Scottish Energy Strategy:
The future of energy in Scotland

December 2017

Scottish Government
Riaghaltas na h-Alba
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Contents

Ministerial Foreword

Choices affecting our energy future are among the most important we face. Scotland's social and economic well-being, and the sustainable productivity and competitiveness of our economy, depend upon a secure, affordable and reliable energy supply. Our energy sector also provides high quality jobs, and a vibrant climate and opportunity for innovation.

The decisions and actions which we take now will shape the Scotland that future generations will live and work in, visit and enjoy. Our vision, set out in this document, strengthens our international reputation for sustainability – we are an ambitious country of outstanding natural beauty, determined to build on our reputation as a renewable energy powerhouse.

This is our Energy Strategy for the period through to 2050 – the result of the lengthy consultation and series of discussions which we embarked upon almost a year ago. It maps out a major transition over the next three decades – a transition which is fully consistent with our climate ambitions, and with Scotland's Climate Change Act. It embodies and reflects our objective to create a dynamic, sustainable and inclusive economy.

Energy represents an enormous economic and industrial opportunity for Scotland. Our oil and gas industry and heritage will remain the bedrock of our future energy system – supplying energy, but also expertise and skills to support our transition to a different, low carbon energy future.

Low carbon and renewable energy already supports thousands of jobs across Scotland, generating billions of pounds in turnover. Scottish yards and workers are already fabricating and manufacturing some of the components that will power our energy future; our supply chains are growing, and the opportunities for innovation are immense. In the future, demand for low carbon skills, goods and services will grow both here in Scotland, and overseas, offering ever greater export opportunities.

Delivering the goals and policies in this Strategy can build on what's been achieved to date – creating more jobs, more investment, and a stronger, more sustainable Scottish economy.

Scotland's electricity production has changed enormously since the turn of the century, sparked by the huge and welcome increase in new renewable generation. We are well on the road to fully decarbonising our electricity system in Scotland. The challenge facing us now is to ensure a similar decarbonisation of our energy requirements for sustainable transport – and to deliver a well-balanced system capable of providing secure and affordable energy to meet Scotland's needs.

Scotland is taking a leading role in promoting electric and other low-emission vehicles – with an ambition to phase out the need for new petrol and diesel cars and vans by 2032. This is as much an energy system ambition as a transport one. We will need to develop and manage the necessary charging and other network infrastructure, while building awareness and confidence on the part of consumers. The challenges here are more than matched by the economic opportunity and environmental benefits which success will bring.

We have much more choice now over how we produce and consume the energy we need. Solar panels or small wind turbines can now help meet energy demand at a household or community level. Groups of consumers may choose to invest jointly in new local energy solutions in the future such as renewable electricity or heat networks, using gas and electricity networks only as backup to local supplies.

Developments in storage technology, and its application at a range of scales – from batteries (including the role of electric vehicles) at a household or local level, to the continuing value of Scotland's existing and new pumped storage hydro – will also have a major influence on our future energy system.

The pace and extent of these disruptions in the energy market create benefits for consumers, but there will be challenges too. This is where government, at all levels, can make a real difference – and the Scottish Government is determined to do so. We will make sure that the benefits are universal, and that change works for everyone across our society – preventing new forms of social exclusion amongst those less well equipped to take advantage of opportunities created by changing markets and smart technologies.

And we know too that energy remains unaffordable for far too many in Scotland, creating hardship for individuals and families. Energy prices and market failures play an obvious part in this – but we also have a building stock in parts of Scotland that is old and, all too often, profoundly wasteful in energy.

Our progress in this area is encouraging. However, continuing to improve the energy efficiency of Scotland's buildings – both domestic and non-domestic – and, over time, decarbonising the heat supply to those buildings, providing warmer homes and better outcomes for our consumers, remains a major challenge. It is a challenge that we are determined to meet.

We are grateful to all who have taken part in the process which has led to this Strategy's publication. It is not the end of the story; it is a live document – a route map, which sets out the first steps on a journey. A number of external factors and developments will influence our progress; however, as Abraham Lincoln once said – "the best way to predict the future is to create it."

We look forward to continuing to work with you all.

PAUL WHEELHOUSE MSP
Minister for Business, Innovation and Energy

Paul Wheelhouse MSP at the 'Surf n Turf' hydrogen fuel cell training compound, Kirkwall, Orkney. (Credit: Colin Keldie)

Hywind Scotland Pilot Park offshore wind farm
(Credit: Jan Arne Wold, Statoil)

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Summary: A 2050 Vision for Energy in Scotland

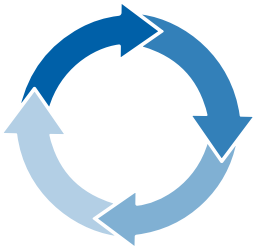
This is our 2050 vision for energy in Scotland:

This Strategy will guide the decisions that the Scottish Government, working with partner organisations, needs to make over the coming decades.

Realising this Strategy's vision will create opportunities for suppliers and consumers of energy. It will support work already planned or underway to achieve our long term climate change targets, and to address the impact of poor energy provision.

No-one can be certain what that future system will look like. However, we should be confident and ambitious about what we can achieve and deliver over the short to medium term, and focus on the areas where we know there are likely to be low or no regrets options.

Our vision remains guided by three core principles:



A WHOLE-SYSTEM VIEW

AN INCLUSIVE ENERGY TRANSITION

A SMARTER LOCAL ENERGY MODEL

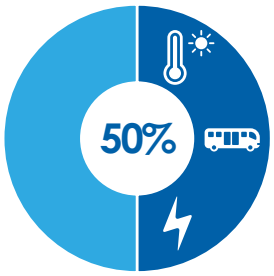
Summary: 2030 Whole-System Targets

The majority of consultation responses identified our targets as a key element of the Strategy – and central to the 'whole-system' approach.

Our energy supplies, and the ways in which we control and manage our consumption of that energy, are equally important factors.

This Strategy therefore sets two new targets for the Scottish energy system by 2030:

- The equivalent of 50% of the energy for Scotland's heat, transport and electricity consumption to be supplied from renewable sources.
- An increase by 30% in the productivity of energy use across the Scottish economy.



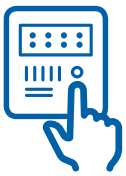
THE EQUIVALENT OF **50%** OF THE ENERGY FOR SCOTLAND'S HEAT, TRANSPORT AND ELECTRICITY CONSUMPTION TO BE SUPPLIED FROM RENEWABLE SOURCES

AN INCREASE BY **30%** IN THE PRODUCTIVITY OF ENERGY USE ACROSS THE SCOTTISH ECONOMY

Fair Isle, Shetland

SCOTLAND'S ENERGY PRIORITIES

THE 2050 VISION IS BUILT AROUND THE FOLLOWING SIX PRIORITIES:

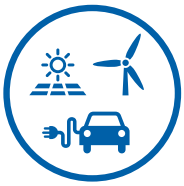


Consumer engagement and protection – we will work hard to protect consumers from excessive or avoidable costs, and promote the benefits of smarter domestic energy applications and systems.

Energy efficiency – we will continue to take direct and supporting actions to improve the use and management of energy in Scotland's homes, buildings, industrial processes and manufacturing.

System security and flexibility – Scotland should have the capacity, the connections, the flexibility and resilience necessary to maintain secure and reliable supplies of energy to all of our homes and businesses as our energy transition takes place.

Innovative local energy systems – we will empower our communities by supporting the development of innovative and integrated local energy systems and networks.



Renewable and low carbon solutions – we will continue to champion and explore the potential of Scotland's huge renewable energy resource, and its ability to meet our local and national heat, transport and electricity needs – helping to achieve our ambitious emissions reduction targets.

Oil and gas industry strengths – we will support investment, innovation and diversification across our oil and gas sector, working with industry to advance key priorities such as maximising the recovery of remaining resources, subsea engineering, decommissioning and carbon capture and storage – collaboratively addressing the challenges of today and preparing the sector and its workforce for a positive role in Scotland's future energy system.

Summary: Scotland's Economic Opportunity

This Strategy highlights the connections between the energy system and all parts of the economy, and its importance to sustainable, inclusive growth.

We intend to continue the work that we've been doing with businesses in Scotland – helping them use their experience, adaptability and willingness to diversify in order to become more competitive.

The global market for low carbon goods and services is also growing, spurred by major investments in low carbon technologies in rapidly developing economies such as China, India, Mexico and South Africa. Scotland will use its reputation to help capitalise on this expanding market.

This Strategy places a sharp emphasis on the energy sector's economic role, benefits and potential, from established technologies to those that are new or still emerging. It sets out what more the Scottish Government is doing to help realise this potential under the following key areas:

- Stimulating Investment;
- Supporting Research and Innovation;
- Strengthening Supply Chains;
- Creating New Business Models;
- Developing Necessary Skills;
- Boosting Inclusive Growth;
- Cultivating Regional Partnerships; and
- Supporting Internationalisation.

Summary: Monitoring and Engagement

This Strategy makes a strong commitment to improving our approach to public awareness raising and engagement.

Modernising and transforming our energy system will also depend on us finding ways to communicate and to work more effectively and meaningfully with wider society.

We are determined to improve the ways in which we raise awareness and understanding about the choices we face – to allow the strengths, capacities, skills and ideas of consumers and producers of energy to combine and play their part in shaping and delivering Scotland's future energy system.

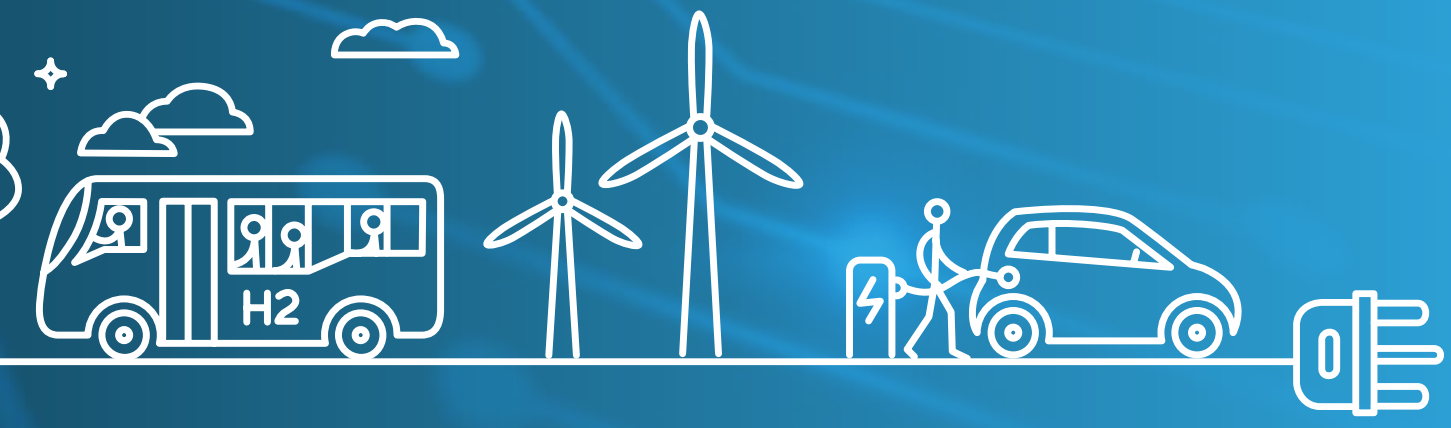
We will work with our partners to consider and to find new ways to widen out this conversation on our low carbon transition, and to involve the wider public much more effectively in the issues addressed by this Strategy.

To support the delivery of the Strategy, the Scottish Government will publish an Annual Energy Statement which sets out:

- the latest energy statistics;
- progress made towards targets;
- developments under each of the six Strategic Priorities;
- changes within the UK energy market and international frameworks; and
- an assessment of technological changes and advances with a bearing on Scotland's energy system.

The Scottish Energy Advisory Board will retain a prominent role as advisors to the Scottish Government and the First Minister, including advising on the Annual Energy Statement.

1. **A 2050 VISION** FOR ENERGY IN SCOTLAND



This is our 2050 vision for energy in Scotland:

OUR VISION

A FLOURISHING, COMPETITIVE LOCAL AND NATIONAL ENERGY SECTOR, DELIVERING SECURE, AFFORDABLE, CLEAN ENERGY FOR SCOTLAND'S HOUSEHOLDS, COMMUNITIES AND BUSINESSES.

This Strategy will guide the decisions that the Scottish Government, working with partner organisations, needs to make over the coming decades.

The energy system described in the Strategy will create economic opportunities for both suppliers and consumers of energy. It will support work already planned or underway to achieve our long term climate change targets, and to address the impact of poor energy provision.

A diverse, well-balanced energy supply portfolio or 'energy mix' will remain essential as we continue to decarbonise our heat, transport and electricity systems – providing the basis for secure and affordable heat, mobility and power in future decades.

The social, environmental, economic and commercial benefits of this new approach depend on our involving of all stakeholders in the transition. We must protect vulnerable consumers and those not able to fully participate in new market arrangements. The Scottish Government and its agencies will work closely with citizen groups, communities, businesses, academic institutions, local authorities and other representative bodies to make sure that no one is left behind.

Our energy system is part of the wider Great Britain and European energy market. The recent UK Clean Growth Strategy and Industrial Strategy show that there is a great deal of common ground between the Scottish and UK Governments. We will continue, and build upon, our existing inter-governmental partnerships to make sure that we deliver the goals and ambitions in this Strategy.

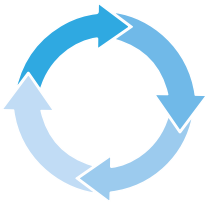
The UK's exit from the European Union (EU) could have a significant bearing on our future energy system. The impacts of 'Brexit' are amplified in Scotland because of the important role that energy plays in our economy. Being part of the internal European energy market is vitally important, as it safeguards our energy security, means lower costs for households and businesses and helps create jobs and investment.

Legally-binding EU renewable energy and energy efficiency targets have played a defining role in stimulating the huge growth in renewable energy in Scotland, and significant inward investment. The ability to continue trading energy openly and fully across Europe can, if unaffected, play a big part in the progress we make towards our renewable and climate change targets, and the growth of Scotland's low carbon energy sector.

Modernising and transforming our energy system will also depend on us finding ways to communicate and to work more effectively and meaningfully with wider society. We are determined to improve the ways in which we raise awareness and understanding about the choices we face – to allow the strengths, capacities, skills and ideas of consumers and producers of energy to combine and play their part in shaping and delivering Scotland's future energy system.

We will explore, through the development of a Culture Strategy for Scotland, ways that Scotland's culture sectors and creative industries can help communities imagine a green future, and to help us all adapt to the changes and opportunities.

Our vision remains guided by three core principles:



A WHOLE-SYSTEM VIEW

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A whole-system view

Our Strategy marks an important advance in Scottish Government energy policy. Building on the Heat Policy Statement[1] of 2015, it continues to broaden our focus to include heat and transport, alongside electricity and energy efficiency – creating an integrated approach which recognises the effect that each element of the energy system has on the others.

The move to ultra-low emission vehicle (ULEV) technologies will change both our electricity and transport systems, creating opportunities but also challenges across each. Taking a coordinated approach – involving our existing transport sector and its suppliers, electricity generators, network owners and operators, not to mention consumers – will help us understand and tackle these opportunities and challenges in the best way possible.

Scotland's Energy Efficiency Programme places a renewed emphasis on managing our energy consumption more effectively, consistent with the designation of energy efficiency in June 2015 as a National Infrastructure Priority. This underlines the economic benefits of energy efficiency investment.

The 'whole-system' approach is woven throughout this Strategy. We have set two whole-system energy targets, while our new Strategic Priorities constitute a set of guiding principles involving multiple sectors – underlining the need for continuing and better collaboration between public, community, and private sectors.

1 The Heat Policy Statement: www.gov.scot/Publications/2015/06/6679

An inclusive energy transition

Scotland continues to lead global efforts to decarbonise and tackle climate change, and to be recognised internationally for doing so. Our overall approach to energy is driven by the need to decarbonise the whole energy system, in line with emissions levels set out in the Climate Change (Scotland) Act.

We need the transition to a low carbon economy over the coming decades to happen in a way that tackles inequality and poverty, and promotes a fair and inclusive jobs market. The Scottish Government will work with partners and colleagues, both within the UK and internationally, to better understand the energy transition. We will make sure that we have the infrastructure and skills needed to make this work, and that we support 'high carbon' communities through the transition. The Scottish Government will establish a Just Transition Commission to advise Scottish Ministers on how to achieve this.

We know that the precise make-up of the future energy system is highly uncertain. Our ability to store and control energy is changing dramatically, driven by growing demand for storage, technological innovation, smarter networks and the growth of the digital economy. Scotland's energy future will be, and needs to be, much more flexible than in the past, with far more choice for domestic and business users.

New and smarter ways to generate and store renewable energy can also open up fresh opportunities for consumers – allowing them to explore and install applications and technologies which can help them to reduce both their carbon footprint and their energy bills.

Investing in energy efficiency, allied to consumer education which promotes behaviour change, helps to tackle fuel poverty by improving living conditions and providing more affordable energy for consumers.

Improving the energy efficiency of Scotland's businesses is a necessary part of promoting innovation in our energy system. It can increase productivity and competitiveness, since the cost of energy is a major driver of unit costs in some key sectors. It can also create opportunities to strengthen supply chains and growth across the Scottish economy.

There is an exciting opportunity to capture the economic benefits of developing and pioneering these approaches, here, in Scotland. However, there is a danger that the benefits of the transition may not be evenly spread. Over the coming years, our approach to consumer advocacy and advice – in tandem with the regulatory framework enforced by Ofgem – will need to respond quickly to the changing landscape. This will ensure that investment in our energy infrastructure and technologies doesn't worsen inequalities.

This principle of an inclusive energy transition will be further supported by our ambition to establish a new energy company. Our aim is that this company will support economic development and contribute to tackling fuel poverty, as well as being publicly-owned and run on a not-for-profit basis.

A smarter local energy model

Our Strategy proposes a smarter, more coordinated, approach to planning and meeting distinct local energy needs. This will link with developments at the national scale, creating a flexible and proportionate response to the challenges raised by the transformation of Scotland's energy system.

Supporting and delivering local solutions to meet local needs, linking local generation and use, can help create vibrant local energy economies. Heat, electricity, transport and energy storage technologies – planned and deployed on an area-by-area basis – can transform both rural and urban communities.

Scotland already leads the way in developing these local energy systems. The shift to renewable generation in areas with little or no spare grid capacity has led to innovation in business and network management – with Scotland's communities and islands playing an increasingly active part alongside the private and public sector.

We will continue to support the development of local energy economies. These are a central part of our response to the challenges presented by the transformation of Scotland's energy system.

However, we know that not all innovative projects will succeed; the next phase of our approach will consolidate the lessons learned from the pilot projects we have supported so far. In doing so, we will support the roll-out of technologies that work most effectively, and which present good value for money.

This will be helped by a new framework for Local Heat & Energy Efficiency Strategies (LHEES)[2], creating a strategy to guide investment in energy efficiency and heat decarbonisation at a local level. Led by local authorities, working closely with their communities, this will set out a long term prospectus for investment in new energy efficiency, district heating, and other heat decarbonisation programmes.

ScotRenewables SR2000 floating tidal turbine at Hatston Pier (Credit: Paul O'Brien)

2 Scotland's Energy Efficiency Programme: Second Consultation on Local Heat & Energy Efficiency Strategies, and Regulation of District and Communal Heating: http://www.gov.scot/LHEES_DCHR_2ndCons

Navigating the Scottish Energy Strategy

We conducted an open consultation[3] on this Strategy, which drew 254 responses, with over half from businesses and representative organisations. Those responses, as well as feedback from the Scottish Energy Advisory Board, have helped shape, inform and influence our approach.

This Strategy sets out our vision for 2050. It includes two indicative scenarios of how that future system might look (Chapter 2), a focus on our priorities and near-term actions (Chapter 3) and a review of the economic opportunities for Scotland (Chapter 4).

We know that setting a vision is only just the beginning. Our 2050 energy system will depend ultimately on how we, society, businesses, the UK and international community, respond to challenges and opportunities along the way.

We need to work on this together, right across Scottish society. All stakeholders and actors in the system – local government, organisations, regulators, individuals, businesses and others – will have a part to play in getting Scotland to the vision we set out above. Chapter 5 looks at how we intend to make this happen.

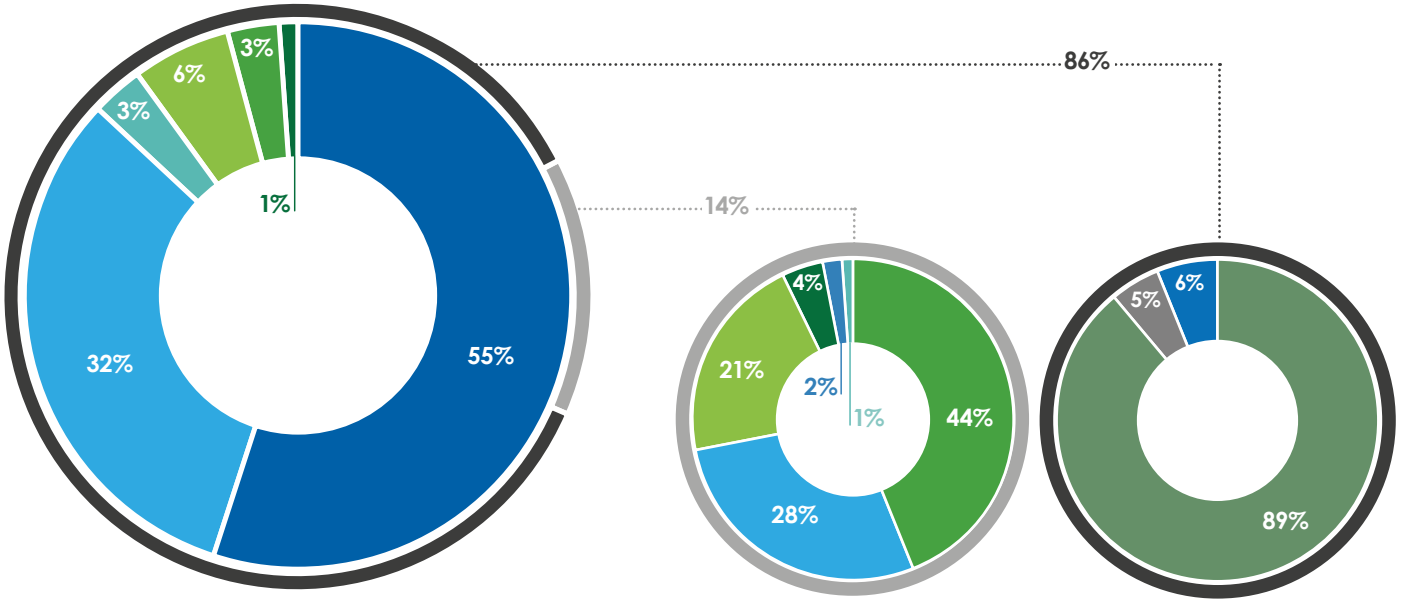
3 The consultation on a *Scottish Energy Strategy: The future of energy in Scotland* sought views on a draft Energy Strategy and ran from January to May 2017. The consultation document, responses and independent analysis report are available on the Scottish Government's Consultation Hub: https://consult.gov.scot/energy-and-climate-change-directorate/draft-energy-strategy/

2. SCOTLAND'S CHANGING ENERGY SYSTEM

Scotland has long been an energy rich nation. That reputation, forged in the development of our coal, oil and gas reserves and engineering prowess, has since grown through the rapid development of our renewable resource.

