

# Scotland's Future Energy Taskforce

## *A vision of the 2030 energy system*



*With more than half of energy consumption in Scotland decarbonised and significant economic and employment benefit from the investment, the success of a **system wide approach** can be seen. Strong Government leadership has driven the governance of the energy system so that coordinated whole system design, regulation, investment and operation is clearly evident at local and national levels, as well as across large and small scale developments.*



***Individuals and communities** have broader options for how they engage with their energy provision, ownership and use. Developments in energy systems, regulation and policy design have improved social equity in access to, and affordability of energy. Improved air quality is showing benefits in health and well-being.*



*Energy use for space **heating in buildings** is significantly reduced thanks to strong regulation which ensures that all new buildings are built to zero carbon standards, underpins incentives for energy efficiency investment in existing buildings, and is driving a long-term investment programme in low carbon heating solutions.*



*The majority of new **cars and vans** purchased are based on electric drives, powered by a variety of low carbon energy sources. A shift has occurred away from private vehicle ownership and usage towards public and shared mobility services as well as to walking and cycling. Heavy vehicles are increasingly low carbon.*



*Scotland now generates more **electricity** from low carbon sources than it uses, maximising natural resource benefits and the synergies from trading reduced carbon intensity, security of service, flexibility and resilience across the GB system and beyond.*



***Industry** is managing the transition and adapting to a shift away from traditional energy sources by showing leadership in low carbon technology development, like CCS, reducing energy waste, converting to lower carbon energy sources and taking advantage of related business opportunities nationally and internationally.*

## 1 Purpose of this paper

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The Scottish Government is committed to producing a new energy strategy and Climate Change plan. The goals set through international commitments in respect of decarbonisation are, seen from today, extremely challenging but also, according to strong, evidence-based scientific consensus, necessary. The year 2030 will be an important staging point in progress towards 2050 targets, but the window of opportunity to influence a steady and deliverable trajectory towards and beyond 2030 is limited, so decisions are required in this Parliament, especially where outcomes depend on major infrastructure development and investment, or involve changes which impact on a large number of individuals. To help inform this process, WWF Scotland has convened a group of energy experts who, in this paper, have formulated a vision for what a decarbonised Scotland should look like by 2030, as well as set out the principles that should be applied to the choice of pathways, and a set of policy recommendations to help deliver the transition.

## 2 Background

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There can be no doubt that a shift away from fossil fuels and towards low carbon energy is underway in most countries, with global emissions levelling off over the past two years and renewables accounting for 90% of new electricity generation investment globally in 2015. The pace of developments is likely to be accelerated by the Paris Agreement which entered into force in November 2016. This transition is exemplified in Scotland's electricity sector, where the last coal power station has now ceased operations and renewables are the biggest source of electricity production.

However, action both worldwide and in Scotland will need to increase considerably if climate change targets are to be met. New advice from the Committee on Climate Change (CCC) recommends that Scotland should accelerate its emission reductions, the delivery of which will require the energy system to play a major role. This will mean the continued decarbonisation of the power sector, but will also increasingly depend on reduced emissions from heat and transport, where the pace of change will need to quicken considerably. This will require vision, leadership, ambition and support.

Based on past experience, a major task like energy system decarbonisation will not be achieved on a piecemeal and incremental basis. It will be necessary to have a strong vision of what is to be created, and a shared narrative of what is needed, what future decisions may be required and how objectives should be realised, i.e. what the rules, standards and support for delivery should be. Reinforcing this through regulation in the form of obligations as well as product and performance standards can be very effective, both in terms of physical delivery and cost efficiency.

### 2.1 Focus on Scotland

There are aspects of energy and climate change policy that will be decided at an international or UK-wide level although Scotland may still influence these outcomes to varying degrees. However, it is important to focus attention on the many elements that can be determined in Scotland, i.e. where the Scottish Government and other Scottish authorities have, or will soon have, the powers to make the necessary decisions. This is particularly true for the influence of formal planning powers, housing policy, some aspects of heat and transport, as well as for increasing areas of tax and expenditure.

Consideration should also be given to an approach that capitalises on Scotland's particular strengths, like its natural and intellectual resources, and to one that is well matched to its wider social fabric. Since many developments will be regional, strong involvement of local authorities is also essential.

## 2.2 The targets

The Climate Change (Scotland) Act 2009 sets long term, legally binding targets for emissions reduction (of all greenhouse gases relative to 1990) of at least 80% by 2050. New climate targets have recently been passed covering the period 2028 – 2032, which will require a 61% reduction in emissions (on a net basis<sup>1</sup>) by 2030. The Scottish Government has also proposed a new Climate Bill that would move targets to a gross basis<sup>2</sup>.

