

Ofgem decarbonisation programme action plan

ofgem

Making a positive difference
for energy consumers



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Foreword

Last year, the UK legislated for net zero carbon emissions by 2050 and we all have a part to play in achieving that target: government, industry and individual consumers.

As the energy regulator, Ofgem has a pivotal role in paving the way for the energy sector to decarbonise and we need to make sure that happens at the lowest cost to consumers. With the United Nations Climate Change Conference in the UK this November, I hope that 2020 is a turning point for climate change.

It is our principal objective to protect both current and future consumers. We deliver many of the government's environmental and social support schemes, which are key to enabling low carbon heat and power. Last summer, we launched our new strategy, recognising that decarbonising at the lowest cost to consumers goes hand-in-hand with protecting consumers and enabling competition and innovation.

It's a privilege to begin my role as Ofgem's new chief executive by launching our action plan. The Board and our Chairman have been invaluable critical friends, challenging us to go further. The result is this ambitious plan, which sets out the actions we will take over the next 18 months to help make low-cost decarbonisation a reality. It is vital that as the regulator we are taking the steps to enable and encourage the decarbonisation of energy, playing our part in helping the government achieve its ambition.

There are great challenges ahead, not least in the form of an electric transport revolution and the need to transform how we heat our homes and businesses. But these also present opportunities for our energy system and we need to be prepared to work together to grasp them.

This action plan is just the start of Ofgem's drive to play our role in achieving net zero by 2050.



Jonathan Brearley, CEO, Ofgem
February 2020



Executive Summary

The challenge

In June 2019, Parliament went beyond the UK's existing commitment to an 80% reduction on 1990 emissions levels by legislating for a net zero greenhouse gas emissions target by 2050. Reflecting the different circumstances of different parts of GB, in September 2019 the Scottish Parliament legislated to set a net zero target for 2045, and the Welsh government intends to introduce legislation to amend its existing target to achieve net zero no later than 2050.

The UK has made significant progress in decarbonising the economy. Overall emissions have fallen by 40% since 1990; more than any other advanced economy. For example, almost half our electricity came from renewable or low carbon sources last year.

However, significant challenges remain if we are to continue on the path to meet our 2050 goals. The way we heat our homes and power our vehicles needs to transform. Only 5% of the energy used to heat our homes today is from low carbon sources and our use of electric vehicles may need to grow from 230,000 today to 46 million by 2050. To meet the challenge of net zero, we must now go further and faster, especially in decarbonising transport, heating and our industrial use of energy.

To achieve net zero will require a huge increase in renewable and low carbon electricity, especially to meet new sources of demand such as electric vehicles. We will also need an energy system which can continue to reliably supply energy when consumers need it. Given the need for new investment, it is imperative that we build an energy system that is as efficient as possible. New technologies, better use of data and AI will also be needed to boost flexible demand.

The transition will also require consumers to be engaged - and to see that the costs and benefits of the transition are falling fairly. How and when energy is used must change. This opens up opportunities for a consumer-led transition, enabled by new technologies.

Government sets the overall framework and policies for meeting its targets. In doing so it must make the highest level decisions about how the costs of the transition will be met, and how to balance different objectives.

Within that framework Ofgem, the energy regulator, has a crucial role to play in helping the UK decarbonise its economy – and in particular, to protect the consumers of today and tomorrow in this transition.

Ofgem regulates the energy network companies, the system operator, the functioning of the wholesale market and the energy suppliers. These companies and consumers themselves will need to do things differently if we are to meet the challenge of net zero: to rewire the electricity system, to move away from natural gas (without carbon capture and storage), to operate and plan differently, and develop new approaches to provide energy and energy services to consumers – especially those that enable consumers to use less energy and to use it at different times. Ofgem must provide the regulatory frameworks and also design and support market frameworks to enable this, to support innovation and protect consumers.

Our trade-offs and decisions

It is expected that there will be additional costs in the short term as our energy decarbonises. We will continue to work to ensure that these costs are as low as possible, are shared as fairly as possible, and that vulnerable consumers in particular are protected. We are clear, however, that investing in the short term will save money in the medium and long term. Not acting today will result in much higher costs in the future as we would face an even tougher challenge to reduce carbon emissions. The dramatic reduction in offshore wind costs demonstrates that in the long term, low carbon energy can be cheaper than traditional fossil fuels.



In setting our regulatory frameworks, and taking regulatory decisions, we recognise that there will inevitably be significant trade-offs – for example between consumers today and tomorrow; or between different consumer groups. Equally, different devolved administrations, regions, cities and local governments may want to move at a different pace and this may have wider consequences across the UK.

In all decisions, we will be transparent and open in our thinking, to enable consumers and wider stakeholders to understand the options and trade-offs considered and how we reached particular decisions.

This action plan sets out the steps that we will take as a regulator in the next 18 months to ensure that we enable the most effective decarbonisation of the energy sector at the lowest cost to consumers. We expect this workplan to adapt as government policy, technologies and circumstances in the energy market change. We will develop an efficient system for the future by beginning to take these actions now.

Our actions

Ofgem's regulation aims to facilitate the most effective path to net zero at the lowest cost to consumers, in the context of government policy. We will use our expertise and knowledge to inform energy companies, government and others.

We are currently devising the next series of network price controls which will set company spending for the next five years. We have already told companies that their business plans must demonstrate how they put the UK on the path towards net zero.[1] We are encouraging network companies to invest in the infrastructure necessary to decarbonise, such as strengthening the electricity grid for electric vehicles, provided they can demonstrate this represents good value for consumers. Such anticipatory investment is already possible in our current regulatory structure. Recognising that there will be significant uncertainty about future needs, we will further develop our guidance to ensure that companies develop well justified proposals.

More fundamentally, in many areas the most cost-effective pathways to net zero are still uncertain and consequently the investment needs are unclear. As a step towards adaptive regulation, we are therefore announcing a new approach to dealing with unforeseen significant policy or technological developments that might affect our regulation of networks. This will help us respond to the net zero challenge whilst keeping down the costs to consumers.

The UK has made great progress in developing offshore wind, but capacity will have to increase enormously to achieve net zero. To facilitate this, Ofgem will work with government and industry to explore regulatory approaches that could enable an expansion of the offshore network at lowest cost. This will include considering a more coordinated approach to offshore networks, and how this could make it easier and cheaper for the electricity generated to reach the shore.

The energy system will need to be more flexible to balance supply and demand. This will ensure a reliable system and keep costs down. Greater flexibility will help smooth peaks in electricity demand, for example by incentivising people to charge their electric vehicles when there is more supply on the system. Batteries, whether industrial scale or those in electric vehicles, and other technologies can store energy when it is not needed, and release it onto the system when demand is high. Such flexibility will reduce the need for more power generation and other new infrastructure, saving consumers billions of pounds on their energy bills. Our regulatory frameworks will enable this flexibility. In this system we will ensure that customers are offered low-hassle ways to participate, and are rewarded for contributing flexibility to the system where they are able to.

The management of our energy system to enable these changes will be even more important in the future. Ofgem is reviewing the way our energy systems are managed and the Electricity System Operator's role (currently carried out by National Grid ESO), to ensure that GB's System Operation framework enables us to meet our net zero challenges at least cost.

[1] www.ofgem.gov.uk/system/files/docs/2019/08/letter_to_networks_on_achieving_net_zero.pdf, www.ofgem.gov.uk/system/files/docs/2019/10/riio-2_business_plans_guidance_october_2019.pdf



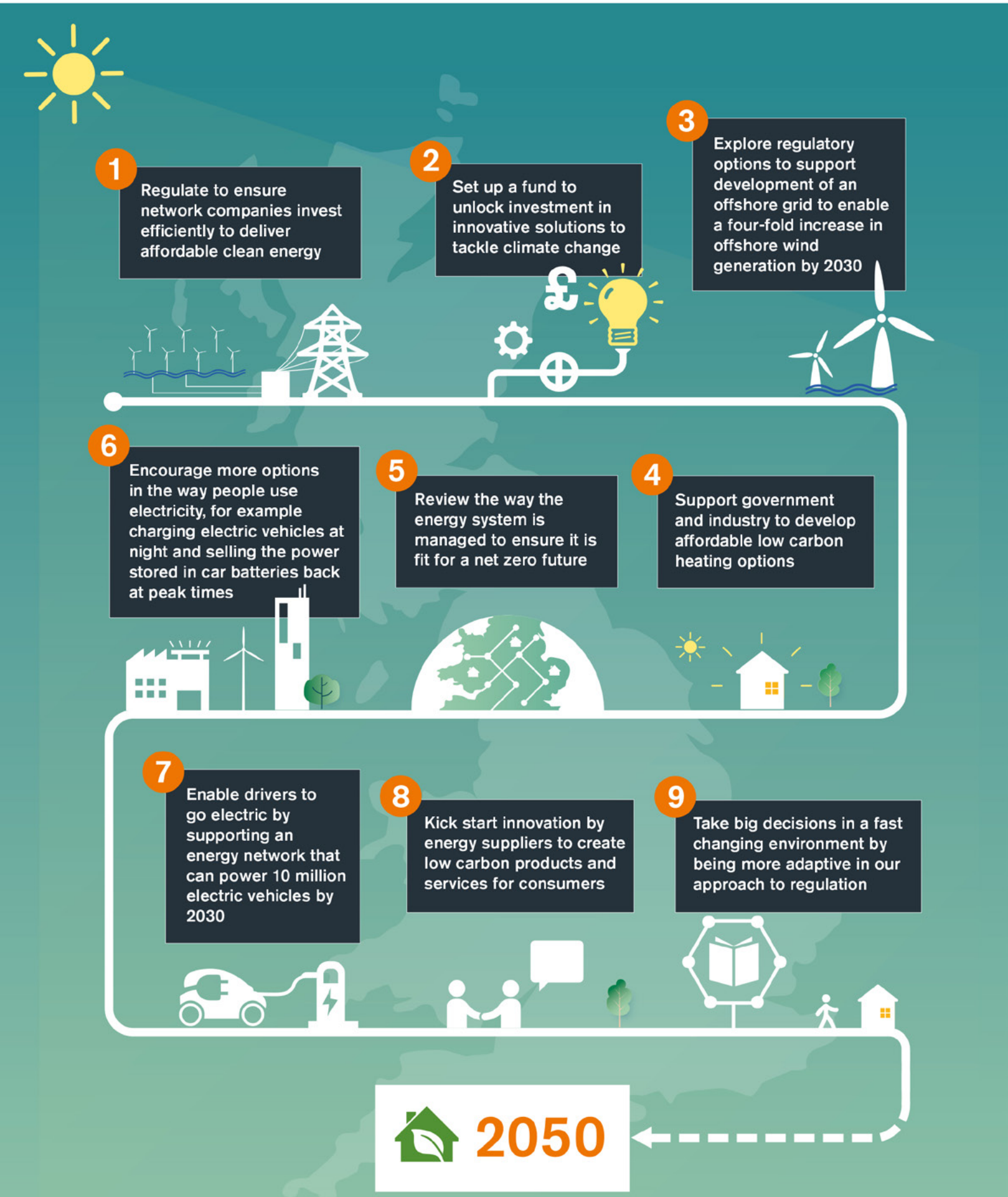
There will be significant changes to the way we heat our homes and businesses. The best way forward is not yet clear, but it could include the development of hydrogen networks and the electrification of heating. We will work with government and harness our expertise, including in running energy support schemes and through innovation funding, to inform and develop the wider evidence base for the different options.