Scotland's electricity supply today is largely decarbonised. We are well on the way to our target of generating 100% of our electricity demand from renewables in 2020 – provisional statistics show 54% of Scotland's electricity needs were met from renewables in 2016, with major new capacity due to connect to the system in the coming years. We are determined now to tackle the challenges of decarbonising heat and transport, in order to meet our longer term energy and climate change targets.

Diagram 1
Scotland's Energy Flow, 2015



Indigenous Production & Imports
1,122 TWh

Primary Oils
Natural Gas
Coal
Primary Electricity
Petroleum Products
Bioenergy & wastes

Final Consumption
157 TWh

Petroleum Products
Natural Gas
Electricity
Bioenergy & wastes
Manufactured fuels & other
Coal

Exports and Losses
965 TWh

Exports
Conversion Losses
Energy Industry & Distribution Losses

Energy Consumption

Energy consumption in Scotland in 2015 was 157 Terawatt-hours (TWh), significantly lower than a decade earlier. Total final energy consumption fell by 15.4% compared with the mid 2000s. Energy efficiency played a big part in this, as did the impact of the economic cycles, prevalent prices and weather patterns.

We have always prioritised tackling fuel poverty and, by the end of 2021, we will have allocated over £1 billion pounds since 2009 on tackling fuel poverty and improving energy efficiency. Scottish Government programmes, coupled with new building standards, have significantly increased energy efficiency. The Scottish House Condition Survey shows that just over two-fifths (43%) of homes in 2016 rated EPC band C or above, an increase of 77% since 2010. Scotland now has proportionately 38% more homes with a good EPC rating (C or above) than England.

More than half (51%) of the energy we consume in our homes and businesses is used for **heating**, the majority of which is supplied by natural gas. An estimated 79% of homes used natural gas as their primary heating fuel in 2016.

Transport accounts for 25% of total energy demand. The majority of this is for road transport. In recent years biofuel has been introduced into road fuel, and currently accounts for 3.1% of total fuels.

Electricity accounts for just under a quarter of total energy demand, with 77% of electricity generation in 2015 coming from zero or low carbon sources, and 27% from wind energy alone. The installed capacity of renewables in Scotland reached 9.5 GW in June 2017.

Diagram 2
Change in Final Energy Consumption, Baseline (2005-07) – 2015

In 2015, total final energy consumption was 15.4% lower than the 2005-07 baseline, achieving our 12% energy efficiency target 6 years early.

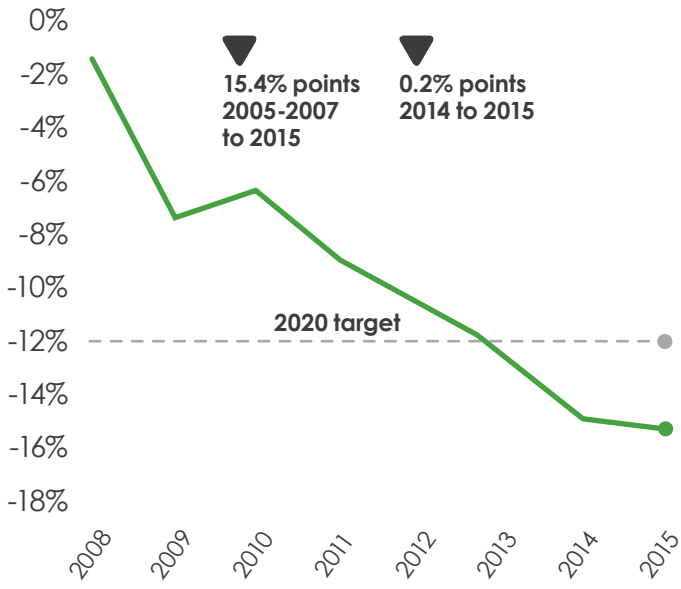
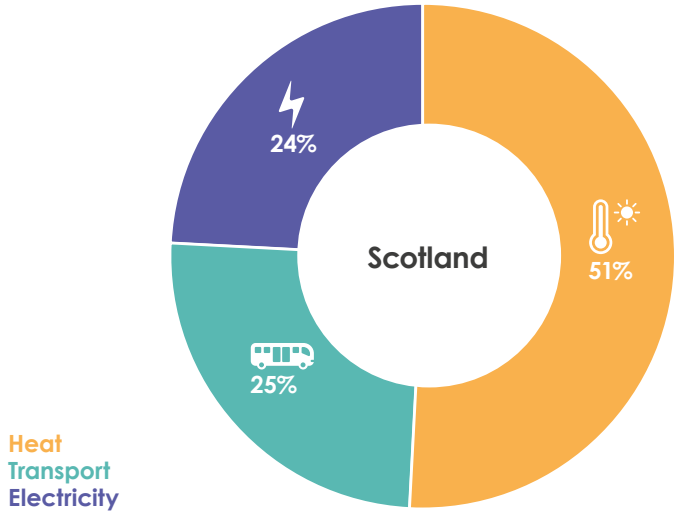


Diagram 3
Final Energy Consumption – split by end use sector, 2015



Source https://www.gov.uk/government/collections/total-final-energy-consumption-at-sub-national-level

The cost of energy to consumers has risen considerably over the past two decades. In 2016 26.5% (or around 649,000 households) were fuel poor[4].

Domestic consumers in Scotland are now paying over 50% more for an average duel fuel energy bill than they were in 1998, with the cost of gas rising at a faster rate than electricity. Prices for non-domestic consumers have also risen substantially, with large industrial consumers in particular now paying some of the highest prices across the European Union.

Producing useful energy for Scotland and beyond

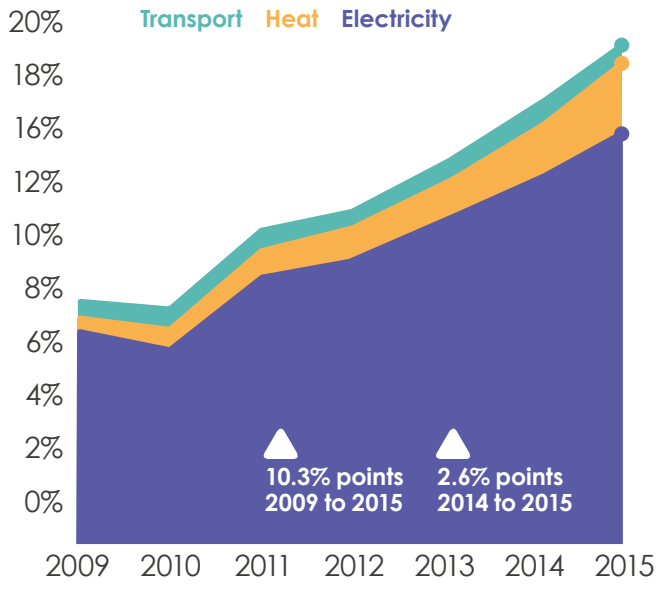
Oil and gas remain vital, accounting for around 90% of total primary energy in 2015[5]. Fossil fuels meet the majority of Scotland's heating and transport demand, as well as significant export demand.

Scotland (including Scottish adjacent waters) produced 63% of total UK gas production in 2016-17. While the UK as a whole has significant dependency on imported gas, in 2015, Scottish gas production represented roughly six times that of final consumption.

The share of renewable energy as a proportion of the energy we generate and consume has increased considerably over the past decade. Renewable energy sources now supply the equivalent of almost 18% of Scottish final energy consumption, up from around 8% in 2009.

Diagram 4
Renewable Energy in Scotland

In 2015, 17.8% of total Scottish energy consumption came from renewable sources, more than double the level in 2009.



Renewables generated 42% of our electricity production in 2015, meeting the majority of Scottish demand alongside the two nuclear power stations at Hunterston and Torness, generation from Longannet[6] coal power station and with a small amount coming from the gas-fired station at Peterhead. The growth of renewable generation is due to the expansion of onshore wind, complementing the post-war investment in large-scale hydro, as shown in Diagram 5 opposite.

An estimated 1.7 Gigawatt (GW) of renewable heat capacity operated in Scotland during 2016, producing 3,752 Gigawatt-hours (GWh) (see Diagram 4). These estimates suggest that Scotland produced enough renewable heat to meet between 4.8% and 5.0% of non-electrical heat demand.

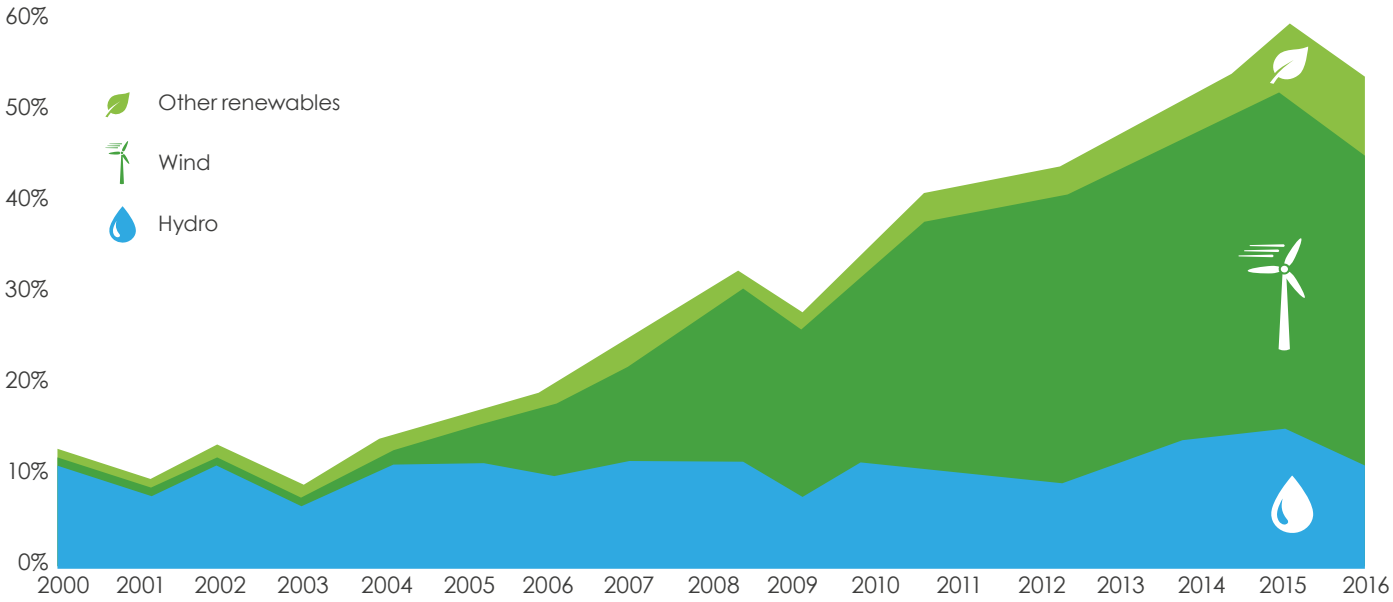
4 The current definition of fuel poverty is "A household is in fuel poverty if, in order to maintain a satisfactory heating regime, it would be required to spend more than 10% of its income on all household fuel use." This definition has been reviewed and a new definition is currently being consulted on as part of the wider consultation on fuel poverty: http://www.gov.scot/Publications/2017/11/6179.

5 Primary energy represents the energy inputs to the energy system before transformation, including those which are exported, and excludes imports of petroleum products and electricity. Final consumption figures represent the energy delivered to consumers.

6 In 2016 Longannet closed, significantly reducing the carbon intensity of electricity generated in Scotland.

Diagram 5
Renewable Electricity in Scotland

In 2016, the equivalent of 54% of total Scottish electricity consumption came from renewable sources, four times greater than the level in 2000[7].

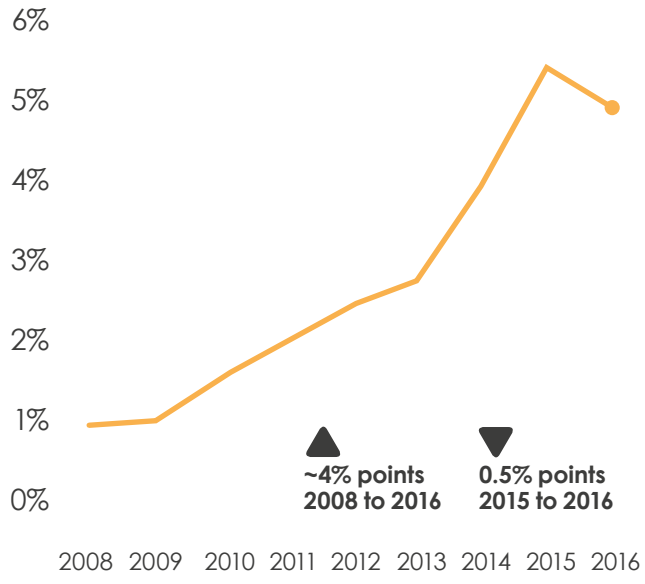


More of us are turning to electric vehicles (EVs). At the end of June 2016, there were 3,575 electric cars and vans licensed in Scotland (eligible for the UK Government's plug-in car and van grant schemes), compared to 2,050 at the end of June 2015.

More EVs were sold in Scotland in 2015 than the previous four years combined, with 2016 sales expected to have risen further. Our ChargePlace Scotland network has expanded to over 600 publicly available EV charging points, equating to over 1,200 charging bays. This includes over 150 'rapid' charging points, one of the most comprehensive networks in Europe.

Diagram 6
Renewable Heat in Scotland

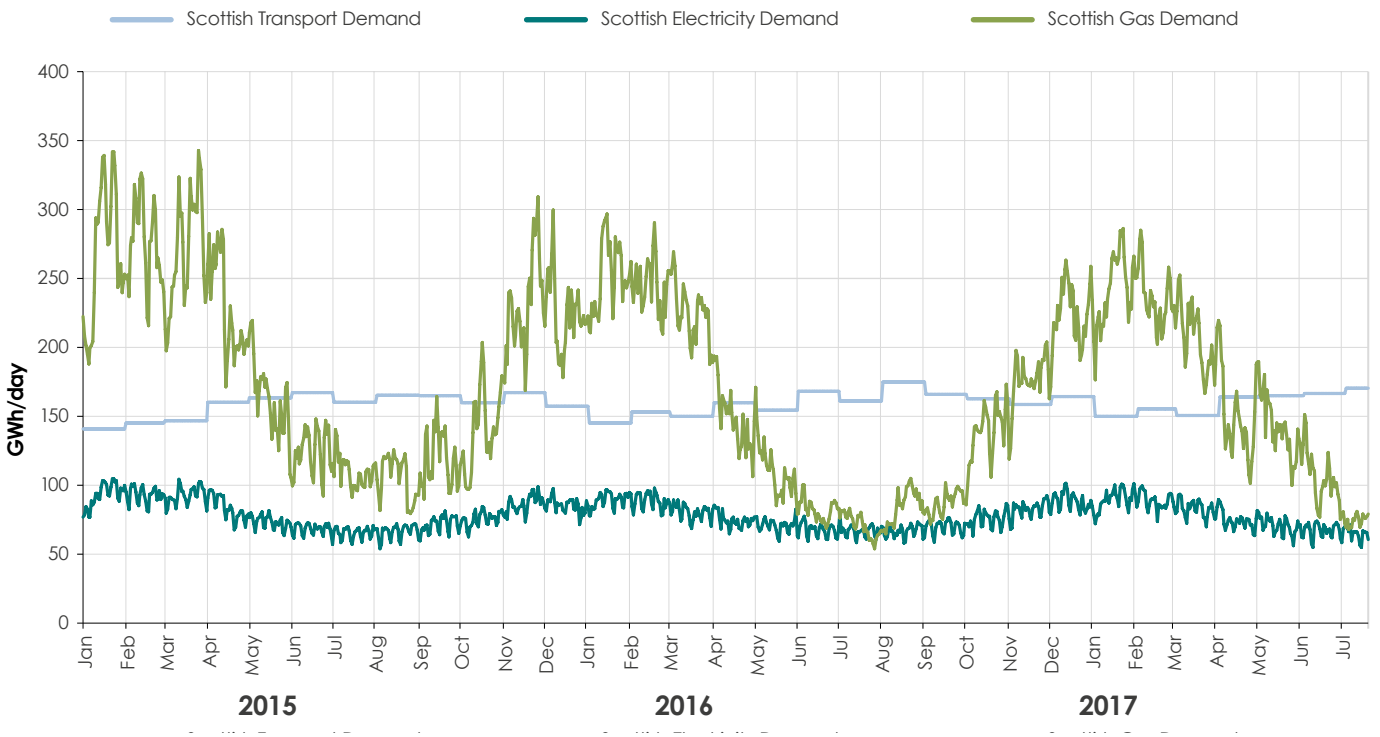
In 2016, an estimated 4.8% to 5% of total Scottish heat demand was met from renewable sources[8].



7 Differences in annual wind speed and rainfall partly explain differences in wind and hydro output between years.

8 The reduction in renewable heat output in 2016 was primarily due to the closure of the Tullis Russell paper mill in Fife, a significant user of renewable heat.

Diagram 7
Yearly Pattern of Energy Consumption



Our energy demand varies over the course of the year, meaning that we need flexibility in the system. Gas provides just that, and can comfortably accommodate large seasonal swings in demand. This means that any future changes to our use of gas, and the effect of such changes on our ability to access that flexibility, will require careful thinking.

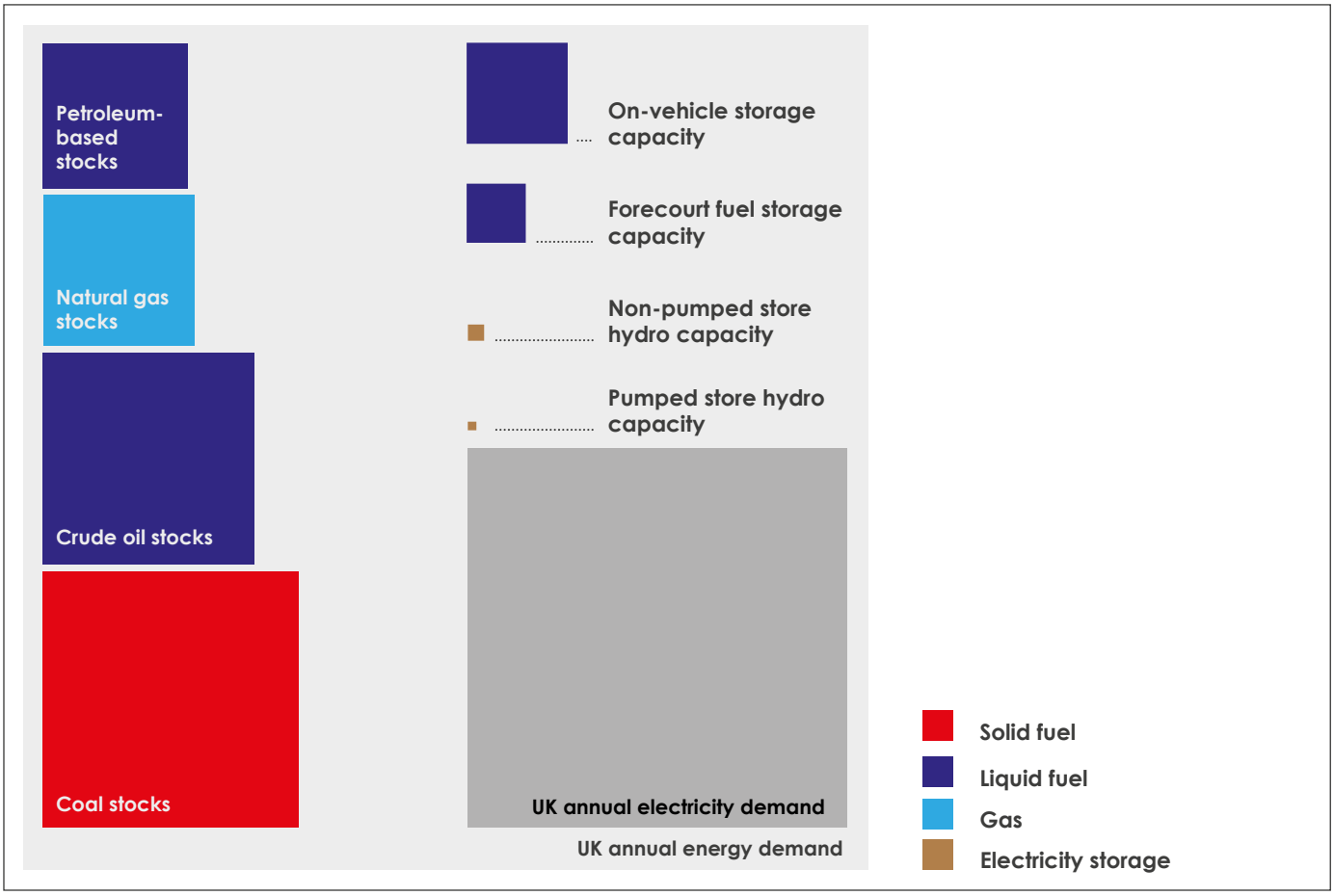
Energy Storage

Energy storage is another important source of flexibility. Energy can be stored in different ways – for example, in pumped hydro storage facilities, chemical batteries, thermal stores, stocks of coal at power stations, gas storage facilities and more locally in the form of petrol and diesel in refilling stations or in vehicle tanks.