Scotland has also set itself targets for the share of energy production in the electricity, heat and transport sectors to come from renewable sources. There are good reasons for this – Scotland is almost uniquely well placed in the UK with regard to indigenous renewable energy sources which, as well as being low or zero carbon, can have additional benefits:

- **Security of fuel supply** – the use of local and mostly free energy sources reduces the geopolitical and economic uncertainties that have caused many previous crises;
- **Health and well-being** – it is estimated that up to 3,000 unnecessary deaths<sup>3</sup> per year in Scotland are the direct result of poor air quality from the combustion of fossil fuels;
- **Employment and economics** – renewable energy can bring high capital investment levels and enduring local economic and employment benefits. Paying for imported fuels is a drain on resources, which contributes little to the local economy.

## 2.3 Achieving energy system change

Achievement of carbon emission reduction targets will depend on a broad range of measures like demand reduction, renewables, other low-carbon technologies such as carbon capture and storage (CCS) for industrial and other uses, electric vehicles and heat pumps, as well as new and adapted forms of energy storage.

Delivering the changes that are needed to decarbonise the energy system on the scale envisaged will require large scale, long duration programmes that engage a great number of individual actors. It will not suffice to depend only on supply side measures that address relatively few, large scale developments. As well as depending on new ways to produce and use energy, achieving the objectives will require significant changes to existing network infrastructure as well as the development of new ones (e.g. vehicle charging and refuelling, district heating, CO<sub>2</sub> from CCS).

As an example of shared infrastructure with many users, networks nearly always sit 'outside the market' – the majority of existing energy carrying networks are owned and operated by regulated monopolies. This emphasises the need for a clear vision to guide timely investment and achieve a low cost of capital for these key enablers of change.

## 3 Progress to date

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In some areas, Scotland has already set a clear vision of what is needed to decarbonise the energy system and has made good progress in reducing greenhouse gas emissions by 39.5% up to 2014<sup>4</sup>, Progress in the energy sector towards this has resulted from a combination of:

- Reduced energy demand through energy efficiency improvements and economic factors (16% reduction between 2005 and 2013, although plateauing in recent years)
- Increased production of electricity from renewable sources (over 50% of demand by 2015)
- Fuel switching away from coal.

Developments have been less marked in other areas:

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<sup>1</sup> Net means emissions after adjustment for trading in the EU ETS.

<sup>2</sup> ie. counting all emissions in Scotland regardless of trading within the EU ETS

<sup>3</sup> Based on 10% of UK figures from the Committee of the Medical Effects of Air Pollution (2010)

<sup>4</sup> On the new gross basis

- Against the target of 11% by 2020, the share of renewable heat was around 5% in 2015 (even that is mostly due to historic wood combustion for domestic and industrial heat).
- Against a target of 10% by 2020, renewable transport remained below 4% in 2014. (NB since the UK Renewable Transport Fuel Obligation (RTFO) has now reached its maximum regulated level, no further progress is likely unless additional or alternative measures are introduced).
- As a result, Scotland's progress against its overall target of 30% renewable energy by 2020 has also been slow, reaching 13.1% in 2013 and on course to miss the 2020 level.

## 4 Components of the vision

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The key factor that is driving the transformation of energy systems in Scotland is climate change and the consequential requirement to reduce carbon emissions. Therefore, while this continues, any vision of the future energy system for Scotland and the transition towards it will have decarbonisation as a dominant characteristic. Importantly though, it must also recognise the need to maintain and improve other significant characteristics, like resilience, flexibility and affordability. To be sustainable, the transition to a new system must manage and reconcile any tensions, as well as achieve a balance between these and the central environmental driver of change, as well as other key factors and Government priorities, including investment, health and employment.

This will require a whole system approach which views and reviews the main sectors of heat, transport and electricity, the different scales of activity, the balance between national and local aspects as well as the variety of stakeholders involved. A whole systems approach helps build an integrated and balanced strategy for delivery which takes into consideration the interactions and aggregate effects each element can have on the others. A holistic perspective will better ensure that system-wide aspects are properly considered, and non-supply services like Demand Side Management, automation and aggregation as well as storage and interconnection are adequately valued.

The vision must be consistent with the overall direction set for 2050 of at least 80% reduction in emissions (against 1990 levels), and with the interim ambition recommended by the CCC for Scottish electricity sector emissions to be between 10 – 20 gCO<sub>2</sub>/kWh by 2030, and the Scottish Government's stated objective of "significant progress" in the heat and transport sectors. Measured against the recommendations of the CCC, "significant progress" could equate to further emissions reductions by 2030 of ca. 2Mt of CO<sub>2</sub> in domestic buildings and 4Mt in the transport sector. Illustratively, this would be equivalent to eliminating the related total carbon emissions from heating about 0.8 million<sup>5</sup> homes, and from over 2 million cars<sup>6</sup>, although the mix of actual measures is likely to be more varied.

