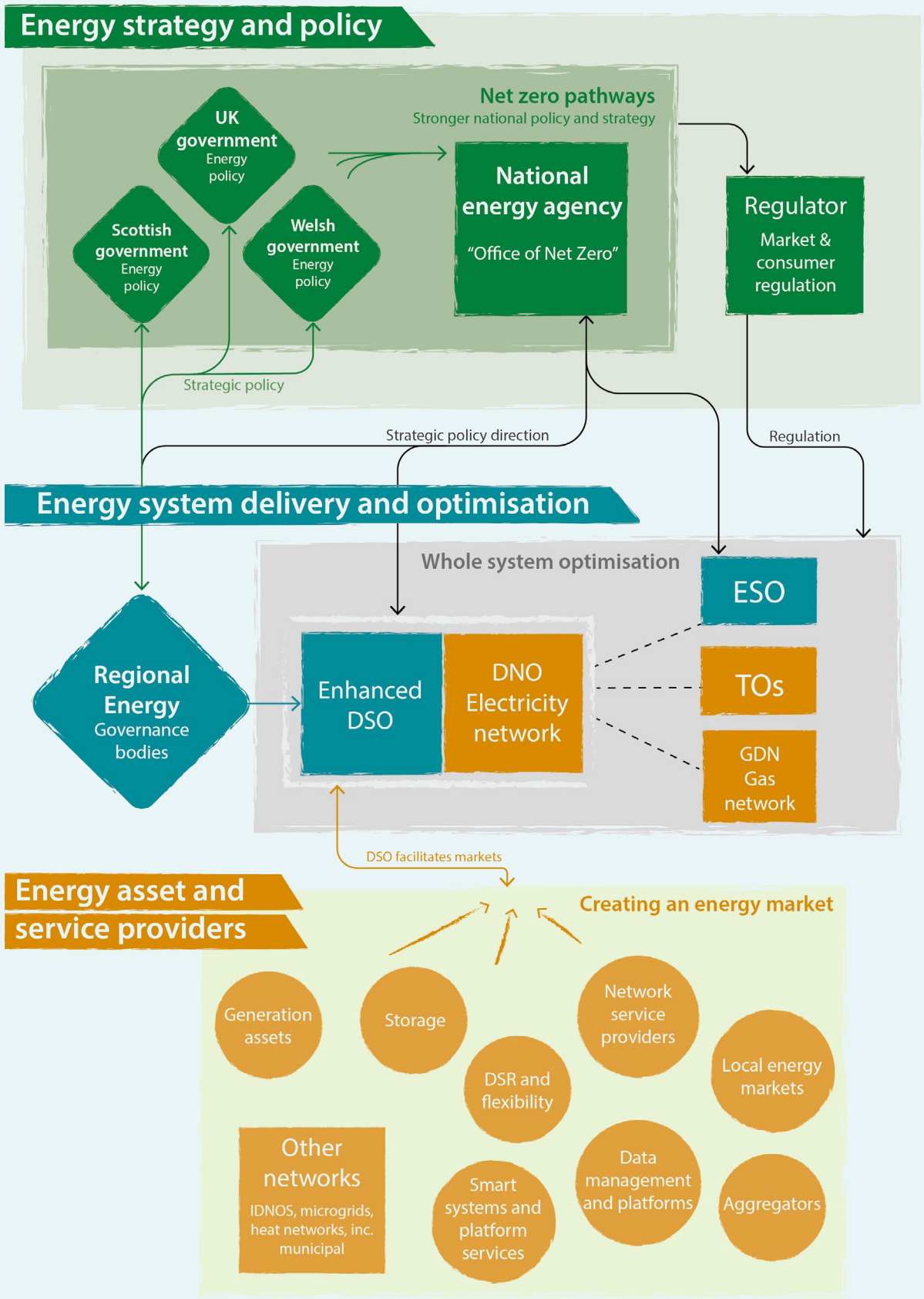
The current slow evolution towards a smarter and more dynamic energy system needs to be accelerated. This could be achieved by radically expanding the DSO role to work with regional partners to deliver wider energy system objectives including decarbonisation at least cost. This would encourage DSOs to fully exploit digital and smart technology to increase consumer value, and to identify energy system optimisation opportunities including; increasing asset and capacity utilisation, facilitating new flexibility markets and business models, while ensuring whole system resilience and optimisation across energy vectors.

Creating new open markets for low carbon energy solution providers

The new model must foster and allow new markets to develop for the provision of energy solutions and services. This can be achieved by setting a clear and consistent net zero strategy, and then creating a transparent and neutral market for new entrants, bringing new technologies and new business models to offer competitive services.

10 See for example Bristol City Leap - £24 billion investment in energy infrastructure.

A new model for network governance and accountability



Summary recommendations

The report analysis and supporting recommendations have focused on six main challenges, or opportunity areas, which encapsulate how the electricity distribution networks must respond to meet the net zero carbon challenge while continuing to deliver an energy system that is both resilient and affordable.

1 Putting the net zero carbon challenge at the heart of energy policy

There is currently an execution and policy gap between the UK's ambitious decarbonisation targets and the pathway of technologies, policies and investment that will deliver them. Networks need to work within a stronger national and regional policy framework to drive the delivery of net zero energy and the transition to a low carbon economy.

- Creation of a new national 'energy agency' or 'office of net zero' that can coordinate and drive net zero delivery across government departments working closely with, and including, devolved governments, cities and regions.
- Definition of a clear net zero decarbonisation pathway, even if there may be uncertainty and decision points along the road, that would allow networks to work with regional partners and other industry stakeholders to identify and plan strategic infrastructure investment.
- A strengthening of Ofgem's decarbonisation objectives; leading to the update of RIIO 2 guidelines to embed net zero as a core objective, with an explicit set of decarbonisation outcomes and incentives against which networks can plan, and their performance be measured.
- Proactive policies to enable smart low carbon technologies to compete against fossil fuel generators in the capacity market, balancing services and local flexibility tenders.

2 Enabling a local energy revolution

Networks should be enabled to work with local and regional partners to support the further devolution and democratisation of energy, so that cities, regions and communities can achieve local energy priorities.

Greater levels of regional network planning and stakeholder engagement are now already being undertaken but could be improved by:

- A regional governance body to provide formal representation for regions to assist and oversee the development of network business plans and investment planning, to set network priorities and to play a key role in the monitoring of delivery performance.
- Measures to allow networks (through the price control and investment appraisal processes) to reflect local and regional priorities, and to enable regional stakeholders to deliver their decarbonisation and socio-economic strategies.
- Devolution of some governance functions from Ofgem to regional bodies while maintaining clear lines of accountability and reporting.
- Support for co-investment and risk sharing models where regions wish to push ahead with more ambitious decarbonisation plans, address equitability issues or to support regional growth strategies.

3 Building smarter, optimised and secure networks

Optimisation of the energy networks will be an essential prerequisite for decarbonisation. There are significant opportunities to achieve this through; network innovation, whole system integration, adoption of smart technologies, data digitalisation and the enhancement, creation of new markets and business models and the further development of the DSO role.

- Accelerating and expanding the roles of the DSO to facilitate local flexibility markets and capacity trading and to leverage non-network solutions.
- Exploiting digital technology to identify value opportunities across the energy system, optimise system use, facilitate new markets and support non-network solutions.
- Steps to improve whole system planning and coordination including the alignment of regional forecasting and business planning processes, network resilience management and cross vector market integration.
- This could lead to a DSO model based on regional whole system operation, working with regional bodies and communities to optimise energy for power, heat and transport.
- Implementation of recommendations from the Energy Data Taskforce including the further digitalisation of energy data that is open source and visible, and the creation of a whole system asset registry, energy data map and data catalogue.

4 Making strategic investment, managing incentives and risk

Balancing risk, incentive and returns to ensure that networks make the right strategic investments in the network, and exploit long term non-network solutions, to deliver energy objectives and outcomes at least cost.

Measures to reduce investment risk, alongside incentives that reward measurable outcomes, should be adopted. Networks should be encouraged to include in their business plans a range of investment options that can be quickly enacted to meet changing requirements.

- Create a risk/reward framework to support long term strategic investment and to manage higher levels of uncertainty.
- Streamline and simplify the use of uncertainty mechanisms so that they can be more responsive and consistently applied.
- Uncertainty mechanisms, such as 'volume drivers' should be more clearly tied to decarbonisation outputs and to regional governance priorities.
- Investment incentive mechanisms need to clearly differentiate between savings made through more efficient solutions, and savings made just by investment deferral. This would help to encourage continued investment in needed infrastructure and non-infrastructure solutions.
- Encouraging new models that allow potential for co-investment and risk/reward sharing between networks, customers and public sector partners.

5 Delivering affordable energy, great service and customer value

Maintaining cost efficiency by ensuring that networks deliver new network (and non-network) energy solutions with higher levels of customer service and productivity.

- Ensuring that incentive and outperformance mechanisms are properly targeted and executed to reward genuine cost saving and efficiency improvements.
- Ensuring greater cost transparency especially in relation to the cost benefit of investment deferral, with a greater focus on the reporting of unit costs.
- Regulators should focus total expenditure allowance based price controls on the maintenance of existing networks requiring incremental or conditional investments.
- Continuing to incentivise networks to invest in innovation in new technologies, digitalisation and whole system solutions.
- Ensuring greater competition in tendering for network and non-network solutions, especially for strategic investments, where this delivers value for consumers.
- An additional layer of budget oversight and accountability at a regional level would help to ensure that cost efficiencies are delivered.

6 Ensuring a just transition

A just transition that delivers positive social outcomes is essential to maintain public and political support. This includes the protection of vulnerable customers, and ensuring a just and equitable transition that enables consumers and workers to fully benefit from the transition to a future net zero carbon energy system.

Networks can play a significant role to ensure the equitable treatment of consumers and access to new technology and markets for example by:

- Ensuring networks play their role as part of a wider low carbon industrial strategy to ensure the transition of skills and workforce to the new economy.
- Continuing to focus on support for vulnerable customers, but also the distributional impacts of network charging on energy poverty.
- Ensuring that access to new energy services, such as domestic EV charging and flexibility markets, is equitable and that no customer is left behind.
- Encouraging networks to collaborate with devolved, regional and city bodies, potentially through co-investment models, to provide economic and social stimulus in deprived areas.

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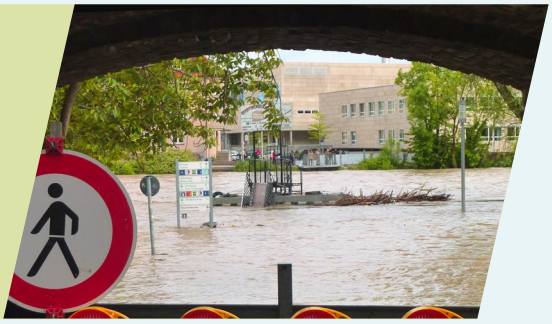
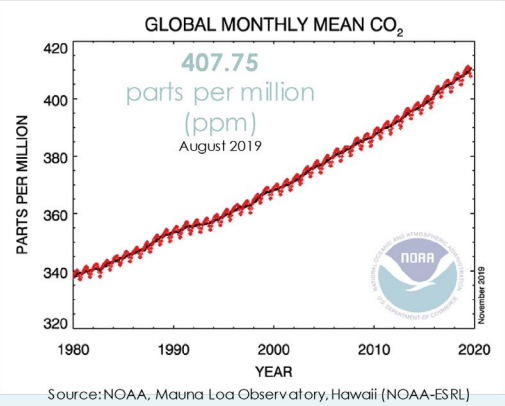
Changing Energy System



1 Climate Emergency

The last year has seen a radical shift in the discourse about climate change. The IPCC special report published in October 2018, which highlighted that the world is not on track to limit global warming to less than 1.5°C above pre-industrial levels, heralded a year of global climate emergency activism culminating in widespread school strikes and civil protest.



Source: NOAA, Mauna Loa Observatory, Hawaii (NOAA-ESRL)

IPCC Special Report
"world is not on track"
October 2018

Global climate emergency protests and school strikes

Local authorities, devolved governments, parishes and communities declare climate emergency

July 2019
UK parliament passed Net Zero Carbon by 2050

As well as a shift in language there has also been a significant shift in political thinking to take urgent action, and the level of ambition that must be achieved. In the UK this has resulted in devolved governments, hundreds of local authorities, city mayors, and hundreds of town councils, parishes, universities and community groups declaring a climate emergency[11].

At a national level, the UK parliament has declared a climate emergency which was followed by an amendment to the 2008 Climate Change Act, committing the UK to a more ambitious net zero carbon target by 2050[12]. The increase from an 80% reduction to a net zero target demands a much more radical approach to decarbonisation. Essentially restricting any fossil fuel carbon emission to those that can to be captured, or offset by negative emission measures such as afforestation.

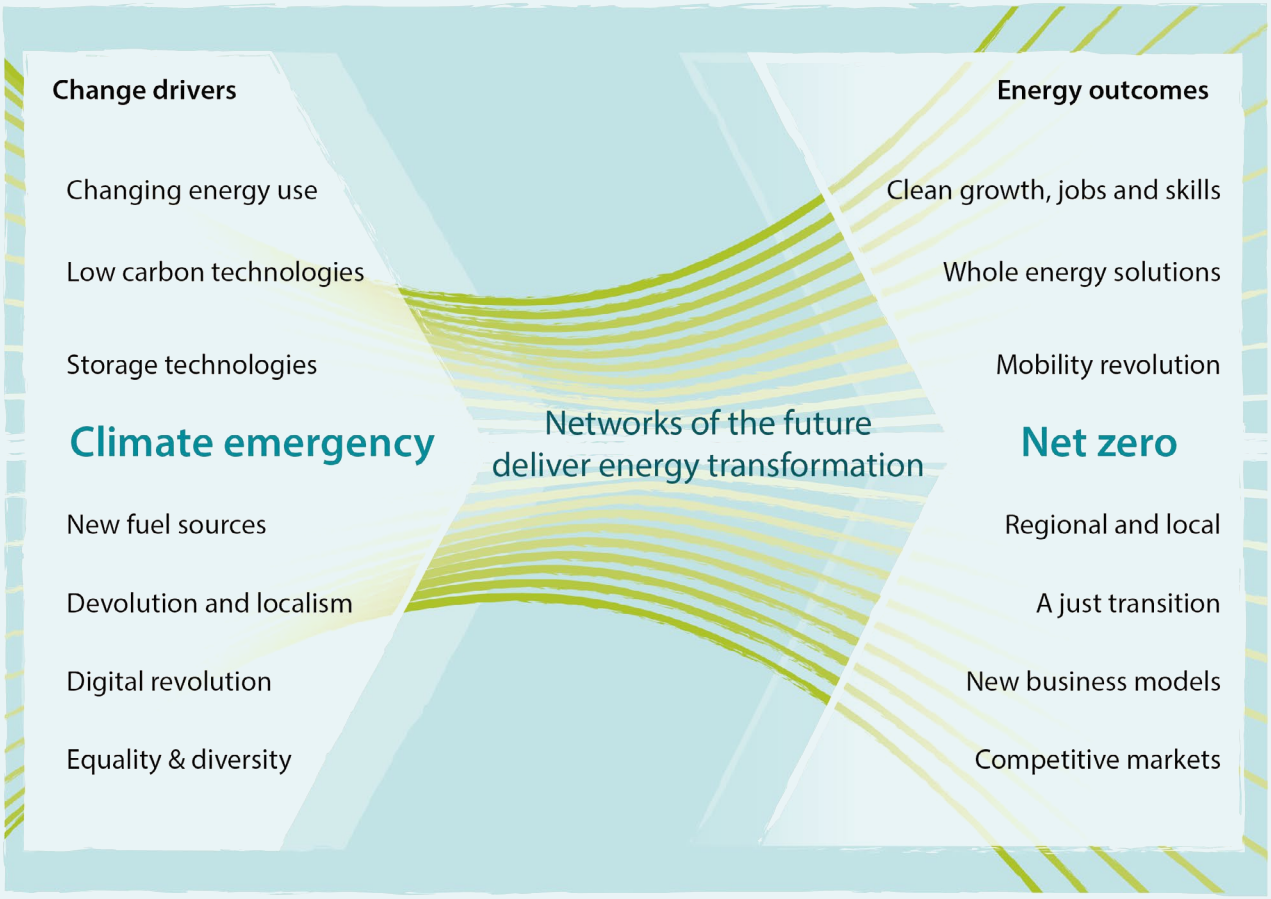
11 www.climateemergency.uk/blog/half-of-uk-local-authorities-declare-a-climate-emergency-in-just-eight-months

12 The amendment increases the ambition from an 80% reduction to net zero. www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law

2 The changing energy system

Energy will be at the heart of the UK's transition to become a net zero carbon economy. The transformation of the UK's energy system has already begun with the growth of renewable electricity generation and the demise of coal, but this is just the beginning of a much more profound and radical transformation of our whole energy system which must happen if the UK is to fully decarbonise.