Changes to how we store energy across the system, and particularly in terms of electricity and heat, could have a profoundly important bearing on our low carbon future.

Diagram 8
Energy Storage in UK, 2014.

The area of each coloured square indicates the energy stored. The size of annual total UK energy demand is indicated by the large light grey square and annual total UK electricity demand by the smaller dark grey square.



As shown in Diagram 8, coal was the single largest store of energy in the UK in 2014, consisting primarily of stocks held at power stations ready for conversion to electricity. Coal and gas storage together formed major inter-seasonal storage capability, playing an important role in managing the difference between winter and summer demand. Petroleum-based products are held in a variety of forms – centralised stocks, in local depots and refilling stations, and carried on board vehicles in fuel tanks.

These fossil fuel stores amounted to hundreds of TWh of storage in 2014, similar in scale to the total annual British demand for electricity. By contrast, the forms of energy storage usually discussed in relation to a low carbon electricity system are typically a much smaller fraction of that. The existing pumped storage hydro fleet accounts for around 30 GWh of storage, while the largest current grid-scale battery projects are in the range of tens of Megawatt-hours (MWh).

Large energy stores in the oil and petroleum sector provide resilience against disruptions in the international energy system. The UK has committed via the European Union and the International Energy Agency to hold stocks of oil-based products equal to more than two months of typical usage. As transport moves away from a reliance on petrol and diesel, the need to hold stocks of these products will reduce. But the issue of our resilience to international disruption will remain important.

The process of decarbonising our energy system is already underway. By the end of 2016, coal stocks had fallen to just 40% of their size in 2014. The Rough gas storage facility is in the process of closing, removing approximately 37 TWh of energy storage from the system.

We need to bear in mind and understand the implications for our energy system of these changes to our existing storage capacity, as well as for the flexibility it has historically provided. We will need to adapt market structures and systems, develop new sources of flexibility, and explore low carbon options which can make use of new and existing storage opportunities.

A future energy system for Scotland

There is little certainty about the exact way in which the energy system might evolve. We have witnessed substantial changes over the past two decades – both large reductions in electricity generated from coal (a 74% reduction between 1998 and 2016) and substantial increases (a more than 10 fold increase since 1998) in renewable generation across the GB system, particularly generation from onshore and offshore wind, driven by large and unforseen cost reductions.

In order to achieve our climate goals, Scotland needs to build on the progress made in decarbonising electricity production, and to see concomitant progress in the decarbonisation of heat and transport – while simultaneously maintaining affordable, secure and reliable supplies. This will not be simple, but Scotland is determined to play its part in the global effort to tackle harmful climate change.

A largely decarbonised energy system by 2050, which meets our climate change targets, can be achieved in a number of ways, and will be influenced by innovations and developments we simply cannot forecast. It will also depend on consumers' willingness and ability to adapt to new opportunities and behaviours, and on the underlying costs of primary energy sources and related infrastructure.

The Scottish Government's Digital Strategy[9], published in 2017, highlighted the continuing revolution in Artificial Intelligence and the data-driven economy. This will also have a powerful bearing on the energy sector; emerging digital technologies and applications such as the Internet of Things, cloud computing, blockchain, 3D printing and machine learning can transform business models, markets and employment. These developments will continue to change the ways in which we produce and consume energy.

Cyber security will also become increasingly important, with smart, connected systems potentially more vulnerable to deliberate attack. Scotland's Cyber Resilience Strategy[10] provides a framework for improving our cyber resilience accordingly.

A greater proportion of both heat and transport demand is likely to be met by electricity. This would allow the continued growth of low carbon electricity generation, combined with technologies such as smart storage heaters and heat pumps, to provide highly efficient ways of providing delivering low carbon end-use space and water heating. However, the uptake of electric heating and transport on a large scale would place extra pressure on the electricity system, and on the network's ability to generate, store and deliver the capacity necessary to meet peaks in demand.

9 Realising Scotland's full potential in a digital world - A digital strategy for Scotland: http://www.gov.scot/Publications/2017/03/7843

10 Safe, Secure and Prosperous – A Cyber Resilience Strategy for Scotland: http://www.gov.scot/Publications/2015/11/2023

This will require investment at all levels of the network, but will also be influenced by changes in the way that networks are operated. There is scope to manage demand much more flexibly – for example, EV charging and heat pump operation could be coordinated through local and national markets – matching local demand and supply to manage and reduce network constraints.

An alternative approach might be to increase the supply of low carbon gas. Low carbon sources of gas could include biogas (from anaerobic digestion), biomethane, bioSNG and hydrogen. Hydrogen gas can be produced through electrolysis from renewable electricity (green hydrogen), or via a process called Steam Methane Reforming (SMR) combined with Carbon Capture and Storage (CCS).

Low carbon gas would use the existing gas transmission and distribution infrastructure, and maintain the system's ability to deal with significant swings in demand. Low carbon gas can either fully replace existing forms of gas, or be blended with existing gas to partially decarbonise the network. The GB gas distribution networks are already investigating the performance of hydrogen across their infrastructure.

Limits on the likely production of biogases and hydrogen from electrolysis would mean relying on significant levels of low carbon gas from combined SMR and CCS industrial processes, although the full suite of future technologies is difficult to forecast.

Scotland in 2050

In order to develop our Strategy, we have developed two indicative scenarios for the energy system, consistent with our current climate change targets. These show how low carbon electricity and hydrogen could be used to meet demand across the industry, services, residential and transport sectors. These are purely illustrative, designed to help us understand what infrastructure and behaviours might be required under different future scenarios.

Scotland's energy system in 2050 is unlikely to match either of these, but will probably include aspects of both. The pace of technological change, and advances in engineering and information technology across the economy and the energy sector over the next three decades, will have a huge bearing on the energy system and the ways in which we interact with it.

Both scenarios represent radical changes to the energy system, and would require sustained investment, high levels of public acceptance and support across society. They offer exciting opportunities for economic growth, using Scotland's existing expertise and knowledge.

The scenarios have been informed by sector-specific analysis and the Scottish 'TIMES' model; a strategic, whole-system energy model, taking into account a range of policy and other constraints. TIMES captures the main characteristics affecting technology deployment and the associated greenhouse gas emissions for Scotland as a whole. The scenarios show the amount and form of final energy delivered to consumers from the energy system.

These scenarios are not intended to predict the future. They are designed to generate discussion about how the future energy system could potentially look, and to help us consider the influence that developments in the near term could have on the eventual shape of the system.

SCENARIO 1
AN ELECTRIC FUTURE

By 2050 electricity generation accounts for around half of all final energy delivered. The sustained growth of renewable generation has helped ensure that we meet our climate change targets.

Scottish electricity demand has increased by over 60% since 2015, and is increasingly supplying transport demand through battery-powered electric cars and vans. Space and water heating is largely supplied, where practical, by highly efficient heat pumps, and via a new generation of smart storage heaters.

Peak electricity demand has risen significantly, moderated to an extent by smart meters, responsive demand, new national and local market structures, and the changes in consumer behaviour that these have supported.

Scotland retains its pumped storage stations, with new capacity added during the 2020s, and electrical energy storage is widely integrated across the whole system. For example, the EV fleet operates as a vast distributed energy store, capable of supporting local and national energy balancing.

Better insulated buildings mean that domestic energy demand has fallen significantly. Most houses, including new and renovated housing stock, now use heat pumps, with heat storage providing an additional level of flexibility where space allows.

80% **Around 80% of residential energy demand is met from electricity**

The Scottish car and van fleet has been fully converted to electric vehicles, with smarter electricity networks and more informed and flexible consumers meaning that demand is managed smoothly.

There is a diverse mix of super-fast chargers replacing petrol pumps at service stations, with a range of charging infrastructure an established feature in supermarkets, car parks, and other destinations, as well as domestically.

Other forms of transport have followed suit. Buses are now almost entirely electric. HGV demand is met partly via electrolysed hydrogen fuel, whilst battery/hydrogen-powered ferries run on Scottish routes.

100% **100% of cars and light goods vehicles are powered by electricity**

Heat pumps provide the majority of heat supplied in the domestic and services sectors. The industrial sector relies on a mix of fuels, including electricity, bioenergy and natural gas, in order to meet the specific requirements of high-temperature processes, or those that require specific chemical reactions which cannot be provided solely by electricity. These sites have found ways to use waste heat from these activities both onsite and, where relevant, offsite.

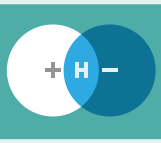
70% **70% of energy in the service sector supplied by electricity**

Scotland remains an integral part of the British electricity transmission system. Vastly improved demand management and new interconnectors to Europe dramatically improve the management and balancing of demand, with our high levels of renewable generation. Scotland retains some gas generation capacity but this is used increasingly rarely, as is the case across the continent.

The high efficiency of heat pumps, and significant improvements in the energy efficiency of road transport, mean that the amount of final energy being delivered by the energy system falls substantially by 2050. However, the move towards electrification places extra demands on electricity networks, and requires greater flexibility and interaction between generators, network operators and consumers to ensure that we meet our objectives of affordability and system security.

30% **30% reduction in final energy delivered through the energy system**

SCENARIO 2
A HYDROGEN FUTURE



By 2050, much of the demand previously met by natural gas has been converted to low carbon hydrogen. This is produced through strategically deployed electrolysers and from SMR plants paired with CCS. The effective transition from natural gas to hydrogen – assisted by Government support and regulation, and by consumer behaviour – has helped us meet our climate change ambitions.

CCS development during the 2020s has allowed the production of low carbon gas on a scale large enough to transform the energy system. Final energy demand has fallen, but natural gas demand has greatly increased – mainly to produce hydrogen, but also to power flexible electricity generation, with both processes utilising CCS.

The flexibility offered by gas has also enabled the expansion of the gas network into new locations without compromising the sustainability of the energy system.

Scotland has developed electrolysis facilities, meeting a proportion of the overall hydrogen supply. This helps balance renewable generation on the system, and creates demand which ensures that new gas generation with CCS can run in the most efficient way.

New hydrogen transmission pipes link production facilities with the main demand centres, and new and repurposed pipelines take captured CO_2 to old North Sea gas fields for storage. The gas distribution network has been converted area by area, starting with the main cities.

Domestic energy requirements have fallen significantly and buildings are now better insulated. Natural gas boilers were replaced during the transition with highly efficient hydrogen boilers and fuel cells, alongside other appliances as part of the conversion programme.

60% **60% of demand in the residential sector delivered by hydrogen**

Scotland's car and van fleet is now hydrogen-powered, with fuel cells running an electric drive-chain. Service stations have converted gradually to hydrogen, the process beginning in the 2020s.

Larger road vehicles have been partially decarbonised, with hydrogen-powered buses and HGVs operating. Hydrogen fuel cells have helped move a significant proportion of freight to railways, a shift mirrored in some sectors of shipping.

100% **100% of cars and light goods vehicles are powered by hydrogen**

Hydrogen has replaced natural gas for most industrial and commercial heat demand, and the expansion of gas networks has reduced the amount of space heating in industrial and commercial premises supplied from electricity. Areas without access to hydrogen or low carbon gas have tended to convert from direct heating to heat pumps, or are supplied via heat-networks where this is feasible.

Some specialist industrial processes continue to use natural gas. Processes at large installations are coupled with CCS, which feeds into the network linking the SMR plants with the North Sea storage capacity.

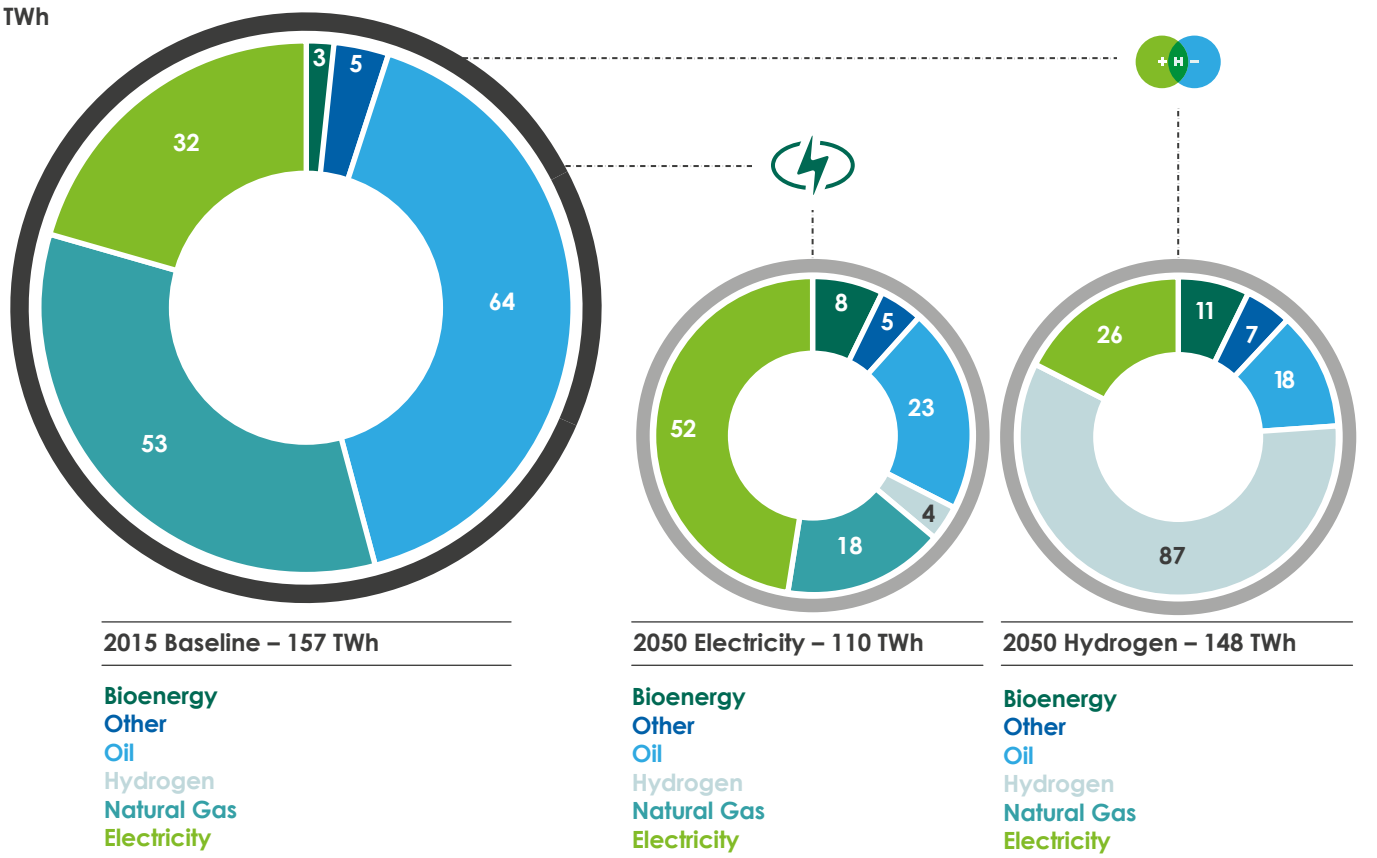
10million **Potential to capture over 10 million tonnes of CO_2 across industry**

The national gas transmission system continues to provide a network of high-pressure pipes across Britain which carry natural gas (methane). Demand increases substantially to feed the hydrogen production process, although this is partly mitigated by the greater penetration of electrolysis. Gas demand is met from a variety of sources in 2050, including a large share of imports of both natural gas from Europe and LNG from world-wide markets.

Biogas, biomethane and bioSNG are also used in a variety of ways, enabling the use of low carbon gas from waste for conversion to hydrogen, to meet industry demand and to feed areas of the gas network where hydrogen conversion isn't feasible.

60% **Demand for gas as an input increases by around 60%**

Diagram 9
Energy Flows, 2015 and 2050



These illustrative scenarios describe two possible solutions to a difficult problem. Both will require major change to, and sustained investment in, existing infrastructure. Scotland in 2050 is unlikely to reflect either of these; it is more likely instead to combine elements of the two, as well as new options that have yet to be developed.

It's possible that some regions of Scotland will depend on hydrogen or other low carbon gases for decarbonisation, whilst others could rely more on electrical solutions. We would take steps to ensure that any infrastructure issues raised by such regional differences that might arise were identified and addressed in full.

Heat pump development and uptake will likely lead to a range of technologies being deployed, including gas hybrid options. District heating has an important role to play too – both scenarios have these networks meeting over 10% of residential and service sector demand.

These uncertainties mean that we need to take a flexible and open approach to decarbonisation. We will need a portfolio of options, capable of adapting over the coming decades as the world changes. Our Strategic Priorities (Chapter 3) propose a flexible approach, and our intention is to pursue 'no regret' or 'low regret' options – see pages 68-73 for a summary of such near-term actions.

Progress over the next five years will have a huge bearing on our decisions about which technologies should form part of the future energy system. We will continue to build our evidence base on the likeliest and best solutions, on how to deliver these economically, and on the associated technical and regulatory issues.

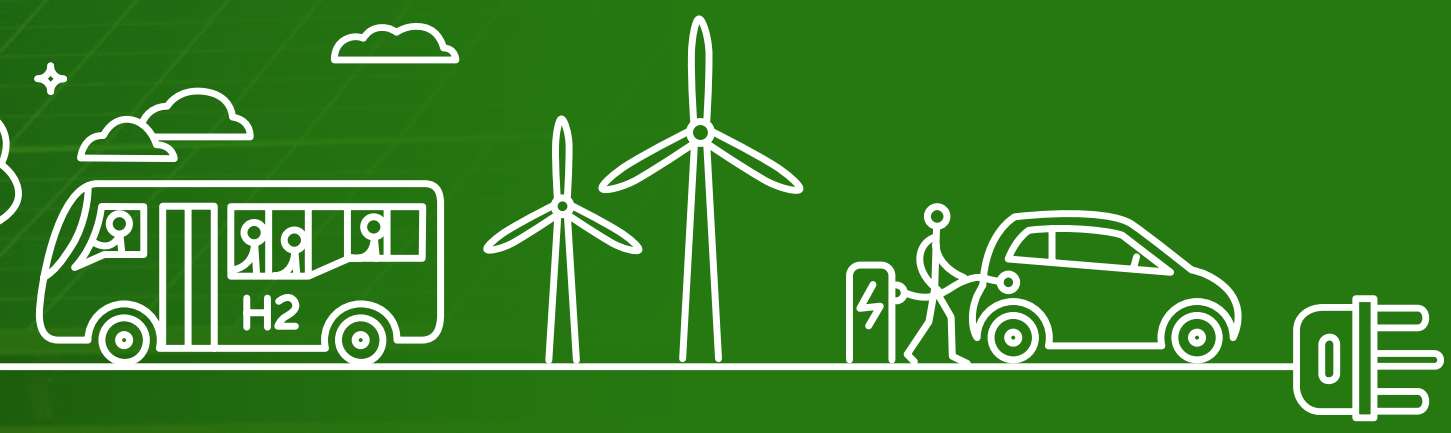
The Scottish Government will work with the UK Government on the major challenges of heat, industry and transport decarbonisation – supporting work proposed across various sectors under the UK Clean Growth Strategy.

Decisions about strategic national infrastructure such as gas and electricity networks will also have a powerful influence. These are financed via infrequent 'price control' periods, managed by the energy regulator Ofgem, with both electricity transmission and gas networks due to begin a new price control period in 2021.

The Scottish Government will develop strategic network vision papers during the coming year for both electricity and gas, to support the development of the respective networks. These will help ensure that the price control processes led by Ofgem take this Strategy and our wider policies fully into account.

Our Annual Energy Statement (see Chapter 5) will reflect changes taking place year to year. We will also periodically review the wider framework put in place by this Strategy to ensure that our approach reflects and responds to changing circumstances.

3. **SCOTLAND'S ROUTE TO 2050:** TARGETS, PRIORITIES AND ACTIONS



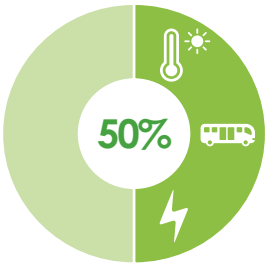
This chapter looks at our 2030 targets, and their component parts, in more detail. It also identifies the near-term actions which will help realise our Strategic Priorities.

This is a long-term Strategy, designed to guide our decision making between now and the middle of the century – over 30 years in the future. We can't be entirely certain what our energy system will look like by 2050; however, our ambition and policies over the coming years, and our pursuit of low or no regrets options, will set us on the right path to the low carbon future that we want for Scotland.

2030 Targets

This Strategy sets two new targets for the Scottish energy system by 2030:

- The equivalent of 50% of the energy for Scotland's heat, transport and electricity consumption to be supplied from renewable sources
- An increase by 30% in the productivity of energy use across the Scottish economy



THE EQUIVALENT OF **50%** OF THE ENERGY FOR SCOTLAND'S HEAT, TRANSPORT AND ELECTRICITY CONSUMPTION TO BE SUPPLIED FROM RENEWABLE SOURCES

AN INCREASE BY **30%** IN THE PRODUCTIVITY OF ENERGY USE ACROSS THE SCOTTISH ECONOMY

RENEWABLE ENERGY

Scotland's long term climate change targets will require the near complete decarbonisation of our energy system by 2050, with renewable energy meeting a significant share of our needs.

In 2009 the Scottish Government established a suite of renewable energy targets for 2020 – with a headline target of the equivalent of 30% of Scotland's heat, transport and electricity consumption to be supplied from renewable sources. We have made good progress to date, with the equivalent of 17.8% being met by renewable sources in 2015.