As energy consumers, we will all need to change the way we use energy. It is Ofgem's aim that these changes will be easy to make and will benefit, rather than disrupt, people's lives. We will base our policies on real-world consumer behaviour so that we fully understand the actual benefits brought to consumers. We will promote greater innovation in the retail market to bring a suite of new products and services to market, which can help save users money and enable the system for a zero carbon future. Electricity prices that vary over time, depending on how much supply is available, will mean that households can save money by using electricity when it is cheaper and more plentiful. If consumers are able and willing to shift their consumption in this way, it can be both less expensive and delivered quicker than building new network and generation capacity.

Finally, Ofgem itself must do things differently to respond to the challenge. We will become a more adaptive organisation to respond to and shape a rapidly changing energy system. We will ensure that our regulations keep pace with government policy developments and new innovations.

This document sets out the actions we will take in the next 18 months, beginning our next steps on an urgent, but decades-long journey towards net zero. We will work closely with government, industry and consumers to do this at the lowest cost. Our approach will continue to evolve and we will develop new actions and programmes as the opportunities arise.

How we'll decarbonise energy to deliver a net zero future at the lowest cost to consumers





Introduction

The energy system is changing rapidly – but the changes need to go further, faster. In June 2019, the UK Parliament made a historic commitment to achieve net zero greenhouse gas emissions by 2050. Reflecting the different circumstances of different parts of GB, in September 2019 the Scottish Parliament legislated to set a net zero target for 2045, and the Welsh government intends to introduce legislation to amend its existing target to achieve net zero no later than 2050. This followed Parliament's declaration of a climate emergency, and the Committee on Climate Change's (CCC) recommendation that achieving this net zero target was necessary, feasible and cost-effective.

In our strategic narrative for 2019 to 2023,[2] published in July 2019, we made clear that decarbonising the energy system at lowest cost to consumers is one of our three priorities over the coming years, alongside protecting consumers and enabling competition and innovation. The scale of the challenge is immense, and we must help the energy sector rise to it. To reach net zero by 2050, we must make a concerted effort together with industry, national, devolved and local governments, and consumers themselves. Thirty years may seem a long time, but to develop new infrastructure and fundamentally change the way consumers interact with energy, we need urgent action.

Ofgem plays a critical role in ensuring that the energy system is fit for the future and we have significant programmes in place that contribute towards decarbonisation. Ofgem's principal objective is to protect the interests of existing and future consumers, including their interests in the reduction of targeted greenhouse gases.[3] Given our principal objective, we act to promote a reliable, affordable and lower-carbon GB energy system. We cannot achieve this alone. Nonetheless, Ofgem has a crucial role in developing the regulatory framework to enable net zero.

In this action plan, we build on our existing work and outline our next steps in making low-cost decarbonisation of the energy sector a reality. We identify here the key actions we will take in the next 18 months, and we will report regularly on progress over that period. We will continue to refine our approach to identify new actions and respond to new priorities, including in our future Forward Work Programmes. This plan does not impact on decisions we have previously taken, or any actions or changes relying on those previous decisions except where explicitly set out.

This action plan is presented alongside the draft Forward Work Programme and we welcome the views of all readers on the actions and proposals contained here. If you have views, comments or suggestions, please email them to Chief.Economist@ofgem.gov.uk **by 21 February 2020.**

[2] https://www.ofgem.gov.uk/publications-and-updates/ofgem-strategic-narrative-2019-23
[3] https://www.legislation.gov.uk/ukpga/2008/27/part/1/crossheading/targeted-greenhouse-gases

The net zero challenge

There is no one agreed route to net zero.[4] Previous predictions on decarbonisation and renewables growth have rarely been accurate. Few commentators anticipated the recent rapid reductions in the cost of wind and solar power. However, some of the potential paths are clear, and we cannot stand still and wait for certainty. We must take action.

The UK has made good progress so far in reducing greenhouse gas emissions (Figure 1). Emissions have fallen by over 40% since 1990, more than in any other major advanced economy.[5] In the power sector, emissions have fallen by almost two-thirds, due to wind, solar and gas replacing highly-polluting coal-fired power generation.

This has been enabled by government and regulatory action, particularly targeted subsidies to low-carbon sources of generation and pricing of the carbon emissions caused by fossil fuels. However, carbon reductions have been more limited in the transport and heat sectors. Emissions from buildings (mostly space heating) have fallen 20% since 1990, primarily due to increased energy efficiency. Transport emissions have risen by 4% since 1990, as efficiency gains have been more than offset by increased demand.

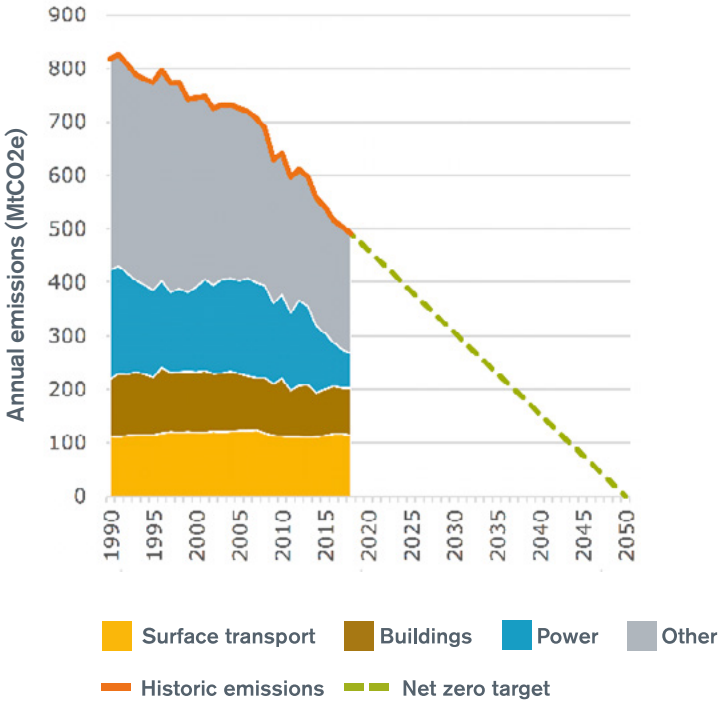


Figure 1:
UK greenhouse gas emissions, historic and targeted

Notes:
Buildings emissions are mainly from space heating, though do include non-heating related emissions. Projections and targets show interpolated trend lines to the target year, not the expected path. 'Other' includes industry, waste, F-gases, shipping, agriculture and aviation.

Source:
Ofgem, based on CCC and BEIS (2019), 2017 Greenhouse Gas Emissions: Final Figures.

[4] Net zero refers to the UK target to reach net zero greenhouse gas emissions by 2050. It is 'net zero', rather than 'zero', as it is expected that some emissions will remain, but they will be at least fully balanced by carbon removal, through the use of removal technologies or land use changes.

[5] All emissions figures based on BEIS (2019), 2017 Greenhouse Gas Emissions: Final Figures.



Power

There is broad consensus on how to decarbonise the power sector. According to the Committee on Climate Change (CCC), low-carbon electricity generation will need to quadruple (to 645 TWh in 2050) to replace existing fossil fuel generation and to meet the expected increased demand from transport and heating.[6] The CCC suggest renewables are likely to provide over half of all electricity generation in 2050, with nuclear and decarbonised gas (either hydrogen or methane with carbon capture and storage (CCS)) providing the remainder. CCC analysis suggests that new demands can largely be met by building 6-10 gigawatts (GW) per year of low-carbon power, the majority of which is anticipated to be wind and solar. To achieve this, we will need greater strategic coordination and increased investment in generation, network infrastructure, storage and other flexibility services. The CCC estimate that investment in the power sector may need to increase to around £20 billion (in 2019 money) per year by 2050,[7] up from an average of around £10 billion between 2013 and 2017.

The changes in the way electricity is generated and its likely increasing use for transport and heating mean we need to consider total GB energy needs as an interconnected whole, to ensure it works reliably under new circumstances. Not only will overall electricity demand increase, peaks of demand could be magnified if not managed correctly, while generation could become less flexible. The energy sector will therefore need to make it easier and more attractive for consumers to shift electricity demand from peak periods, and to increase the provision of energy storage. This includes using car batteries, smart charging, and home energy systems as well as grid scale storage. System operators and network owners will have to step up to the challenge of a decarbonised energy sector too, integrating more small-scale and inflexible sources of generation while maintaining high standards of security of supply.[8]

Surface transport

The UK is on the brink of a rapid transition to electrified transport. However, the scale of the challenge is significant.