Alongside the climate emergency, other disruptive factors will revolutionise how we generate, distribute and consume energy. Significantly, new digital technologies and innovative business models are enabling a smarter and more flexible energy system with a far greater degree of cross energy vector[13] integration, decentralisation and the provision of local energy solutions.



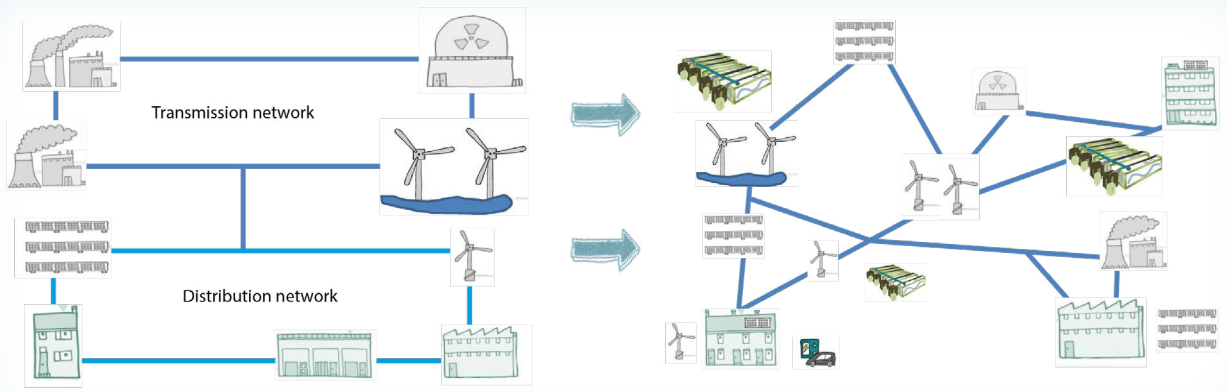
13 Cross energy vector: interchange in use of energy fuels and sources for power, heat, industrial process and transport

2.1 Changes in energy generation and demand

The transformation of the UK's energy system is already having a major impact on the energy networks, and in particular, the regional electricity distribution networks which have arguably experienced the greatest level of change.

2.1.1 Growth of decentralised generation

In terms of energy generation the most obvious change has been the growth of renewable energy generation capacity[14], and in particular, the increase in the amount of decentralised generation connected to the distribution networks[15].



There are now circa one million[16] individual renewable electricity generators in Great Britain ranging from 2-4 kW micro solar systems on individual houses to Hornsea 1, which at 1.2 GW, will be the largest offshore wind farm in the world. Alongside the increase of renewable generation there has also been an increase in the use of gas for power generation, particularly in the number of smaller gas generators including Open Cycle Gas Turbine (OCGT) plants and gas reciprocating engines and a very significant reduction in the use of coal for power generation.

Although there hasn't been the equivalent decentralisation in the supply of gas, the number of biomethane injection sites and volumes has increased, particularly in rural areas like the south west of England[17]. The opportunity to decarbonise gas, using green gas and hydrogen manufactured by electrolysis and steam methane reformation, could have a far reaching impact on the structure and utilisation of the gas distribution networks and increase the integration between gas and electricity networks.

14 44 GW of renewable energy capacity providing about 33% of the UK's power consumption www.gov.uk/government/statistics/renewable-sources-of-energy-chapter-6-digest-of-united-kingdom-energy-statistics-dukes Table 6.4.

15 Around 30% of generating capacity is now connected to the distribution networks http://fes.nationalgrid.com/fes-document Table ES1

16 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/822304/Chapter_6.pdf

17 There are currently 18 biomethane injection sites in WWU South West LDZ, supplying circa 1.7% of energy content compared to a national average of 0.4% - Regen DFES scenario analysis on behalf of WWU www.regen.co.uk/the-future-of-heat-and-the-role-of-gas-in-our-energy-system

2.1.2 Changing patterns of energy demand

Alongside changes in electricity generation, the last decade has seen a number of significant changes in energy demand. The overall demand for energy, both heat and power, has fallen, as has peak demand.

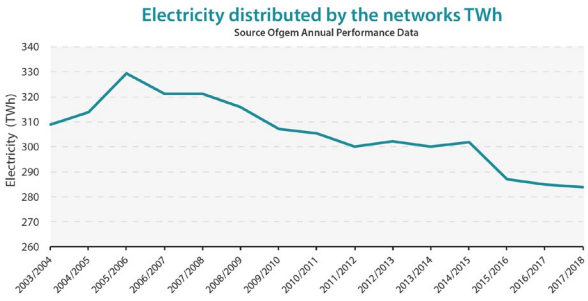


Figure 1 Electricity distribution in TWh since 2004, source Ofgem Annual Performance Data

Overall annual electricity demand has fallen by 12% since 2005/06 to around 300 TWh, of which 284 TWh is distributed to consumers by the regional networks[18].

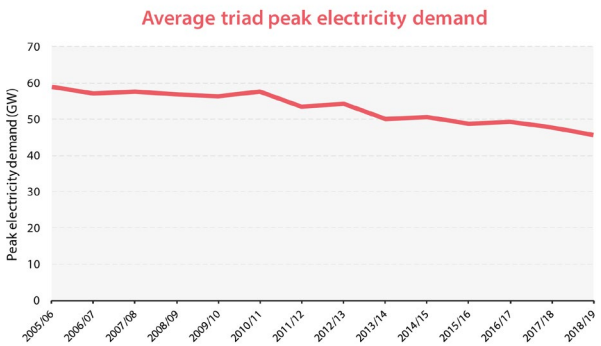


Figure 2 Average triad peak electricity demand, National Grid ESO Triad data

Peak electricity demand[19] has also fallen from a high of just under 57-58 GW before the financial crash in 2008, to a new low in 2018/19 of 46 GW.

The fall in electricity demand has been the result of a combination of energy efficiency, particularly from low energy lighting and new appliances, the continued de-industrialisation[20] of the UK economy, and the use of smarter demand management and on-site generation to avoid peak time energy charges. Consumers of energy are now better able to generate and store their own energy on-site and utilise smarter energy controls to avoid peak energy costs. Consumers, or prosumers, are becoming active participants in the smart energy system.

It is important to note that the fall in energy demand has not been evenly spread across the networks, with some networks experiencing a fall of up to 20% in electricity distributed, while others have seen much smaller reductions. The variation at sub-regional and at a local level has been even more dramatic with significant falls in demand in traditionally industrial areas, contrasted with demand increases in new areas of new economic development, new housing developments and service industries.

The fall in electricity demand is not expected to continue and, even with greater energy efficiency, the future projection is that demand for low carbon electricity will rise significantly in the next decade as UK consumers shift to electric vehicles for transport and the greater use of electricity for heating. The networks will therefore face a new challenge to meet the future rise in electricity demand, especially from householders on the low voltage network.

18 2017/18 Ofgem annual network performance reporting.

19 Measured by the Triad Peak demand measured on the Transmission network.

20 Service industries now make up 79% of the UK's economic output. ONS www.ons.gov.uk/economy/grossdomesticproductgdp/timeseries/abmi/pgdp

3 How the electricity networks have responded

The dramatic increase in distribution-connected electricity generation, and also the changes in both the load and geographic spread of demand, has had a very significant impact on the distribution networks. Networks designed to essentially distribute electricity out from central generators are now having to deal with a much more diverse and decentralised energy system with bi-directional flows from new wind and solar farms.

Given the level of change, the rapid connection of over 45 GW of renewable electricity to the UK energy system, while at the same time maintaining high levels of customer service and network resilience, should be seen as a significant achievement.

The distribution networks, and in some areas the transmission networks, have however been experiencing increasing levels of constraint, particularly with regard to the connection of new generation assets such as solar PV and wind. In some areas this has led to increased connection costs to pay for network reinforcement, which can become a virtual moratorium on new connections.

Similar examples can be found around the UK including the constraints faced by Scottish islands and wind farms in the highlands, the current National Grid restrictions on new thermal plant in South Wales and restrictions on solar generation on the Isle of Wight.

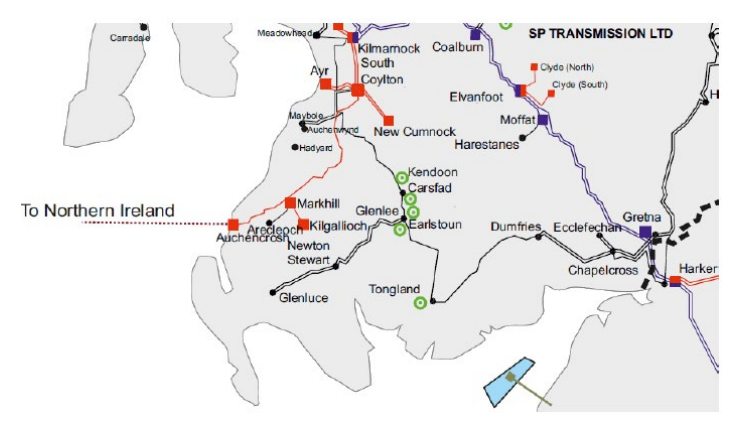
In almost all parts of the UK there are now constraints and/or high costs to connect new generation (or storage) capacity in areas where there is significant renewable energy resource. Under the current regulatory model networks are effectively prevented from making pre-emptive investments to support increased levels of renewable generation and the cost of network upgrades are borne by each generation project.

As well as slowing down the deployment of renewable energy projects, network and transmission level constraints will have an increasing system cost in terms of electricity curtailed from the system.

3.1.1 Actively managing networks constraints

There are however, ways in which the networks can mitigate constraints. Although there are clearly instances of physical constraint, capacity constraints are quite often the result of contractual commitments, risk avoidance and how the reservation of network capacity is currently operated.

In many cases, ways can be found to free up capacity if a more proactive approach is taken to managing the network and the requirements of different network customers. This can be done, for example, by providing alternative types of connection agreement and through Active Network Management (ANM) schemes which allow generators and demand customers with synergistic load profiles to share capacity.



An example of ANM in action is the ARC project on the SP Energy Networks distribution network in Dumfries and Galloway, which has enabled three new onshore wind farms and an energy from waste project, totalling 50 MW, to connect to an otherwise constrained network under the Dunbar Grid Supply Point (GSP).

Although ANM is becoming more common, it is still generally the case that network operators take a precautionary, worst case scenario, approach when managing constraints. Moving to a more value-, or market-based approach would require better actual and forecast data and a much better understanding of local and regional energy loads, as well as new commercial and regulatory models that allowed network operators to facilitate capacity trading.

Changes in the way the networks are charged[21], with respect to connections and network use, could also have a significant impact to allow more capacity to connect in the right locations to optimise the system.

ANM is just one example of the more proactive role that could be undertaken by the networks to reduce costs, optimise asset utilisation and deliver whole system solutions. This new role is discussed in more detail in section 9 of this paper.

3.1.2 Regional forecasting, planning and stakeholder engagement

The rapid changes in supply and demand, and the uncertainties this has introduced, has forced the distribution networks to become much more sophisticated in how they forecast and plan for the energy loads on the network. For example, Western Power Distribution's experience of the rapid increase of solar PV in the south west led to creation of a new function now specialising in developing highly evidence based network investment plans[22] using scenario forecast data provided by Regen. Other distribution networks have also increased their forecasting and planning capability including the development of distribution level future energy scenarios (DFES).

The operators of both gas and electricity networks are now improving the way in which load forecasting and network planning analysis is conducted. Innovation has included using Geographic Information System (GIS) and socio-economic data to develop much more granular and evidence based load forecasts at sub-distribution network levels[23] to stress test different system outcomes.