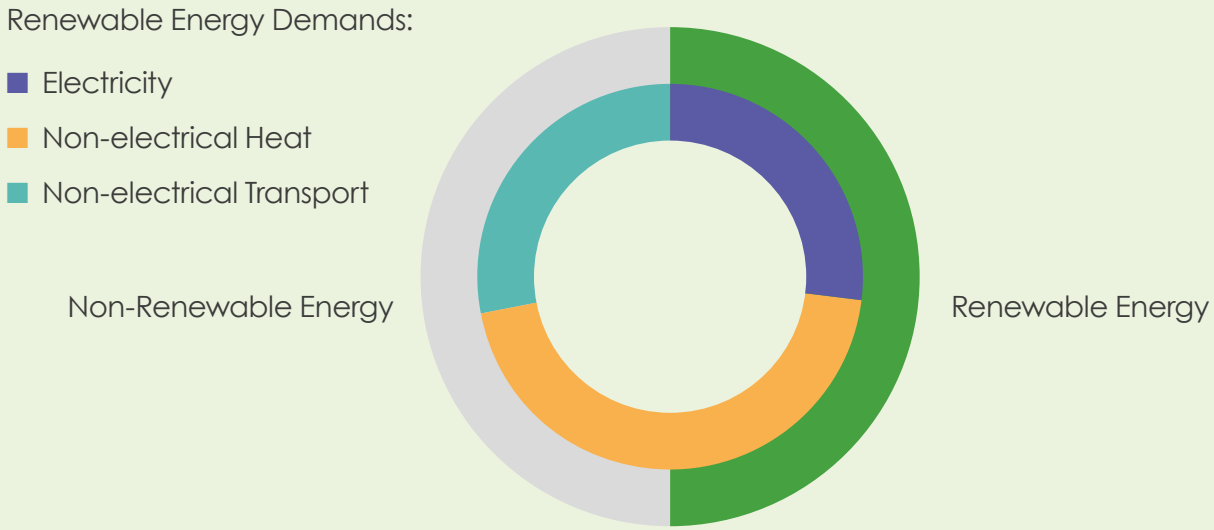
Reaching 50% in 13 years will be challenging, particularly in more uncertain market conditions compared to those in the preceding decade, and due to the fact that not all the relevant policy levers are devolved to the Scottish Government. But the target demonstrates the Scottish Government's commitment to a low carbon energy system and to the continued growth of the renewable energy sector in Scotland. It also underlines our belief in the sector's ability to build on its huge achievements and progress thus far.

ENERGY PRODUCTIVITY

The Scottish Government's previous energy efficiency target was to reduce final demand for energy by 12% by 2020 (from a 2005-07 baseline). This target was achieved 6 years early, and final demand in 2015 was 15.4% lower than the baseline. However, reducing demand is only one part of our energy efficiency ambition.

Our new target is a measure of the combination of energy consumption and the output of the economy.

Diagram 10
2030 Renewable Energy Target



Scottish Government analysis underpinning this target shows that renewable electricity – which has already outperformed our interim 2015 target of 50% – could rise to over 140% of Scottish electricity consumption, ensuring its contribution to the wider renewable energy target for 2030.

This assumes a considerably higher market penetration of renewable electricity than today – requiring in the region of 17 GW of installed capacity in 2030 (compared to 9.5 GW in June 2017) – with greater interconnection with parts of continental Europe providing an expanded market for our electricity.

It also anticipates the switch from fossil fuels in transport to ultra-low emission vehicles, including plug in hybrids, battery powered electric vehicles, hydrogen fuel cells, and biofuels. We assume the non-electrical proportion of transport demand met by renewables to be around 5%.

Renewable heat grows to around 20% of non-electrical heat demand, with a big rise in heat pumps and continued growth in biomass. Renewable heat is also likely to increase due to growth in district heating – if powered by renewable fuels.

The heat and transport figures do not include the impact of electrifying heat and transport demand to 2030. These impacts are captured within the electricity sector, as metered demand for electricity rises and our gross consumption increases.

Higher energy productivity means squeezing more out of every unit of energy consumed across the economy – more economic activity for each unit of energy being used. Energy productivity in Scotland increased by approximately 31% between 2005 and 2015.

Enhanced energy efficiency and improved productivity will help curb energy consumption without limiting growth – enabling the continued reduction in emissions whilst still growing the Scottish economy. It can make businesses more competitive by improving their productivity in respect of each unit of energy consumed, with investment in industrial energy efficiency reducing operating costs and protecting against some or all of any rise in energy prices.

Scotland's Economic Strategy makes clear that improving productivity is about making better use of all our resources – whether they are people, infrastructure or natural assets. It is the principal long-term driver of economic growth. More productive economies can produce greater quantities of goods and services for a given set of resources, typically leading to higher incomes, living standards and wealth.

We are already seeing the results, with improved productivity in transport, industry and home appliances in the last decade driven by improved efficiency standards, with new techniques and informatics technologies leading to enhanced productivity.

This is consistent with the overall EU ambition to implement an EU-wide energy efficiency improvement by 2030[11], and with our Climate Change Plan analysis. The change in productivity between 2005-07 and 2030 could be in excess of 60%.

11 The methodology for monitoring the energy productivity measure can be found in the Energy in Scotland 2017 publication, page 32 and 33: http://www.gov.scot/Topics/Statistics/Browse/Business/Energy/EIS/EIS2017

Strategic Priorities

Achieving our aims will involve energy and non-energy policy levers, and a combination of reserved and devolved powers.

Certain aspects, such as energy efficiency and fuel poverty initiatives, and our positions with respect to granting consent and planning permission for nuclear power and unconventional oil and gas, are matters for the Scottish Government and Parliament, while others – such as market support for different forms of power generation, and regulation of the gas and electricity grids – are reserved to the UK Government.

The following pages set out the detail of the balance between Scottish Government actions and action required by the UK Government or other national or international actors.

We will need to collaborate across public, community and private sectors – building upon our existing partnership approach with local government and other organisations, trade bodies and community groups. This will help to manage any tensions and trade-offs, and maximise the beneficial outcomes for Scotland.

The Strategy's six priorities summarise our approach. They are flexible, able to respond to changes in individual technologies and wider market developments. Our focus is on the near term, rather than the full transition – on the next five years particularly, as we prepare to make the major medium and long-term decisions in the next decade.

Even within that period, considerable change is likely. For example, the nature of the UK's exit from the EU, policies to deliver the Clean Growth Strategy and Industrial Strategy, international efforts to deliver the Paris Climate Agreement – all of these and more could have a powerful bearing on our progress. We will keep that progress, and our approach, under close review (see Chapter 5).

CONSUMER ENGAGEMENT AND PROTECTION

WE WILL WORK HARD TO PROTECT CONSUMERS FROM EXCESSIVE OR AVOIDABLE COSTS, AND PROMOTE THE BENEFITS OF SMARTER DOMESTIC ENERGY APPLICATIONS AND SYSTEMS.

Consumers remain at the heart of our future plans for the energy system. Our policies and actions will continue to reflect their varied needs, and the new ways in which they can interact with and affect the energy system.

The days of people passively consuming energy are beginning to change. There is still a distance to travel before these changes extend to everyone, however, the growing number of options, and our choices, behaviour and actions as consumers, will have a huge influence on the shape of future energy systems, and on the pace of our low carbon transition. The Scottish Government will play its part in ensuring that consumers are informed, engaged and empowered as the energy system evolves.

FUEL POVERTY AND CONSUMER ENGAGEMENT

New energy companies have eroded the market dominance of the "Big Six" in recent years – from a 98% market share in 2013, to around 80% in 2017. The increase in competition, and in choice for consumers, is something that the Scottish Government has warmly welcomed.

But not all households are able or willing to take advantage of such opportunities. And switching rates in Scotland are lower than the rest of Great Britain. So while recent moves by the UK Government to cap tariffs for certain consumers may help to reduce bills, these must form part of wider efforts to ensure a fairer market for all.

The current energy market is failing many Scottish households. In 2016, 26.5% of Scottish households were fuel poor. Many of those fuel poor households are part of a significant group who do not switch suppliers – and are therefore on some of the most expensive energy tariffs.

Consumers who take advantage of competition and choices are typically higher-income earners; they have access to a mains gas supply, use the internet to compare and find the best deals, and choose to pay by Direct Debit. However, this creates a situation where those who are less able to pay effectively subsidise the better-off, engaged consumers. This worsens the existing inequalities, and penalises households living in fuel poverty. This unique set of circumstances reinforces the case for further action.

We are currently consulting on a new long term fuel poverty strategy[12] and will introduce a Warm Homes Bill in 2018, as part of our ambition to eradicate fuel poverty. This will put in place a new cross-portfolio fuel poverty strategy, setting a new statutory target and adopting a revised definition of fuel poverty that will place a greater emphasis on households with lower incomes and high housing and fuel costs.

Our work to promote consumer engagement in Scotland is one way of tackling this inequality. The Scottish Government has supported a partnership between its Home Energy Scotland service and the social enterprise Citrus Energy to promote impartial tariff-switching. In 2018, we will begin a pilot project to examine how to extend the benefits of competition to vulnerable and disengaged consumers – with face to face advice and support for them to switch energy supplier or tariff. This project will operate through Home Energy Scotland, in partnership with a range of trusted organisations, and in an area chosen to include consumers who are more likely to be disengaged.

We have also announced plans to introduce financial health checks to address the poverty premium[13], including through helping people switch to the lowest energy tariff.

12 Consultation on a Fuel Poverty Strategy for Scotland: http://www.gov.scot/Publications/2017/11/6179

13 'Poverty premium' is the term used to describe the circumstances where poorer people pay more for essential goods and services.

In October 2017, we announced an ambition to establish a new energy company. Our aim is that this company will support economic development, contribute to tackling fuel poverty, will be publicly-owned and run on a not-for-profit basis.

Central to our concerns is improving the level of trust that consumers in Scotland should have in the energy market through tackling inequality and promoting inclusive growth.

Establishing a publicly-owned Scottish energy company is a unique challenge, requiring deep expertise. Analysis is now underway to consider the best route to achieve our principal aims.

The aim is to have the new company set up by the end of the current Parliament (2021).

The company may also have a role to play in helping delivery broader Government energy ambitions – including the promotion of renewable generation and maximising benefits for local communities.

SMART METERS AND HOME AUTOMATION

Smart systems and technology can also help increase consumer engagement. For example, customer data from smart meters could be used to provide tailored energy efficiency solutions and advice.

Smart meters and appliances give consumers the ability to manage their energy use more carefully and economically – for instance, appliances may switch on and off based on local network demand and prices. This ability is likely to become much more widespread as the next generation of smart meters is installed – and underlines once more the need to ensure that less engaged and more vulnerable customers are not left further behind.

The power to regulate the market rests with the UK Government and Ofgem. We welcome Ofgem's development of principle-based regulations, including vulnerability principles which shift the focus of suppliers from simply meeting the letter of the regulations to identifying and supporting those that are vulnerable. This pro-active approach will become even more important as the energy system develops.

These regulations complement Ofgem's moves to make switching easier and energy costs more transparent, while introducing protections around the installation of pre-payment meters. We share common ground with Ofgem here, and will continue to work in partnership to tackle the issues facing energy consumers.

But the Scottish Government has its own role to play too, through our newly devolved powers on consumer advocacy and advice – powers which can help us make sure that the views of Scottish consumers are heard properly, and that any threats or failures are swiftly addressed.

We will be consulting over the coming months on our plans to deliver a powerful, effective consumer advice and advocacy service. We appreciate the role that organisations such as the Citizens Advice service, the Extra Help Unit, Energy Action Scotland and Home Energy Scotland play in providing support and advice direct to consumers, championing consumers at local and national levels and highlighting the difficult issues faced by consumers.

We will continue to work closely with consumer bodies and to make sure that industry listens to consumers, identifying and responding to specific issues.

We will also develop an energy consumer Action Plan to take a more detailed look into consumer issues across the energy sector.

ENERGY EFFICIENCY

WE WILL CONTINUE TO TAKE DIRECT AND SUPPORTING ACTIONS TO IMPROVE THE USE AND MANAGEMENT OF ENERGY IN SCOTLAND'S HOMES, BUILDINGS, INDUSTRIAL PROCESSES AND MANUFACTURING.

BUILDINGS

The Scottish Government has designated energy efficiency as a National Infrastructure Priority. The cornerstone of our approach is Scotland's Energy Efficiency Programme (SEEP). In May 2018 we will launch a full Route map for SEEP and introduce the SEEP Transition Programme.

SEEP is fully in line with our draft Climate Change Plan, and our ambitions for sustainable growth. It is a 15-20 year programme; its aim is to make Scotland's buildings near zero carbon wherever feasible by 2050, and in a way that is socially and economically sustainable.

By 2050, SEEP will have transformed the energy efficiency and heating of Scotland's buildings. This will make our homes, shops, offices, schools and hospitals warmer and easier to heat.

Reducing energy demand will help tackle fuel poverty, help businesses become more competitive, and release savings in the public sector for front line services.

SEEP can help create multiple benefits, including:

- a substantial Scottish market and supply chain for energy efficiency services and technologies, with an estimated 4,000 jobs per annum across Scotland;
- health and early years improvements through people living in warmer homes; and
- regeneration of communities through upgraded building stock.

SEEP aims to radically improve the energy efficiency of Scotland's homes, and buildings in the commercial, public and industrial sectors. It will build upon a transition programme which offers local authorities incrementally greater opportunities to deliver integrated energy efficiency projects.

SEEP will build on existing successful programmes such as the Energy Efficiency Standard for Social Housing (EESSH), Home Energy Efficiency Programmes Area Based Schemes (HEEPS:ABS) and the Public Sector Non Domestic Energy Efficiency Framework and Project Development Unit.

SEEP will focus to the mid-2020s on reducing energy demand in all buildings across Scotland – establishing solutions for switching heating supplies from high to lower carbon or renewable sources for properties off the mains gas grid. It will also encourage appropriately-sited low carbon district heating, where that is the most appropriate 'low regrets' heat decarbonisation technology. Beyond that we will develop SEEP in the context of wider changes to heat policy set by the UK Government (see section below on renewable and low carbon heat).

Our 2016 Programme for Government confirmed a minimum of £0.5 billion for SEEP over the 4 years from 2017/18. We are already funding SEEP pilot projects in 23 local authorities. These are looking at integrated programmes to improve the energy performance of residential, commercial and public buildings, and investments to decarbonise the heat supply.

We are also developing as part of SEEP a significant new approach to Local Heat & Energy Efficiency Strategies (LHEES) and district heating regulation – with associated legislation later in this Parliament, if appropriate (see box in section on 'Innovative local energy systems').

Twelve local authorities are also considering approaches to LHEES within the wider SEEP pilots, supported by Resource Efficiency Scotland, Scotland Futures Trust and our enterprise agencies.

In May 2018, our SEEP Routemap will set out more detail on the transition programme and the role of legislation. The first priority will be to bring forward the Warm Homes Bill in 2018. This will set a new statutory fuel poverty target – demonstrating our commitment to resolving this issue, and our support for those most in need of help to heat their homes.

SEEP will build on our current successful support offering, which provides free impartial advice and a range of financial mechanisms. These mechanisms include low-cost loans for small and medium-sized enterprises (SMEs) and households to install energy efficiency and low carbon heat measures, as well loans for district heating projects.

A pilot project, offering a cash back incentive to SMEs who take out loans for energy efficiency measures, will begin in early 2018 for a limited time. This aims to increase the uptake of energy efficiency measures amongst SMEs, achieving both energy cost and carbon savings.

The Scottish Government will continue to work closely with local authorities and COSLA on the design of SEEP, and to support the development of local energy efficiency and heat strategies – providing the basis for public and private infrastructure investment in energy efficiency and heat decarbonisation, including district heating. Planning policies at a national and local level support energy efficient buildings, and encourage consideration of district heating development and wider decarbonisation projects.

BUILDING STANDARDS

In addition to SEEP, action over the past decade has delivered staged improvements to energy standards within building regulations. This has resulted in emissions from new buildings built to current standards being, on aggregate, around 75% lower than those built to standards in force in 1990, with corresponding reductions in energy demand.

We will begin a further review of energy standards in 2018, and investigate a number of measures that offer greater potential for reductions in emissions and energy demand from new buildings, and from work that is undertaken in existing buildings.

The review of energy standards, originally planned for 2017, was deferred briefly to support a clear focus on current reviews of both fire safety and compliance and enforcement of building regulations, which are being undertaken in light of recent events in Scotland and elsewhere in the UK.

INDUSTRIAL

Scotland's industrial sector accounts for over half of our exports and total business research and development expenditure. The sector also sustains a significant number of high-value jobs across Scotland.

Scottish industry is also playing a leading part in the collective European and UK efforts to decarbonise – increasingly adopting sophisticated IT and automated technology, and investing in more energy-efficient equipment or reusing waste heat.

These advances make factories smarter, safer, more efficient and environmentally sustainable. They can also reduce costs through improved competitiveness and enhanced productivity. Reducing the carbon intensity of industry and increasing energy productivity are key priorities in Scotland's Manufacturing Action Plan.[14]

14 Scotland's Manufacturing Action Plan: http://www.scottish-enterprise.com/knowledge-hub/articles/insight/scotlands-manufacturing-action-plan

This Strategy sets out our commitment to manage the transition towards a future energy system in a way that reduces the risk of domestic industries relocating overseas, where climate or energy regulation may be less stringent (referred to as 'carbon leakage').

We want to continue removing barriers to energy efficiency and decarbonisation investment, building on recent uses of our devolved powers. For example, we have amended our Renewables Obligation legislation to exempt Scottish energy intensive industries reducing the energy-related costs that they face.

Investing in energy efficiency can lead to reduced operating costs, protection against energy price rises and provide an income stream through the recovery or use of heat.

We understand that securing these investments can be challenging – for example, payback periods for equipment or technology are often considered to be too long. Board decisions can also be difficult to reach due to the multi-national nature of many of the businesses, with strong global competition for capital resulting in a barrier to investment. Regulatory regimes and the tax system can also distort the commercial case for diverting investment capital to less productive uses.

Our recently convened energy intensive industries' roundtable discussion highlighted where there are opportunities to increase investment into energy efficiency measures across industrial sectors such as refining, chemicals, metals, mineral products, paper and food production.

Government, agencies and industry must collaborate to improve our competitiveness and productivity, and to strengthen the case for low carbon investment.

We are working with our energy intensive industries to build on existing programmes of support, and to provide incentives for industrial energy efficiency or decarbonisation. We will support efforts to deliver the Energy Efficiency and Industrial Decarbonisation Roadmaps[15] for the energy intensive sectors, and look at specific Scottish aspects within the UK Sector Deals being developed under the UK Industrial Strategy.

We will also continue to work with industry to encourage investment in key industrial clusters, such as Grangemouth, where energy efficiency, bio-technology and carbon capture utilisation (CCU), and CCS could offer significant opportunities for decarbonisation and economic growth[16].

We are also liaising with the UK Government to work out how the proposed UK industrial energy efficiency scheme can be designed or developed to ensure that Scottish sectors are given good opportunities to access support or advice.

We are planning to develop a collaborative agreement with key industrial sectors in Scotland, which will:

- raise understanding by sharing good practice;
- identify key opportunities for industrial energy efficiency and decarbonisation; and
- identify and overcome barriers to investment.

We will publish a discussion paper in 2018 that considers how to achieve these outcomes in a way that builds on our existing commitments in SEEP and the Scottish Manufacturing Action Plan.

15 Industrial Decarbonisation and Energy Efficiency Roadmaps to 2050: http://www.gov.uk/government/publications/industrial-decarbonisation-and-energy-efficiency-roadmaps-to-2050

16 Future Grangemouth Vision 2025 Evaluation of Economic Effects: http://www.chemicalsciencesscotland.com/content/uploads/2017/11/Future-Grangemouth-Vision-2025.pdf

RENEWABLE AND LOW CARBON SOLUTIONS

WE WILL CONTINUE TO CHAMPION AND EXPLORE THE POTENTIAL OF SCOTLAND'S HUGE RENEWABLE ENERGY RESOURCE, AND ITS ABILITY TO MEET OUR LOCAL AND NATIONAL HEAT, TRANSPORT AND ELECTRICITY NEEDS – HELPING TO ACHIEVE OUR AMBITIOUS EMISSIONS REDUCTION TARGETS.

Renewable and low carbon energy will provide the foundation of our future energy system, offering Scotland a huge opportunity for economic and industrial growth.

Our resources and potential resources have a value which extends beyond Scotland, and can help decarbonise the wider-GB and European energy system. Scottish renewable electricity displaced an estimated 9.4 million tonnes of CO_2 across the GB system in 2016.

Successive Scottish Governments, through a mixture of ambitions, targets and direct action, have enhanced our renowned reputation for renewables – wave, tidal, solar and wind.

Nova Innovation's Nova M100 tidal turbine
(Credit: Scottish Enterprise)

Since 2012, the Scottish Government has provided significant capital finance to support renewables through our Renewable Energy Investment Fund (REIF). In five years, the Fund has invested £60 million and supported over 20 projects. REIF has successfully supported community renewables – helping to secure deals and streamline diligence costs – and marine energy, where it has been recognised as at a European level as an exemplar for investment.

We will build on the success of REIF to broaden its scope beyond renewables to include low carbon energy solutions as an Energy Investment Fund, and bolster its funding with up to £20 million made available in 2018-19.

The new Energy Investment Fund will be operated as a transitional measure before the Scottish National Investment Bank becomes operational, as the latter is expected to have low carbon investment as part of its mission-based approach to maximising investment growth in Scotland.

Since 2015, the Scottish Government has also operated the Low Carbon Infrastructure Transition Programme (LCITP). The LCITP stimulates commercial interest and investment, building on Scotland's vast potential in the low carbon sector. It helps projects to develop investment-grade business cases, and to secure public and private capital finance.

The LCITP has accelerated the deployment to date of over 50 low carbon projects through providing over £48 million of financial support. We will now build on LCITP's success by establishing a Low Carbon Innovation Fund, investing a further £60 million to deliver innovative low carbon energy infrastructure solutions.