There are over 30 million cars in the UK, but by Q3 2019, there were around 230,000 plug-in electric vehicles, up from just over 50,000 in 2015.[9] The government's current target is that the sale of new conventional petrol and diesel cars and vans will end by 2040.[10] However, the CCC recommend that all new vehicles sold (excluding heavy goods vehicles (HGVs)), should be low carbon by 2035 at the latest, and preferably by 2030.[11] The CCC forecasts a required 46 million electric vehicles on UK roads by 2050. This will need new charging infrastructure – the CCC estimates that 3,500 rapid and ultra-rapid chargers near motorways and 210,000 public chargers in towns and cities will be needed, up from 30,000 public chargers of all speeds currently installed.[12]

Increased uptake of electric vehicles creates a rare opportunity for a win-win-win for society, through lower carbon emissions, improved air quality and a more robust and low-cost energy system. But this will only be achieved if drivers are supported to charge their vehicles typically at off-peak times, for example, through smart charging. Support for drivers using their electric vehicles in novel ways will also be needed, for example by 'vehicle-to-grid' technology to share energy from car batteries back to the electricity grid when it is needed.

Heat

The future of heating is less certain, with a range of possible different pathways to decarbonise. In 2017, just 4.5% of the energy used for heating the UK's 29 million homes and other non-residential buildings was from a low carbon source. This number needs to rise significantly by 2050; CCC analysis proposes that 90% of homes, and 100% of non-residential buildings, should be heated from a low carbon source.

[6] All of the references to the Committee on Climate Change (CCC) in this section are from CCC (2019), Net Zero: The UK's contribution to stopping global warming.

[7] Includes investment in renewables, firm low-carbon power, CCS, peak power and networks (including transmission and distribution).

[8] The ESO has announced plans to be able to operate GB's electricity system with zero carbon by 2025. See: https://www.nationalgrideso.com/news/zero-carbon-operation-great-britains-electricity-system-2025 (accessed 9 January 2020).

[9] Department for Transport, Plug-in cars and light goods vehicles, Vehicle Licensing Statistics (https://www.gov.uk/government/collections/vehicles-statistics)

[10] Road to Zero Strategy, see: https://www.gov.uk/government/news/government-launches-road-to-zero-strategy-to-lead-the-world-in-zero-emission-vehicle-technology (accessed 13 January 2020).

[11] The CCC also notes that hydrogen may be a leading option for some surface transport, such as HGVs.

[12] https://www.zap-map.com January 2020



Electric heat pumps (including hybrid variations) and replacing natural gas with hydrogen are two of the alternative low carbon technologies to heat our buildings in the future, but there is uncertainty as to their relative roles. Heat networks equally have a role to play, where heat is provided by heat pumps, hydrogen, biomass, waste heat or other low carbon fuels. There is unlikely to be one single solution across GB; different areas are better suited to different approaches due to resource availability and housing types. But greater energy efficiency is a low regret option, an option that can be taken in the knowledge that it will be beneficial regardless of what technologies come to the fore in the future. We expect that heat pumps will be needed to heat many homes, regardless of the future of hydrogen. According to the CCC, switching to low carbon heating will require annual investment by 2050 of around £15-20 billion (in 2019 money),[13] up from just £100 million in 2018.

Innovation, consumer empowerment, and climate adaptation

A successful energy transition will require continued innovation, empowered consumers, and a fair distribution of costs and benefits. Continued rapid innovation in the energy sector will make achieving net zero at low cost much more feasible. This includes innovation in business models, which may include new ways of incentivising consumers to help provide system benefits such as flexibility; local or peer-to-peer trading of electricity; or providing 'energy services' rather than supplying energy. Digitalisation will play an important role, and is already beginning to change how we control our energy systems – for example, allowing people to control their home heating on their commute. In the future, artificial intelligence could help with complex tasks in real time, such as managing millions of connected devices to balance the grid.

Consumer empowerment, supported by technology, can increase public acceptability of the lifestyle changes that net zero requires, and ensure that those changes are tailored to individual circumstances. Good customer service, supported by robust regulation, will always be important. But more radical changes to how consumers interact with the energy system could have a profound impact, for instance through buying heat as a service and through selling energy services routinely to the grid or directly to other consumers. The Energy Systems Catapult's ongoing trials of offering 'Heat Plans' to consumers provide one example of how greater consumer empowerment could develop.[14]

In addition to mitigating climate change by reducing emissions, the CCC has made it clear that the energy sector will need to adapt to the effects of climate change, including more frequent and intense storms, heatwaves and flooding.

For example, according to the CCC, the population at significant risk of flooding by 2050 will be around 2.6 million in a 2°C scenario,[15] rising to 3.3 million in a 4°C scenario.[16] Our energy infrastructure, including in people's homes, will need to be resilient to these changes.

The challenges of net zero are stark and require us to step up our efforts to meet them. As the energy regulator, we can create the regulatory framework to enable the appropriate investment, and help direct that investment where it is needed. The rest of this action plan sets out our initial response to this challenge.

[13] Relative to high carbon counterfactual. Includes investment in energy efficiency and low carbon heating systems for residential and non-residential buildings.
[14] See, e.g., https://es.catapult.org.uk/news/ssh2-heat-plans-made-to-measure/
[15] A 2°C scenario means a scenario in which the global average temperature rise is limited to 2°C above pre-industrial levels.
[16] CCC (2016) Climate Change Risk Assessment 2017 Evidence Report.



Ofgem's role

Ofgem has a critical role to play to achieve decarbonisation at the lowest cost to consumers and the energy system. But for us to be most effective, we need to share an understanding of our role with other stakeholders. Ofgem is a statutory regulator set up by government to regulate the energy companies to protect consumers' interests. Government has a democratic mandate to set the overall direction of energy policy, and decides how to balance different objectives at the highest level. In particular it decides how the costs of the transition will be met through consumers and taxpayers, and the overarching framework of the energy system under which Ofgem operates.[17]

Ofgem's approach and regulatory frameworks directly impact the GB energy systems and their development, for example through market design and network regulation. Working together with government, we can deliver on our commitments to net zero.

Our work stems from our statutory duties to act in the interest of current and future consumers, including their interests in greenhouse gas reductions. Our principal means of influence is through setting the requirements that need to be met to operate in the sector through means of licences, and as a delivery body for government support schemes.

Our regulation affects the construction and operation of network infrastructure, and the functioning of wholesale and retail energy markets – all of which will be central to decarbonising the sector. In relation to decarbonisation, this means we have critical roles in five key areas:

- Responsibility for the evolution of the networks.
- Partnership with government in the evolving market design and system operation.
- Primary responsibility for regulating the retail market.
- Administering environmental and social energy schemes.
- Showing leadership to encourage partnership between industry, regulation and government, and providing advice to government and other stakeholders.

As the GB regulator, we are uniquely placed to ensure that networks are developed and run in a way that is fit for the future. This includes enabling new networks to be built cost-effectively, and ensuring they are run flexibly and efficiently to keep costs down. We need to help prepare for a future beyond natural gas for space heating, for a future without conventional fossil-fuel vehicles and for renewable, increasingly variable electricity generation.

[17] Government is currently undertaking a review of how progress towards net zero can best contribute to growth.



We have an important role in designing and facilitating markets so that the correct market signals are created to enable decarbonisation through the whole system – from the consumer up to the generators.

We also deliver many of the government's environmental and social support schemes which are key to enabling low carbon heat and power.[18] Our scheme administration activities include ensuring compliance and supporting innovation. Through our work administrating these schemes, we have helped facilitate the deployment of over 40 GW of renewable capacity and over £12 billion in lifetime bill savings delivered to vulnerable households through energy efficiency schemes. We have shown leadership in environmental administration at the global level through the experience gained, sharing knowledge with international partners to strengthen decarbonisation efforts worldwide. In the future, we will use our regulatory and administrative experience to support government to develop and implement effective net zero policies.

We will continue our work to protect consumers' interests, promoting value for money and security of supply and sustainability for present and future generations of consumers. In line with Ofgem's principal objective[19] we will balance the benefits to future consumers of greenhouse gas reductions alongside the potential costs to current consumers. We will need to ensure that consumers are protected as new services are developed and as the way consumers interact with the energy system changes – with the result that all consumers, including those in vulnerable situations, are benefitting too, and not paying an excessive share of the costs.

Ofgem is one of many organisations who must take responsibility for ensuring that GB progresses towards net zero. As an independent regulator, we will be able to challenge and provide leadership to other energy system stakeholders. However, we will also work alongside government and industry, recognising the whole system thinking that is needed, in considering the opportunities and implications of the electrification of transport and increasing energy efficiency and demand side management. We will use our convening power to bring people and organisations together to find solutions where joint action is needed.

[18] Including the Smart Export Guarantee, Renewable Heat Incentive, Warm Home Discount, Energy Company Obligation, Renewable Energy Guarantees of Origin, Feed-in-tariff and the Renewables Obligation.

[19] See: http://www.legislation.gov.uk/ukpga/1989/29/section/3A



Our trade-offs and decisions

Ongoing technological advances are changing the energy landscape. Specifically, the dramatically reducing costs of renewable technologies are shifting the balance of the traditional trilemma of environmental sustainability, security of supply and affordability. Some decarbonisation policies can create win-wins for consumers and society: in addition to mitigating climate change, such policies can improve air quality, and result in lower costs.

However, given the scale of the investment required, elements of the transition to net zero will involve additional costs or changes to how costs are distributed. This is particularly the case where spending now is required to avoid higher costs in the future, such as mitigating or reducing the future impacts of climate change. Where the costs of this are met through consumer bills, this will be generally regressive, impacting the poorest, hardest. It is our role as a regulator to ensure that, where possible, these additional costs are minimised, efficient and distributed fairly – notably through effective price controls on the network companies and competition in the retail and wholesale markets. We will also help communicate, together with government, industry and others, why additional costs are emerging and how these can be managed. As part of this, we will consider the outcomes of the government's Net Zero Review.[20]

We need to help achieve rapid decarbonisation alongside the other two pillars of our strategic narrative, namely: protecting consumers, especially those in vulnerable situations; and enabling competition and innovation that drives down prices and results in new products and services. We need to make sure that consumers in vulnerable situations are not left behind or disadvantaged by the changes. While we recognise that we cannot always protect the individuals who are in the most vulnerable circumstances when thinking about specific system-wide changes, we need to consider these impacts for our regulatory policies in aggregate.