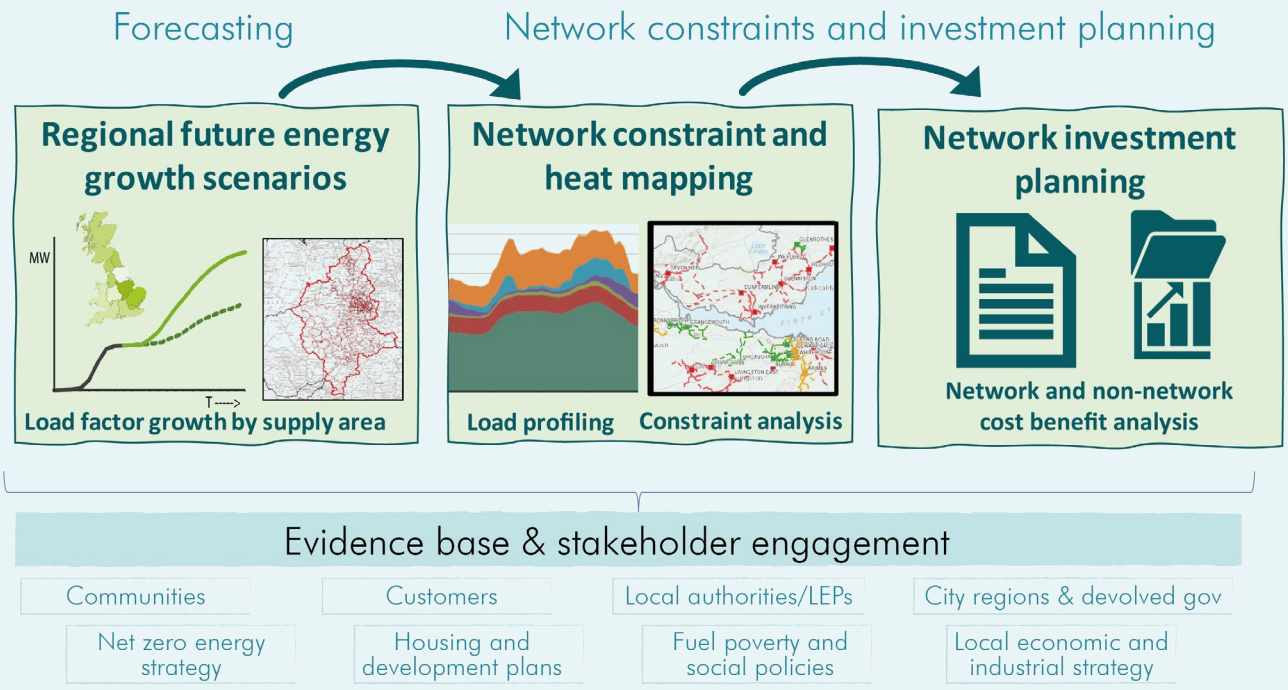
21 See Ofgem Network Charging Review www.ofgem.gov.uk/publications-and-updates/targeted-charging-review-minded-decision-and-draft-impact-assessment and www.ofgem.gov.uk/electricity/transmission-networks/charging/reform-network-access-and-forward-looking-charges

22 See WPD hwww.westernpower.co.uk/smarter-networks/network-strategy/strategic-investment-options-shaping-subtransmission

23 Regen has been working with a number of electricity and gas networks to create distribution level future energy scenarios (DFES). See www.regen.co.uk/area/local-future-energy-scenarios

While developing local forecasts, the networks are also engaging much more closely with regional stakeholders, including local authority planners, developers and energy users, to understand how the demand and supply of energy within their network areas is likely to change over time to meet regional energy and economic objectives.

The communication of network constraints has also greatly improved with the widespread use of GIS and network heat maps to inform customers of where there is a constraint or an opportunity created by over-capacity in the network.



3.1.3 Harnessing new forms of energy flexibility

Enabled by digital technology, smart applications and new trading platforms, new ways to harness energy flexibility are now being developed, trialled and introduced as commercial models. The falling costs of large scale batteries have already had a significant impact on the provision of grid balancing services such as frequency response and have helped to reduce the cost of these services to maintain system operability by 60%[24]. It is estimated that the UK now has over 600 MW of battery storage installed, and could see 12-14 GW of energy storage technologies by 2030.

Other forms of flexibility, like the ability to adjust demand to respond to dynamic price signals, or use smart charging technology to ensure that EVs are charged at optimal times to take advantage of lower costs energy and reduce local grid constraints, will help to reduce energy price volatility and provide additional energy security.

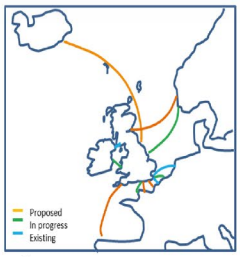
At the other end of the scale, interconnectors to Europe open the possibility of increased integration with the continent that would allow, for example, surplus electricity generated by wind in Scotland to displace coal generation in Poland.

24 National Grid ESO - Dynamic frequency response auctions have fallen to circa £6-7/MWh in 2019

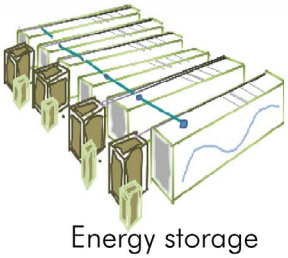
Distribution network operators (DNOs) are already tapping into the potential of flexibility[25] through tenders for flex service as an alternative to investing in network asset infrastructure. The use of flexibility tenders, to secure either generation or demand response capacity to mitigate the risk of grid constraints is now a key part of the network operator's armoury and could herald the start of more dynamic and widespread flexibility markets.

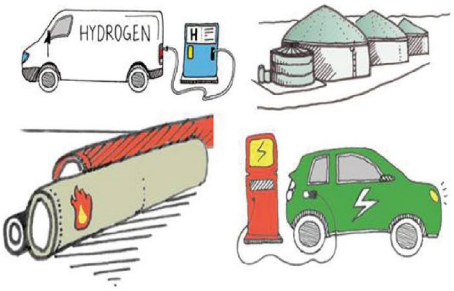
However, providers of flexibility assets and services need, like any other energy service investor; access to a market, a supportive policy and regulatory environment and a line of sight to future revenue streams. A big question is whether these new flexibility markets and business models can be scaled up to address the UK's net zero challenge.

Regen research[26] has confirmed that community energy groups and other local stakeholders are interested in offering flexibility services, but their main driver to do so is to allow more low carbon energy generation to be used locally. They are less interested in deferral of network investment, and the idea of using fossil fuels as flexible plant is an anathema to their decarbonisation goals. It is disappointing therefore that, to date, the majority of local flexibility auctions have been won by diesel and gas generators, while the main focus has been to address the risk of demand constraints and not to free up capacity for low carbon generation. This should change in future as the market for flexibility develops, and if the options appraisal methodology is weighted to support explicit decarbonisation objectives and support of the UK's smart and flexible industrial strategy.

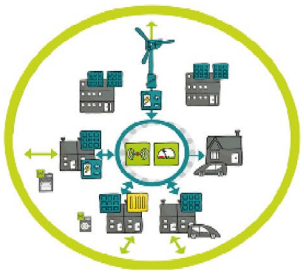


Interconnection


Energy storage



Multi-vector energy integration


Local energy markets and capacity trading


Demand side response

25 See for example those flex tenders that have been run on the Piclo platform which (as of Sept 2019) tallies 4.5 GW of flex volume provided by 200 flex providers. See https://picloflex.com/

26 Regen 2019 "Power to Participate: A specification for community energy to participate in a flexible energy system" www.regen.co.uk/wp-content/uploads/P2P-Specification-for-community-energy_Sept19.pdf

The Future for Energy Networks

Image credit: By Paul Cuffe - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=70226122

4 Challenges to the current regulatory model

The energy networks have played a significant role to support the reduction in carbon emissions achieved to date. The changes that have happened in the last decade are, however, only the start of a much more radical transformation of the energy system as the UK transitions to a net zero carbon economy.

It is therefore understandable, and indeed positive, that policy makers, politicians and wider stakeholders are asking the question of whether the current market model is fit for purpose. Several alternative policy proposals have been put forward to address the fundamental question of how the industry can deliver the innovation and scale of investment that is needed to achieve net zero decarbonisation and wider societal objectives, without losing the efficiencies and innovation that has been introduced by the private sector.

4.1 Alternative views on the regulatory model

4.1.1 Renationalisation

One potential approach to deliver this transformation is to renationalise the networks into a form of public ownership where they can be directly financed and managed for the public good in order to deliver decarbonisation and "equitable decentralisation".

The 'Bringing Energy Home' paper[27], published in May 2019, argues that energy privatisation has failed, and that the use of the profit motive in a strategic industry with so much social value is fundamentally wrong. Instead it is argued that publicly owned networks would provide better value for money, and allow the industry to deliver societal objectives, such as decarbonisation. This represents the new renationalisation push within the Labour Party, and sits alongside other proposals to nationalise water utilities and public transport.

> Only by taking the grid into public ownership can we decarbonise the economy at the pace needed to secure the planet for our children and grandchildren while ending the rip off, creating good jobs in local communities and making heating and electricity a human right.
>
> **Rebecca Long-Bailey, Labour shadow business secretary, May 2019**

The nationalisation argument is underpinned by a strong push for greater levels of economic democracy and participation, a just transition and the principle of subsidiarity, where decisions are taken as closely as possible to citizens, workers and communities.

27 "Bringing Energy Home" Labour Policy Paper May 2019 www.labour.org.uk/wp-content/uploads/2019/03/Bringing-Energy-Home-2019.pdf

4.1.2 Public investment, regulation and intervention

A broader suite of policy proposals, which have been put forward by a number of organisations and political parties under the banner of a Green New Deal, proposes an industrial strategy centred around large scale public investment, regulation and a comprehensive programme to accelerate the transition to low carbon technologies.

Although with less focus on renationalisation of existing network assets, the "green industrial revolution" would support a greater degree of state and public intervention at both a national and regional level. Labour's version of a green new deal suggests "a state-led programme of investment and regulation for the decarbonisation and transformation of our economy that reduces inequality and pursues efforts to keep global average temperature rises below 1.5°C"[28].

The argument for a form of mixed-economy, co-investment model, is in part a recognition that, without providing the very high returns that have driven investment in fossil fuels, some form of public investment will be needed to de-risk and crowd-in the enormous investment needed to achieve net zero[29].

Under a green new deal, public sector and community co-investment in new energy assets is seen as a catalyst for energy transformation. Greater public investment, and opportunities for wider ownership, could be achieved through a re-established green investment bank and new financial products that would enable individuals and smaller investors to invest in large renewable energy assets such as offshore wind farms. Municipal co-investment in heat networks, energy efficiency, EV charging networks, energy storage and new energy network assets would be encouraged where there is a market failure or public good benefit.

4.1.3 Market deregulation and competition

At the other end of the policy spectrum there have been calls for the radical deregulation and liberalisation of the energy sector, with less focus on societal outcomes, to unleash the power of the free market. This would allow competition and the market, even to the point of attempting to break up the networks, to dictate levels of investment and services to deliver a more cost-efficient energy system.

Criticism of the current regulatory model, from economists such as Dieter Helm, has focused on the challenge the regulator faces in trying to balance levels of investment, returns made by networks and the cost to the consumer.

> 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.
>
> **Helm, Cost of Energy Review 2018**[30]

28 Labour For a Green New Deal https://labour.org.uk/press/rebecca-long-bailey-speaking-labour-party-conference/

29 See for example Nick Butler FT opinion piece, 29 October "The private sector alone will not deliver the energy transition".

30 Dieter Helm Cost of Energy Review 2018 – especially Chapter 8 on Networks www.gov.uk/government/publications/cost-of-energy-independent-review

Helm's conclusion is that; "Periodic reviews should be abandoned […] A better approach would be to accept that this is a hopeless task". Instead it is argued the role of the regulator should be to maximise competition within an overall policy framework.

While regulating natural monopolies is clearly difficult, many in the industry disagree with the assertion that the current model has hopelessly failed. The Energy Networks Association (ENA) has put up a strong defence of the current model arguing that the RIIO[31] periodic price control "has been positive for consumers and has more strongly aligned network companies with the interests of their customers and stakeholders. We don't agree that it should be replaced when the RIIO-1 periods end."

4.1.4 Open, smart, clean and flexible networks

Working with the industry, policy makers in the Department for Business, Energy and Industrial Strategy (BEIS) and Ofgem have launched a series of policy papers and consultations on the theme of creating a new smart, flexible and clean energy system[32]. This has led to a wide range of policy and regulatory initiatives including the Open Networks Project[33], Power Responsive[34] and a number of policy consultations looking at the future of network access and charging.

While not proposing to radically change the current regulatory model they do present a new vision that networks of the future, enabled by digital technology, will:

- 'remove barriers to smart technologies',
- enable 'smart homes and businesses',
- and 'make markets work for flexibility'.

A critical part of the new smarter energy system envisaged by BEIS and Ofgem is the development of a new set of DSO functions to optimise the network using both network and non-network assets. The role of a more expansive DSO function could be extended further to optimise network utilisation across whole energy system vectors and to maximise support for decarbonisation and low carbon technologies.

4.1.5 Strategic investment and public confidence

Adding to the debate, the National Infrastructure Commission (NIC) has published a new report entitled 'Strategic Investment and Public Confidence'[35], that looks at how energy, water and telecoms infrastructure is regulated in the UK.

31 RIIO "Revenue = Incentives+Innovation+Outputs" periodic investment, price and revenue review process For a more complete explanation of the RIIO model see https://www.ofgem.gov.uk/system/files/docs/2017/01/guide_to_riioed1.pdf

32 Eg see Upgrading Our Energy System Smart Systems and Flexibility Plan July 2017 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/633442/upgrading-our-energy-system-july-2017.pdf

33 Open Networks Project managed by the ENA www.energynetworks.org/electricity/futures/open-networks-project

34 Power Responsive programme managed by National Grid ESO http://powerresponsive.com/

35 National Infrastructure Commission www.nic.org.uk/wp-content/uploads/NIC-Strategic-Investment-Public-Confidence-October-2019.pdf

Although the NIC does not suggest the complete abandonment or wholesale change to the existing regulatory model, the NIC report presents a compelling case that the regulator model needs major reform to ensure better strategic investment and to regain the trust of public and consumers.

> The current regulatory system has generated investment and improved performance. But the system was not set up to provide strategic direction for investment to tackle issues such as achieving net zero greenhouse gas emissions by 2050, transitioning to full fibre digital networks, and managing the increasing risks of floods and drought.
>
> **NIC October 2019**

The NIC report in particular highlights the scale and level of change that will be required to achieve net zero carbon and makes a number of recommendations which were also identified during stakeholder interviews for this paper.

These include the need for regulators to "consistently consider vital, long-term factors such as resilience and environmental impact, which cannot be left completely to the market", the need for a new approach to manage the delivery of long term strategic investments and the greater need for infrastructure providers to work with regional and devolved bodies.

4.2 What do we want the networks to deliver?

Across the broad spectrum of policy options, there is a large degree of consensus in terms of what outcomes and objectives the energy system of the future should deliver. As well as least cost decarbonisation, there is also a positive focus within the industry around questions of energy justice, equality, environmental protection, transparency and workforce diversity. Critically, there is a clear understanding that public trust and the consumers' willingness to embrace change must be maintained.

4.2.1 Regulatory reform not renationalisation, nor a reliance on the market

A consistent message from the stakeholders interviewed was that the current regulatory model requires significant reform to bring forward the scale of infrastructure investment, non-network solutions and innovation needed to meet the net zero challenge, while also maintaining an affordable and resilient energy system. However there was also a view that neither a blunt recourse to renationalisation, nor a simple reliance on a deregulated free market, will achieve this.

There is a recognition that the public sector has a critical leadership role to play, through strategic policy leadership, regional governance and targeted intervention. Public/private co-investment may also be an effective way to support new technologies and to address market failure and other economic and social objectives. Renationalisation however, if in the form of a reversion to central state ownership, would not necessarily achieve this, and risks undoing the cost efficiencies and service improvements that have been achieved over the past decades.