RENEWABLE AND LOW CARBON ELECTRICITY

We are well on the way now to meeting our target of generating the equivalent of 100% of Scottish demand from renewable sources by 2020.

All renewable and low carbon solutions will have a role to play; this section focuses briefly on some of the key sectors and opportunities.

Coigach Community Wind Turbine
(Credit: Highlands and Islands Enterprise)

COMMUNITY BENEFIT AND SHARED OWNERSHIP

Community benefit payments can be a valuable source of income for communities located near to renewables developments. As of November 2017, over £12 million had been paid out to communities over the preceding 12 month period.

We accept that the support mechanisms and investment conditions for new renewables projects have changed considerably. However, our expectation remains that developers should continue to offer meaningful community benefits in line with our Good Practice Principles.

We also want to see a significant increase in **shared ownership** of renewable energy projects in Scotland – putting energy into the hands of local communities, and delivering a lasting economic asset to communities across Scotland.

Our ambition remains to ensure that, by 2020, at least half of newly consented renewable energy projects will have an element of shared ownership.

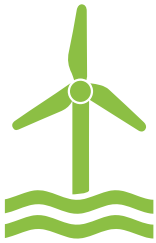
Shared ownership will play a key part in helping to meet our targets of 1 GW of community and locally-owned energy by 2020 and 2 GW by 2030. We expect community involvement in onshore wind developments to continue to play a vital role in reaching these targets.

The new Community and Renewables Energy Scheme (CARES) contract up to 2020 has supporting shared ownership opportunities as a top priority. The support and advice available through CARES has been praised by both developers and communities.

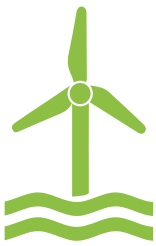
The Scottish Government will continue discussing shared ownership issues with our stakeholders. These discussions will form a key part of our review of Good Practice Principles for Shared Ownership of Onshore Renewable Energy Developments, which will take place during the course of 2018.

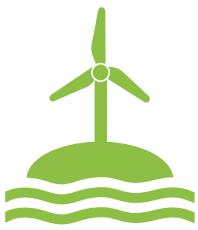
Technology	Opportunity
Onshore wind: **We will push for UK-wide policy support for onshore wind, and take action of our own to prioritise and deliver a route to market – combined with a Land Use Planning approach which continues to support development while protecting our landscapes.** 	Onshore wind is now amongst the lowest cost forms of power generation of any kind, and is a vital component of the huge industrial opportunity that renewables create for Scotland. The sector supports an estimated 7,500 jobs in Scotland, and generated more than £3 billion in turnover in 2015. Campbeltown is also currently home to the UK's only turbine tower fabricator. We are determined to build on these strengths. Our energy and climate change goals mean that onshore wind must continue to play a vital role in Scotland's future – helping to decarbonise our electricity, heat and transport systems, boosting our economy, and meeting local and national demand. That means continuing to support development in the right places, and – increasingly – the extension and replacement of existing sites with new and larger turbines, all based on an appropriate, case by case assessment of their effects and impacts. It means continuing to provide a route to market for that power – in ways which reduce and ultimately eliminate any additional costs for consumers. And it means developers and communities working together and continuing to strike the right balance between environmental impacts, local support, benefit, and – where possible – economic benefits deriving from community ownership. This can be done in a way which is compatible with Scotland's magnificent landscapes, including our areas of wild land. This means that the relevant planning and consenting processes will remain vitally important. A major review of the Scottish planning system is well under way, and will continue as now to fully reflect the important role of renewable energy and energy infrastructure, in the right places. More detail on our wider approach to onshore wind is set out in the **Onshore Wind Policy Statement**, published alongside this Strategy.

Technology	Opportunity
Offshore wind: **We will open consideration of new opportunities for development in Scottish waters – and renew our support for the development of an innovative and competitive supply chain in Scotland.**	Offshore wind is now substantially cheaper than new nuclear electricity generation. With countries around the world investing more in offshore wind renewables projects, global expenditure is expected to reach £210 billion in the next decade. The competitiveness of Scottish offshore wind has been underlined by Scottish successes (Beatrice, Moray and Neart na Gaoithe) in recent Contract for Difference auctions. And Scotland is now home to the world's first floating offshore wind array, in waters off Peterhead – a project made possible by the distinct and higher support offered through Scotland's renewables obligation legislation. Our deeper waters in particular offer tremendous potential for future development. Scotland's first National Marine Plan[17] (2015) sets the overall framework for the management of Scotland's Seas, including energy installations. The first review report is due in March 2018, providing an opportunity to establish whether the National Marine Plan reflects the priorities set out in this Energy Strategy. Marine Scotland also produces "Sectoral Marine Plans" to support the development of offshore renewable energy, and is currently beginning the identification of potential areas for new offshore wind energy sites. This work will culminate in a Sectoral Marine Plan for Offshore Wind in deeper Scottish waters. Crown Estate Scotland, the body which manages the leasing of Scotland's seabed on behalf of Scottish Ministers, has now begun to consider the potential case for and approach to issuing new leasing rights for commercial-scale offshore wind projects. Crown Estate Scotland will be speaking to local, Scottish and UK stakeholders during 2018 and asking for views on their proposed approach. There is huge industrial and economic potential attached to offshore wind development. Our offshore wind supply chain is strengthening and expanding – building on Scotland's established oil and gas expertise and experience. Scotland has the necessary competitive advantage and the building blocks – a skilled, committed workforce, excellent port infrastructure and a strong innovation hub.



17 Scotland's National Marine Plan: http://www.gov.scot/Publications/2015/03/6517

Technology	Opportunity
	That innovation is being spearheaded by Offshore Renewable Energy Catapult, whose cost-cutting activities we are pleased to support and host through their Glasgow headquarters and their operations at Levenmouth. The same can be said of the activity taking shape at the European Offshore Wind Deployment Centre near Aberdeen. We are determined to continue supporting and growing this sector in Scotland – creating more opportunities for Scottish manufacturers and our supply chain from the developments taking place in our waters and beyond. The UK Government's Industrial Strategy rightly points to the achievements of the offshore wind industry, and the potential that it represents. We will continue to work with the UK Government to ensure that its approach under the proposed offshore wind Sector Deal takes Scotland's offshore wind potential and opportunity fully into account.

Technology	Opportunity
Island wind: **We will provide full support for the emerging proposal to provide Scotland's island wind a route to market – offering a new opportunity for our island communities to participate in the energy transition.** 	The Scottish Government and our partners have pressed the UK Government consistently for a long period over the need to support remote island wind. That means providing a distinct and meaningful opportunity for large wind developments on the Western Isles, Shetland and Orkney to compete for long-term contracts, through the UK Government's Contracts for Difference (CfD) process. We have welcomed the UK Government's recent confirmation that it will provide this access as part of the next CfD auction round, subject to consultation. But that means getting the details and the design right, and providing confirmation and certainty as quickly as possible. We will continue to work with our partners, and with the UK Government, to ensure that this is the case.

Technology	Opportunity
Wave and tidal energy: **We will continue to champion the Scottish wave and tidal energy sector – supporting the research, development, innovation and demonstration that will maintain Scotland's competitive advantage.**	Scotland continues to lead the world in developing and supporting wave and tidal energy technologies. That is due partly to consistent and committed support from the Scottish Government and its enterprise agencies, but mainly due to the passion, expertise, investment and innovation of the industry. Although securing further cost reductions and a route to market remain big challenges, Scotland continues to deliver world firsts. • Scotrenewables – developer of the world's most powerful floating tidal turbine – is exporting an impressive amount of power to the Orkney grid. • Nova Innovation successfully deployed a third turbine at the Shetland Tidal Array earlier this year and has more than doubled its workforce. • The first phase of the MeyGen tidal project is now operating at full 6 MW capacity. • The European Marine Energy Centre (EMEC) has tested 30 different wave and tidal energy devices to date – more than any other single site in the world. Our Wave Energy Scotland (WES) technology programme – funded entirely by the Scottish Government – has supported over 60 projects, engaged 170 organisations from industry and academia, and made over £25 million available so far to support innovation. The sector is already integrating storage, grid management and transport solutions into demonstration projects. It has also developed an impressive Scottish supply chain, providing high value jobs and creating diversification opportunities for Scotland's world class marine services, subsea and oil and gas sectors. The Minister for Business, Innovation and Energy has agreed to chair a new short life industry working group. This group is working to agree the priorities for securing the future growth of the sector in light of changes in UK Government energy policy and EU exit.

Technology	Opportunity
Solar photovoltaic power (solar PV): **We will consider the role for solar and other renewable technologies under the forthcoming review of energy standards within Building Standards and the next National Planning Framework.**	Solar PV can make an increasing contribution to Scotland's energy needs. There is enough capacity in Scotland to power the equivalent of over 50,000 homes, and potential for the sector to provide low cost energy, system stability (e.g. through storage) and create jobs. Solar will play an important role in a low carbon energy system, helping meet Scotland's renewable generation ambitions. Combining storage with wind and solar assets presents a valuable solution for the energy system as a whole, offering the potential for demand to be managed locally. This kind of flexibility and control will be important as electric vehicles become an integral part of the transport system. The Scottish Government is considering, as part of the Planning Review, the potential to expand permitted development (PD) rights for certain renewable installations (removing the need to apply for planning permission for certain developments). Solar will also be considered under the forthcoming review of energy standards within building regulations.

Technology	Opportunity
Bioenergy: **We will develop a Bioenergy Action Plan to provide clearer scope for the development of bioenergy in the Scottish energy system. We will also conduct research to improve our understanding of the potential contribution that bioenergy can make towards meeting Scottish energy demand.**	Biomass provides almost all (90%) of existing renewable heat in Scotland, with biogas also used to produce heat . We will continue to engage with stakeholders as we develop our Bioenergy Action Plan. Our approach will apply the following guiding principles: • Policies to support bioenergy are consistent with the ambitions laid out in this Strategy, and with Scotland's Climate Change Plan and land use strategy. • Bioenergy schemes deliver greenhouse gas emission reductions that help meet Scotland's climate change targets. • Bioenergy schemes represent good value for money, deliver benefits for communities, and help tackle fuel poverty. • Biomass is produced and managed in a sustainable way, and should be used in heat-only or combined heat and power schemes to exploit available heat and local supply. • Demands on land for food, energy crops and other non-food crops are managed equitably. We will conduct research to improve our understanding of the potential contribution which bioenergy can make to meeting Scottish energy demand (power, heat and transport fuels). We will also develop closer ties to UK Government plans to develop a Bio-economy Strategy under the Clean Growth Strategy.

Technology	Opportunity
Hydro Power: **We will partner with the hydro sector to support their ambition, including helping them to explore potential solutions through our Hydro Task and Finish Group. Following the Barclay Review of Non-Domestic Rates, in early 2018 we will 'fast track' the plant and machinery consideration in respect of hydropower.**	Hydropower has a long and illustrious history in Scotland, which can continue, with small scale hydro playing an important role in our economy and our energy mix as we make the transition into a low carbon future. Over 90% of the UK's power from hydro is generated in Scotland, and the sector is important to our growing economy – both in terms of generating investment into the construction industry, and in creating valuable local jobs, often in our most rural areas. Whilst hydro is a mature and reliable source of electricity, small scale hydro in Scotland has experienced a number of challenges in recent years. The Scottish Government remains committed to working closely with the hydro sector, including helping them to explore potential solutions through our Hydro Task and Finish Group established in 2017.

NON DOMESTIC RATES AND THE BARCLAY REVIEW

The proposals set out in the 2018-19 Draft Budget show our commitment to competitive non-domestic rates. We have accepted most of the recommendations of the external 'Barclay review' that concluded in August 2017.

For example, any new-build property will from April 2018 only enter the valuation roll once it is first occupied, and then from that point be liable for no rates for a further year. Any improvements or expansions in respect of existing properties will not lead to rates increases for a year. These new incentives to drive investment and growth are unique in the UK, and have been widely welcomed by business.

We are also targeting specific support through rates reliefs for community renewables, hydropower and district heating respectively. These will continue, pending the outcome of the review of plant and machinery rateability, as recommended in the Barclay report. We have committed to 'fast track' plant and machinery considerations in respect of hydropower, and have been working closely with the sector with a view to this commencing in early 2018.

We will also engage stakeholders to scope out a potential separate review of plant and machinery rateability beyond the hydropower sector.

LOW CARBON AND RENEWABLE HEAT

Heat regulation is devolved to the Scottish Parliament. However, many of the issues which affect the heat market, such as the gas network, electricity and oil, are reserved. Our longer-term approach to decarbonising heat will depend on UK Government decisions on the future of the gas network.

We know that the UK Government has now commissioned work on the long-term direction of heat decarbonisation. This will help to determine the most appropriate mix of solutions, such as district heating, electrification of heat with heat pumps, and gas network decarbonisation.

We expect the UK Government to have taken these decisions by the early 2020s. We will continue to work closely with the Department for Business Energy and Industrial Strategy, urging them to come to a decision as rapidly as possible – and to carefully consider Scottish circumstances and the aims of this Strategy as they take decisions on the future of the gas network, and the overall mix of heat decarbonisation in reserved areas.

The Scottish Government will thereafter develop and identify the best approach to the long-term decarbonisation of the heat supply in a future Climate Change Plan, and will adjust the actions under the Energy Strategy accordingly.

We will continue to use the powers at our disposal to prioritise the decarbonisation of Scotland's heat supply. This will include, as an integral part of SEEP:

- a priority to reduce heat demand as set out in the heat hierarchy of the Heat Policy Statement; and
- promoting low carbon heat via low regrets options as set out by the Committee on Climate Change[18], such as:
  - district heating projects where appropriate, delivering affordable, low carbon heat efficiently; and
  - renewable heat technologies to individual properties, particularly in areas off the gas network.

18 Next steps for UK heat policy: https://www.theccc.org.uk/publication/next-steps-for-uk-heat-policy/

We will also:

- support investment and consumer protection, as outlined in our second SEEP consultation on Local Heat & Energy Efficiency Strategies and Regulation of District and Communal Heating[19];
- continue to provide support for low carbon heat supply and heat demand reduction through our existing funding programmes (e.g. District Heating Loan Fund, Low Carbon Infrastructure Transition Programme), and develop new funding programmes under SEEP;
- work with stakeholders to consider future support for low carbon renewable heat, including discussions with the UK Government around the ending of the current Renewable Heat Incentive commitment period to 2020-21.

The Scottish Government will continue to provide support for low carbon heat supply, including investments in heat networks.

19 Scotland's Energy Efficiency Programme - Second Consultation on Local Heat & Energy Efficiency Strategies, and Regulation of District and Communal Heating: www.gov.scot/LHEES_DCHR_2ndCons

GEOTHERMAL ENERGY

Geothermal energy is the natural heat that exists within our planet. This heat can be used for space and water heating.

The Scottish Government has worked with regulators to produce guidance for those interested in undertaking a deep geothermal project in Scotland.

We made around £0.2 million available under the Low Carbon Infrastructure Transition Programme (LCITP) to explore the technical feasibility, economic viability and environmental sustainability of the geothermal resource in sites in Fife, North Lanarkshire, Aberdeen, Aberdeenshire and Clackmannanshire.

And we are making £1.8 million available for a large scale deep geothermal district heating network to serve the low carbon HALO Kilmarnock development being built on the former Johnnie Walker bottling plant.

LOW CARBON AND RENEWABLE TRANSPORT

Our approach to a low carbon transport system involves a range of measures to drive down transport emissions across all modes, creating a cleaner, greener transport network where sustainable travel modes are the norm.

Traditional motorised vehicles of all types contribute to transport emissions, but low and ultra-low emission vehicle (ULEV) technologies are available which can reduce or eliminate these. As cars and light vans contribute the largest portion of overall emissions, that group is a priority for action.

Electrifying this sector – using a range of options including batteries, hydrogen fuel cells and hybridisation – could achieve a large percentage of the overall reductions required by our Climate Change (Scotland) Act. However, a range of other technologies across different sectors – from those improving efficiencies, to advanced liquid and gaseous biofuels – will play a part in the wider decarbonisation of transport.

The Scottish Government is already supporting innovative approaches to decarbonising transport, such as the Aberdeen Hydrogen Bus Project.

ABERDEEN HYDROGEN BUS PROJECT

Ten hydrogen buses run on two routes in the city, with an integrated hydrogen system producing and storing hydrogen produced on-site to fuel the bus fleet – Europe's largest fleet of green hydrogen buses.

The Scottish Government and Scottish Enterprise provided a total of £3.3 million support in 2013 for the project. The Scottish Government provided an extra £3 million in 2017 to double the fleet of hydrogen fuel cell buses to 20 vehicles. The additional 10 buses are expected to be deployed in 2018.

We have confirmed our intention to support the use of ULEVs, and to phase out the need for new petrol and diesel cars and vans by 2032. To meet that commitment, we will:

- expand our electric charging infrastructure between now and 2022, making 'range anxiety' a thing of the past in Scotland;
- work with each of our delivery partners to create Scotland's first 'electric highway' on the A9, with charging points along the route;
- accelerate the procurement of ULEVs in the public and private sectors, transforming public sector car and van fleets by the mid-2020s and commercial bus fleets by the early 2030s;
- introduce large scale pilots across the country, removing barriers and encouraging private motorists to use ULEVs;
- address the particular challenges to expanding the charging infrastructure in Scotland, such as charging in tenement properties; and
- take steps to better integrate electric vehicle policy within wider energy systems policy including renewable generation and energy storage systems.

Many of the key fiscal levers still rest with the UK Government; we will urge them to use their powers to help shape the market, including through vehicle standards and taxation.

More ULEVs will mean higher electricity demand, creating particular pressures for local distribution networks as drivers look to connect and charge their vehicles. We are already discussing these issues with Scotland's grid operators, and starting to consider different options and approaches.

There will be big challenges here – but opportunities too, for example, in developing solutions such as smart chargers, and interfaces which can manage and reduce pressure on electricity networks. The development and use of innovative software can reduce the need for investment in more expensive and disruptive "hardware", in the form of grid upgrades. There is a big innovation opportunity here for Scottish businesses, and a chance to develop and export the necessary technology and solutions. Initiatives such as the "My Electric Avenue" project[20] have already looked at some of these issues, and others are underway.

A report by Transport Scotland and Urban Foresight published in 2016[21] concluded that large numbers of EVs across Scotland can help support 'whole-system' energy solutions by:

- providing significant and distributed energy storage capacity, able to absorb intermittent loads from renewable generation;
- helping to integrate more micro-generation;
- increasing overall energy efficiency; and
- potentially providing a source of grid power input when required.

20 The My Electric Avenue Project: http://myelectricavenue.info/
21 Energy Systems and Electric Vehicles: http://urbanforesight.org/wp-content/uploads/2016/07/Energy_systems_working_paper_4.0.pdf

LAND USE PLANNING AND THE PLANNING BILL

Place is at the heart of how we live our lives. The shared vision of National Planning Framework 3 and Scottish Planning Policy includes a growing, low carbon economy where we live in sustainable, well-designed places.

Renewable energy is a core part of our planning policy, as it provides a key means of reducing greenhouse gas emissions as well as significant economic opportunities.

The planning system already supports the energy system in the following ways:

- guides wind farms to appropriate locations, setting positive policies for heat network installations and other renewable generation technologies;
- encourages grid connections which can help decentralise power systems across Scotland, noting the role and value of energy storage solutions where the grid is weak;
- supports designing places to promote active travel; our streets are already changing to accommodate electric vehicle charging infrastructure; and
- supports the creation of a national carbon capture and storage network.

We are currently reviewing the planning system, with a Planning Bill introduced to the Scottish Parliament on 4 December 2017, designed to support the planning and delivery of infrastructure and high-quality homes, and improving places.

We want to deepen the relationship between communities and the planning system. This can be done through formal and informal means, including continued use of the 'place standard' as a means of considering and evaluating place quality.

We also want to improve the connection between our national policies and regional priorities – providing for new and emerging regional partnerships to support national planning policy.

We expect to publish our next National Planning Framework in 2020, in parallel with Scottish Planning Policy. The period running up to this will create opportunities to collaborate on a revised set of planning policies wholly in line with the goals of this Energy Strategy and the Climate Change Plan.

INNOVATIVE LOCAL ENERGY SYSTEMS

WE WILL EMPOWER OUR COMMUNITIES, SUPPORTING THE DEVELOPMENT OF INNOVATIVE AND INTEGRATED LOCAL ENERGY SYSTEMS AND NETWORKS.

LOCAL ENERGY SYSTEMS

Scotland aims to maintain its leadership in developing local energy systems – building on the global shift away from centralised generation and passive consumption.

Scotland has a legacy of strong community engagement in local renewable generation, led by rural Scottish communities, including islands. These groups have led the way in developing innovative local energy solutions, overcoming their limited access to national infrastructure.

The Scottish Government has supported a number of these early pilot projects through initiatives such as the Low Carbon Infrastructure Transition Programme and the CARES Local Energy Challenge Fund. We recognise the importance of local solutions in National Planning Framework 3.

We are determined to build on this, and can learn a great deal from our work to date as we continue this transition towards energy systems which more directly benefit local economies and consumers.

The main challenges we face are expanding these principles into more densely-populated and urban areas, and identifying sustainable, replicable commercial models.

We need to move from projects with a single beneficiary to ones that are more strategic – covering larger geographical areas, and involving partnership arrangements between communities, local authorities, the public and private sectors.

From innovation to commercialisation

Delivering low carbon energy, including local energy system and efficiency improvements, will depend upon greater private sector activity and investment in Scotland's low carbon sector.

Our ambition is to help commercialise these projects, removing the need for Scottish public sector subsidy or assistance. This means improving the ways in which we identify, manage and mitigate risks – cutting costs and generating new income streams and revenue. This will make the projects more attractive investment propositions, both for the private sector and for communities.

A number of demonstration programmes have supported the delivery of low carbon projects across Scotland in recent years. These early projects are risky, and not all will work as planned, or translate into commercial propositions. Our priority will be to ensure that we learn from any failures, and can repeat the successes. This will cut more carbon and increase our ability to export the technologies and systems in question to other parts of the world.