As the changing energy system reaches more aspects of our lives, including transport and heat, and may require more active engagement from consumers, this brings new challenges in thinking about fairness and trade-offs. We need to consider how costs and benefits fall between different groups, in different places, and at different times. There are several specific trade-offs which we need to consider, including:

- Balancing the needs of current and future consumers.
- Balancing the distributional impacts of funding policies from consumer bills, taxpayers or others.
- Providing support to early adopters without creating a risk of leaving some consumers behind.
- Balancing the need to do things differently with a recognition that changes may be easier or more advantageous for some people.
- National versus regional action. Regional action can allow for more rapid experimentation and tailoring of policies, but action at the national level can provide better coordination.

For example, as the electrification of transport proceeds, there will be additional investment needed in the electricity system, although the overall cost of transport is expected to be reduced, and air quality improved. Not all electricity consumers drive, but may benefit from other electrified transport. There are other significant non-energy impacts: for example, initially, electric vehicle (EV) uptake is likely to be in urban and peri-urban areas, the residents of which will also benefit most from improved air quality. Decisions will need to be made about how the costs of additional investment will be apportioned between EV drivers, general electricity consumers, and the wider population. Government policy will determine some of this, but some aspects will fall to Ofgem.

[20] https://www.gov.uk/government/news/net-zero-review-launched-to-support-uks-world-leading-climate-commitment



Subsidy schemes (such as the Renewable Heat Incentive) can encourage uptake of innovative technologies with costs that are higher than the conventional alternative. To be effective, subsidies need to offer a high value to users - this can result in early adopters receiving disproportionate returns, paid for by taxpayers or consumers. Since early adopters are often wealthier, this can effectively lead to transfers from poorer to richer consumers. Alongside government, we therefore need to consider carefully the design of any subsidy schemes, particularly to ensure they are cost-effective in achieving decarbonisation benefits.

Demand side management has a significant influence in the needs of the future energy system, and hence its costs to consumers. At the most basic level, energy efficiency is often a low regrets action, resulting in savings to consumers through reduced energy bills. These are measures particularly suited to counteracting any higher costs associated with new forms of low carbon energy. More sophisticated measures, such as shifting demand from peak periods, may result in savings due to avoided network upgrades as well as avoiding new peak generating plants. Both of these impact energy bills. Ofgem is setting up market frameworks to enable the latter, whilst the former is mostly determined by government policy (including energy efficiency policies for housing, products and industry). How much energy efficiency will be achieved is an uncertainty we need to account for. Where government has given a role to the energy sector in delivering energy efficiency, we support it in our delivery role. We will work with government in considering how far we should or could use our powers to require or promote the greater uptake of energy efficiency.

Devolved administrations have different targets for net zero, currently in line with CCC recommendations. Some local authorities are bringing forward decarbonisation ambitions and strategies that go further and faster than the UK government. Such local leadership could help GB as a whole to learn what works best and to develop supply chains. Local planning can also help to develop the most appropriate pathways to decarbonisation – both through local buy-in of citizens and consumers and through better tailoring of solutions. For example, as noted above EV take-up is likely to be initially faster in urban and peri-urban areas. However, earlier action may mean higher costs in the short term and brings higher risks of investment in underutilised assets. Due to the structure of the energy system, these costs and benefits may accrue to consumers outside the boundaries of elected authorities, such as where network upgrades are required.

There are also trade-offs to be considered here with regards to the costs, benefits and risks of early action. Such plans may require additional policy and financial commitments to make them a reality. Where localities or regions have secured or made early commitments, the long term costs will be reduced and/or the risk that assets will be stranded is also reduced. Boundaries of network companies do not fit neatly with local and regional government structures. Where costs are socialised broadly within an area of democratic accountability, we may be able to support proposals for additional funding, for example through network price controls. But where funding needs to be cross subsidised from outside an area of accountability then the trade-offs may be different and our decisions will, where appropriate, need to account for this. Such decisions will need to consider the costs, benefits and risks to current and future consumers of bringing forward or postponing action, noting the need for significant transformation but also the varying levels of uncertainty about future technological solutions. We are willing to take some carefully measured risks, on issues such as technology lock-in or stranded assets, where local action and commitment is clearly demonstrable, and linked to national plans. We will continue to develop our thinking alongside government and industry as to how to best address these issues, and to develop realistic approaches that seek to harness personal, local and regional leadership without burdening consumers.

Above all, we will be transparent and open in our thinking, to enable consumers and wider stakeholders to understand the options and trade-offs considered and how we reached particular decisions.



How we will meet the challenge

We are taking some actions immediately, building on existing activity. They will be supplemented by further work as new opportunities to support decarbonisation emerge. For clarity of presentation, our actions, which focus on the next 18 months, are described across networks, the energy system and the retail sector. There are important interactions taking place across these areas, and we recognise the importance of fully incorporating these in our decision-making.

Preparing the networks to drive changes

Designing a cost-effective network for net zero

The network price controls are among the key regulatory tools that Ofgem has to facilitate net zero at lowest cost to consumers. They enable Ofgem to directly fund the networks to efficiently deliver the infrastructure that will support a decarbonised future; support innovation projects to develop and prove new solutions; and incentivise new ways of working that will deliver sustainable outcomes for consumers and wider stakeholders. Ofgem will use these price controls to deliver the network changes that are needed to achieve net zero. We will ensure that networks continue to connect the low carbon technologies required to meet climate change targets and maintain high levels of reliability, while ensuring that network capacity is not increased unnecessarily or at high cost.

Our price controls are set under our RIIO (Revenue = Incentives + Innovation + Outputs) regulatory framework and determine the revenues networks can recover as part of energy bills, so that consumer interests are protected. The cost of operating, maintaining and strengthening these networks is significant. This currently averages around £12.5 billion each year, a figure which is likely to increase in the short term as we move to net zero. Currently these network costs amount to about a quarter of total consumer costs of gas and electricity.

The next price control (RIIO-2) periods run from 2021 to 2026 for gas distribution and electricity and gas transmission, and from 2023 to 2028 for electricity distribution. These years are expected to see fundamental changes if we are to meet net zero at lowest cost. The route that is taken to decarbonise will depend on government policy, technological developments and consumer behaviour as well as regulatory policy choices. The CCC has advised that government must take some key decisions, in particular on the future of heat, in the mid-2020s. We must also act together with others, including local and regional governments.

We therefore recognise the importance of embedding coordination and flexibility into the design of the RIIO-2 price controls. These price controls will provide for a level playing field between traditional network reinforcement options and potentially lower cost flexible solutions, such as storage and demand-side response. We will retain the approach of previous price controls to allow us to reopen the price control with uncertainty mechanisms in response to major system or policy changes. In addition, we will introduce a suite of net zero investment and innovation mechanisms, including the strategic network innovation fund and a new net zero reopener, that can help to enable key developments in regulatory policy or technology to be reflected flexibly in the price controls. These would allow for net zero-related actions to be put into place in the price controls at any time, rather than just during the preparatory phase prior to the start of each control period.

We will also take into account the recommendations of the Net Zero Advisory Group of key sector stakeholders. This advisory group is part of a wider



Ofgem approach to adaptive regulation (Section 5) but will, in particular, consider how price controls can best enable decarbonisation, including by bringing forward appropriate anticipatory investment.

One future path involves network companies working more closely with third parties, particularly local, regional and devolved governments, to help identify low-cost approaches to heat decarbonisation and to respond cost-effectively to wider decarbonisation challenges such as the roll-out of electric vehicles. This could include local authorities and communities being engaged in the development of local area energy plans to identify the best basket of solutions for a particular area.

Action 1

Designing cost effective networks for net zero

We will make the network price control regulatory regime more adaptive to deliver the most effective transition at lowest cost. A new mechanism – a system-wide net zero reopener spanning the gas and electricity sectors – aims to balance the need for investor confidence and the need to respond flexibly to changing technological and policy developments in the path to net zero. We will review the design of the electricity distribution network price control to facilitate the transition to net zero, and electric vehicle uptake in particular.

Anticipatory investment

Our network price control framework requires network companies to take account of long-term requirements when maintaining and upgrading their assets. To fulfil these obligations, companies must invest, and nearly all network investment is in some sense anticipatory. Recognising this, we developed the existing price controls (RIIO-1) to enable companies to invest ahead of need.

Investment for network capacity that is ultimately not needed will increase costs for consumers.

Nevertheless, we recognise that some investment ahead of need will be necessary to achieve decarbonisation at lowest cost to consumers. Before the upcoming electricity distribution price control, we will develop additional guidance, to help network companies provide the well-justified cases for consideration. We will consider such proposals in the next price control (RIIO-2), taking account of the advice of the Net Zero Advisory Group on strategic investment needs, and by using net zero reopeners as necessary.

Strategic innovation

Innovation funding within network price controls has achieved significant successes in encouraging network companies to think about how they can innovate to achieve better outcomes for consumers. We plan to build on this success by developing the structure of innovation funding so that it is more focussed on the strategic challenges the networks face, particularly decarbonisation. This will encourage network companies and others to develop and test out a wide range of solutions to support decarbonisation of heat and transport. We expect networks to search out different approaches to achieving outcomes such as: wide-scale deployment of electric vehicle infrastructure and smart charging, including vehicle-to-grid technology; greater uptake of domestic and commercial heat pumps to electrify heating; and exploring low carbon alternatives to gas heating such as hydrogen.