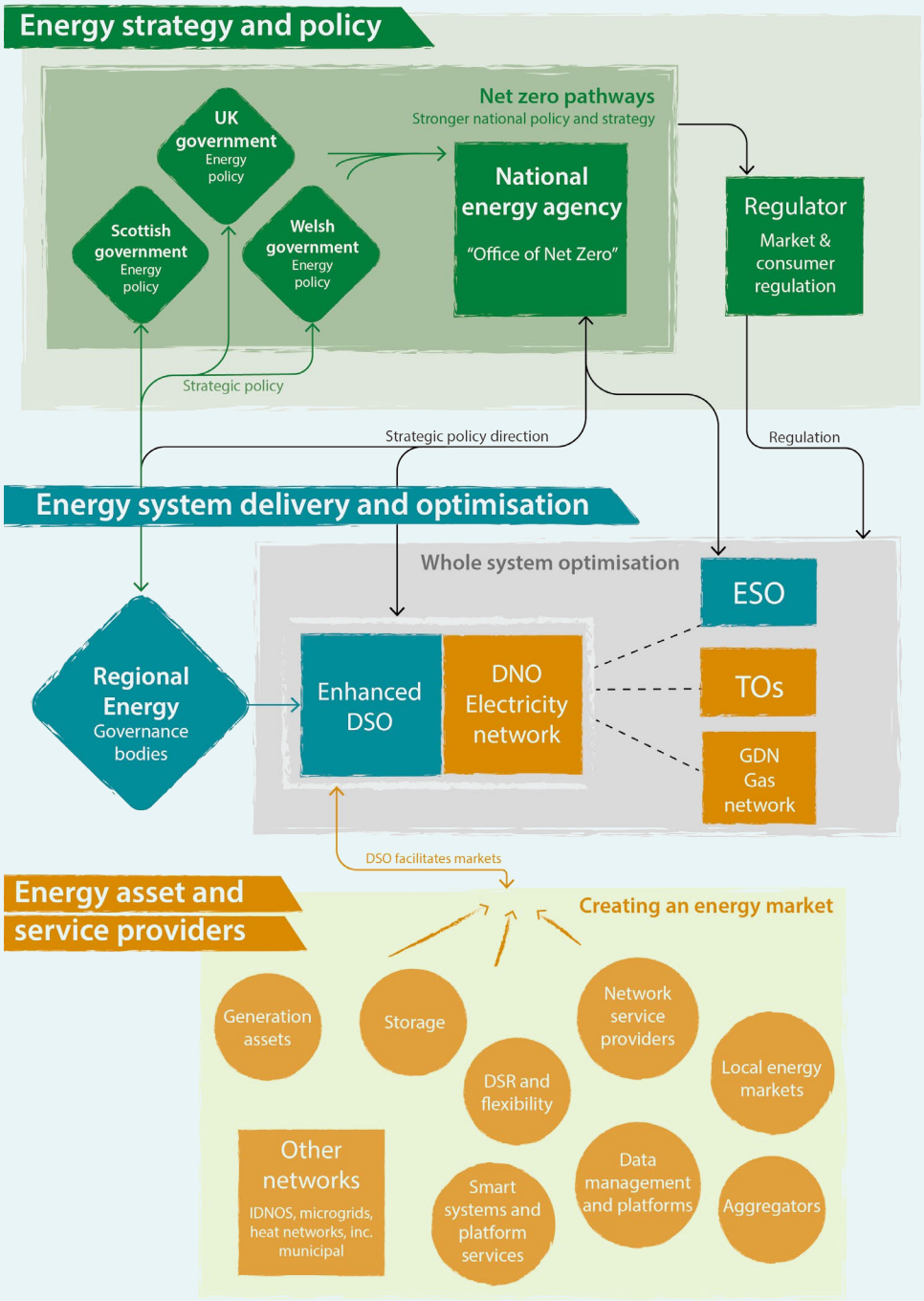
Equally there was a strong view that, while the energy system would benefit from more competition at every level, the energy networks cannot be treated as a "free" market. Reliance on a simple deregulated profit motive, without significant regulatory and policy intervention, would not deliver an optimal energy system that serves all consumers, wider societal goals or the strategic investment needed to achieve net zero.

The question of ownership may therefore be less important than the ability of the public and private sectors to work together in a new partnership to innovate, develop smarter solutions and secure long term investment. Without a clear strategic direction however, there is a risk that the industry could stagnate around the defence of the status quo, or be distracted by largely political and academic arguments that could create an investment hiatus and slow the transition to a low carbon economy.

A better approach, which this paper supports, would be to continue a constructive dialogue to build a consensus about the future of the networks, based around the objectives and outcomes we want the energy system to deliver and how this is best achieved.

5 A sketch of a future network governance model

It is beyond the scope of this short study to propose in any detail a new regulatory model for the electricity distribution networks, but through the course of the stakeholder interviews a number of core elements which could underpin a new governance model were highlighted. We have called this a sketch of a future network model only, the detail of the relationships and roles of a new regulatory model would have to be explored and analysed in detail.



National agency or office for net zero carbon

The net zero carbon amendment to the Climate Change Act 2008 has put the UK in a leadership position in terms of its declared decarbonisation commitment. There remains, however, a significant execution gap between the UK's ambitious decarbonisation targets and the energy strategy, policies and investment needed to deliver them.

The Committee on Climate Change has strongly argued that a net zero target is achievable, but has also consistently highlighted the lack of a joined up and credible strategy to meet the previous carbon budget targets and an even bigger gap to meet net zero.

> A net-zero GHG target for 2050 will deliver on the commitment that the UK made by signing the Paris Agreement. It is achievable with known technologies, alongside improvements in people's lives, and within the expected economic cost that Parliament accepted when it legislated the existing 2050 target for an 80% reduction from 1990.
>
> However, this is only possible if clear, stable and well-designed policies to reduce emissions further are introduced across the economy without delay. Current policy is insufficient for even the existing targets.
>
> **Committee on Climate Change 2019**[36]

The delays in publishing an energy white paper may in part be explained by the Brexit morass, but is also a symptom of the ongoing poor coordination between government departments and the other agencies that share responsibility for economic transformation.

The declaration of a climate emergency requires the creation of a new "national energy agency" or "office of net zero". This body would be tasked to develop and implement a long term energy and decarbonisation strategy to deliver the government's energy policies, with the political backing to drive net zero carbon action across government departments, devolved governments, cities and regions.

Regulator to protect the consumer and for a sustainable future

A clear national energy strategy would then allow Ofgem to focus on its core regulatory role; to protect the consumer, to oversee the regulated market including competition, performance, budgets and investment, and provide market framework and code regulation.

Regen also agrees with the conclusion drawn by the NIC and a view long advocated by industry, that the regulators role and remit should be strengthened with "a direct duty to consider the government's long-term policy commitment of achieving net zero greenhouse gases by 2050[37]" and an increased focus on long term sustainability of the energy system to achieve societal outcomes.

36 Committee on Climate Change: Net Zero The UK's contribution to stopping global warming https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf

37 NIC Strategic Investment and public confidence October 2019 www.nic.org.uk/wp-content/uploads/NIC-Strategic-Investment-Public-Confidence-October-2019.pdf

Regional energy governance

Energy and the climate emergency have become priorities for devolved governments, regions, cities and local communities. Their commitment is essential to deliver the transformational change that will be needed.

> Achieving net-zero overall requires an integrated set of policies throughout the UK, which make the most of the attributes of each of the UK nations.
>
> **Committee on Climate Change 2019**

Networks can play a key role to support energy devolution and local climate change action, as well as regional economic growth and social issues linked to air quality, health, energy poverty and vulnerability that have always been high on the local energy agenda. Increasingly networks will also be asked to address issues under the banner of just transition to ensure that workers and consumers are not left behind in the low carbon economy.

In order to do this, UK regions should have a more formal governance role over the future of critical infrastructure, while the regulatory model should allow and encourage the networks to be more responsive to local energy priorities.

Establishing regional governance bodies, which could be defined by licence areas or based around the emerging city regions, would help build public trust and engage local stakeholders, and also allow the networks to leverage the investment potential of regional economic plans and industrial strategies[38].

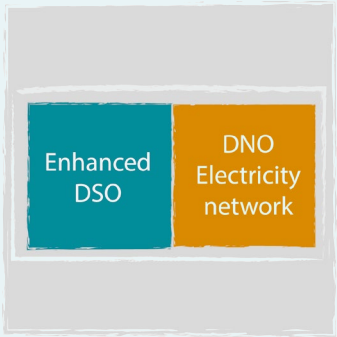
Regional governance bodies could also play a role to bring together a wide range of regional stakeholders, provide budgetary and investment planning oversight and ensure that cost efficiencies are tied to local energy priorities.

An important caveat made by a number of stakeholders was to be careful that regional governance did not muddy the waters in terms of accountability. Clear lines of reporting and responsibility for cost and price control would have to be established with Ofgem.

38 See for example Bristol City Leap - £24 billion investment in energy infrastructure.

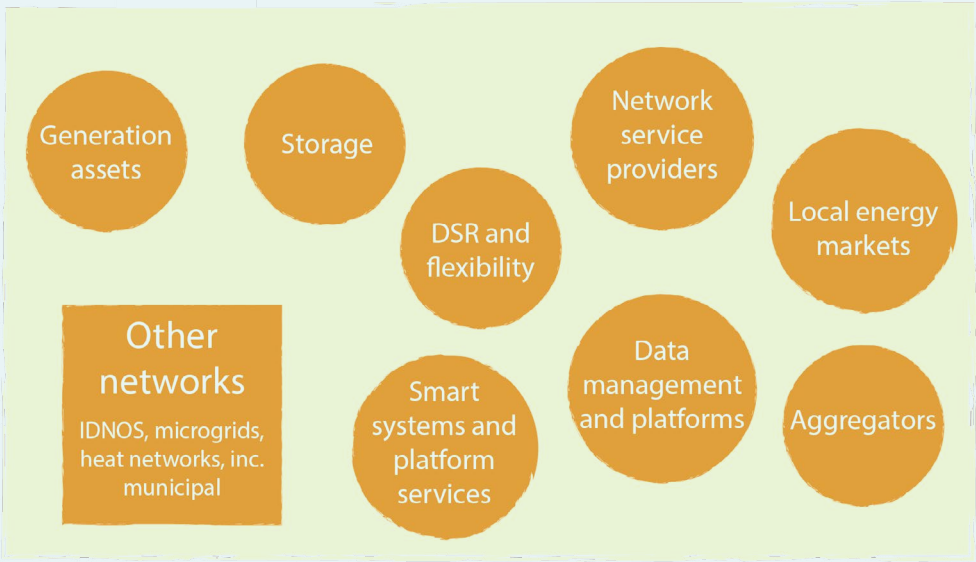
Expanding the DSO role

The current slow evolution towards a smarter and more dynamic energy system needs to be accelerated. This could be achieved by radically expanding the DSO role to work with regional partners to deliver wider energy system objectives including decarbonisation at least cost. This would encourage DSOs to fully exploit digital and smart technology to increase consumer value, and to identify energy system optimisation opportunities including; increasing asset and capacity utilisation, facilitating new flexibility markets and business models, while ensuring whole system resilience and optimisation across energy vectors. The role of the DSO is discussed further in Section 9.



Creating new open markets for low carbon energy solution providers

The new model must foster and allow new markets to develop for the provision of energy solutions and services. This can be achieved by setting a clear and consistent net zero strategy, and then creating a transparent and neutral market for new entrants, bringing new technologies and new business models, to offer competitive services.



6 Meeting the net zero carbon challenge

With a new regulatory governance model in place, networks would be enabled to bring forward strategic investment and work in partnership with regional and local stakeholders to respond quickly to changing customer needs.

The networks have a critical role to play to enable the UK to meet the net zero carbon challenge which, with the amendment to the Climate Change Act 2008 enacted in summer 2019, has now become a legally binding commitment.

A significant amount of investment in new technology, innovation and new infrastructure will be needed. The Committee on Climate Change modelling suggests that annual capital investment in the power sector infrastructure may rise to £20 billion per year to achieve net zero by 2050, almost double the current investment[39].

However, it is also clear that simply increasing expenditure, and therefore consumer bills, cannot be the answer. The networks need to become smarter, more integrated, more flexible and crucially open to new business models in order to increase productivity and optimise the use of both network and non-network assets to deliver a system that is both affordable, secure and resilient and resilient.

The networks cannot operate in isolation. The new energy model must encourage whole energy solutions that integrate and optimise the supply of energy for heat, power and transportation. Networks must also work with, and enable, other actors in the new economy including devolved governments and regional bodies that are charged with delivering wider economic and societal change.

Our analysis and supporting recommendations have focused on 5 main challenges or objectives, which encapsulate how the electricity distribution networks must respond to meet the decarbonisation challenge and to continue to deliver an energy system that is both resilient and affordable.

39 Committee on climate change www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming

Energy network challenges and opportunities

Putting the zero carbon challenge at the heart of energy policy

Enabling a local energy revolution

Building smarter, optimised and secure networks

Making strategic investments, managing incentives and risk

Delivering affordable energy, great service and customer value

Ensuring a just transition

7 Embedding decarbonisation within the network model

The UK has shown global leadership in terms of its declared net zero decarbonisation commitment. There remains however a significant execution gap between the UK's ambitious targets and the implementation plan and strategic investment that is needed to develop them. Several industry stakeholders highlighted that the absence of a clear decarbonisation pathway and strategy is a fundamental barrier to transformation.

As well as the need for a more joined up strategic approach to decarbonisation at a national level there is an urgent need to ensure that decarbonisation outcomes and objectives are embedded throughout the network regulatory model.

7.1 Setting decarbonisation objectives and outcomes within the regulatory model

While there continues to be a debate about whether the government has given Ofgem a sufficient climate change mandate, in recent months there has been a definite shift in language from within Ofgem. Ofgem chair, Martin Cave[40], in particular, has highlighted that the regulator should have a bigger role in the delivery of decarbonisation.

In response, Ofgem is consulting[41] on how the RIIO price control framework might be reformed, and specifically how "price control should be set in the context of an increased focus on decarbonisation, digitalisation, and decentralisation". It is also positive that Ofgem has issued an open letter that asks the networks to "clearly propose and evidence how their Business Plans are able to flex to support achieving the Net Zero target in line with a range of such pathways"[42] and to consider how strategic investment ahead of need "may provide additional optionality or cost-efficiencies for achieving pathways to the Net Zero target".

There is still a tendency however to talk in general terms about supporting the low carbon transition without yet setting explicit and measurable objectives and outputs against which the networks can be measured and incentivised.

With the business planning phase of RIIO 2 price control period already underway there is an urgency now to ensure that decarbonisation objectives are embedded within the regulatory model at an operational level. That means setting explicit decarbonisation objectives, outputs, performance measures and incentives within the RIIO framework and updating the business planning guidelines that have been issued to incorporate them.