We are aware that the UK Government will launch a new Industrial Strategy programme – "Prospering From the Energy Revolution". This programme, alongside other initiatives, such as Ofgem's Network Innovation Competitions and Low Carbon Networks Fund, will help develop world-leading local, smart energy systems, delivering cheaper and cleaner energy across power, heating and transport – creating high-value jobs and export capabilities.

LOCAL ENERGY SYSTEMS: SCOTLAND'S ISLANDS

Many of Scotland's island communities are already successfully demonstrating complex energy solutions. Their isolation from mainland energy and supply networks creates a strong incentive for innovation, helped by some of the most powerful renewable energy resources in Europe.

Orkney, for example, is home to what was the UK's first smart grid – connecting renewable generation to Orkney's distribution network at a considerably lower cost than conventional network connection.

The **'Surf 'n' Turf'** project demonstrates a fully integrated energy model, with hydrogen produced using electricity from tidal and onshore wind turbines. This is stored in a fuel cell, and used to provide low carbon heat, power and transport. A European-funded project called **'BIG HIT'** will build on the Surf 'n' Turf project in Orkney by producing hydrogen from renewable sources for transport and heating.

The projects will benefit the community by providing employment and training, as well as reducing harbour electricity costs and increasing revenue.

There are many other examples of innovation on Scotland's islands and remote rural communities, supported by Local Energy Scotland (https://www.localenergy.scot/). For example, the **Mull Garmony Community Hydro scheme** and the **Assisting Communities to Connect to Electric Sustainable Sources Project (ACCESS) project** – a cost-effective platform for enabling the real time matching of local electricity generation and local electricity demand at a distribution network level.

We intend to develop a local energy systems position paper, containing detailed principles, along the following lines.

- Local Heat & Energy Efficiency Strategies in use at a local level, creating a strategy to guide investment in energy efficiency and heat decarbonisation. Led by local authorities, working closely with their communities, this will set out a long-term prospectus for investment in new energy efficiency, district heating, and other heat decarbonisation programmes.
- Communities empowered wherever possible to develop and commission local energy system plans where they are the full or part owners of the final scheme.
- All local projects encouraged to use existing energy infrastructure before developing projects with new transmission or distribution requirements.

These principles will support and promote the following outcomes:

- Systems designed and developed in line with local need;
- Active, energy efficient consumers (both residential and non-residential);
- Lower annual energy bills; and
- Opportunities for local supply chains and investment in local businesses.

Solar PV array on the Isle of Eigg, Inner Hebrides; part of a community owned renewable electricity system on the island.
(Credit: Highlands and Islands Enterprise)

LOCAL ENERGY PLANNING

The Scottish Government is committed to developing strategic approaches, based on locally distinctive needs, opportunities and priorities. This includes consulting on a new statutory framework for Local Heat & Energy Efficiency Strategies (LHEES).

Led by local authorities working closely with their communities, this will provide opportunities for communities to not only develop their own energy projects, but also to have their voices heard in the planning processes for energy developments.

The Scottish Government has already supported local authorities to develop strategies for district heating infrastructure through the Heat Network Partnership Strategy Support Programme, using tools such as Scotland's Heat Map[22]. We are also supporting the voluntary approach to LHEES through the SEEP Phase 2 pilots, with 11 local authorities receiving support in piloting LHEES development from 2017-19, as part of a capacity support programme.

Local authorities and city regions will have an enhanced role in this strategic approach – helping to deliver new investment and to manage the local challenges of decarbonisation. We expect Local Heat and Energy Efficiency Strategies to inform, and be informed by, the development plan for the area.

22 Scotland Heat Map: http://heatmap.scotland.gov.uk/

SYSTEM SECURITY AND FLEXIBILITY

SCOTLAND SHOULD HAVE THE CAPACITY, THE CONNECTIONS, THE FLEXIBILITY AND RESILIENCE NECESSARY TO MAINTAIN SECURE AND RELIABLE SUPPLIES OF ENERGY TO ALL OF OUR HOMES AND BUSINESSES AS OUR ENERGY TRANSITION TAKES PLACE.

Scotland enjoys a supply of energy from a range of indigenous sources, and has the potential to generate much more. We expect our energy system to change considerably over the period set out in this Strategy.

Our continuing efforts to reduce demand will affect the amount of electricity and gas we consume. But the possible electrification of heat and transport on a large scale could place much greater demand on the renewable electricity sector, on other forms of low carbon or cleaner generation, and on our grid.

Renewables will play a huge part in meeting our future energy needs. But there will be roles too for other sources and technologies – for thermal generation with carbon capture, for pumped storage hydro and other forms of storage, and for smarter, more interconnected networks.

The Scottish Government has always worked closely and effectively with the UK Government, Ofgem, National Grid and Scotland's grid operators and generators on matters of energy and system security. This will remain hugely important as we move to a low carbon, decentralised system.

SYSTEM SECURITY AND FLEXIBILITY (ELECTRICITY)

Scotland needs a balanced and secure electricity supply. That means a system and a range of technologies which provide sufficient generation and interconnection to meet demand. It means an electricity network which is resilient and sufficiently secure against any fluctuations or interruptions to supply.

For example, efficient and flexible gas-fired generation is a natural complement to a high renewables future – especially when fitted with CCS technology. Gas-fired generation can be scheduled and controlled, meaning that it can be instructed to power up or down depending on rising or falling demand. It provides "inertia", helping to maintain a stable frequency across the network and increasing its resilience.

These attributes have a strong locational value, as the network benefits from having this synchronous generation spread across the network. However, this locational value is not sufficiently reflected in existing market and regulatory mechanisms.

We believe that a more strategic approach which takes this locational value into account, and which supports controllable thermal generation in each region of the country, would be in the best long-term interests of consumers in Scotland and across GB.

That needs market mechanisms and incentives which provide a sufficient and fair incentive to maintain – or to invest in new – efficient, controllable generation in Scotland.

This means looking again at the full set of current market and regulatory arrangements including the Capacity Market, which is reserved to the UK Government, network access and charging arrangements, and balancing services.

Investors in facilities connecting to the electricity network face a range of costs and opportunities. We need to ensure that the various market and regulatory arrangements, together, do two things – incentivise choices that lead to lowest energy costs to end consumers, and remove barriers to the offering of services that contribute to security of supply.

Achieving this needs long-term contractual arrangements that give investors confidence, that allow comparisons between different technologies, and that place sufficient value on security of supply and resilience – both for the GB system as a whole, and in each region.

Pumped Storage Hydro

This approach would also provide a stronger opportunity for more large scale pumped storage hydro (PSH). Scotland already hosts PSH facilities, at Cruachan and Foyers. These stations can store large amounts of power, releasing that energy when demand on the system is high.

We believe that investment in new PSH capacity in Scotland could greatly enhance the flexibility and resilience of our electricity network and power supplies. These are major infrastructure projects, with considerable economic and industrial value attached.

The Scottish Government believes that more can be done to reduce the risks and remove the barriers to the major investments required to deliver these developments. We will continue to work with the developers and with the UK Government to find a fair and reasonable solution which supports their build.

Smart, flexible networks

The electricity market is evolving, reflecting changes in technology and in our expectations and behaviour as consumers – a process which smart meters and smart appliances are accelerating.

New approaches are being developed, which take into account the extent to which our local networks – designed to accept power transfers from the high voltage network, and from a relatively small number of large generators – are now increasingly home to myriad forms of small and micro generation.

There are also new ways to store electricity and to manage the times at which we choose to use it. The UK Smart Systems and Flexibility Plan[23], published in July 2017, looks at the issues and potential benefits connected with this shift, and some of the actions necessary to realise these. Its scope includes steps to enable smart consumers, markets and businesses, and how to support more flexibility across the system.

These are common issues and opportunities; the Scottish Government will continue to work with the energy sector, with Ofgem and with the UK Government to ensure that Scottish consumers, businesses and other energy users are able to benefit from the necessary and relevant changes.

Electricity storage

The UK Smart Systems Plan includes a strong commitment to improving the prospects for and uptake of electricity storage. We are seeing remarkable growth and changes in storage potential and technologies – such as the availability and reducing cost of batteries which can help manage and control domestic demand, with much larger applications able to complement large scale renewable generators connected to higher voltage networks.

23 Upgrading our Energy System - Smart Systems and Flexibility Plan: http://www.ofgem.gov.uk/publications-and-updates/upgrading-our-energy-system-smart-systems-and-flexibility-plan

Electrolysers, which can provide an alternative form of energy storage in the form of hydrogen, particularly long-term or seasonal storage, are also becoming more efficient and less costly.

The ability to store power can help businesses and communities in areas where the network capacity is limited or weak – having reserve or stand-by power available can protect against temporary losses of supply. It also provides an opportunity to earn additional revenue through providing power and other related services to the grid.

The Scottish Government agrees that storage is a strategically important issue, with real potential benefits for Scotland. We will continue to support innovation and deployment in this area, and to work with energy sector and academic stakeholders on steps designed to accelerate its penetration and value across Scotland.

We are providing support for new and innovative storage solutions through the Low Carbon Infrastructure Transition Programme. For example, Nova Innovation will build and operate an energy storage solution for the Shetland Tidal Array[24] – a key aim of this project is to demonstrate the economic, technical and system benefits of Nova's combined renewable energy and storage approach, overcoming local grid constraints.

Nuclear power

We have confirmed the Scottish Government's continued opposition to new nuclear stations, under current technologies. The economics of these stations are prohibitive, especially given the falling costs of renewable and storage technologies.

We believe that the criticism directed towards the UK Government's support and long-term contract for the proposed station at Hinkley – on the grounds that it is risky, expensive, and a bad outcome for UK consumers – is wholly justified.

Our priority will continue to be to support energy efficiency, develop Scotland's huge renewable resource and to promote storage and flexibility. We are aware of increasing interest in the development of new nuclear technologies, such as Small Modular Reactors. We are duty bound to assess new technologies and low carbon energy solutions, and will continue to do so based on their safety case, value for consumers, and their contribution to Scotland's low carbon economy and energy future.

The UK Industrial Strategy focuses on nuclear decommissioning, and rightly acknowledges the expertise which exists across the UK. We will work with the UK Government to ensure that the proposed Sector Deal delivers meaningful support and benefits for Scottish businesses which are experienced and active in this area.

Interconnection

Scotland's security of supply, and our ability to export and import power when needed, is enhanced by our interconnection with other power markets and networks. Scotland's current and long-standing interconnections with England and Northern Ireland are good cases in point.

There are currently several UK interconnector projects at various stages of development. These include the NorthConnect cable that would enable renewable electricity to be traded directly between Scotland and Norway.

Ofgem's initial assessment of this project[25] has concluded that it is likely to benefit consumers, and that it could also improve our security of supply by providing access to a vast alternative source of renewable generation when required.

24 Nova Innovation's Tidal Energy Storage Demonstrator: http://www.novainnovation.com/lcitp

25 NorthConnect initial project assessment: http://www.ofgem.gov.uk/publications-and-updates/cap-and-floor-regime-initial-project-assessment-gridlink-neuconnect-and-northconnect-interconnectors

We will continue to work closely with NorthConnect, and consider in more detail its potential economic and supply chain benefits for Scotland, as well as its implications for investment in domestic capacity and security of supply.

SYSTEM SECURITY AND FLEXIBILITY (GAS)

Scotland's natural gas network consists of over 25,000 km of pipes, supplying energy to around 1.9 million consumers. It is designed to meet extreme peaks in heat demand, and is one of the most reliable networks in the world. The distribution network in Scotland is connected to the UK's National Transmission System, the high pressure network that transports gas from a range of sources across the country.

Security of energy supply and gas storage remains reserved to the UK Government. However, the Scottish Government will continue to engage closely with the department for Business, Energy and Industrial Strategy on resilience and security of supply in Scotland.

Our current supplies of gas come from a mixture of North Sea gas fields and imported supplies from pipelines within continental Europe, or from liquefied natural gas (LNG) from international markets. The production of natural gas from the North Sea is declining. By 2025, the UK is expected to be importing 67% of its gas from outside the UK.

LNG and Liquefied Petroleum Gas (LPG) play a crucial role in supplying energy to the Scottish Independent Undertakings (SIU's) located in Oban, Campbeltown, Wick, Thurso and Stornoway. These towns have separate networks which aren't directly connected to the main distribution networks but maintain the benefits of gas.

Heat accounts for 51% of the energy consumed by Scotland's homes and businesses, with 79% of Scottish households using mains gas as their primary heating fuel. These figures show the extent to which Scotland currently relies on natural gas.

Our commitment to energy efficiency, and the growth of more diverse heat networks, means that demand is likely to reduce; however, gas will remain an important part of Scotland's energy mix for the foreseeable future. Meeting this demand, and balancing the needs of consumers with a lower carbon secure energy system, will be a key challenge.

The shift to decarbonisation creates new possibilities for the gas network. It could provide a flexible asset able to transport and store a range of low carbon gases, including hydrogen, biogas, biomethane and bio-SNG (substitute natural gas). There are currently 13 biomethane sites in Scotland connected to the gas distribution network – producing enough gas to supply the equivalent of 85,000 homes – and there are more sites in development.

This could make an important contribution to reducing heat emissions, while having little impact on the way consumers use their appliances. It could also provide a useful role in electricity grid management, energy storage and the transport sector.

Some regulatory and market changes will be needed – most of which are reserved to the UK Government – in order to deliver a resilient, flexible and smart low carbon gas network in Scotland. The commercial viability of CCS will also have a bearing on the long-term role of gas.

OIL AND GAS INDUSTRY STRENGTHS

WE WILL SUPPORT INVESTMENT, INNOVATION AND DIVERSIFICATION ACROSS OUR OIL AND GAS SECTOR, WORKING WITH INDUSTRY TO ADVANCE KEY PRIORITIES SUCH AS MAXIMISING THE RECOVERY OF REMAINING RESOURCES, SUBSEA ENGINEERING, DECOMMISSIONING AND CARBON CAPTURE AND STORAGE – COLLABORATIVELY ADDRESSING THE CHALLENGES OF TODAY AND PREPARING THE SECTOR AND ITS WORKFORCE FOR A POSITIVE ROLE IN SCOTLAND'S FUTURE ENERGY SYSTEM.

OIL AND GAS

A strong and vibrant domestic offshore oil and gas industry will play an essential role in our future energy system, with the sector's expertise invaluable in supporting jobs and skills. Almost all scenarios confirm that oil and gas will continue to play a significant role for decades to come in meeting future global energy demand. Demand for gas in particular is expected to continue to rise until the middle of this century.

North Sea oil and gas production is highly-regulated, with some of the most advanced and comparatively least-polluting production methods in the world. Maintaining domestic oil and gas production can lead to lower net global emissions than under a scenario where Scotland depends more on imports. This is due to a number of possible imported crude oil sources having a higher carbon-intensity than Scottish production.

The latest Environmental Report published by Oil & Gas UK[26] also shows strong progress on carbon intensity, with North Sea oil and gas production increasing and greenhouse gas emissions from production continuing to fall. This is encouraging and provides a strong basis for the oil and gas industry to continue to reduce the carbon intensity of the global energy mix, and to explore new business models which increase the penetration of lower carbon technologies.

As the UK is now a net importer of oil and gas, a balanced approach where we reduce our reliance on imported fossil fuels, where practical to do so, can help reduce exposure to cost and supply fluctuations – minimising our vulnerability to security of supply risks. This is supported by analysis produced by the Committee on Climate Change under the UK's fifth carbon budget.

There are still significant opportunities in the North Sea, with up to 20 billion barrels of oil equivalent remaining – which could sustain production for at least another 20 years.

That is why we continue to support Maximising Economic Recovery from the North Sea. We will go on working constructively with the industry, to encourage new exploration in the North Sea and to enhance the capacity and competiveness of our world leading supply chain.

Oil and gas also has a role as a destination fuel within the power sector and heavy industry – for use in CCS, for example, as well as heating and transport, through conversion to clean hydrogen.

Expertise gained through 40 years' experience of operating in the North Sea, such as vital subsea skills, can help overcome the engineering and innovation challenges presented by moving to a low carbon future. For example, Scotland's oil and gas industry has developed a cluster of companies with expertise in underwater engineering which is among the strongest in the world. Approximately half of the subsea installations in the world today are in the North Sea. This is a strength that we want to build upon and develop even further.

26 Oil & Gas UK Environment Report 2017
https://oilandgasuk.co.uk/environment-report.cfm

We have an opportunity to extend those skills and knowledge into other sectors. We can do this by ensuring that the appropriate investments are made – into our supply chain to keep it competitive, and into our infrastructure to ensure that we have the appropriate research and testing. We also need investments into technologies applicable to both oil and gas and other subsea areas, including renewable energy[27].

The skills and expertise in our oil and gas sector could also assist other sectors in overcoming the technical and engineering challenges of our future energy system. So far, our Transition Training Fund has helped over 2,800 individuals, which is due to close in 2018-19, to retrain and secure new jobs or opportunities in the oil and gas sector and wider economy. We will continue to work with Skills Development Scotland to deliver this fund, keeping its focus on key opportunities within the Scottish economy.

OIL AND GAS DECOMMISSIONING

The Scottish supply chain is already capturing a large share of the value of the decommissioning contracts available and underway from some North Sea operators, from well plugging and abandonment through to onshore dismantling and disposal.

We are supporting investment in decommissioning capacity across Scotland – with in the region of £2.5 million likely to be allocated in this financial year through the Decommissioning Challenge Fund.

Our latest Programme for Government commits a further £7.5 million towards establishing a deep water port in Scotland which is compatible with the largest decommissioning vessels and highest value projects.

ALTERNATIVE HYDROCARBON RESOURCES

New and innovative ways of using hydrocarbons are already emerging, and will continue during the coming decades.

Rising demand for alternative hydrocarbon resources in the form of LNG (Liquefied Natural Gas), LPG (Liquefied Petroleum Gas) and CNG (Compressed Natural Gas) could potentially reduce emissions – especially when derived from bio-sources. The marine, power generation, industrial, road transport and residential sectors could all play a part in pushing up demand for these alternatives.

We support the uptake of these energy streams, where the current infrastructure is able to meet the expected growth in demand. Investment could support economic development, safeguarding and creating jobs in the energy sector.

The Scottish Government may choose in some cases not to support particular technologies or fuel sources. Underground Coal Gasification and Unconventional Oil and Gas (see box overleaf) are examples of this.

27 Subsea Engineering Action Plan: http://www.scottish-enterprise.com/knowledge-hub/articles/publication/oil-gas-subsea-action-plan

UNCONVENTIONAL OIL AND GAS

The Scottish Government has undertaken one of the most far reaching investigations of any government, anywhere, into unconventional oil and gas.

This work began in 2013 with the establishment of an Independent Expert Scientific Panel to examine the evidence on unconventional oil and gas, including hydraulic fracturing, or 'fracking', and coal bed methane extraction.

The Expert Panel reported its findings in July 2014. After carefully considering its findings, the Scottish Government introduced a moratorium on onshore unconventional oil and gas in January 2015. This created space to explore the specific issues and evidential gaps identified by the Panel, and to undertake a comprehensive period of public engagement and dialogue.

In early 2016, the Scottish Government commissioned a further suite of independent research reports to address the evidential gaps identified by the Expert Panel. The reports, covering health, economic and environmental matters (including analysis of climate change impacts), allowed for the consideration of further independent expert scientific advice, including from the British Geological Survey, Health Protection Scotland, and the UK Committee on Climate Change.

In January 2017 the Scottish Government launched a four-month public consultation on unconventional oil and gas, Talking "Fracking", which received more than 60,000 responses. Approximately 99% of responses who expressed a view were opposed to fracking.

Responding to the publication of the consultation responses in early October 2017, the Minister for Business, Innovation and Energy announced that the Scottish Government does not support the development of unconventional oil and gas in Scotland and that the Directions which gave effect to the moratorium in January 2015 will remain in place indefinitely.

In late October 2017, the Scottish Parliament voted overwhelmingly in favour of the Scottish Government's preferred position of not supporting unconventional oil and gas. The Scottish Government's preferred policy position will be subject to a Strategic Environmental Assessment. Once finalised, the policy on unconventional oil and gas in Scotland will also be reflected in the next iteration of the National Planning Framework.

Further information, including links to the parliamentary statements, the research reports, and the consultation responses, can be found at:
http://www.gov.scot/Topics/Business-Industry/Energy/onshoreoilandgas

HYDROGEN

Hydrogen is flexible, and could help to decarbonise heat and transport while providing wider energy system benefits. As it produces no harmful emissions at point of use, it can also help improve air quality.

It can provide many of the same uses as fuels such as gas and oil, and be transported by road or pipeline, potentially using re-purposed infrastructure. However, hydrogen does not exist naturally and must be produced from other energy sources. This production can be scaled from large centralised sites to local units, closer to point of use, with the energy transmitted by electricity or gas.

Hydrogen could also potentially deliver the lowest cost and least disruptive solution for decarbonising heat. Alongside green hydrogen (produced from renewables), the deployment of hydrogen at scale will most likely require large volumes of natural gas (methane) as a source feedstock.

Hydrogen also has a variety of industrial applications that can contribute to decarbonisation. For instance, it can be used with captured CO_2 (or CO_2 from biomass) to replace fossil fuels in the production of hydrocarbon-based chemicals such as methanol and transport fuels. It can also be used in the production of 'green' ammonia, which is used in the manufacture of fertilisers.

While markets are starting to develop on the back of progress and innovation to date, there is still much more scope to reduce costs and to make hydrogen a much more realistic prospect, improving access to emerging international markets.

We have supported several projects which demonstrate how hydrogen can be renewably produced, stored, and used when needed for local energy and transport. There is potential to replicate or scale up these projects.

The Scottish Government has worked with the UK Government and other partners to develop the 2017 Hydrogen and Fuel Cells Roadmap[28]. We remain committed to supporting further research and development in this area, including proposals by SGN to assess the viability of constructing and operating the first hydrogen distribution network in Scotland.

28 Hydrogen and Fuel Cells: Opportunities for Growth – A Roadmap for the UK: http://www.e4tech.com/wp-content/uploads/2016/11/UKHFC-Roadmap-Final-Main-Report-171116.pdf

CARBON CAPTURE AND STORAGE (CCS)

There is widespread international recognition that CCS will be essential to cost-effective climate policies – a position reflected in Scotland's draft Climate Change Plan.