In the coming months, we will set out further details of this framework and how our RIIO-2 network innovation programme can be used to develop and test innovation projects. We will also develop proposals to ensure that network innovation projects funded under the RIIO-2 innovation programme are aligned with wider public sector R&D activity and whole-system decarbonisation challenges. We will work with government to explore the opportunities to give a wider range of parties direct access to our innovation funding. We will also explore requiring networks to engage more extensively with a suite of relevant stakeholders as a precondition of a successful grant application.



Ensuring long-term resilience in the face of climate change

Climate change raises several important risks for the UK's energy infrastructure, including:[21]

- River and coastal erosion;
- Risk of cascading infrastructure failures across interdependent networks;
- Surface water flooding;
- Wave and tidal impacts on electricity lines/poles and offshore renewable energy infrastructure;
- High winds and lightning; and
- Extreme temperatures.

Mitigating these risks requires action from the energy industry. Many network companies consider elements of climate adaptation in their business plans, notably where specific elements have been identified as at risk. But we would like to see the development of better and more systematic climate adaptation strategies and risk assessment from all network companies, and the development of widely-shared industry best practice.

We will work together with industry and other stakeholders to ensure that the network companies undertake comprehensive assessments and put in place appropriate plans to deliver resilience to climate change. We will take account in particular of the Bank of England's work to enhance the management of financial risks from climate change.[22]

Action 2

Long-term planning and innovation

We will encourage further long-term planning, leadership and innovation in networks through regulatory design and funding. To help unlock investment needed for the transition while protecting consumer interests, ahead of the electricity distribution price controls we will develop guidance to aid the development of investment proposals where there is significant uncertainty of need. We will set up a new strategic innovation fund focussed on the challenge of decarbonisation. We will also ensure that the networks put in place appropriate plans and measures to deliver resilience to climate change.

[21] See HM government, UK Climate Change Risk Assessment 2017.

[22] See Bank of England (2019), Enhancing banks' and insurers' approaches to managing the financial risks from climate change.



More effective coordination to deliver low cost offshore networks

The current frameworks relating to developing and connecting offshore wind generation need to be reviewed in light of the government's expectations for offshore wind. In 2019, the government stated[23] its ambition of achieving a significant increase in offshore wind capacity by 2030 from the level of around 10GW currently. We do not consider that individual radial offshore transmission links[24] for this amount of offshore generation are likely to be economical, sensible or acceptable for consumers and local communities. We are therefore working with government and industry to review the frameworks for connecting offshore wind generation, and will explore whether a more coordinated offshore transmission system could reduce both financial and environmental costs.

The Electricity System Operator (ESO) is responsible for planning a coordinated and efficient transmission system both onshore and offshore. We will work with the ESO to ensure it rigorously assesses the options for coordination of offshore transmission, including analysis of the likely costs and benefits, beginning in spring this year. We will support and scrutinise the ESO's work, and identify current barriers to the development of coordinated offshore transmission assets and work to remove them.

We will work with government and key stakeholders to design and plan any required changes to the existing regulatory frameworks and the offshore transmission regime. In addition, we are discussing the potential for projects that integrate international interconnectors with offshore transmission networks with governments, other regulators and industry. We will consider how best to work with developers and network firms in order to identify regulatory barriers for future international meshed or hybrid projects, and work to ensure these projects can be rigorously assessed to maximise consumer benefits.



Action 3

More effective coordination to deliver low cost offshore networks

We will explore, with government and industry, options for a more coordinated offshore transmission system to connect offshore wind generation, to achieve a rapid and economic expansion of the offshore network. As a first step we will work with the Electricity System Operator (ESO) to ensure it can take forward an options assessment for offshore transmission.

[23] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/853886/Queen_s_Speech_December_2019_-_background_briefing_notes.pdf

[24] To date, offshore windfarms in GB have been connected to the shore via standalone transmission links. With more offshore windfarm projects planned, many of which are further from shore than those developed already, there is potential for efficiencies from greater coordination of offshore transmission infrastructure.



Heat and the future of the gas network

Decarbonising residential heating, which is currently responsible for around 18% of the UK's greenhouse gas emissions,[25] is arguably the biggest challenge that the energy sector faces over the coming decades. The UK government plans to publish a Low Carbon Heat Roadmap in 2020. This should provide some direction for the future, but fundamental technological uncertainty means that many questions will remain. However, we and other stakeholders can take sensible 'low regrets' actions[26] now, to ensure GB is well set up to achieve the huge task of heat decarbonisation. In particular, developing evidence on the feasibility and cost of different routes to decarbonisation will be critical to enable the sector to deliver a timely transition at lowest cost. The Clean Growth Strategy noted the need to make decisions about low-carbon heating for properties connected to the gas grid in the first half of the 2020s.[27] The CCC also suggest that large-scale deployment of low carbon heating must begin before 2030.

We will therefore work together with government, industry and other stakeholders to help build the evidence base, in particular through innovation funding and delivery of support schemes. We will draw on our expertise in scheme delivery, networks, markets and consumer behaviour.

We may work with others to consider: how low carbon heating can be rolled out cost-effectively; the role of the energy sector in delivering household energy efficiency measures; and how the Fuel Poor Network Extension Scheme[28] could be updated with low carbon alternatives in the future. We will take the findings into account in regulatory policy making, developing and implementing new programmes of low regret measures within our core competencies. We will work with government and devolved administrations at the earliest stage to inform the scope, delivery and compliance processes of new environmental schemes they may propose, and to determine if Ofgem has a role in administering such schemes alongside our existing ones. In addition, we will work with government to consider any role for Ofgem in the protection of consumers connected to heat networks.

[25] https://www.gov.uk/government/statistics/provisional-uk-greenhouse-gas-emissions-national-statistics-2018

[26] Low regret options in the past have included increasing energy efficiency of houses, for example through loft insulation and choosing more energy efficient appliances which, create both carbon reductions and economic savings.

[27] Clean Growth Strategy, 2017, available: https://www.gov.uk/government/publications/clean-growth-strategy (accessed 17 January 2020)

[28] https://www.ofgem.gov.uk/publications-and-updates/decision-change-criteria-fuel-poor-network-extension-scheme



We also want to ensure that current and future consumers bear their fair shares of the costs of preparing for heat decarbonisation. To this end:

- In the early part of the next price control for the gas distribution network, we will work together with government and the Health and Safety Executive to review the 'Iron Mains Risk Reduction Programme' (IMRRP). This programme requires qualifying iron gas mains to be decommissioned – this is currently done via replacement. The programme is expected to run until 2032 with an estimated total cost of £4 billion over the next price control period. This review will consider how this programme can ensure consumer money is best spent in light of the government's net zero commitment, whilst ensuring that public safety is not compromised.
- We will work with National Grid to review the capacities required on the gas transmission network, in light of the potential futures of gas in a changing energy system.
- We will carry out a strategic review of gas network asset depreciation once there is more certainty around the future of heat generation and transmission. This will be an important step to ensure that our approach to gas network asset depreciation is aligned with the government's net zero target, whilst taking into account the anticipated impact on investment alongside the potential effect on consumer bills.

Action 4

Making progress on low-carbon heat

We will support government and industry to ensure that there is a fair balance of costs in preparing for heat decarbonisation across different groups of consumers and firms, including between current and future consumers. During the price control, we will review gas network depreciation. We will work with the Health and Safety Executive (HSE) to review the Iron Mains Risk Reduction Programme and with National Grid to review the capacities required on the gas transmission network, in light of the potential futures of gas in a changing energy system. We will harness our existing knowledge and expertise to help government and industry develop cost-effective and low risk options to decarbonise heating.



Ensuring the electricity system is ready to deliver

Ensuring system operators play a full role in decarbonisation

Given the scale of the decarbonisation challenge and the need for effective coordination across many different areas, the system operators will play a key role in enabling the transition to a net zero sector.

Within the existing structure, we have already redesigned the electricity system operator's (ESO's) financial incentives framework to encourage the delivery of greater value through its market facilitation role. This has focused on the integration of low carbon technologies into balancing and ancillary services markets, which are critical for reliable functioning of the electricity system. In our design and implementation of the ESO's RIIO-2 price control (which takes effect from 2021), we will continue this focus.

The increasing amount of renewables on the system is expected to make the ESO's balancing role more difficult. However, this capability will be essential to reaching net zero. In 2019, the ESO committed to being capable of operating a zero-carbon system by 2025. We will seek to hold the ESO to account, through the ESO's financial incentives and regulatory framework, for delivering on this commitment.

Distribution network companies face an additional challenge as they play an increasingly important system operation role, particularly due to the rapid increase in distributed generation and flexibility resources. Our work on the Distribution System Operation reforms[29] aims to realise the opportunities presented by decarbonisation, decentralisation and digitalisation. For instance, we will consider how distribution network companies can most appropriately take into account the carbon intensity of the flexibility services they procure.

As well as managing the increasing challenges of maintaining a secure and reliable energy system, system operators will need to promote greater strategic planning of investment and improved coordination across transmission and distribution, and across electricity and gas. We therefore believe that now is a good time to review the core roles of the system operators, and have recently announced a strategic system operation review. This will be informed by our investigation into the power outage of 9 August 2019, and will take account of the wider considerations of enabling effective system operation in a net zero world. We will also work closely with the Department for Business, Energy and Industrial Strategy (BEIS) ahead of its planned position paper on system governance.



Action 5

Preparing system operators for a net zero future

We will ensure that the roles and responsibilities to plan and operate a future energy system are adequately fulfilled, including making recommendations to government where change is needed. As part of this, we are undertaking a strategic review of the way our energy systems are managed, to ensure they are fit for a low carbon future.

[29] We think of Distribution System Operations as the effective delivery of multiple functions and processes in the distribution network to manage the system and network. For more information, see https://www.ofgem.gov.uk/publications-and-updates/ofgem-position-paper-distribution-system-operation-our-approach-and-regulatory-priorities



Enabling more low carbon power at lowest cost

As described above, we have an important role in ensuring that networks are able to integrate new sources of low carbon power, such as offshore wind. In addition, we are providing our expertise on monopoly regulation to help government decide on future funding models for some low carbon sources of power. The government is considering whether to introduce a Regulated Asset Base (RAB) funding model for nuclear power projects, and potentially for some other technologies such as carbon capture, usage and storage.