40 See for example Martin Cave speech June 2019 www.ofgem.gov.uk/system/files/docs/2019/06/martin_caves_speech_at_utility_week_energy_summit_2019.pdf

41 Ofgem Open letter Consultation on approach to setting the next electricity distribution price control (RIIO-ED2) www.ofgem.gov.uk/system/files/docs/2019/08/open_letter_consultation_on_the_riio-ed2_price_control.pdf

42 Ofgem Open Letter to networks on achieving net zero www.ofgem.gov.uk/system/files/docs/2019/08/letter_to_networks_on_achieving_net_zero.pdf

7.2 Changes in the regulatory philosophy

The current regulatory philosophy, with a clear focus on creating efficient markets, ensuring neutral playing fields and bearing down on expenditure, has helped to reduce costs and improve services for current consumers.

It is ill-suited, or perhaps insufficient, however, to deal with the sort of transformational changes and uncertainties that must be addressed to achieve net zero. The emphasis that is placed on avoiding regret cost, the fear that investment may in some way be wasted, has created a very conservative approach to evaluating network business plans and investment proposals. A good example of this can be found in the guidelines that have been issued to gas distribution companies, which effectively preclude investment to support future decarbonisation technologies on the basis that the future is uncertain[43].

Finding and developing the right pathway to decarbonisation, given the level of uncertainty and critical decision points that must be taken, is difficult and involves risk. There may well be investments made which transpire to have been wasted, fracking is already a good example, and some of the early generation of smart meters (SMETS1) which lost functionality on supplier switching.

The Committee on Climate Change[44] has highlighted the need to "act now to keep long-term options open". This doesn't mean adopting a cavalier approach but it does mean being prepared to back investments for long term optionality even at the risk of incurring short-term costs.

In a similar vein the NIC has recommended that "where upgrades to our networks are needed Ofgem should continue its work in encouraging network companies to make long term strategic decisions. Whilst this does increase the risk of stranded assets, the Commission believes that if there is a potential net gain to future consumers then this approach may be justified. If network owners are not best placed to manage this risk, they should work with third parties to help facilitate these investments[45]."

It's difficult to do this without a coherent national net zero strategy, however there is now an opportunity under RIIO 2 to encourage the networks, their stakeholders and policy makers to address the net zero challenge. It would make sense therefore that a net zero scenario (or scenarios) form the basis of the RIIO 2 core business planning assumptions to allow networks to consider different decarbonisation pathways. Even if this then highlights areas of uncertainty and delivery challenges, it will then allow policy makers and other stakeholders to confront those issues.

43 Regen www.regen.co.uk/ofgems-investment-guidelines-highlight-the-need-for-a-clearer-decarbonisation-mandate

44 Committee on Climate Change www.theccc.org.uk/publication/reducing-uk-emissions-2018-progress-report-to-parliament

45 NIC Smart Power www.nic.org.uk/wp-content/uploads/Smart-Power.pdf

8 Enabling a local energy revolution

Devolution, energy localism and the climate emergency are changing the way people and communities consider energy and the demands they make of the energy networks. There is a fantastic opportunity here to harness the energy, commitment and capability of local energy to accelerate the energy transformation.

Previous chapters have addressed the changing picture of the distribution networks and the incredible growth of community and local energy projects has been well documented. The revolution in local energy has taken a number of forms including local supply, community energy, local energy strategies, innovation hubs and local energy markets. Suffice to say, local energy is now one of the biggest drivers for innovation and change in the industry.

The wave of climate emergency declarations and adoption of ambitious net zero targets in devolved governments, local authorities, cities and towns have also increased the emphasis on local action. These movements are also closely tied with the concepts of a just transition and social justice which are gaining traction and will require local implementation. The role energy networks have to play in these movements will be discussed further in section 12.

8.1 Harnessing local and regional capability

All of the stakeholders interviewed highlighted the key role that networks must play to enable local and regional partners to achieve their decarbonisation and wider energy objectives. In many respects the networks are already heavily engaged with local stakeholders through the regional planning process, customer engagement groups, energy strategy development, and the work being undertaken to support energy efficiency measures, community energy groups and vulnerable customers.

The networks have also engaged with communities and other public and third sector organisations to support local energy initiatives and new network innovation projects. A great example of this is the engagement activity supported by the Energy Networks Association to increase participation in innovation projects[46], which has resulted in a number of excellent case studies on how communities can actively participate in network innovation projects.[47]

46 Engaging Communities in Innovation www.regen.co.uk/wp-content/uploads/Engaging_Community_in_Network_Innovation_WEB.pdf
47 Community Network Innovation Case Studies www.regen.co.uk/wp-content/uploads/Community_Network_Innovation_Case_Studies.pdf

8.2 Supporting energy devolution

A consistent theme however, from our stakeholder interviews, was the need for networks to be further empowered to work with regional partners to deliver local energy priorities, and therefore the need for a more decentralised energy governance model which can be responsive to the local energy agenda.

While the local energy movement has been supported by the networks and has now become an integral part of how the networks operate, the current regulatory model is still largely based on a very centralised governance model.

Several of our stakeholder interviewees highlighted the issue that although networks can engage with, and gather evidence to support, local stakeholder priorities (including their net zero and energy strategies) the final reality is that business plans are ultimately approved through Ofgem in accordance with Ofgem's national objectives and guidelines.

This centralised governance and approval process applies to the RIIO process and also to the acceptance of reopeners and uncertainty mechanisms by which networks might apply to change their investment and business plans to support regional energy priorities.

There is a tension therefore between the need to engage with regional stakeholders and the ultimate ability of networks to respond to local priorities. Inadvertently this tension, and the perception that the networks are therefore unresponsive to local need, is one of the factors that is fuelling calls for renationalisation and the creation of a more regionalised energy system.

As energy devolution continues, the current model will need to adapt. A new form of regional governance structure, which would require the devolution of some of the regulators budget review and approval process, is almost certainly needed.

Networks should be enabled to work with local and regional partners to support the further devolution and democratisation of energy so that cities, regions and communities can achieve local energy priorities.

8.3 Future energy governance

Greater levels of regional network planning and stakeholder engagement are now already being undertaken but could be improved by:

- A regional governance body to provide formal representation for regions to assist and oversee the development of network business plans and investment planning, set network priorities and to play a key role in the monitoring of delivery performance.
- Measures to allow networks (through the price control and investment appraisal processes) to reflect local and regional priorities, and to enable regional stakeholders to deliver their decarbonisation and socio-economic strategies.
- Devolution of some governance functions from Ofgem to regional bodies while maintaining clear lines of accountability and reporting.
- Support for co-investment and risk sharing models where regions wish to push ahead with more ambitious decarbonisation plans, address equitability issues or to support regional growth strategies.

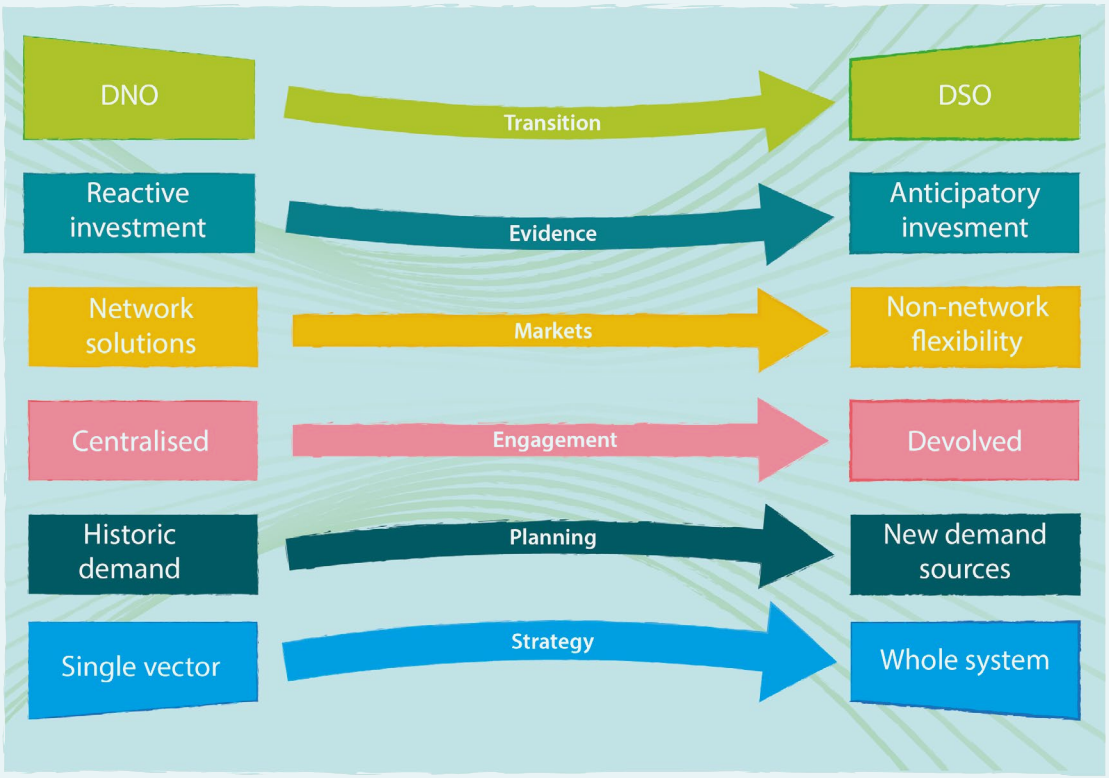
9 Building smarter optimised networks

9.1 Evolution of the Distribution System Operator role

A huge amount of work is currently underway[48] within the industry to redefine the role that the networks could play to increase the efficiency and optimisation of the whole energy system. The first building blocks for this wider role, including regional forecasting and stakeholder engagement, acquisition and management of data, active network management and the introduction of flexibility tenders, have already been described in Section 3. This is leading to a new way of thinking about the role of the network operator; to optimise the use of network and non-network assets and to facilitate new flexibility and local energy markets.

The previous role of the DNO was primarily concerned with the safe, secure and cost effective operation of network assets. The DNO's main function was to plan, design, build, finance, maintain and safely operate physical infrastructure to distribute energy from suppliers to consumers.

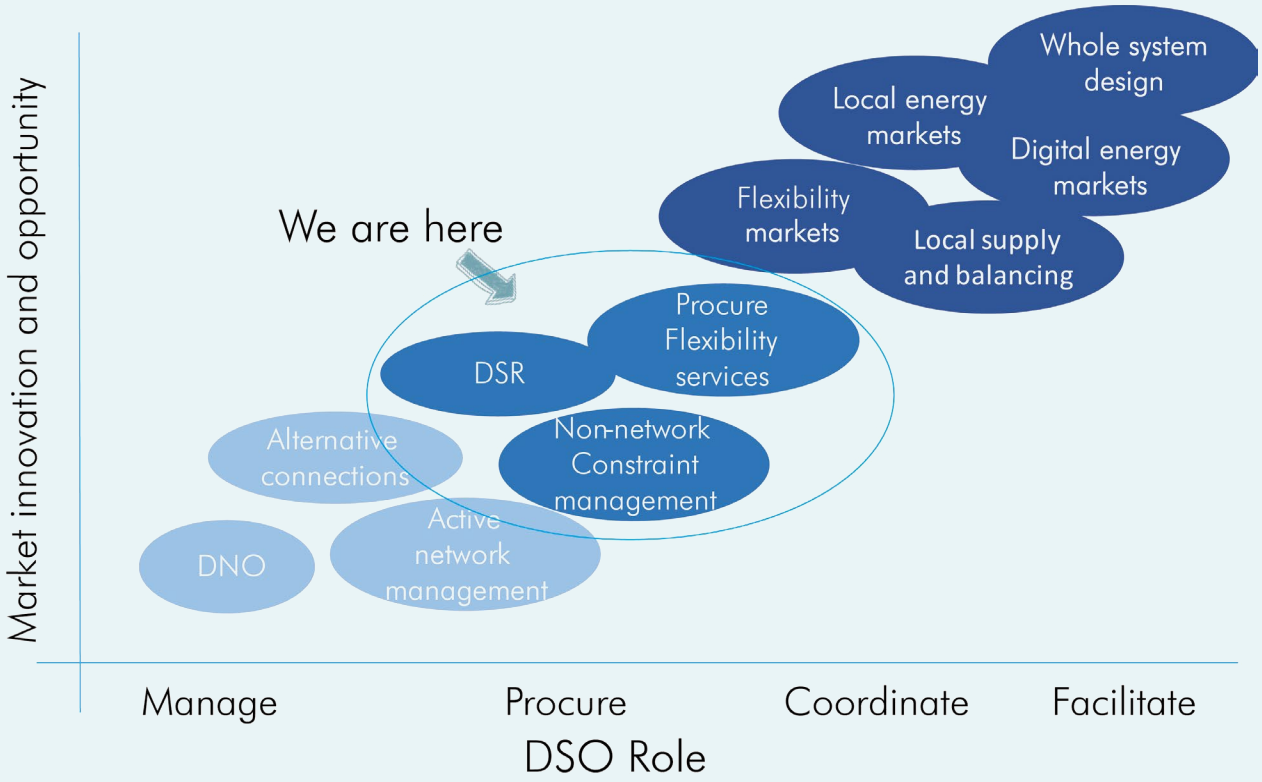
In the old model, the pace of change was relatively slow and easily planned. DNOs had to manage only a few new generation assets coming online (mainly gas fired power stations) and while new consumers and business customers were continually connecting, their demand profiles were understood and could be modelled to allow steady incremental investments. DNOs were largely reactive to the energy market, while maintaining a sufficient capacity margin to deal with the unexpected or worst case scenario. The DNO was expected to maximise network efficiency but to take limited risk for a limited return on investment.



48 See for example Open Networks Project www.energynetworks.org/electricity/futures/open-networks-project/open-networks-project-overview

In the new energy system the pace of change has greatly accelerated. Decarbonisation, decentralisation and new sources of energy demand have already forced network operators to become far more proactive participants within the energy system. A typical network operator may now be managing hundreds of active new generation connections within each licence area, as well as supporting myriad new demand customers. Decentralisation has also caused energy flows within the system to become more complex. Many consumers are now also generating energy and, with smarter technologies, have the ability to flex demand to take advantage of lower cost energy or to provide grid services. Widespread energy storage and other forms of flexibility have added a new dimension to energy system management.

The need to support new developments, regional economic growth and decarbonisation has led to a more fundamental change in how the networks engage with customers and stakeholders, with a greater emphasis now on future planning, collaboration, data sharing and pre-emption investment. Electrification of heat and of transport is set to add a further layer of complexity as well as the opportunity to optimise across energy vectors.



The new network role has been defined as that of a DSO[49], although system 'optimiser' might be a better term to use. Each of the networks is now developing its DSO development strategy in consultation with Ofgem and with regional stakeholders.