Scotland's waters in the North Seas provide the largest carbon storage resource in Europe. Coupled with our existing oil and gas capabilities, ready supply chain, and existing pipeline and platform infrastructure, Scotland is one of the best-placed countries in Europe to realise CCS on a commercial scale.

The Scottish Government has been a strong advocate of the opportunities CCS could bring to Scotland, and has consistently supported its development, both as important decarbonisation infrastructure and as an industrial opportunity for Scotland. This is why we were concerned at what we regard as the short-sighted decision by UK Ministers to remove £1bn funding for CCS projects in 2015.

CCS is currently the only viable technology capable of mitigating industrial scale climate change in some of the most carbon intensive industrial processes – such as cement production, oil and gas processing and the production of aluminium, steel and ammonia. CCS would also be critical to unlocking the potential for large scale hydrogen production.

Scottish Government support has helped develop a world-leading academic and research reputation in CCS. We have also forged important international collaborations, both in the North Sea Basin and Guangdong Provence in China.

The Scottish Government is also supporting the innovative ACORN CCS project at St Fergus, near Peterhead. Building on past studies and with an emphasis on repurposing existing infrastructure, this aims to demonstrate a lowest cost, full chain CCS project that targets industrial emissions.

Carbon Capture Utilisation (CCU) could also help Scotland shift to a lower-carbon, more sustainable and circular economy through better management and re-use of its carbon. In doing so, it can also help create new, potentially lower carbon manufacturing processes and opportunities[29].

The UK Government has also renewed its commitment to Carbon Capture Utilisation and Storage (CCUS) in its Clean Growth Strategy, and has a set out a range of actions to support the cost effective development of these technologies, including establishing new leadership groups and allocating funding for CCUS projects.

The Scottish Government will continue to work closely with the UK Government, and the Oil and Gas Authority, to ensure that Scotland's priorities, opportunities and interests are reflected in this work – such as the preservation of critical infrastructure and the demonstration of CCS and CCU projects in Scotland.

29 Actions required to develop a roadmap towards a Carbon Dioxide Utilisation Strategy for Scotland: http://www.evaluationsonline.org.uk/evaluations/Search.do?ui=basic&action=showPromoted&id=606

ACORN CARBON CAPTURE AND STORAGE (CCS) PROJECT[30]

The Acorn CCS Project at St Fergus, supported by Scottish Government and EU funding, aims to demonstrate a lowest cost, full-chain CCS project that targets industrial emissions.

The project, currently at a feasibility stage, aims to stimulate an ambitious new pathway to securing CCS in Scotland, and targets the following milestones:

2020-2025 – Demonstrator project at St Fergus exemplifying the viability of full-chain CCS, at lowest cost;

2025-2030 – Pipeline investment to connect early adopted industrial emitters to north sea storage;

2030-2040 – Extend pipeline investment to enable UK-wide connection to Scottish storage, and bring online second phase industries, which could include the energy sector;

2040 onwards – Commercialisation/privatisation, with access opened up to storage on international market.

Port of Cromarty Firth (Credit: Highlands and Islands Enterprise)

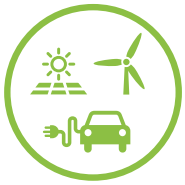
30 Acorn CCS Project: https://pale-blu.com/acorn/

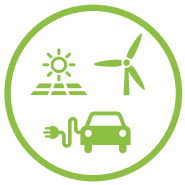
Near-term actions

The near-term actions relevant to each Strategic Priority are summarised below:

Strategic Priority	Scottish Government Actions
Consumer Engagement and Protection 	• Develop the aim to create a publicly-owned energy company that could be operational by 2021. • Further engagement on a publicly-owned energy company is planned for the end of 2018. • Develop an energy consumer Action Plan to look into consumer considerations in more detail across the energy sector. • Hold a summit of energy suppliers and consumer groups to address the needs of Scottish consumers. • Establish a Consumer and Competition Task Force made up of key stakeholders to tackle consumer issues generally – energy will be a priority theme. • Consult on the most effective way to implement newly devolved powers in relation to consumer advice and advocacy. • Put in place a robust and accessible framework of consumer protection as SEEP develops. • Deliver a Smart Meter Advice Project delivered through Home Energy Scotland to enable customers to make the most of the energy use data provided by their smart meters. • Fund a pilot project to examine how to extend the benefits of competition to vulnerable and disengaged consumers – with face to face advice and support for them to switch energy supplier or tariff. • Introduce financial health checks – addressing the poverty premium and helping people switch to the lowest tariffs.

Strategic Priority	Scottish Government Actions
Energy Efficiency (Buildings) 	• In May 2018, publish a SEEP Routemap and introduce the SEEP Transition Programme. • Continue our existing programmes as SEEP develops, including our national advice services (Resource Efficient Scotland and Home Energy Scotland) and financial support such as HEEPS loans, SME loans, District Heating Loans and Salix loans for the public sector. • Evaluate and monitor the SEEP Pilots to influence the final design of the SEEP programme.
Energy Efficiency (Industrial) 	• Continue to support business, industry and public sector collaboration through working with the enterprise agencies, SEPA and the Scottish Manufacturing Advisory Service. • Pool leadership and expertise from industrial sectors by working in partnership through a new Scottish energy intensive industries forum. • Build on our Manufacturing Action Plan and SEEP commitments by publishing a discussion paper in 2018 looking at a range of options to attract new investment in industrial energy efficiency or decarbonisation. • Work with the UK Government on the development of the new Industrial Energy Efficiency Scheme proposals announced under the Clean Growth Strategy.

Strategic Priority	Scottish Government Actions
Renewables and Low Carbon Solutions 	**Low Carbon Funding** • Establish a Low Carbon Innovation Fund, investing a further £60 million to deliver innovative low carbon energy infrastructure solutions. • Broaden the scope of REIF beyond renewables to include low carbon energy solutions as an Energy Investment Fund, and bolster its funding with up to £20 million made available in 2018-19. **Onshore wind** • Push for UK-wide policy support for onshore wind and take action of our own to prioritise and deliver a route to market. • Build on the positive and practical provision for onshore wind in our planning system under the next National Planning Framework and Scottish Planning Policy. • Implement the new Onshore Wind Policy Statement, which underlines the continued importance of this established, low cost resource. **Offshore wind** • Work with Crown Estate Scotland and Marine Scotland on new offshore wind opportunities, including floating offshore wind. • Continue to work with the sector, our enterprise agencies and other partners to increase the industrial and supply chain benefits for Scotland of development in our waters. • Contribute to UK Offshore Wind Sector Deal discussions between industry and the UK Government. **Local and small-scale renewables** • Review guidance on business models to support local energy projects. • Target specific support through non-domestic rates relief for community renewables, hydropower and district heating respectively. These will continue pending the outcome of reviewing plant and machinery rateability, as recommended in the Barclay Review. • Consider the role for solar and other renewable technologies under the forthcoming review of energy standards under Building Regulations, and the development of the next National Planning Framework.

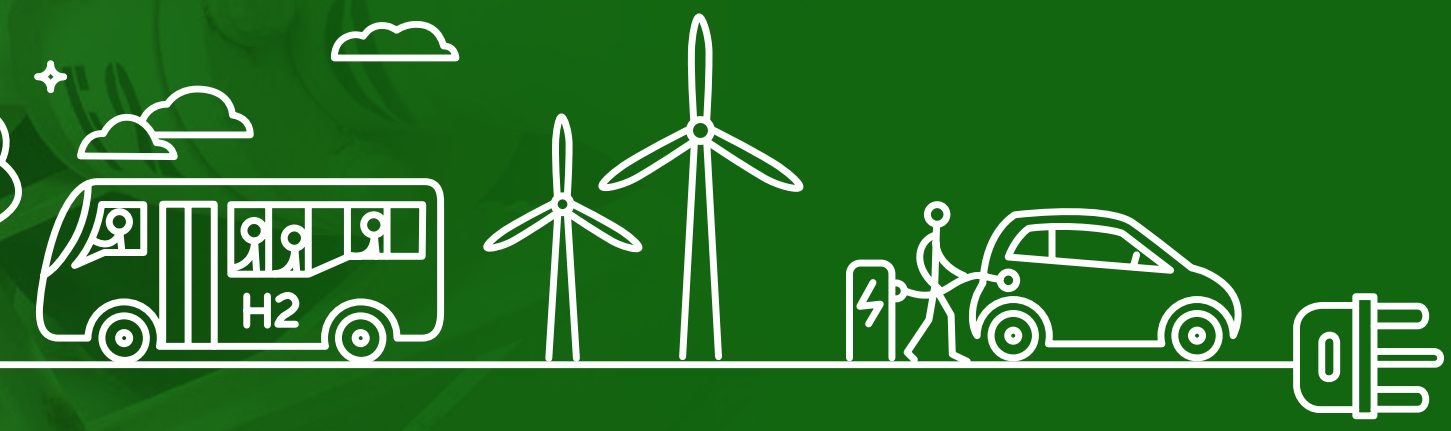
Strategic Priority	Scottish Government Actions
Renewables and Low Carbon Solutions 	**Bioenergy** • Conduct research to better understand the potential contribution of bioenergy to Scotland's energy demand (power, heat and transport fuels). • Work with stakeholders to develop a bioenergy Action Plan. **Marine energy** • Continue to champion the tidal and wave energy sector in Scotland. • Support Wave Energy Scotland with its internationally recognised research and development programme. • Work with the marine energy industry working group to agree the priorities for securing the future growth of the sector in light of changes in UK Government energy policy and EU exit. **Low carbon heat** • Continue to support the development of low carbon heat supply and heat demand reduction through our existing funding programmes (e.g. District Heating Loan Fund, LCITP), and the development of new funding programmes under SEEP. • Develop district heating regulation in Scotland to support investment and consumer protection, as outlined in our second consultation on Local Heat & Energy Efficiency Strategies and regulation of district heating. • Work with stakeholders to consider future support for low carbon and renewable heat, including discussions with the UK Government about Heat decarbonisation pathways and future support for renewable heat beyond the Renewable Heat Incentive. **Low carbon transport** • Take the lead in promoting the use of ultra-low emission vehicles (ULEVs) and phase out the need for new petrol and diesel cars and vans by 2032. • Introduce large scale pilots across the country, to encourage private motorists to use ULEVs and remove barriers to their use, working closely with Transport Scotland, network operators and others.

Strategic Priority	Scottish Government Actions
Innovative Local Energy Systems 	• Develop a Local Energy Systems position paper. • Continue to support local energy systems project through existing and future schemes (e.g. LCITP, CARES and Energy Investment Fund). • Disseminate and share learning from all projects supported so that others can learn from, develop and replicate. • Promote local energy systems that provide a credible low carbon alternative, and which are economically viable to operate in the longer term. • Develop Local Heat & Energy Efficiency Strategies with local authorities to provide a collaborative approach that allows local communities to play an active role in planning for low carbon systems. • Continue to support communities to develop, benefit from and own local energy systems where appropriate.
System Security and Flexibility 	• Continue to work in partnership with National Grid, network owners and other key partners on electricity security and system issues in Scotland. • Ahead of the relevant regulatory price control reviews, develop: ◦ a Scotland Electricity Network Vision statement, and ◦ a Scotland Gas Network Vision statement. • Collaborate with UK Government, Ofgem and others to deliver the goals in the UK Smart Systems and Flexibility Plan. • Continue to closely engage with SGN in their 100% Hydrogen pilot project.

Strategic Priority	Scottish Government Actions
Oil and Gas Industry Strengths 	**Oil and gas** • Continue to work constructively with the industry to encourage new exploration in the North Sea and enhance the capacity and competiveness of our world leading supply chain. • Support research and innovation through the Oil and Gas Technology Centre (OGTC). • Continue to work with Skills Development Scotland to deliver essential support through the Transition Training Fund (TTF). • Enhance the capacity of our decommissioning capacity and capabilities through the Decommissioning Challenge Fund and support for a deep water port in Scotland. **Hydrogen, CCS and CCU** • Establish new forums to help us work with industry and academia to advance and track progress on CCS , CCU and Hydrogen. • Continue to make support available for innovative hydrogen projects and trials. • Continue to commission evidence on the impact of technology, regulatory and market barriers to hydrogen and CCUS opportunities in Scotland. • Support the ACORN CCS project. • Continue our membership of the Global CCS Institute. • Continue to work with the UK Government and Oil and Gas Authority to progress Scottish CCS interests, including protecting existing critical infrastructure assets. • Build on our initial work carried out in 2017 to develop a roadmap towards a Carbon Dioxide Utilisation Strategy for Scotland.

Nigg Energy Park
(Credit: Highlands and Islands Enterprise)

4. SCOTLAND'S ECONOMIC OPPORTUNITY



The energy sector is the cornerstone of Scotland's modern, industrialised economy. It delivers reliable and secure energy to our homes and businesses, supports tens of thousands of jobs and generated £45.7 billion in turnover for Scotland in 2015[31].

VALUE OF THE ENERGY SECTOR TO THE SCOTTISH ECONOMY

Oil and Gas[32]

Scotland is estimated to be the **largest oil producer** and second largest gas producer in the EU on an internationally comparable basis.

2000+

2000+ companies supporting circa 115,000 Scottish oil and gas supply chain jobs in 2017.

£17.5bn

Oil and gas production estimated to be worth £17.5 billion to the Scottish economy in 2016/17.

£8bn

£8 billion of capital investment committed to oil and gas production from beneath Scottish waters in 2016/17.

Renewables & Low Carbon Technologies[33]

58,500

An estimated 58,500 jobs supported by Scotland's low carbon and renewable energy sector and supply chain in 2015.

£10.5bn

The Scottish low carbon and renewable energy sector and supply chain **generated a turnover of £10.5 billion** in 2015, accounting for 13.5% of the total UK turnover in this sector.

£910m

£910 million was invested in Scottish renewable generation assets in 2015.

£224.5m

Scotland's low carbon and renewable energy sector **generated £224.5 million of exports** in 2015.

31 Growth Sector Briefing – Energy: http://www.gov.scot/Topics/Statistics/Browse/Business/Publications/GrowthSectors/Briefings

32 Sources: Supporting Scotland's oil and gas supply chain companies: http://www.scottish-enterprise.com/knowledge-hub/articles/comment/oil-and-gas-supply-chain-support Oil & Gas UK Workforce Report 2017: https://cld.bz/qdp3Yat/4. Supporting Scotland's oil and gas supply chain companies: http://www.scottish-enterprise.com/knowledge-hub/articles/comment/oil-and-gas-supply-chain-support. Oil & Gas UK Workforce Report 2017: https://cld.bz/qdp3Yat/4. Survey of International Activity in the Oil and Gas sector 2015/16: http://www.scottish-enterprise.com/knowledge-hub/articles/insight/international-activity-accounts-for-over-half-of-oil-and-gas-sales

33 All figures taken from ONS Low carbon and renewable energy economy survey 2015: https://www.ons.gov.uk/releases/lowcarbonandrenewableenergyeconomysurvey2015?:uri=releases/lowcarbonandrenewableenergyeconomysurvey2015

Building on Scotland's Energy Strengths

Scotland has a well-established oil and gas sector and a proud engineering heritage. We also have enviable natural resources, which have provided the platform for the recent growth in renewable energy deployment.

Building on these strengths will help us deliver our goal of a modern, integrated, low carbon energy system, and support the delivery of the ambitions and priorities set out in Scotland's Economic Strategy (SES)[34].

Supporting continued **investment** in oil and gas exploration and production, and in renewable and low carbon solutions, will provide Scotland with the energy system we need for the 21st century. Energy research expertise and **innovation** in renewables and local energy systems will help our transition to a low carbon, sustainable economy.

Scotland's rich energy history and expertise will support greater **internationalisation** by strengthening our renewable supply chains and research dissemination. All of these actions will work towards our overarching aim of producing **inclusive growth**, with the benefits of this Strategy felt across a wide range of places and people in Scotland.

The Scottish Government is committed to building on Scotland's international reputation for excellence in energy, and to forging collaborative partnerships with other countries.

This Strategy is consistent with the key outcomes and ambitions of the Scottish Government's International Policy Statement[35] and Framework[36], which highlights 'Energy' as an area through which we can enhance Scotland's global outlook.

34 Scotland's Economic Strategy: https://beta.gov.scot/publications/scotlands-economic-strategy/
35 Scotland's international policy statement: https://beta.gov.scot/publications/scotlands-international-policy-statement-9781788514026/
36 Scotland's international framework: https://beta.gov.scot/publications/scotlands-international-framework-9781788514033/

Hywind Scotland Pilot Park construction (Credit: Roar Lindefjeld, Statoil)

Decommissioning of Buchan Alpha oil production vessel at Dales Voe, Lerwick Harbour (Credit: Highlands and Islands Enterprise)

Great Glen House, Inverness – The first BREEAM 'Excellent' office in the UK (Credit: Scottish Natural Heritage)

Oil and Gas

Scotland remains at the forefront of the worldwide oil and gas industry. Half a century of North Sea oil and gas exploration and production has created a hugely valuable Scottish industry, with internationally-renowned offshore engineering expertise. Our world leading supply chain now trades with over 100 countries.

In particular, Scottish expertise and skills in subsea engineering are globally renowned – and are regularly used in other sectors, such as marine and defence.

Our commitment to helping maximise economic recovery from the North Sea will maintain Scotland's energy security throughout the energy transition. It will also mean our energy companies retaining the capabilities that will help them take advantage of future supply chain opportunities at home and allow further internationalisation within this sector.

Decommissioning

As the North Sea is a relatively mature basin, decommissioning on a significant scale will commence earlier than other basins – meaning that Scottish supply chain companies have the opportunity to build on their success and develop expertise which can then be exported.

The latest forecasts suggest that decommissioning in the UK Continental Shelf could be worth around £60 billion over the coming decades, with a forecast spend of nearly £17 billion in the next 8 years alone[37].

Nuclear decommissioning also represents huge opportunity for Scotland. There are more than 400 civil nuclear reactors across the world due to decommission[38]. Over 50 Scottish companies are already operating within the nuclear decommissioning supply chain, and doing so with a competitive advantage through their experience and involvement at Dounreay.

Renewable and Low Carbon Solutions

Renewable and low carbon solutions can enable new or emerging sectors to develop products and services for use in Scotland and around the world.

Analysis by the International Finance Corporation indicates that the Paris Agreement will help open up $23 trillion worth of opportunities for climate-smart investments in emerging markets between 2016 and 2030.

This is an area where Scotland has a history of innovation, where high investment is expected and where Scottish companies will be well placed to develop deeper ties with their international trading partners. The move to renewable and low carbon solutions is central to our ambitions of producing sustainable, inclusive growth.

Offshore Renewables

The offshore wind sector expects to invest up to £210 billion between 2016 and 2025, primarily in Europe[39]. This presents tremendous opportunities for the Scottish supply chain and manufacturers, building on Scotland's oil and gas expertise and experience, as well as major investment in port and harbour infrastructure.

Our reputation for innovation, as hosts to the Offshore Renewable Energy Catapult and the world's first floating offshore wind farm, also places Scotland on a strong footing.

37 UKCS Decommissioning – 2017 Cost Estimate Report: https://www.ogauthority.co.uk/media/3815/ukcs-decommissioning-cost-report-2.pdf

38 Operational and Long-Term Shutdown Reactors: http://www.iaea.org/PRIS/WorldStatistics/OperationalReactorsByCountry.aspx

39 Oil and Gas 'Seize the Opportunity' Guides – Offshore Wind: http://www.scottish-enterprise.com/knowledge-hub/articles/guide/seize-the-opportunity-offshore-wind

Workers in front of an AR1500 turbine, used in the world's flagship tidal stream project, MeyGen, in Scotland's Pentland Firth (Credit: Highlands and Islands Enterprise)

Scotland's outstanding natural resources, and our decades of offshore engineering experience, make us a hugely attractive prospect for marine renewables. The Scottish Government has done more than any other nation to support the development of these technologies.

Orkney hosts not only the world's first grid-connected wave and tidal test centre (the European Marine Energy Centre) but also the world's largest tidal turbine (ScotRenewables), whilst the Pentland Firth is home to the world's largest planned tidal stream array (MeyGen).

Onshore Wind

Onshore wind is another key component of the big industrial opportunity that renewables create for Scotland. The sector supports an estimated 7,500 jobs in Scotland, generating more than £3 billion in turnover in 2015[40].

Our businesses have developed real strengths across the whole supply chain – in project development, civil engineering, and operation and maintenance. Campbeltown is also currently home to the UK's only wind turbine tower fabricator.

Energy Efficiency

Scotland's capabilities in architecture and design provide a natural advantage in the low carbon buildings sector. Scotland's Energy Efficiency Programme offers a huge opportunity for construction and energy systems technologies companies, with low carbon building technology sales in Scotland forecast to be worth £1.9 billion by 2020[41].

40 ONS Low carbon and renewable energy economy survey 2015: https://www.ons.gov.uk/releases/lowcarbonandrenewableenergyeconomysurvey2015?:uri=releases/lowcarbonandrenewableenergyeconomysurvey2015

41 Construction – Low Carbon Opportunities in Scotland: https://www.scottish-enterprise.com/knowledge-hub/articles/insight/construction-low-carbon-opportunities-in-scotland

Emerging Energy Opportunities

The areas explored above constitute a huge prize for Scotland. But there are other opportunities which we are well placed to exploit.

Our economic development agencies have several programmes and partnerships in place to support energy innovation. These have led to major investments, designed to support key infrastructure projects and companies, and to help Scotland exploit these emerging opportunities.

Energy System Technologies supporting Innovative Local Energy Systems

Energy System Technologies (ESTs) span the management, transfer, storage and transformation of energy. Global spend on ESTs could amount to around £70 billion between 2018 and 2020, with about half occurring in Europe, presenting opportunities for Scottish companies to gain a foothold in this market.