This may be similar to the current structures for supporting investment in monopoly energy networks. If the government decides to go ahead with such a model, we stand ready to provide continued support as appropriate to its development.

Promoting electricity system flexibility

To ensure a reliable energy system, we need to integrate into the energy system a growing volume of renewable energy sources that have fluctuating generation patterns, as well as nuclear power which is relatively inflexible in its output. This will require much more flexibility in our energy system and our consumption patterns, especially to achieve this at lowest cost. New technologies for energy storage and for matching supply and demand can provide alternatives to building additional network and generation capacity and help to manage peak demand. New and cost-effective ways of matching supply with demand can also improve system efficiency – using technology such as flexibility platforms, automated demand-side response (DSR), aggregation and trading.[30] We will support this need for increased flexibility by helping markets operate more effectively and providing the correct signals to market participants to take efficient actions.

We set out our joint vision with government of a smart and flexible energy system in the Smart Systems and Flexibility Plan[31] and have been working together to implement the actions in the Plan. We will now work with government and stakeholders to develop the next phase of this work. As part of this we will consider whether the current arrangements, when taken together with other price signals, can be expected to bring forward adequate low carbon flexibility.

Many stakeholders have a role to play in delivering the flexibility the electricity system will need in the long term. Network companies have a particular part to play in facilitating flexibility markets and we believe they should be transparent, consistent and value flexibility fairly - they are crucial in developing the levels of flexibility required across the electricity system. The Electricity System Operator, Transmission Operators and Distribution Network Operators should be evaluating flexibility on a level playing field against reinforcement. We facilitated reforms to enable elective half-hourly settlement, which came into effect in 2017, to make it easier for retailers to offer products which reward customers for using energy more flexibly. Market-wide settlement reform is expected to build on this and enable significant benefits for consumers by putting the right incentives on retailers to develop and offer new tariffs and innovations which would encourage consumers to use energy more flexibly.

Our work is designed to support the efficient rollout of smart enabling technologies, such as network monitoring hardware and software, to support the operation of these markets. We support this on a needs basis rather than as a blanket approach.[32] It is important that the value of decarbonisation is fully accounted for when considering the needs case for smarter energy network technologies.

We are currently undertaking a major programme of reforms to electricity network charging - the Future Charging and Access Programme.[33] This is considering how network costs are recovered so that networks are used efficiently and flexibly, reflecting users' needs and allowing consumers to benefit from new technologies and services. The programme includes reducing distortions to forward-looking charges and improving the fair recovery of residual charges.

[30] https://www.ofgem.gov.uk/publications-and-updates/ofgem-s-future-insights-paper-6-flexibility-platforms-electricity-markets

[31] www.ofgem.gov.uk/publications-and-updates/upgrading-our-energy-system-smart-systems-and-flexibility-plan

[32] https://www.ofgem.gov.uk/publications-and-updates/key-enablers-dso-programme-work-and-long-term-development-statement

[33] This includes the Access reforms, the Targeted Charging Review and the Balancing Services Task Force. https://www.ofgem.gov.uk/electricity/transmission-networks/charging/reform-network-access-and-forward-looking-charges



We support the development of markets for flexibility services at the transmission and distribution level of the electricity system.[34] We advocate innovation and exploration of these technologies to develop routes to more transparent flexibility markets. This will be driven by greater data availability and transparency, interoperability of platforms and systems and reduced barriers to entry for new, innovative entrants. Working together with other stakeholders, we will promote the standardisation of products and processes and enhanced data management and data sharing to enable flexibility markets.

Most forms of flexibility will require consumers to change their behaviour. Retailers will be critical to fostering this behaviour change in homes and businesses - by developing and marketing products and services that encourage and make it easy for consumers to use energy efficiently and at different times.

These new products and services need to be accessible and trustworthy, and consumers need to feel that they are benefitting from these new offerings. To enable this change, Ofgem has a role to play in ensuring that the conditions are in place for such services and products to emerge and for consumers to be suitably protected when using them. We will also ensure that those who cannot provide flexibility are not unduly disadvantaged.

Action 6

Supporting flexibility

We will enable a flexible future electricity system by ensuring markets adequately reward flexibility, including through our reforms to access, charging and half-hourly settlement, and our work to encourage networks to tender for flexibility services. We will support innovation to develop easy and engaging ways for small businesses and consumers to provide flexibility through demand-side management.

[34] https://www.ofgem.gov.uk/publications-and-updates/ofgem-position-paper-distribution-system-operation-our-approach-and-regulatory-priorities



Enabling electric vehicles at low cost

A smarter, more flexible energy system is also crucial for maximising the benefits associated with electric vehicles (EVs). The National Infrastructure Commission estimated that, if EVs are rolled out without smart charging, average annual system costs could increase by £2 billion, adding up to £30 per year to domestic consumer bills.[35] However, smart charging of EVs can also create opportunities for a more flexible and cheaper energy system, for instance by using vehicle batteries for short-term storage to smooth peaks in energy demand and maximise use of renewables. Government has consulted on mandating that all chargepoints are smart.[36]

We have been working closely with government to support the rapid take-up of electric vehicles. To complement the government's work, we will develop a regulatory strategy that will set out our role and define our actions in response to government policy on the electrification of transport. This will draw together activity on identifying and tackling regulatory barriers and enabling rapid roll-out of EVs in a cost-effective way. In coordination with our work on reforming electricity network charging, our strategy will outline our thinking on how network costs could be recovered to ensure networks are used efficiently and flexibly, and to allow consumers to benefit from new EV-related products and services.

Enabling decarbonisation through modernising energy data

Digitalisation is playing an increasingly important role in energy and in the transition to net zero. Greater complexity and volumes of data from smart meters, appliances, trading and flexibility platforms are opening up new opportunities and new business models as well as new and unforeseen personal data protection issues. Good data use and availability are crucial to provide better visibility of system usage, spare capacity and constraints, to inform investment needs, and to facilitate opportunities for strategic coordination. Several innovations to support a low-carbon future, such as smart vehicle-to-grid flexibility services, flexibility platforms, peer-to-peer energy trading and new demand side response services, rely upon the energy system's data architecture.

In June 2019, the Energy Data Taskforce set out its key recommendations for achieving a modernised, net zero energy system.[37] We are working with the government and InnovateUK[38] on these recommendations, and other changes that will facilitate better use of energy data, while ensuring that consumers' personal data is appropriately protected. For instance, we have launched a £1.9 million innovation competition[39] to determine solutions to the problems of data interoperability, and are developing best practice guidance to define expectations for how energy data can be used.

Action 7

Enabling electric vehicles at low cost

We will develop a regulatory strategy for electric vehicles, taking account of developments in government policy and technologies, to support roll out and maximise the consumer benefit. We will identify and tackle regulatory barriers, removing obstacles to new business models, products and services such as EV users selling flexibility services.

[35] National Infrastructure Commission's National Infrastructure Assessment 2018 https://www.nic.org.uk/wp-content/uploads/CCS001_CCS0618917350-001_NIC-NIA_Accessible.pdf.

[36] https://www.gov.uk/government/consultations/electric-vehicle-smart-charging

[37] See https://es.catapult.org.uk/news/energy-data-taskforce-report/

[38] https://www.gov.uk/government/organisations/innovate-uk

[39] https://www.ofgem.gov.uk/publications-and-updates/19m-modernising-energy-data-access-competition



Opening up retail innovation and driving behaviour change

Review and reform of retail markets to enable innovation

The transition to net zero will entail an important role for retailers, suppliers and other actors such as intermediaries. Retailers will be critical to fostering behaviour change in homes and businesses. Retailers will play a key part in developing compelling and trustworthy products and services that encourage and make it easy for consumers to use energy efficiently, for example, by enabling customers to pay for 'heat as a service' instead of a certain quantity of energy. The regulatory framework is a key part of the environment within which this innovation can happen. We want to ensure regulation maintains public confidence and that consumers will be well protected in this essential services market, offering the transparency and predictability that investors look for and the flexibility that innovators require. We will support innovators where possible by removing regulatory barriers to new business models, products and services. This includes the expansion of our regulatory sandbox service and a greater openness to adapt or lift some licence conditions to enable firms to experiment and test innovative concepts.[40]

Consumers will need to be engaged in the net zero target, and should be able to play an active role in the transition, through adopting new services or retail offerings that make a real difference. For example, by adopting products and services that use electricity more flexibly, consumers can help lower the costs of the transition. We will continue to work with government so that consumers have the option to adopt such products and services. If regulatory reforms such as half-hourly settlement and network charging reform do not deliver a market that allows consumers to offer flexibility to the system easily, we will take further steps to encourage smarter products and services to emerge.

Renewable or 'green' energy tariffs are increasingly popular, as more and more consumers seek to play a role in tackling climate change. It is critical that consumers can trust that tariffs marketed as green will in fact make the expected positive impact for the planet, for example by stimulating additional investment in renewable generation. We are aware of growing concerns about 'greenwashing', where the environmental impact of a particular tariff or supplier is overstated. We expect suppliers to be transparent about what constitutes a 'green tariff' and we will undertake work to ensure that consumers are not misled.

Understanding consumers and enabling behaviour change

In order to decarbonise effectively, consumers need to be part of this change. Consumers need to see that the changes are implemented fairly. Furthermore, the system changes that are needed rely on consumers either engaging more with their energy use or adopting technologies that will make the relevant changes on their behalf.

Historically, there have been assumptions that consumers will behave in an economically rational way, for instance switching tariffs if there are savings to be made. However, a large body of research, including work done by Ofgem's behavioural insights team, shows that most consumers do not make active energy tariff choices even when prompted to do so.

As changes start to impact consumers' heating and transport (rather than their electricity), understanding consumer needs and behaviours becomes increasingly important and complex. Building on our successful programme of behavioural trials on engagement with tariff choices,[41] we will continue to build a better understanding of the needs, interests and behaviours of different consumer segments.