A specific objective of the DSO transition has been the increased use of flexibility and non-network assets (for example energy storage) to reduce the need to build network infrastructure. Practical examples of this change include the introduction of auctions to procure flexibility contracts[50] as an alternative to committing capital expenditure to network reinforcement.

49 See for example www.westernpower.co.uk/customers-and-community/community-energy/community-energy-animations/#yt-gal-1

50 www.westernpower.co.uk/the-role-of-local-flexibility-animation

The flexibility auctions to date have been limited in terms of their scale and duration, and have tended to be awarded to existing fossil fuel generators. This is not a sustainable outcome, and the focus now must be to develop more open and active market for flexibility, based on low carbon solutions. It can be imagined that, in the very near future, actors within the energy market would be able to trade generation, demand and storage capacity with the network operator, and with each other, in order to optimise energy costs and maximise the use of renewable energy. This could in turn help to create local energy markets enabled by new digital trading platforms.

The new market opportunities will become even more exciting when multi-vector opportunities are exploited; integrating energy markets for heat, transport and hydrogen manufacture and interconnectors to European markets.

9.2 Future enhanced role for the DSO

The importance of the DSO role has been highlighted by Ofgem and BEIS[51]. They have called for a rapid evolution of the of the DSO functions with much greater transparency and openness, greater network coordination and data sharing, whole system solutions and increasing competition at all levels.

9.2.1 Flexibility for whole system outcomes

While the focus of flexibility auctions has been the management of demand constraints, the expectation is that DSOs will also be incentivised to optimise network capacity to increase the connection of renewable energy generation, energy storage and cross-vector technologies. This could be accelerated by moving the networks towards a "connect and manage" approach for generation customers, characterised by shallower connection charging and a move away from the current 'last-in-first-out' based active network management approach towards a more value/market based approach to capacity trading.

9.2.2 Neutral market facilitator

A critical success factor to achieve this will be the ability of the DSOs to act as a "neutral market facilitator" to enable under-utilised capacity to be traded, facilitating collaboration between energy system actors, allowing grid connection collaboration and creating local energy markets. Ofgem is right therefore to highlight the need for the DSO function to "address actual or perceived conflicts of interest" between its role as a market facilitator and its role as the owner/operator of network assets.

This was a subject of discussion during the stakeholder interviews. However, while there is a view that, at a future point, parts of the DSO function may need to be separated away from the DNO functions, there is a pragmatic argument that the close alignment of the DNO and DSO provides greater benefit through operational synergy and efficiency[52].

Ofgem has itself noted the issue but stated that it is "too early to implement institutional reform at distribution level as DSO functions are still developing". But that the regulator "will be carefully monitoring developments and will consider whether over time there may be a case for greater separation of certain DSO functions from the DNOs" [53].

51 Ofgem and BEIS Open Letter www.ofgem.gov.uk/system/files/docs/2019/07/ofgem-beis_joint_open_letter_to_the_ena_open_networks_project.pdf

52 SPEN DSO vision consultation. 71% of respondents felt the DNO was best placed to lead the DSO transition. See www.spenergynetworks.co.uk/userfiles/file/SPEN_DSO_Vision_Consultation_Responses.pdf

53 Ofgem DSO Position Paper www.ofgem.gov.uk/system/files/docs/2019/08/position_paper_on_distribution_system_operation.pdf

9.2.3 Setting the right incentives and outcomes

It is important however that incentives, and output requirements, for the DSO to facilitate open markets and support non-network solutions are clearly set out in the regulatory model and in the RIIO 2 review process.

This would require a model that:

- Incentivises the DSO to identify value opportunities across the energy system, optimise system use, facilitate new business models and energy markets and support non-network solutions.
- Allows the DSO to deliver whole system outcomes, to improve whole system planning and coordination including the alignment of regional forecasting and business planning processes, network resilience management and cross vector market integration. In the longer term this could lead to a model based on regional whole system operation.
- Enables proactive measures to deliver the UK's clean growth agenda by increasing the deployment of low carbon flexibility assets including energy storage, Demand Side Response (DSR) and local energy supply markets.
- Is closely aligned with how network charging is applied.
- Is aligned with the UK's net zero carbon target by positively transitioning away from fossil fuel technology, for example, by limiting flexibility market access by unmitigated high carbon generators.

The creation of "Regional Energy Governance Bodies" would also provide a greater degree of local governance and oversight to ensure that the DSO delivers whole system outcomes that meet regional objectives as well as ensuring that the DSOs act in a transparent way as neutral market facilitators.

9.2.4 Networks as key providers of open data

Closely aligned with the DSO role is the important role that can be played by the networks in the acquisition, management and open provision of energy and network data. Regen's own experience working with network operators has been of an increasing level of sophistication and data capability within the networks and a recognition that the networks can add value to a wide variety of customers and stakeholder by the provision of open data.

With increased levels of digitalisation, for example the capture of energy flow data at substations[54] the networks can also support the provision of data for wider applications enabling smart cities and communities.

The management and provision of data should therefore be one of the key capabilities against which network performance is measured. We would also support the recommendations from the Energy Data Taskforce[55] including the further digitalisation of energy data that is open source and visible, and the creation of a whole system asset registry, energy data map and data catalogue.

54 See Open LV project https://openlv.net/

55 Energy Data Task Force Recommendations https://es.catapult.org.uk/wp-content/uploads/2019/06/Catapult-Energy-Data-Taskforce-Report-A4-v4AW-Digital.pdf

10 Making strategic investments by managing incentives and risk

It has been widely recognised that the transition to a net zero economy will require a massive uplift in strategic investment in critical energy infrastructure. The consensus feedback from stakeholders is that the current regulatory model will need to change in order to bring for the level of strategic, long term, investment that will be needed.

10.1 How much network investment will be needed?

Without a clear strategy and decarbonisation pathway it is difficult to estimate how much investment will be needed. A key challenge for all parts of the energy system is that the level of investment required is uncertain.

To give some idea of the scale of what might be needed, the Committee on Climate Change modelling suggests that annual capital investment in the power sector infrastructure may rise to £20 billion per year by 2050 to achieve net zero. That is almost double the current level of capital investment[56]. This estimate includes all power sector investment including distribution networks, transmission grid, new generating assets, interconnectors and flexibility.

For the electricity distribution networks, total capital expenditure has varied over the economic cycle but has been running at an average of £1.5 billion[57] per year since 2010.

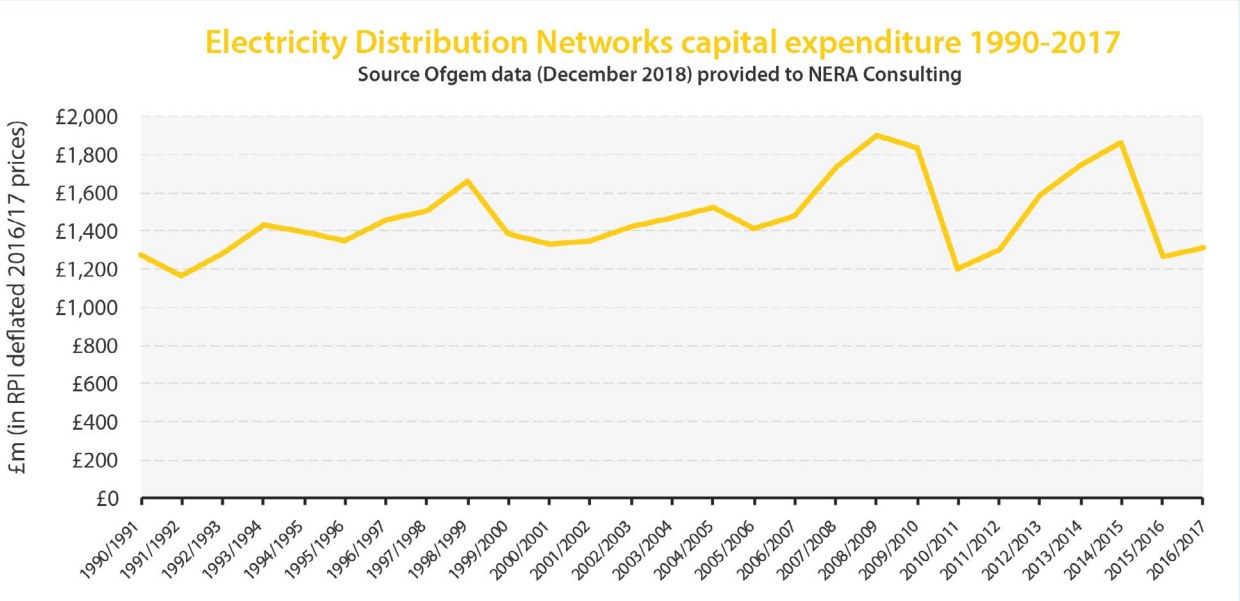


Figure 3 DNO capital expenditure 1990-2017, source, Ofgem

56 Committee on Climate Change www.theccc.org.uk/publication/net-zero-the-uks-contribution-to-stopping-global-warming/

57 Annual expenditure data provided by Ofgem to NERA consulting June 2019 www.ofgem.gov.uk/ofgem-publications/145746 (RPE deflated 2016/17 prices.)

The RIIO[58] regulatory model which has been reformed to control network prices and revenues and to incentivise investment, is designed around a periodic review process. The current RIIO 1 review period for electricity distribution networks runs for 8 years from 2015/16 to 2022/23.

The RIIO 1 budget planning allowance for distribution network "total network reinforcement"[59] (the main cost category for improvements to the network) has been forecast at around £2.5 billion[60], an average of around £360 million per year. Actual expenditure on reinforcement in the first three years of RIIO 1 has been running at significantly less than this, averaging around £236 million per year, which is only around 7% of total expenditure.

There are several good reasons for this underspend, which has resulted in lower consumer bills, including lower than anticipated levels of electricity demand, rephasing of investment to later in the control period and the positive use of non-network asset solutions and reconfiguration. It is disappointing therefore that, to date, the majority of local flexibility auctions have been won by diesel and gas generators, while the main focus of the auctions has been to address the risk of demand constraints and not to free up capacity for low carbon generation. This should change in future as the market for flexibility develops, and if the options appraisal methodology is weighted to support explicit decarbonisation objectives and the UK's smart and flexible industrial strategy.

So the summary analysis suggests that current level of network reinforcement investment is lower than forecast and is low by historic standards. The big question however is by how much network reinforcement will have to increase as electricity demand, and also decentralised renewable generation increases, to achieve net zero. There isn't a clear answer to this question at present, and a lot of work is being done now in preparation for the next RIIO 2 control period to better understand the long term impacts of net zero.

As a benchmark, reinforcement investment on the transmission grid, which has been embarking on a significant reinforcement programme, has been running at around 35% of total expenditure. A further benchmark comes from a review of future network expenditure by Capital Economics[61] which has estimated that the distribution networks may have to increase network reinforcement investment by up to £48.5 billion in the period to 2050, an average of around £1.6 billion per year, which if other costs remain the same would also equate to around 35% of total distribution network expenditure.

This may sound like a very big number but it is worth considering that if electricity networks are going to be providing the main energy source for transportation in the future, then we are in effect replacing a legacy supply chain for petrol and diesel that comprises many hundreds of billions of assets in pipelines, refining, distribution terminals, tankers and petrol stations.

However, it is also clear that simply increasing expenditure, and therefore consumer bills, cannot be the whole answer. Network investment will certainly increase, but the networks need to become smarter, more integrated, more flexible and crucially open to new business models in order to increase productivity and optimise the use of both network and non-network assets to deliver a system that is affordable and resilient.

It should also be noted that looking at reinforcement to increase capacity in isolation is potentially misleading and would itself result in sub-optimal investment. Given that much of the current network was built before World War II, there is a compelling case to look at network reinforcement and the need for network refurbishment or replacement in an integrated way. There are significant economies of scale that can be realised by taking a more strategic and long term view of network investment which would future proof infrastructure.

58 RIIO "Revenue = Incentives + Innovation + Outputs" periodic investment, price and revenue review process. For a more complete explanation of the RIIO model see https://www.ofgem.gov.uk/system/files/docs/2017/01/guide_to_riioed1.pdf

59 Includes reinforcement of the network to support increased loads and new connections.

60 Ofgem RIIO ED1 Annual performance supplementary data 2017/18.

61 Capital Economics analysis https://www.spenergynetworks.co.uk/userfiles/file/Zero_Carbon_Communities_Report.pdf

10.2 Can the current model deliver this level of investment?

A second key question is whether the current model will allow industry, the regulator and wider stakeholders to work together to deliver the level and type of investment needed to achieve net zero, at least cost and at a time of increased risk and uncertainty.

The RIIO regulatory framework seeks to allow networks to achieve a reasonable return on investment, Return on Regulated Equity (RoRE), but also to encourage investment where it is really needed to deliver customer service, resilience and other defined outcomes. It does this by applying a tight control on permitted investment budgets while at the same time offering an incentive to the network operator to avoid unnecessary investment, innovate to find network efficiencies and to adopt alternative non-network solutions[62].

The RIIO model therefore seeks to address the inherent tension within a regulated industry between the need to incentivise investment to maintain infrastructure and deliver future goals, and the need to ensure that the right investments are made and the most cost effective solutions deployed.

The inner workings of RIIO featured frequently in our stakeholder interview feedback and were seen as a critical enabler, or potential barrier, to incentivise networks to support future decarbonisation.

Strengths of the RIIO model

There was a broad agreement that the RIIO methodology has introduced more rigour into the review process by tying revenues and incentive mechanisms more tightly to levels of output and performance. It has also introduced a more disciplined and evidence-based approach to investment and cost planning.

It also provides a basis for networks to engage with their regional stakeholders, evidence of which is now an important prerequisite for budget approval. The increased focus on evidence based planning, including the use of regional scenario forecasts[63] and extensive stakeholder engagement, has been positive.

From an investment perspective, a key feature of RIIO is that it gives a relatively long timeframe for network companies to plan investment and secure finance. It is therefore seen as investment friendly which has helped to reduce the cost of capital including debt finance.

Weaknesses within the RIIO model

Several of the stakeholders however identified that the RIIO process is best suited to a steady state scenario with high degrees of certainty, so that plans and outcomes can be locked in to a performance contract but that it is less suited, as it is currently structured, to handle the inherent risk and uncertainty that accompanies periods of industry transformation, technological innovation and market change.

The inflexibility to manage change works both ways. Network companies find it hard to propose new investments in response to energy system changes[64], however the process by which Ofgem can recoup revenues for underinvestment within a review period is also arduous, to the point where it can be easier to ask transmission and network companies to agree to a "voluntary" allowance reduction[65].

62 The RIIO total expenditure (Totex) approach seeks to create a level playing field between Opex or Capex. The Totex Incentive Mechanism efficiency incentive rate sets the percentage value share of any under- or overspend.