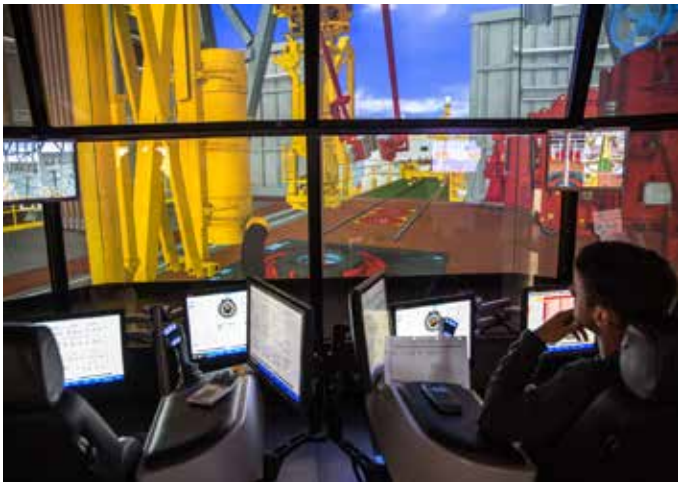
Scotland has strengths in knowledge provision, digital platforms, sensors, controls and security, engineering services and power electronics. We also host facilities such as the Power Networks Demonstration Centre (PNDC) – a world-class establishment, designed to accelerate the adoption of new, smart technologies within advanced power grids.

The shift to smart, flexible networks, already underway, will also demand and depend upon the continuing development of systems and technologies which can store power and help to manage increasingly decentralised electricity grids.

Scotland is already developing local energy solutions, in line with the Scottish Government's place-based approach to inclusive growth. These are mainly in Island communities and other rural areas, with innovative methods of energy storage helping to manage grid constraints.

Surf 'n' Turf hydrogen electrolyser, Orkney (Credit: Colin Keldie)

Aberdeen hydrogen bus project (Credit: Transport Scotland)



The DART® simulation suite at Robert Gordon University (Credit: Scottish Enterprise)

Our Low Carbon Infrastructure Transition Programme can help demonstrate and improve innovative local energy systems, creating an opportunity for Scotland to lead in developing, deploying and exporting these solutions. Scotland's development agencies will continue to support companies working and innovating in this field.

Carbon Capture and Storage and Carbon Capture and Utilisation

Carbon capture and storage (CCS) in depleted North Sea oil and gas reservoirs could be hugely important to our energy future, with opportunities to repurpose infrastructure and draw on Scotland's extensive expertise in the offshore sector.

Carbon capture and utilisation (CCU) refers to the reuse of CO_2 captured from industrial processes or power generation to create premium chemical products. This has been identified as an increasingly important market for Scotland's chemical industry. When coupled with green hydrogen, this could include the manufacture of renewable transport fuels.

Both opportunities would use existing Scottish supply chain strengths in chemicals and oil and gas.

Low Carbon Transport

The turnover for Scottish companies involved in the transport sector is around £2 billion per annum[42]. Our target to phase out the need for new petrol and diesel vehicles by 2032 creates a raft of new opportunities for these companies.

We want to help maximise Scottish content in the UK vehicle supply chain, which manufactures 1.8 million vehicles and 2.5 million engines per annum.

There are also opportunities to develop niche transport applications in Scotland's rural and island communities – given Scotland's existing bus and ferry manufacturing capability, hydrogen's compatibility as a fuel for these heavy duty cycle vehicles, and because the refuelling infrastructure is greatly simplified as the vehicles operate constrained routes.

Digital Energy

Digital technologies and skills will continue to transform and disrupt markets, with new, data-driven business models and platforms based on a better-improved understanding of customer and market behaviour. The growth of innovative local energy systems presents an opportunity for Scottish businesses to develop new ways to trade energy.

Scotland has rich potential in these areas, with a growing digital economy and particular capabilities in areas such as data science and informatics. We have around 150 businesses delivering value from data and employing over 5,500 people.

We believe that Scottish technology developers and businesses are well equipped to deliver the software, systems and innovations that smarter homes, appliances, vehicles and networks will demand. All these innovations have significant export potential.

42 Data science in Scotland: www.sdi.co.uk/knowledge-hub/articles/insight/data-science-in-scotland

Hydrogen/Fuel Cells

Scotland already has several hydrogen projects. The hydrogen buses in Aberdeen, hydrogen refuse trucks in Fife, and the Surf 'n' Turf hydrogen project in Orkney, have all attracted international interest.

Our natural resources, and our geography, mean that fuel cell buses and ferries have great potential. Fuel cells can also help provide backup or prime power, particularly in remote areas.

A range of industrial applications for hydrogen are in use or emerging that could help displace high carbon inputs to production processes, including in the manufacture of fertilisers and petrochemicals, and in refining and steel production. These applications have the potential to improve energy productivity whilst enhancing approaches to the circular economy.

Scotland's considerable renewable generation capacity could be used to produce hydrogen, or ammonia, and help balance networks, support local energy models, and decarbonise our heat and transport systems. International markets are also emerging as demand grows for flexible energy system technologies.

There is also potential for other forms of fuel cell, for example, a hybrid combined heat, power and cooling fuel cell is being installed at the new Aberdeen Exhibition and Conference Centre, which uses a combination of mains gas, grid electricity and biomethane.

Realising the Economic Opportunity

We intend to continue the work that we have been doing with businesses in Scotland – helping them use their experience, adaptability and willingness to diversify in order to become more competitive, and to deliver sustainable, inclusive, economic growth.

We can increase growth and competitiveness across the energy sector by developing leadership and entrepreneurial capability – equipping companies to manage change, realise opportunities and increase productivity.

The newly established Enterprise and Skills Strategic Board will improve this capability by co-ordinating the activities of Scotland's enterprise and skills agencies (Scottish Enterprise, Highlands and Islands Enterprise, Skills Development Scotland and the Scottish Funding Council).

Stimulating Investment

The Scottish Government and its partners have used initiatives such as LCITP, REIF and others to attract and stimulate interest and private sector investment across a range of renewable energy projects and companies, including at community level.

Our £500 million Scottish Growth Scheme will target high-growth, innovative and export-focused small and medium-sized enterprises (SMEs). It aims to stimulate more than £200 million of investment to help businesses grow via the Scottish-European Growth Co-Investment Programme and the SME Holding Fund – which, alongside additional private sector investment, we expect to provide over £100 million to innovative, high-growth companies.

The establishment of a Scottish National Investment Bank, announced in the recent Programme for Government, will provide an important resource for the Scottish economy. The Bank will be a key partner for Government and business, through the provision of patient long-term capital, supporting our Economic Strategy and this Energy Strategy.

The Bank will provide and catalyse investment – creating opportunities for Scotland, increasing innovation and accelerating the transformation to a low carbon, high-tech, connected, globally-competitive and inclusive economy.

Supporting Research and Innovation

Research and innovation are fundamental drivers of sustainable growth and long-term competitiveness, and lie at the heart of Scotland's Economic Strategy.

In Scotland, we have world-class research and innovation strengths, with facilities such as the Oil & Gas Technology Centre, European Marine Energy Centre, Edinburgh Centre for Carbon Innovation, the National HVDC Centre, and the Power Network Demonstration Centre.

The Scottish Government, along with the Scottish Funding Council, currently supports the Energy Technology Partnership (ETP.) This is the largest power and energy research partnership in Europe, and supports R&D capability across a range of technologies. The ETP has recently begun a new programme to support the recruitment of PhD students undertaking research related directly to the key themes within this Strategy.

We will continue to support the work of these and other centres and innovators – in particular those operating at UK and European levels such as the UK Energy Research Centre (UKERC), the Energy Systems Catapult, the National Centre for Energy System Integration, the International Energy Agency and the International Renewable Energy Research Agency. Their continuing success in analysing whole energy system change, and proving and scaling new technologies and processes can help reduce energy costs and provide huge commercial opportunities.

We will also support research and development activity within businesses – for example by increasing Scottish Government funding for new business research and development projects by 70%, with an additional £45 million to be invested over the next three years.

Strengthening Supply Chains

Scottish businesses have developed real strengths across the whole energy supply chain, including in project development, civil engineering, and operation and maintenance.

Renewable power delivers so many benefits for Scotland, none more so than the economic and industrial potential. Scottish yards and docks, new and established businesses, manufacturers and suppliers, engineers and innovators. From the production and assembly of huge towers and jackets, to the installation and maintenance of community and household developments, Scottish yards and docks, new and established businesses, manufacturers and suppliers, engineers and innovators, have grown into the renewables opportunity.

We are determined to continue to harness this potential – to support as much Scottish industrial, developmental, innovation and supply chain activity as possible as we continue to exploit the onshore and offshore renewables potential that will power all of our futures.

The Scottish Government will pursue activities with developers which will secure the full benefits of the low carbon transition and establish economic activity here. We will do this through the full suite of powers at our disposal.

Creating New Business Models

Digital technologies and techniques – such as the capture and application of "big data" to create or improve products and services – are already transforming sectors across the economy.

This is happening in the energy sector too, reflected by the move from passive to more active energy systems and consumers. For example, heating systems which respond to a user's location or remote commands, or smart devices which can operate when demand and prices are low.

Scotland's Digital Strategy[43] sets out our determination to anticipate and react, in an agile way, to the ever-changing opportunities of the digital age.

Our Circular Economy Strategy[44] maps out opportunities and actions to reduce unnecessary waste in the energy system, and across the wider Scottish economy. The circular economy approach is already having an effect in the manufacturing sector, with more thought given to the use and re-use of materials in manufacturing processes.

Developing Necessary Skills

Scotland already has many of the skills in engineering, construction, information technology and chemical science, that will speed our transition to a low carbon energy system. Our research and postgraduate education remains world leading.

Skills Development Scotland (SDS) works extensively with employers, colleges, universities and other partners to develop new work-based learning frameworks, and to match initiatives and investment with future demand.

We are determined to maintain a pipeline of suitably-skilled people. We will do this by working collaboratively, through a responsive system that can anticipate future skills needs, and the opportunities and challenges which new technologies and business models present.

Our STEM Education and Training Strategy[45] offers a comprehensive plan designed to improve science, technology, engineering and mathematics across the education and training landscape. It will ensure that more young people have access to inspiring science events and activities through Scotland's science centres and festivals. We will also develop a Scottish Young STEM Leaders programme to grow and spread inspiration and enthusiasm for STEM, starting in the early years.

Boosting Inclusive Growth

Inclusive growth is our highest strategic priority. This means helping establish businesses, workplaces, workforces and places which are fairer and more creative in their growth and development.

This Strategy, with its focus on improving energy efficiency and consumer engagement and protection, seeks to address inequalities that are exacerbated by high energy prices and barriers to improved market access for certain vulnerable groups in society.

The Scottish Government supports a holistic energy system, where treating consumers fairly is viewed as an important economic outcome for businesses and society alike. Empowered consumers, acting within a system of fair competition, support inclusive and sustainable growth in our economy, enabling businesses to innovate and grow in response to consumer need. This also creates an environment where businesses can have confidence that doing the right thing will be rewarded, and that unlawful or poor business practices will be tackled.

43 Realising Scotland's full potential in a digital world – A digital strategy for Scotland: http://www.gov.scot/Publications/2017/03/7843

44 Making Things Last: A Circular Economy Strategy for Scotland: http://www.gov.scot/Publications/2016/02/1761

45 Science, Technology, Engineering and Mathematics – Education and Training Strategy for Scotland: http://www.gov.scot/Publications/2017/10/1386

Inclusive growth, particularly in our most fragile rural areas, depends on strong communities and on creating the conditions for successful businesses to thrive.

Community-owned renewables projects generate income, which communities can re-invest. This has the potential to create jobs, deliver local services and increase population as a result. Increasing the level of shared ownership of energy projects can play a big role in this process.

As our energy system changes, the jobs market will change too. Energy employment may become more spread out across Scotland rather than concentrated in areas where major energy producers or power plants are located.

Low carbon investments may therefore provide an opportunity for more balanced regional development within Scotland. Smaller businesses across Scotland – and in particular those in rural locations – will benefit from engaging in growing markets for local energy systems, renewable energy, energy efficiency and low carbon heat and transport solutions.

Cultivating Regional Partnerships

The creation of new Regional Economic Partnerships, delivering city-region and regional growth deals across Scotland, will be a key driver of inclusive growth, taking cognisance of the variety of natural assets across the country.

Regional Economic Partnerships bring together local authorities, enterprise agencies, the private sector and education and skills providers to create coherent regional economic strategies and plans.

This means harnessing all of our natural, and human, resources at the regional level. Using Regional Economic Partnerships to align national and local priorities, and to maximise the impact of public resources through combining with private sector investment, can multiply the value of energy projects to communities.

Supporting Internationalisation

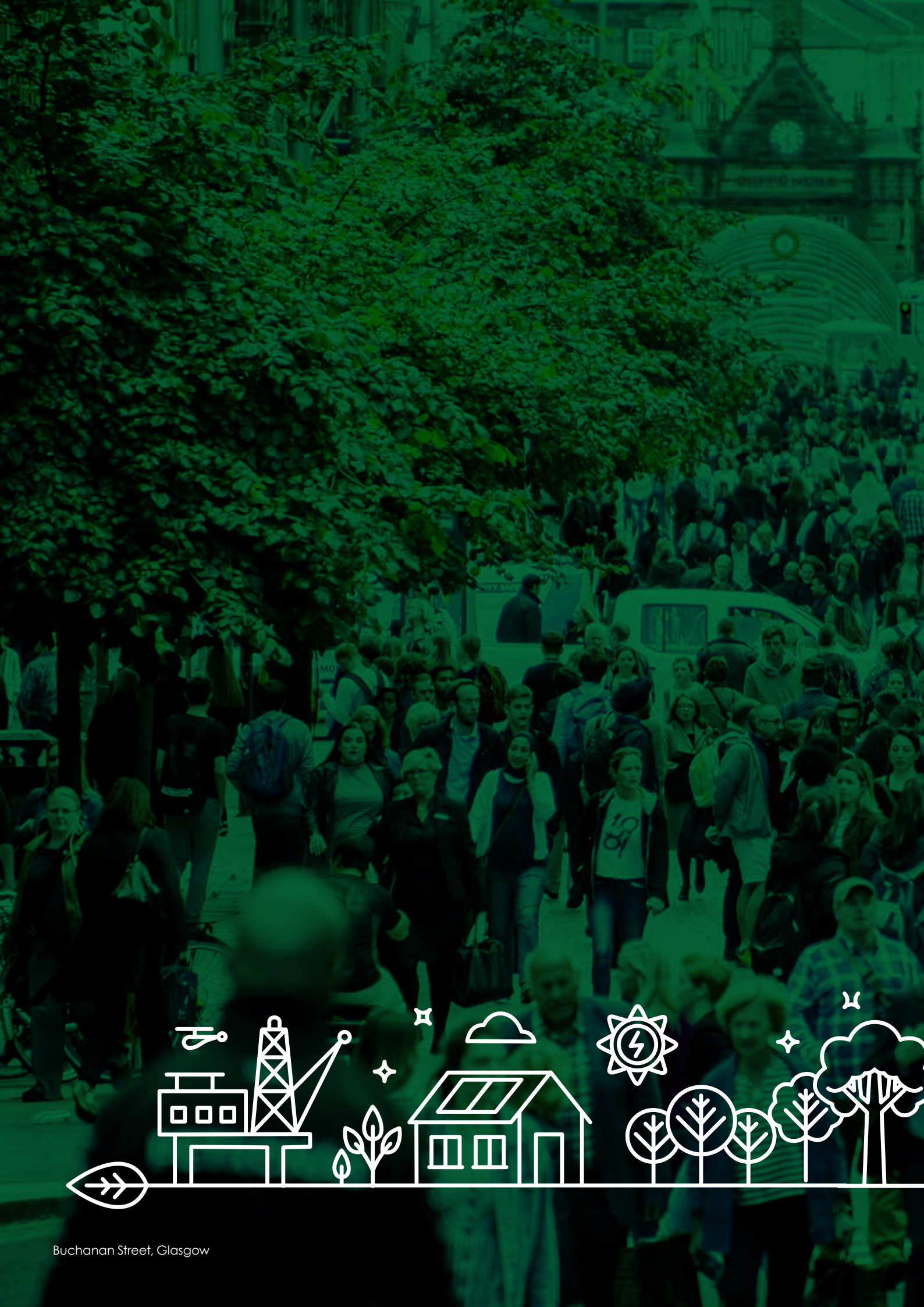
Scotland's energy companies are already highly successful in the international marketplace, with Scottish energy exports worth £16 billion in 2015.

Strengthening our focus on overseas opportunities can help attract new investment into Scotland, creating more opportunities to strengthen our renewable energy supply chain.

We are establishing a network of Trade Envoys to champion Scotland's export interests and strengthen our market intelligence capacity. We are adding to our Innovation and Investment Hubs in London and Dublin by establishing hubs in Berlin and Paris, maximising opportunities in France and Germany, while developing our existing presence in Brussels into a hub.

Our enterprise agencies will work with more companies than ever, helping them to export more of their products and services. For example, Scottish Enterprise and the Nippon Foundation in Japan will work together to invest in collaborative research and development projects related to subsea technology and innovation challenges. Scottish companies will apply their knowledge and expertise of the marine environment through a series of technology calls. Scottish Enterprise is working closely with Subsea UK and others to help deliver these calls, the first of which was announced in December 2017.

In addition, we have an opportunity to secure and exploit a position of global leadership for Scotland in relation to smart local energy systems. The Sustainable Islands International programme is a major new three year programme launched by the enterprise agencies and Scottish Development International. It will support companies working together to identify opportunities in international markets, and to develop innovative solutions to reduce carbon emissions, increase energy security and reduce costs to consumers.



Buchanan Street, Glasgow

5. MONITORING AND ENGAGEMENT

Deepening public engagement

We have learned a lot about public attitudes to energy issues from our public engagement during the past 12 months. Our public consultations on the draft Scottish Energy Strategy, the Climate Change Bill, Scotland's Energy Efficiency Programme and the Talking "Fracking" consultation have given us rich evidence and valuable insight into what matters to consumers and industry stakeholders alike.

People are becoming more active, informed and vocal about energy issues, and want to engage with policy makers on low carbon topics. The transition to a low carbon energy system is as much a social challenge as it is technical – that means finding a way to meaningfully involve wider society in the conversation and process.

Research commissioned and published by ClimateXChange earlier this year explores current evidence on Scottish public values and attitudes towards energy system transformation[46].

The UK Energy Research Centre (UKERC) has recently mapped wider UK public engagement with energy, showing the extensive and diverse ways in which citizens are engaging with the energy system[47].

This kind of insight is essential to finding the best ways to reach and inform wider audiences, and the best range of communication tools and channels to use.

We need to review and learn from related initiatives undertaken by government, business, academia and civil society. This will help to ensure we develop an engagement plan for this Strategy that reflects the best ideas and practices in play, and which is as effective as possible.

Government can't do this alone. We need to work and communicate effectively with the public, with communities, with all stakeholders – to raise awareness, and to be direct, fluent and persuasive about the benefits and impacts of changing our behaviours.

We will work with our partners to consider and to find new ways to widen out this conversation on our low carbon transition, and to involve the wider public much more effectively in the issues addressed by this Strategy.

We will be flexible, adapting our public engagement on energy issues over time. Our objectives are to:

- **raise awareness** and improve understanding of the choices, opportunities and challenges facing Scotland as we move towards decarbonising the energy system;
- encourage a **greater sense of ownership** and control amongst communities and individuals as consumers, producers and investors in their energy system; and
- improve the design of our programmes and initiatives by finding **better ways to share ideas**, and listening to and feeding in the views of the public in designing policy.

46 C. Demski and N. Pidgeon, Public Engagement with Energy System Change in Scotland: http://www.climatexchange.org.uk/files/3914/8916/2826/Public_engagement_with_energy_system_change_in_Scotland.pdf

47 Jason Chilvers, Helen Pallett and Tom Hargreaves, Public Engagement with Energy: broadening evidence, policy and practice. http://www.ukerc.ac.uk/publications/public-engagement-with-energy.html

Our approach will consist of three core components:

INFORMATION SHARING AND AWARENESS RAISING
We intend to do all that we can to inform the public about the choices available to us all when it comes to decarbonising the energy system. Our goal is to make those choices together.

As we move forward to the delivery stage of both this Strategy and the Climate Change Plan, we will develop an engagement framework on low carbon behaviours, to support the move to the low carbon economy over the coming decades.

We will use digital platforms to make information and data accessible and open. Our Digital Strategy will shape and inform our approach.

LOCAL CONVERSATIONS
We will encourage and support communities to hold local conversations about local energy systems. We want stakeholder organisations to engage with local communities, to share ideas and good practice with each other.

We are also continuing with 'Climate Conversations'[48] to engage the wider public in discussions about climate change and transition to a low carbon future.

CONSULTATION AND DELIBERATION
We will combine the strengths, capacities, skills and ideas of communities, industry, and other stakeholders. We will do this through much more effective and meaningful consultation, using a range of tools, methods and platforms to involve people in the decisions that affect them.

Monitoring the Scottish Energy Strategy

This Strategy is designed for the long term – with the flexibility to respond to developments in energy technologies and changes in consumer behaviour in the coming decades.

That means continuing to monitor our progress, and adapting our policies to ensure they continue to support the long-term vision set by the Strategy.

The Scottish Government will publish an **Annual Energy Statement** which sets out:

- the latest energy statistics;
- the progress made towards existing targets and the new 2030 targets;
- developments under each the six Strategic Priorities;
- changes within the UK energy market and international frameworks; and
- an assessment of technological changes and advances with a bearing on Scotland's energy system.

The Annual Energy Statement will take account of the Climate Change Plan monitoring framework and the relevant energy indicators.

The Scottish Government will also update the Remit of the Scottish Energy Advisory Board (SEAB) to take account of this Strategy's themes and strategic priorities. This will give the Board a wider perspective and support the delivery of this Strategy.

SEAB will be closely involved in the publication of the Annual Energy Statement, providing advice to the Scottish Government and Scottish Ministers on their approach to delivering the Strategy.

48 Supporting Climate Conversations: http://www.gov.scot/Topics/Environment/climatechange/lowcarbonbehaviours/publicengagement

This publication is available at **www.gov.scot**

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