[40] www.ofgem.gov.uk/publications-and-updates/what-regulatory-sandbox

[41] https://www.ofgem.gov.uk/consumers/household-gas-and-electricity-guide/how-switch-energy-supplier-and-shop-better-deal/prompting-engagement-energy-tariff-choices.



We will also explore, using innovative experiments and trials, how to stimulate the necessary consumer behaviour required to enable them to play their role in decarbonisation and what steps Ofgem needs to take to support this.

In particular, we propose to explore how to encourage uptake and engagement with time-of-use tariffs and EV charging. This is likely to include (1) testing the impact of various time-of-use style tariff designs on consumer electricity consumption patterns and (2) testing methods of increasing the adoption of smart charging, either through managed charging or time-of-use style tariffs amongst EV owners, e.g. default versus opt-in enrolment.

In addition, Ofgem needs to do more to embed consistent and realistic assumptions about consumer behaviour in relation to decarbonisation into the development of relevant policies. By doing this at an early stage, the resulting solutions and interventions will make use of the full range of factors that are known to influence behaviour, helping to ensure that the policies designed and the mix of policies implemented are more successful.

We will work with government to explore ways to better understand behaviour in a more holistic manner and ensure our learning about consumer behaviour is applied to government policy design.

Action 8

Opening up retail innovation

We will enable new energy service business models, particularly in the retail market, that will be needed to deliver the transition. We will do this by adapting regulatory requirements to enable experimentation and to foster innovation, and by supporting open access to suitable energy data, including across market sectors. We will also explore the use of innovative experiments and randomised control trials, in particular to better understand how to stimulate the consumer behaviour change that will be necessary to support decarbonisation.



Reforming the organisation - How we will change

Given the pace of change, we understand that we need to change not just what we do, but how we work. This means continuing to build on the skills and expertise of our people, particularly in emerging capabilities such as data and technology, and in techniques, such as agile, where these can be applied to support areas of our work. In such a fast-moving environment, we recognise the importance of combining a clear strategy and solid grounding in the sector and customers we serve, with an evolving programme that is able to meet the challenges and opportunities we face as we move towards a net zero economy. We have now started to take steps to update how we make decisions, become a more adaptive regulator, modernise the use of data at Ofgem, and minimise Ofgem's organisational environmental footprint. As a regulator we have a statutory role and we view our statutory duties as the starting point for all of the actions that we propose here. We will work closely with government and energy sector stakeholders in the development of our plans to carry out these actions.

Updating how we make decisions

We strive to make effective decisions based on robust analysis and thorough stakeholder engagement from the discovery and scoping phases, through to our impact assessment and final decisions.

However, we need to evolve how we think about behaviour in our policy making. Ofgem's award-winning behavioural insights capability has demonstrated the value of taking a behaviourally informed approach through its work on increasing consumer engagement. We recognise that it would be more powerful if a realistic model of consumer behaviour were to be incorporated into policy making from initial conception to implementation and evaluation. By doing this we are more likely to meet our goals around decarbonisation and have better foresight of where the consumer protection risks are.

Our approach is to seek to deliver the most effective decarbonisation at lowest cost using the full suite of tools in our toolbox, including those that rely on competition, as well as tools based on other forms of intervention. Our policy analysis will consider the full range of options open to us, especially at the early scoping stages.

We are currently updating our guidance on how we account for decarbonisation in our impact assessments. In addition to providing clearer and more explicit guidance and consideration of carbon valuation, we will increasingly consider potential whole system impacts (including for example potential enabling effects and impacts on pathways to net zero). We plan to publish and invite comments on the draft guidance shortly.

We need to weigh up a range of factors and uncertainties, and to do so transparently and consistently. Judgements will be made that are informed by, and integrated into, analytical frameworks that deal with uncertainty appropriately. Alongside the entire energy industry, we need to take decisions in the face of an uncertain future. We will therefore work with the system operator, industry and other stakeholders to build on and learn from existing practices. We will explore how to develop the use of scenarios and other tools at transmission and distribution level, to help enable effective system planning and future decision making.

A clear view of the trade-offs between policy effects on the pathways to net zero and impacts on other parts of our duties is crucial, to allow for informed decisions on wider impacts, while keeping on course to net zero. We are developing an approach to identify the impacts of our individual and cumulative regulatory policy choices on consumers, especially those in vulnerable situations, including in our annual Consumer Impact Report.



In taking our decisions, Ofgem must have regard to the Social and Environmental Guidance (SEG) issued by government. This was last issued before the 2019 target of achieving net zero by 2050. Although we believe that Ofgem's duty to reduce greenhouse gas emissions should be viewed in the context of that legislated target, we would welcome further clarification, as has been suggested, for example, by the National Infrastructure Commission.

Adaptive Regulation

To enable rapid change, we need to provide enough regulatory certainty to encourage high levels of investment, and be able to adapt regulation to meet the needs of a changing energy system. Therefore, we will adopt a more adaptive approach to regulation to be more resilient to changing circumstances. An adaptive approach means ensuring that our regulations keep pace with government policy developments and changes, and innovation in technology, costs and social practices on the path to net zero.

As an organisation it will require us to take a more project-based approach in our ways of working, with faster decision making, and to be capable of flexibly deploying our resources within less rigid structures. Our staff will learn to work in different ways – using techniques such as agile where these are appropriate and continuing to build our expertise in dealing with data. We must continue to have a solid grounding in the industry we serve, but keep abreast of emerging trends and developments.

To inform our more adaptive approach in regulatory policy making, we are setting up a Net Zero Advisory Group of key sector stakeholders. This advisory group will consider these changes related to Ofgem's regulatory policies in the round, in particular to advise on the focus of our innovation, and how price controls can best enable decarbonisation, including by bringing forward appropriate anticipatory investment. The Advisory Group will make recommendations to Ofgem's board on how to resolve these issues.

Modernising the use of data at Ofgem

Detailed, accurate and up-to-date data on the energy sector is essential for us to make effective decisions on decarbonisation. We are currently modernising our data capability and exchange at Ofgem and we will publish our full Digital, Data and Technology & Cyber Strategy to follow our Forward Work Plan in 2020. In September 2019, we launched the Data Exchange, which will minimise the burden for companies exchanging their data with Ofgem.[42] Finally, we are coordinating our portfolio of data-related regulations, promoting common working practices and interoperability of data across the energy sector and other sectors too.[43]

Effective and efficient environmental scheme delivery underpins a significant part of the UK's energy system decarbonisation. We aim to put in place the framework to provide more cost effective and real time intelligence, and will make sure that our environmental scheme administration is fit for purpose in the changing energy market.

Action 9

Adapting the organisation

We will become more adaptive in the way we work and in our regulatory approaches in order to take decisions in the face of significant uncertainty. As part of this we will set up a Net Zero Advisory Group to enable Ofgem to keep in step with policy and other developments. In addition, we will work with industry to develop toolsets to enable better decision making under uncertainty; and provide more detailed guidance on how we assess regulatory options and their contribution to net zero.

[42] See our Data Exchange launch statement here: https://www.ofgem.gov.uk/publications-and-updates/we-are-launching-our-new-data-exchange-service (accessed 13 January 2020)

[43] For example, see our Data Best Practice guidance, available here: https://www.ofgem.gov.uk/publications-and-updates/early-draft-data-best-practice-guidance-available (accessed 13 January 2020)



Minimising Ofgem's organisational environmental footprint

We also need to show leadership in our own daily activities. We have set up a staff-led group to look at ways (as individuals and as an organisation) we can reduce our impact on the environment, in particular with regard to emissions attributed to the carbon footprint of our offices and staff travel. The group will also lead cultural initiatives to empower staff to contribute positively to sustainability through behaviour change and awareness raising so that we can lead by example in transitioning to a sustainable future.



Annex 1: Ofgem Decarbonisation Programme - Action List

Introduction

In this action plan, we build on our existing work and outline our next steps in making rapid, low-cost decarbonisation of the energy sector a reality. We are on a decades-long journey to net zero, and we will continue to adapt and develop our programme, as opportunities arise and to reflect changes in government policy and circumstances in the energy market.

Preparing the networks to deliver

1. Designing cost effective networks for net zero

We will make the network price control regulatory regime more adaptive to deliver the most effective transition at lowest cost. The new mechanism – a system-wide net zero reopener spanning the gas and electricity sectors – aims to balance the need for investor confidence and the need to respond flexibly to changing technological and policy developments in the path to net zero. We will review the design of the electricity distribution network price control to facilitate the transition to net zero, and electric vehicle uptake in particular.

2. Long-term planning and innovation

We will encourage further long-term planning, leadership and innovation in networks through regulatory design and funding. To help unlock investment needed for the transition while protecting consumer interests, ahead of the electricity distribution price controls we will develop guidance to aid the development of investment proposals where there is significant uncertainty of need. We will set up a new strategic innovation fund focussed on the challenge of decarbonisation. We will also ensure that the networks put in place appropriate plans and measures to deliver resilience to climate change.

3. More effective coordination to deliver low cost offshore networks

We will explore, with government and industry, options for a more coordinated offshore transmission system to connect offshore wind generation, to achieve a rapid and economic expansion of the offshore network. As a first step we will work with the electricity system operator to ensure it can take forward an options assessment for offshore transmission.

4. Preparing for low-carbon heat

We will support government and industry to ensure that there is a fair balance of costs in preparing for heat decarbonisation across different groups of consumers and firms, including between current and future consumers. During the price control, we will review gas network depreciation. We will work with the HSE to review the Iron Mains Risk Reduction Programme and with National Grid to review the capacities required on the gas transmission network, in light of the potential futures of gas in a changing energy system. We will harness our existing knowledge and expertise to help government and industry develop cost-effective and low risk options to decarbonise heating.



Ensuring the electricity system is ready

5. Preparing system operators for a net zero future

We will ensure that the roles and responsibilities to plan and operate a future energy system are adequately fulfilled, including making recommendations to government where change is needed. As part of this, we are undertaking a strategic review of the way our energy systems are managed, to ensure they are fit for a low carbon future.