63 See for example distribution future energy scenarios (DFES) work done by Regen on behalf of WPD, SSEN and WWU www.regen.co.uk/area/local-future-energy-scenarios

64 See for example Ofgem's minded to decision to reject or accept proposals for RIIO 1 Reopeners www.ofgem.gov.uk/publications-and-updates/consultation-riio-ed1-price-control-reopeners-may-2019

65 See for example National Grid Electricity Transmission's deferral of £480m of RIIO-T1 allowances voluntary.

Specifically our stakeholder interviewees identified five key issues:

- The RIIO model is essentially a centralised process and, although there are prerequisites for stakeholder engagement, there is a lack of more formal regional and stakeholder governance, approval and accountability.
- That the way in which RIIO handles uncertainty and risk encourages an overly cautious planning approach, both by the regulator and the networks. The way in which subsequent changes may be made via a range of uncertainty mechanisms[66] is onerous, difficult and unresponsive to changes in the energy system.
- The Totex Incentive Mechanism, which incentivises networks to optimise network asset investment, does not easily differentiate between cost efficiencies, including the use of smarter non-network solutions, and simple investment deferral.
- Better and more consistent use of uncertainty mechanisms and reopeners, such as volume drivers for investment in network infrastructure to support the roll-out of EVs and the electrification of heat.
- Networks should also be empowered to work with regional stakeholders to make strategic investments that can help regions create their own decarbonisation pathway, optimise investment costs, minimise risk and respond to local and regional social and economic priorities.

10.2.1 Investing for a net zero future

Given the critical importance of getting both infrastructure and non-infrastructure investments in place to support decarbonisation, it is critical that the regulatory model strikes the right balance between encouraging strategic investment and managing costs.

Our analysis and discussions with interviewees, suggest that a periodic planning approach is a good basis for industry regulation and the RIIO approach has introduced new rigour to that process. However, the regulatory model will need to adapt in order to support the scale of investment and change needed to achieve net zero decarbonisation.

The NIC report[67] has proposed that periodic price control processes and incentives are best suited to steady state investments with higher levels of certainty, but that a different approach is needed for strategic investments.

This could lead to different approaches to manage different classes of investment.

66 Reopeners, bespoke uncertainty mechanisms and volume divers.

67 National Infrastructure Commission NIC www.nic.org.uk/wp-content/uploads/NIC-Strategic-Investment-Public-Confidence-October-2019.pdf

Class of investment	Potential approach
Steady state and incremental investment Investment including refurbishment and replacement with high degrees of certainty. **Uncertainty/risk - low**	• Managed via the periodic review process with budget allowances and incentive mechanisms. • Integrated approach to consider reinforcement and conditional investments together to achieve economies of scale and future proofing. • Additional focus and a consistent approach to assess the cost benefit use of non-network solutions and flexibility.
Enabling investment Forecasted investment to support demand growth and decarbonisation in the medium term. For example, upgrading low voltage networks to support the forecasted increase in EVs, electrification of heat and growth of decentralised generation and energy storage. Often volume driven. **Uncertainty/risk - medium**	• Managed via the periodic review process. • Better and more consistent use of uncertainty mechanisms, such as volume drivers, which can be easily applied and made more responsive to changing need. • More transparent investment decision making and application of incentive mechanisms. • Additional governance and accountability to regional stakeholders to ensure cost effectiveness, competitiveness and alignment with regional goals.
Strategic investment Longer term investment, or investment with a higher degree of risk/uncertainty, to create net zero pathways and bring forward new low carbon technologies. For example, strategic investment to enable broadscale electrification of heat in cities and regions, pre-empt EV adoption, hydrogen production and a step-change in renewable generation. Often tied to a wider energy and industrial strategy and the net zero pathway. **Uncertainty/risk - higher**	• Managed separately with distinct investment planning and oversight. • Backed by national investment strategies and policy frameworks. • Increased competition where this can deliver additional value. • Working in partnership with regional stakeholders, potentially with risk sharing and public/private co-investment models.

11 Delivering affordable energy, great service and customer value

Continuing to demonstrate that the energy networks are delivering affordable and reliable energy, with excellent customer service, during a period of major change will be essential to ensure that consumers sustain their commitment to decarbonisation.

As the industry enters a period of demand growth and the need for significant network investment it is inevitable that network expenditure will begin to increase. It is essential therefore that the drive for greater cost efficiency is maintained, and that there is even more transparency and clear analysis of the cost drivers and effectiveness of cost reduction measures.

As we ask the networks to do more, there will also need to be a shift of emphasis from absolute cost measures towards measures of cost per unit of service and output delivered.

11.1 Network costs have continued to fall in real terms

Ofgem's historic cost data[68] shows that electricity distribution network costs fell dramatically in the decade after privatisation and up to the 2008 financial crash, as networks introduced greater cost efficiencies including investment in new business processes and IT systems. They have continued to fall in real terms the period since 2010, albeit at a lower rate by circa 8%, to an annual average total expenditure (Totex) of circa £115 per customer in 2017/18[69]. In terms of the impact on the end consumer the combined cost of operating the distribution and transmission networks currently equates to around 36p per day on the average customer bill.

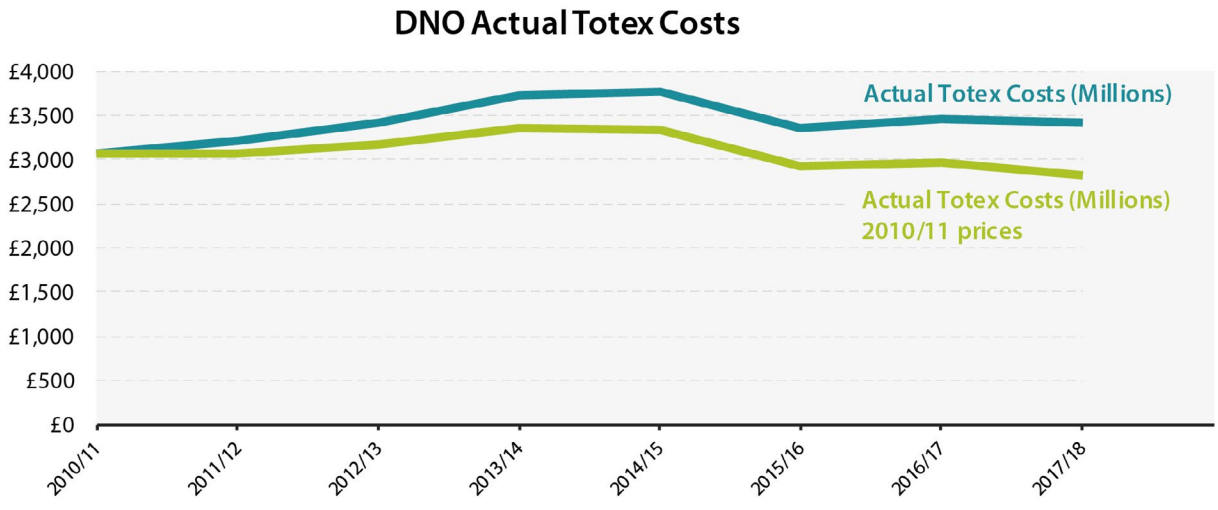


Figure 4 Distribution annual network total expenditure (Totex). Source Ofgem 2017/18 performance data

68 Annual expenditure data provided by Ofgem to NERA consulting June 2019 www.ofgem.gov.uk/ofgem-publications/145746

69 Average for electricity distribution Totex cost for all customers. Ofgem Annual Performance Supplementary Data 2017/18 actual costs.

A further observation is that there is significant cost variation between network areas. As one would expect network areas of low customer and demand density, such as the Scottish highlands and parts of Wales, will tend to have much higher costs per customer or energy delivered, compared to urban areas. Historic differences in network architecture and investment. Differences in terms of rates of decarbonisation and other regional factors will also have a significant impact.

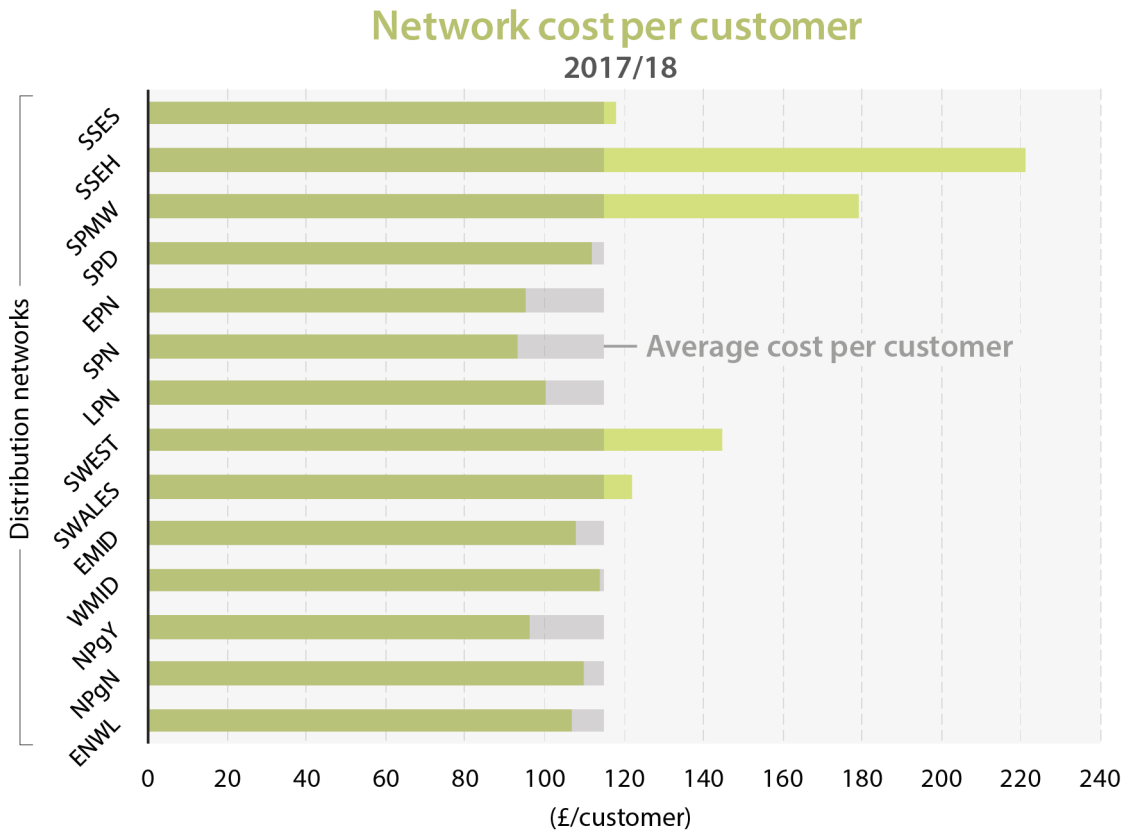


Figure 5 Average electricity network total expenditure (Totex) per customer. Source Ofgem 2017/18 annual performance data

The thorny question of whether UK distribution networks are more expensive than EU networks, which has been raised by critics of the UK model, is more difficult to resolve. "Comparison against other EU networks using Eurostat data[70] suggests that the UK ranks around 9th or 10th cheapest out of the 28 EU region countries for overall electricity network costs, but this ranking is not the same across all consumer groups. Industrial consumers in the UK pay higher electricity network costs than the majority of their EU competitors, while network costs for domestic customers and smaller businesses in the UK are amongst the cheapest in the EU. So really this data says less about the underlying cost efficiency of the networks and more about the allocation of costs and subsidies to different consumer groups, and how costs are recharged, in the different regulatory regimes.

70 The Eurostat data suggest that UK electricity network costs are higher for large industrial users (3rd highest in the EU) and for medium industrial users (6th highest in the EU). The same data suggests that network costs are comparatively low for domestic household consumers and for small industrial users where the network costs are 26th and 24th highest respectively.

11.1.1 Customer service and productivity

Ofgem's review of annual network performance has highlighted significant improvements in customer service and an increase in customer satisfaction levels.

Notwithstanding the recent blackout on Friday 9 August, the UK energy system has proven more resilient to faults with less interruptions than the majority of our EU counterparts[71] and a more rapid resolution when faults do occur. The key service measure of customer minutes lost (CML) has fallen from a recorded network average of 60 minutes per thousand customers in 2010/11 to 36 minutes in 2017/18. The number of customer interruptions (CI) has similarly improved[72]. The fact the blackout received such attention is an indication of how rare power interruptions have become.

Customer satisfactions scores, measured for complaints, connections, interruptions and fault resolutions and general enquiries, have also continued to improve.

Figure 6 Source Ofgem Annual Network Performance data 2017/18

While customer service has increased, productivity studies, such as those conducted by the Energy Policy Research Group (EPRG) at Cambridge University on behalf of Ofgem[73] can produce mixed and perhaps counter intuitive results. The ERPG report, which used both quantitative and qualitative productivity factors, showed that electricity distribution network productivity has increased in the period from 1990 to 2016 by 34%.

However, the main productivity improvements were made in the period up to the financial crash in 2007. In the period since then, productivity improvement has slowed and by some measures has fallen. This may seem odd as network costs have continued to fall.

71 A UK Ranked 6th overall in EU in terms of lowest Customer Minutes Lost https://www.ceer.eu/documents/104400/-/-/963153e6-2f42-78eb-22a4-06f1552dd34c

72 From around 65 per thousand customers to 45 in 2017/18. Source Ofgem Annual Performance Reports.

73 Energy Policy Research Group: Productivity growth in electricity and gas networks since 1990 (revised 2018)

In part the answer is that network productivity reflects wider falls in productivity across the UK economy, against which the electricity sector has performed better than average. It is also the case that typical productivity indicators, such as cost per GWh delivered, have been impacted by falls in energy demand.

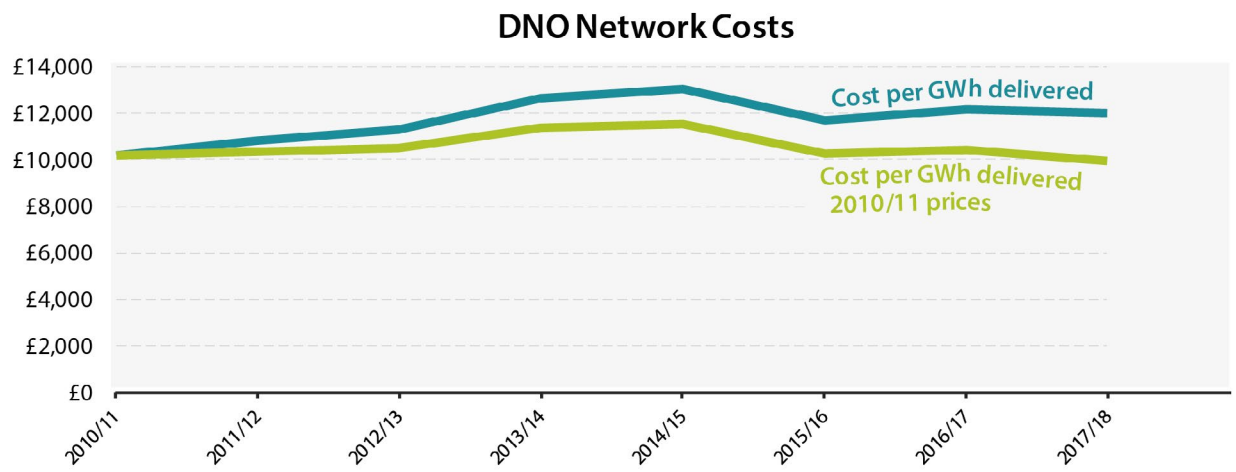


Figure 7 Source Ofgem Annual Performance Data 2017/18

Energy efficiency measures and changes in UK energy usage (a shift from energy intensive to service industries) have led to a drop in both overall electricity consumption and peak demand.[74]

The irony therefore is that energy efficiency and shifts in energy demand away from peak periods, which is something we have asked the networks to support, can lead to lower network utilisation and productivity scores. This is really about how we measure productivity. If the reduction in carbon intensity, EV charger roll-out, or the increase in renewable generation supported, had been included as key productivity outcomes then the analysis would very likely have produced a very different set of results.