The creation and delivery of a plan to achieve this would benefit from an approach which:

- pulls together a long-term vision for the whole energy system and beyond
- coordinates across the main sectors and stakeholder groups
- considers the complicated interlinkages between them
- balances the tensions between often conflicting objectives
- adapts in a predictable manner to new and changing circumstances.

The following sets out the recommended vision established over a series of expert workshops. Many of the individual elements may not appear particularly radical in themselves, but delivering them all together in the limited timescales available and managing the impacts that are increasingly felt by individuals actually represents considerable ambition.

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<sup>5</sup> Based on annual average gas consumption for heat of 12,500kWh at an average carbon intensity of 200g/kWh

<sup>6</sup> Based on Scottish Transport Statistics of 12,300 km per annum and the SMMT estimate of average carbon intensity of cars of 156g/km (both for 2014)

## 5 Principles for the process

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There are many routes to achieve a vision and a set of objectives. To guide the selection process, a set of principles is recommended below which should be applied to the choices of pathways and methodologies as decision points arise, recognising that in some areas where decisions are made outside Scotland, it may be more difficult to apply them without wider agreement.

### 5.1 Engagement

- **Open access:** provide individuals and communities with options for if/how they engage with and access their energy provision, ownership and use. Keep them involved in development and delivery.
- **Socially equitable:** avoid levying costs in a regressive manner and ensure that access to benefits is provided without unfair discrimination.
- **Winning hearts and minds:** underpinning and crucial to all of these policies will be the need to win the hearts and minds of consumers and provide them with high quality information, advice and support to enable them to make informed choices about their energy use.

### 5.2 Governance

- **Government asserts leadership and overall control:** change will not happen without a concerted and integrated long-term plan.
- **Top down and bottom up meet seamlessly in the middle:** Ministers and officials in central Government should lead, empower and coordinate, allowing local activities to develop and deliver.
- **The start of an ongoing process:** acknowledge that the situation is dynamic and iterative. Include a mechanism and schedule for how and when plans will be reviewed and updated.
- **Roadmap for the system and each sector:** decisions should be taken guided by experience and observations, rigorous modelling and expert advice. A map should be produced and maintained which outlines the changes required and details the interventions designed to achieve them.
- **Policy objectives are SMART** – Specific, Measurable, Achievable, Relevant and Time-bound.

### 5.3 Strategy selection

- **Decisions are made – no one waits for ‘silver bullets’:** look for low regrets, rather than no regrets options. Make decisions, even though some are difficult and not all will be optimal. Adopt a dynamic ‘learning’ approach, adjusting policies for changing circumstances and emerging information, but lay out in advance the principles for any future revision. Recognise that even low regret options do not happen automatically, (e.g. retrofit energy efficiency).
- **Transparent:** those involved in policy and implementation develop a shared narrative to capture ‘hearts and minds’, set out how the vision will be delivered, and the rules and standards to be applied.
- **Optionality and focus are balanced:** use demonstrations and trials to create options for **development** and keep them open if available at relatively low cost; however, for **delivery** and to reflect urgency, focus resources by narrowing down as soon as practicable
- **Focus on desired outcomes rather than on specific measures and leave space for innovation:** e.g. for transport, consideration should be given to the wider concept of mobility services rather than just on how to replace a vehicle with an internal combustion engine with some other type of vehicle.

### 5.4 System considerations

- **Whole-systems approach:** avoid optimising the parts only to sub-optimize the whole. Look at wider system impacts and costs, not just the immediate ones.
- **Resilience and flexibility:** maintain these important characteristics of the energy system across different sectors, scales and timescales - from seconds to seasons.
- **Timely infrastructure decisions:** many actions will be part of long-term infrastructure programmes. Set up an ongoing process and avoid delay in making or amending decisions to create and maintain momentum into the long-term and to provide clarity about the investments needed by all players, as well as to minimise cost and disruption.

## 5.5 Policy approach

- **Clear targets** provide confidence in the direction of travel and attract investment. Attainment is more successful when aligned with other goals and championed across Government.
- **Strong leadership and regulation** will be needed to help overcome the natural, but significant inertia that otherwise slows or blocks the necessary changes.
- **Policy learning:** while maintaining confidence in the overall direction of travel, be prepared to revise incentives in the light of emerging data on low carbon innovations. Promote dissemination and knowledge sharing of early installations and pilot programmes.

## 6 Policy recommendations

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### 6.1 Governance

Agree appropriate governance arrangements to deliver headline carbon reductions and to cover:

- whole system design, investment and operation
- specific sectoral issues, particularly for heat
- cross-governmental policy alignment
- local and national arrangements.

Develop and clearly articulate supportive arguments for appropriate carbon reduction policies.