6. Supporting flexibility

We will enable a flexible future electricity system by ensuring markets adequately reward flexibility, including through our reforms to access, charging and half-hourly settlement, and our work to encourage networks to tender for flexibility services. We will support innovation to develop easy and engaging ways for small businesses and consumers to provide flexibility through demand-side management.

7. Enabling electric vehicles at low cost

We will develop a regulatory strategy for electric vehicles, taking account of developments of government policy and technologies, to support roll out and maximise the consumer benefit. We will identify and tackle regulatory barriers, removing obstacles to new business models, products and services such as EV users selling flexibility services.

Opening up retail innovation and driving behaviour change

8. Opening up retail innovation

We will enable new energy service business models, particularly in the retail market, that will be needed to deliver the transition. We will do this by adapting regulatory requirements to enable experimentation and to foster innovation, and by supporting open access to suitable energy data, including across market sectors. We will also explore the use of innovative experiments and randomised control trials, in particular to better understand how to stimulate the consumer behaviour change that will be necessary to support decarbonisation.

Reforming the organisation – How we will change

9. Adapting the organisation

We will become more adaptive in the way we are run and in our regulatory approaches in order to take decisions in the face of significant uncertainty. As part of this we will set up a Net Zero Advisory Group to enable Ofgem to keep in step with policy and other developments. In addition, we will work with industry to develop toolsets to enable better decision making under uncertainty; and provide more detailed guidance on how we assess regulatory options and their contribution to net zero.



Glossary of terms

Term (Abbreviation)	Description[44]
Access	Access refers to the nature of users' contact with the electricity networks (for example, when users can import/export electricity and how much) and how these rights are allocated.
AI	Artificial intelligence
Balancing Mechanism (BM)	This is a mechanism that enables the Electricity System Operator (ESO) to instruct generators and suppliers to vary electricity production or consumption close to, or in real-time, in order to maintain safe operation of the system.
BEIS	The Department for Business, Energy and Industrial Strategy.
Capacity Market (CM)	The Capacity Market is a mechanism designed to secure electricity supplies for the future. It works by offering all capacity providers (new and existing power stations, electricity storage, and capacity provided by demand-side response) a steady, predictable revenue stream on which they can base their future investments.
Carbon Capture and Storage (CCS)	Carbon capture and storage is the removal, capture and storage of carbon dioxide (CO_2) from fossil fuels either before they are burnt or after they are burnt.
Carbon Capture and Utilisation (CCU)	Carbon capture and utilisation is the removal, capture and use of carbon dioxide (CO_2) from fossil fuels in chemical process or as a raw material, either before or after they are burned.
Carbon Footprint	This is the total amount of greenhouse gas emissions caused directly and indirectly by a business or activity.
Committee on Climate Change (CCC)	The Committee on Climate Change (CCC) is an independent statutory body established under the Climate Change Act 2008. Its purpose is to advise the U.K. and devolved administrations on emission targets and report to Parliament on progress made in reducing greenhouse gas emissions and preparing for climate change.
Consumer	Within the regulatory framework, we consider consumers as the end users of gas and electricity, whether for domestic or business use.
Demand-Side Response	Demand-Side Response (DSR) refers to the ability of sources of demand (for example, an industrial process) to increase or decrease their net demand in response to signals (sometimes price-signals) in order to support system or network management.

[44] These terms have been drafted in a user-friendly way, to assist the reader for the purposes of better understanding this document only and should not be treated as the strict legal definition of any term.



Term (Abbreviation)	Description
Depreciation	Depreciation is a measure of the consumption, use or wearing out of an asset over the period of its economic life.
Devolved Administrations	Devolved administrations is a collective term for the executive bodies in Northern Ireland, Scotland and Wales: the Northern Ireland Executive, the Scottish Government and the Welsh Government.
Distributed Generation	This is any generation connected directly to the local distribution network, as opposed to the transmission network, as well as combined heat and power schemes of any scale.
Distribution Network Operator (DNO)	A DNO is a company that operates the electricity distribution network, which includes all parts of the network from 132kV down to 230V in England and Wales. In Scotland, 132kV is considered to be a part of transmission rather than distribution, so their operation is not included in the DNOs' activities.
Distributional Impact	Distributional impacts are the effect of our policies on different groups of consumers, particularly those that are vulnerable.
Distribution Network	The Distribution Network includes the low-voltage grid that carries electricity from the high voltage transmission grid to industrial, commercial and domestic users. The distribution network also carries electricity from power stations directly connected to the distribution grid (i.e., embedded generators). In the case of gas, distribution is operated through low-pressure pipelines. There are 14 licensed electricity distribution network operators (DNOs), owned by six different groups and eight gas distribution networks (GDNs), owned by four groups.
Distribution System Operation (DSO)	We consider Distribution System Operation (DSO) to be a set of functions and services that need to happen to run a smart electricity distribution network. This does not focus on a single party as an operator, but recognises roles for a range of parties to deliver DSO.
Electricity System Operator (ESO)	This is the System Operator for the electricity transmission system for Great Britain.
Electric Vehicles (EVs)	An electric vehicle is a vehicle that uses one or more electric motors for propulsion, as opposed to the traditional internal combustion engine.
Flexibility	Flexibility refers to the ability of users on the network to quickly change their operations (e.g., modifying generation and or consumption patterns) in reaction to an external signal. (e.g., change in price) in order to provide system services, such as supporting system balancing and network constraint management. Sources of flexibility are typically demand-side response, storage, and dispatchable generation.



Term (Abbreviation)	Description
Flexibility Market	A flexibility market is the arena of commercial dealings between buyers and sellers of Flexibility.
Fuel Poor	In England, a household is said to be fuel poor if it has above-average required fuel costs, and if it were to spend the amount needed to fully meet its energy needs, it would be left with a residual income below the official poverty line. In Scotland and Wales, fuel poverty is currently defined as households which would have to spend 10% of their income to achieve adequate standards of warmth (although the calculating methods differ between Scotland and Wales).
Fuel Poor Network Extension Scheme (FPNES)	The FPNES helps households that are not on the gas grid switch to natural gas by offering funding towards the cost of connection.
Gigawatt (GW)	A gigawatt is a unit of power equal to one billion (10^9) watts.
Green House Gas Emissions (GHGs)	Greenhouse gas emissions are the gasses released into the atmosphere mostly by human activity. For instance, carbon dioxide is released when power is generated from natural gas. This document refers to the targeted greenhouse gases identified in the 2008 Climate Change Act, namely carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride.
Half-Hourly Settlement (see Settlement below)	Half-hourly settlement in this document refers to the process of using half-hourly readings from smart / advanced meters to make the settlement process more efficient, and to better link suppliers' costs with the consumption of their customers, exposing the true cost of supplying and transporting electricity in any given half-hour period. This will place incentives on suppliers to offer consumers products that can help them shift their consumption to times when electricity is cheaper to generate and transport.
Heavy Goods Vehicles (HGVs)	Heavy Goods Vehicles are those with a total weight above 3,500 kg. (vehicle + load).
Industry Codes	The industry codes underpin the electricity and gas, wholesale and retail markets. Licensees are required to maintain, become party to, or comply with the industry codes in accordance with the conditions of their licence.
Licence Condition (Obligation)	Licence conditions apply to electricity and gas licensees. They place rules on how holders can operate within their licence. The Authority has the power to take appropriate enforcement action in the case of a failure to meet obligations contained within licence conditions.



Term (Abbreviation)	Description
Net Zero	In June, 2019 the UK legislated by amending section 1(1) of the Climate Change Act, which now provides that it is the Secretary of State's duty to ensure that the net UK carbon account for the year 2050 is at least 100% lower than the 1990 baseline, by reducing emissions from all sectors of the economy.
Price Control	This is the control developed by the regulator to set targets and allowed revenues for network companies. The characteristics and mechanisms of this price control are developed by the regulator in the price control review period, depending on network company performance over the last control period and predicted expenditure in the next.
Regulated Asset Base (RAB)	The regulatory asset base (RAB) is a key aspect of infrastructure industry regulation in the UK and elsewhere. Under a RAB regime, utility owners derive revenues, which are calculated as a function of the value of their regulated assets. Great Britain developed the RAB to provide comfort to investors in privatised network utilities such as electricity, natural gas, and water, that their investments would not be treated unfairly.
RIIO (Revenue = Incentives + Innovation + Outputs)	RIIO (Revenue = Incentives + Innovation + Outputs) is Ofgem's performance-based framework, used to set the price controls.
Settlement	Settlement is the process through which the differences between a supplier's contractual purchases of electricity and the consumption of its customers is reconciled.
Smart Meter	A smart meter is an electronic device that records the consumption of electricity and gas, and communicates the information for the purpose of system monitoring and billing.
System Operator (SO)	The SO is the entity responsible for operating the transmission system and for entering into contracts with those who want to connect to the transmission system. In relation to electricity, this role is performed by National Grid Electricity System Operator (NGESO) and for gas by National Grid Gas (NGG).
The Authority/Ofgem/GEMA	Ofgem is the Office of Gas and Electricity Markets, which supports the Gas and Electricity Markets Authority (GEMA), the body established by section 1 of the Utilities Act 2000 to regulate the gas and electricity markets in Great Britain.
Time-of-Use-Tariff	Time-of-use-tariffs are designed to incentivise customers to use more energy at off-peak times, in order to balance demand. These tariffs charge lower rates at certain times of night or day, when demand is at its lowest, and higher rates at popular times.



Term (Abbreviation)	Description
Transmission Network	This includes cables and lines that transfer high-voltage electricity 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). High-pressure underground pipelines play an equivalent role for the transmission of gas. The National Transmission System (NTS), which is owned and operated by National Grid Gas plc, transports high pressured gas from entry terminals to gas distribution networks, or directly to power stations.
Uncertainty Mechanism	Uncertainty mechanisms allow changes to the base revenue during the price control period to reflect significant cost changes that are expected to be outside the company's control. Examples include revenue triggers and volume drivers.

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