74 Peak GB winter demand on the transmission network has fallen by 22% from 2005/06 to 2017/18, and in 2017/18 was less than 1990/91.

11.1.2 Higher than expected network returns

While cost and customer services measures have improved, Ofgem has identified in the 2019 State of the Market Report[75] that network Returns on Regulatory Equity (RoRE) have been higher than anticipated in the current price control period[76].

Several reasons have been given by Ofgem for the higher than predicted RoRE. As well as positive factors such as efficiency, good performance against targets and cost cutting innovation, Ofgem also identifies forecasting errors, some high budgets against low targets, and a failure to predict interest rates accurately as contributing factors.

There also appears to be an underlying issue with the application, and transparency, of the Totex Incentive Mechanisms which allows companies to retain a significant share of the expenditure savings that can be made by delaying or reducing network investment.

These incentives are intended to promote genuine efficiencies, asset optimisation and the smarter use of non-network solutions. It is difficult however to differentiate between genuine efficiency and other factors, such as falling network demand, which may allow networks to defer investment. Other reasons for investment delay may include re-phasing works to achieve operational efficiency or to address challenges around land access, network constraints and resource capacity.

As we have already discussed, levels of network investment have been lower than forecasted. Ofgem's analysis of the largest cost categories shows that, in the years from 2015/16 to 2017/18, distribution networks achieved the highest underspend against their budget allowances in areas of capital expenditure, including categories for network reinforcement and replacing and refurbishment of equipment. The largest overspend in the same period was in operational support and network faults.

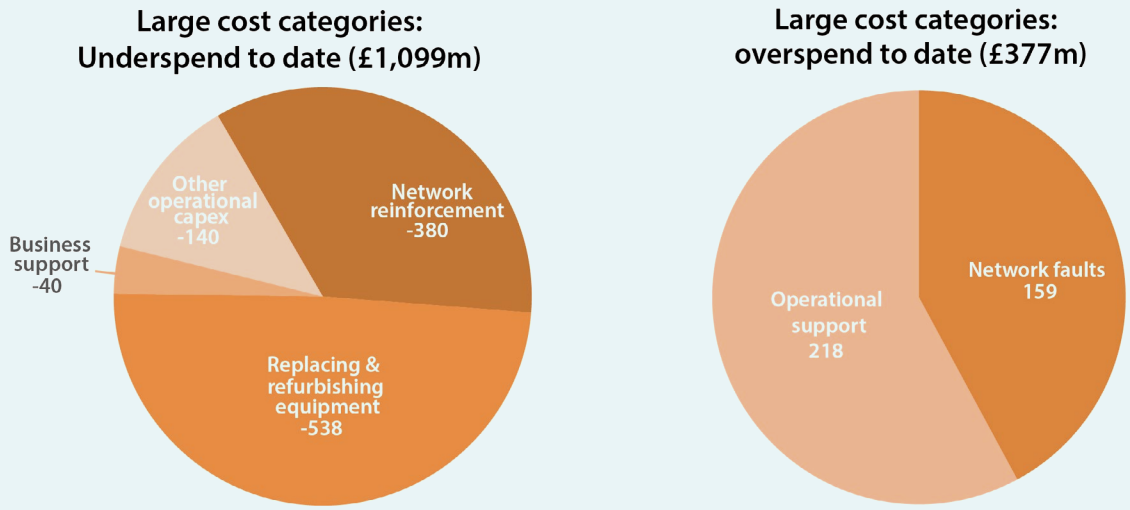


Figure 8 Source Ofgem 2017/19 Annual Report – Distribution networks RIIO under & over spend to date largest cost categories 2015/16 to 2017/18

75 Ofgem State of the Market Review www.ofgem.gov.uk/system/files/docs/2019/10/20191030_state_of_energy_market_revised.pdf

76 In RIIO 1 Ofgem is projecting higher than anticipated Return on Regulated Equity RoRE of an average of 9.15%. Ofgem RIIO1 Annual Report 2017/18.

There is a significant degree of variation between the networks in terms of the level of capital expenditure underspend. Some networks are operating at close to their capital expenditure budget allowance, while others have so far spent around 50-60% of their allowances. Most networks are forecasting that expenditure on network reinforcement and refurbishment will increase during the remaining price control period to 2023.

Whatever the reason for the investment underspend, the variation in capital expenditure and higher RoRE risks eroding public trust and suggests that more scrutiny is needed to identify genuine efficiencies when applying incentive mechanisms.

11.1.3 Maintaining cost efficiency and customer value as network demand rises

The networks are about to face the biggest challenge and period of change since privatisation. During this new phase of development the networks will be asked to deliver a range of new customer and societal services and to meet a massive increase in the demand for electricity driven by the electrification of heat and transport.

Distribution network – future cost drivers

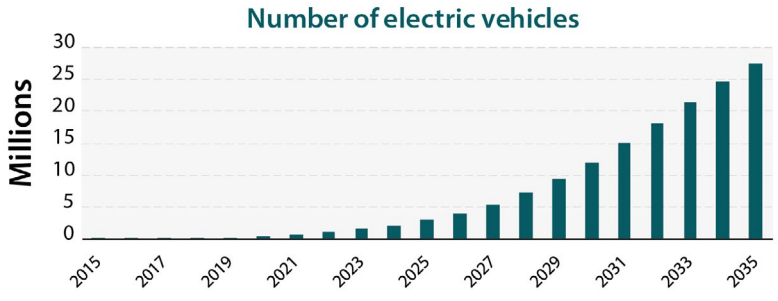
1. Electricity transport revolution which could see 27 million EVs by 2035 requiring 52 TWh of additional electricity annually.

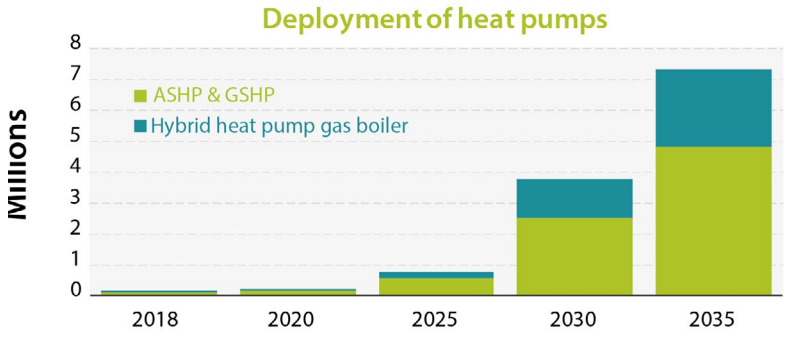
2. Electrification of heat with the potential deployment of 7.3 million heat pumps by 2035, which would require circa 25 TWh per year.

3. Growth of renewable electricity with up to 130 GW of capacity by 2035, compared to 43 GW in 2018, of which up to 50% could be connected to the distribution networks.

4. Increase in industrial demand as industry and commercial properties switch to low carbon electricity to achieve their net zero targets.

5. Potential increase in electricity required to support the manufacture of hydrogen (if via electrolysis).





While meeting these challenges, maintaining cost efficiency and high levels of customer service and network reliability will be vital both to retain public trust and to allow the affordable deployment of low carbon technologies such as heat pumps and EVs. If we ask the networks to deliver societal outcomes such as decarbonisation, energy efficiency, support for vulnerable customers and investment in innovation to support new smart energy technologies, then it makes sense that these outputs must be considered as part of the overall productivity scorecard.

Ofgem has already indicated that in the next price control period[77], RIIO ED2, which will run from 2023, it intends to apply further downward pressure on networks costs, including a reduction in the value share of expenditure reduction incentives retained by the networks, with the intention to reduce equity returns achieved by network operators and increasing cost savings for consumers.

While it is right to focus on cost efficiency, a more sophisticated approach is needed. Feedback from interviews and stakeholders points to a number of measures that would improve overall performance management. These include:

- A greater focus, in both reporting and use of incentives, on cost productivity per unit of output delivered, which should be widened to include the delivery of decarbonisation outputs
- Ensuring that incentive and outperformance mechanisms are properly targeted and executed to reward genuine costs saving and efficiency improvements
- Ensuring greater cost transparency especially in relation to the cost benefit of investment deferral and use of non-network solutions.
- Regulators should focus total expenditure allowance based price controls on the maintenance of existing networks requiring incremental or conditional investments.
- Continuing to incentivise networks to invest in innovation in new technologies, digitalisation and whole system solutions.
- Encouraging greater competition in tendering for network and non-network solutions, especially for strategic investments.
- An additional layer of budget oversight and accountability at a regional level would help to ensure that costs efficiencies are delivered
- Greater cost transparency, and better communication of performance to maintain public and stakeholder trust.

77 In the methodology now proposed for the next price control period, Ofgem has promised a much tighter methodology framework that will deliver lower costs, lower returns for networks and lower consumer. May 2019 www.ofgem.gov.uk/publications-and-updates/ofgem-confirms-network-price-control-methodology-so-consumers-can-benefit-cheaper-smarter-and-more-sustainable-energy-network

12 Ensuring a just transition

The radical shift to decarbonise must achieve societal goals as well as environmental ones and is essential to maintaining public and political support. This broad aim is encompassed in a number of evolving concepts; the just transition, green new deal and climate justice, all of which are loosely defined and have varying degrees of political and non-political support.

Just Transition

The concept of a just transition was originally created as part of the trade union movement and is broadly focussed on jobs and the workforce. Learning from previous industrial transitions, the movement recognises the potential harms that could evolve, but also the opportunity that decarbonisation gives to create better jobs, better protections and job security for the workforce.

Green New Deal

A Green New Deal is a broader concept, first proposed in 2008 by the New Economics Foundation[78], and advocates massive government and private investment in decarbonisation, creating jobs and reducing social inequalities. A Green New Deal will play an enabling role in ensuring a just transition whilst also delivering investment and an economy that actively tackles the climate crisis.

Climate Justice

Although beyond the scope of this paper, the global climate justice movement is worth noting. The concept recognises the disparities across the world in terms of development, cumulative contributions to CO2 emissions and the acute effects of climate change on poorer and minority communities. While network companies may not play a direct role in ensuring global climate justice, they must be mindful of their indirect involvement in future.

78 https://neweconomics.org/campaigns/green-new-deal

12.1 What role do energy networks have to play in these movements?

A challenge for all of the above movements is pinning down concrete actions across our economies and industries. Working out where energy network companies can play a role is an important and revealing exercise and it's likely that a comprehensive approach will draw on elements from each movement, developing new and evolving existing policies.

Energy justice for consumers. Networks must ensure that the cost of the large infrastructure changes to decarbonise are spread equitably across all consumers. Low carbon technologies should not be deployed only for the affluent and support for vulnerable customers must continue and evolve to meet these changing needs. Accurate, fair network charges, which take into account externalities, will be crucial in achieving this.

Societal equality. Investment must be made fairly and evenly, both across time and geography. The EV roll out is already bringing some of these issues to light with greater investment in EV charging being made in areas of greater adoption. If this trend continues, early adopters in more affluent areas will see EV infrastructure increase, while rural and less affluent areas are left behind.

Workers' rights. Ensuring networks play their part in the wider low carbon industrial strategy to enable the transition of skills and workforce to the new economy. Network companies will need to support re-training, provide job security and increase the diversity of their workforce.

Regional development. With their inherently local role, network companies will need to collaborate with devolved, regional and city bodies, potentially through co-investment models, to provide economic and social stimulus in deprived areas, and support for both rural and urban communities that face higher costs and barriers to adapt to the energy solutions.

Industrial strategy and innovation. The transformation of energy and adoption of low carbon technologies has the potential to stimulate a new green industrial revolution, creating new jobs and new export opportunities for UK companies. Networks must be part of the low carbon industrial strategy at both a regional and national level. They must continue to be at the forefront, supporting innovation, new skills development and new technologies within the networks and across the wider economy.

13 Conclusion

Opening a dialogue

Regen would like to thank the industry leaders and stakeholders who agreed to be interviewed as part of the research for this paper, and also to the very many Regen member organisations, board members and community groups who have contributed to this paper directly and by adding to our collective understanding of the energy system.

Realising the critical role that the networks play, and therefore the wide spectrum of views that are held about their structure and governance, we approached this paper with a great deal of caution bordering on trepidation. In fact, the research, and our discussions with industry stakeholders, have revealed a very high level of consensus about what we want the networks to deliver. We also received an overwhelming message that energy cannot be treated as a typical market, and that the networks are keen to embrace their wider role to enable decarbonisation and a range of social outcomes. If anything, the frustration felt by industry was not the burden of meeting these objectives, but the limitations that the current model is pressing on them.

This reminds us that the energy industry is made up of people who care deeply about the climate emergency, and who take great professional pride in being part of the solution. This commitment to change from within will help us to make the transition to a new zero carbon economy. Matching the expertise, resource and capability of the networks with the commitment and activism of local energy communities, cities and regions, provides the underlying basis of the new energy partnership to bring about the energy transformation that this paper proposes.

It has been impossible to cover in any detail the full complexity and nuances of the regulatory model, changing energy markets and the role of the networks. This paper is therefore a sketch of a potential future model with the intention to encourage a discussion. There is no doubt that some of its premises and conclusions may be challenged, but we hope that this in itself will provoke a new dialogue about the future of energy.

We would welcome feedback on this paper and the work that Regen does.

This discussion paper has been researched and produced by Regen, an independent not-for-profit organisation that is committed to the transformation of the UK's energy system. Regen would like to thank our members, and the wide range of industry stakeholders that have provided their expertise and insight to help us develop our thinking. We would also like to thank SP Energy Networks for supporting the production of the paper.

All opinions and views expressed in the paper are Regen's, unless explicitly referenced. We would welcome feedback and comments, and encourage readers to continue to engage with us through our events and membership.

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