Revise the terms of reference and membership of the Scottish Energy Advisory Board and its sub-groups to take a whole energy system approach, as well as to address issues that arise within individual sectors but interact across the sectoral boundaries. It should take a long-term view for Scotland as a whole, paying particular attention to sustainability and the policy choices available to best balance any tensions between conflicting societal, economic and environmental goals.

Identify the appropriate roles in the energy system for local and national institutions, then allocate sufficient resource to support the necessary activities.

Put in place appropriate governance arrangements to deal with wider GB/UK/EU interactions, like security/resilience of energy supply, interconnection and market operation.

Appoint champions to drive major initiatives and design programmes to inform and incentivise stakeholders.

Set appropriate targets, e.g. how much low carbon energy should come from renewable sources, and ensure regulation is aligned to deliver this and provide backstops for compliance, recognising regulation can be very effective and cost less than financial incentives, but might be seen as draconian and lead to poor acceptance, if applied inappropriately.

### 6.2 Heat

### 6.3 Reductions through efficiency

Scotland has made clear progress with efficiency programmes, as shown by an increase in the number of households rated EPC A-C from 24% in 2007 to 37% in 2013, and by generally making a greater per household investment in energy efficiency schemes than the UK average. Future policy should build on existing successful initiatives, like the HEEPS programme, and finalise plans for the agreed national infrastructure priority investment in building energy efficiency to begin in 2018. These should include:

#### ***New build***

- regulating to ensure that all new buildings are built to zero carbon standards (for both heat and power requirements), and that these are harmonised across all local authority areas<sup>7</sup>.

#### ***For retrofit***

- carrying out/completing pilot studies and setting a programme target for all homes to be brought up to a minimum of EPC 'C' by 2025, where practicable and within a cost-cap
- providing details of public finance support for low income households and financing incentives for others, e.g. Council Tax and/or Land and Buildings Transaction Tax and/or low interest rate loans
- setting details of trigger points at which upgrading becomes necessary (e.g. moving, change of tenancy, refurbishment and extension)
- regulating to provide clear backstops for the achievement of energy efficiency targets if none of the trigger points has been reached

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<sup>7</sup> This may not be achievable immediately so transitional arrangements should be set out to ensure that all new buildings are made low-carbon heat ready, e.g. using underfloor heating or central heating using low flow temperatures to enable easy retrofit of heat pumps

- leading by example and setting specific ambitious trajectories for achieving significantly improved levels of building performance in public sector buildings
- supporting supply chain development and expansion through clear and long-term policy and delivery targets<sup>8</sup> as well as support for training
- extending/modifying measures to cover commercial properties.

#### 6.4 Reductions through decarbonisation

Relatively slow progress has been made on decarbonising heat supply over and above the historic use of wood combustion for domestic and industrial heat. The majority of renewable heat brought forward under the Renewable Heat Incentive (RHI) has been biomass or biogas and by 2015 only around 5% has been achieved against a 2020 target of 11% in Scotland. The main policy instrument in place remains the UK-wide RHI, but funding for this is capped at levels below what will be needed to reach the overall target.

As well as ensuring adequate levels of funding and finance are available, the delivery process for heat decarbonisation in Scotland should be driven by appropriate policies which should include:

- carrying out/completing pilot studies and demonstrators at scale
- developing clear principles and a national delivery plan for heat decarbonisation (through, as appropriate, electrification, low carbon district heating and repurposed gas grids) from now to 2030; within this framework, guiding and empowering Local Authorities to add the detail for zoning in their areas
- revising buildings standards within the current Parliament to drive uptake of decarbonised heat sources in newly constructed buildings
- ensuring there is funding and planning support for the necessary network investment by regulated monopoly organisations.
- working with UK government and regulator, ensure the introduction of supportive regulation to encourage the appropriate development of heat networks, rights to developers and operators, consumer protection as well as the potential to provide lower cost finance on a regulated asset base.
- Ensure timely regulation of heating appliance sales to prevent consumers buying what will be stranded assets.

#### 6.5 Transport

The main existing drivers for decarbonising energy for transport are UK wide and include the Renewable Transport Fuel Obligation (RTFO) and fiscal incentives for the uptake of low carbon vehicles. The Scottish Government has a national transport strategy, which does include decarbonisation but does not currently engage with the kind of transition required out to 2030. Although sales of low carbon vehicles are increasing, at current levels this still makes only a small contribution to decarbonisation targets and the incentives driving company car take up of electric vehicles are being removed by the UK Government.

Transport policies should accelerate nascent developments in transport services as follows:

#### 6.6 Set up a new policy hierarchy

- adopt the 'avoid, shift and improve' approach of reducing unnecessary mobility ("avoid"), moving towards more energy-efficient forms of mobility ("shift") and enhancing the sustainability and efficiency of existing forms of mobility ("improve") as a useful framework for developing the new Scottish Transport Strategy and for taking action in support of decarbonised transport.
- Ensure consistent and comprehensive reference is made across policies to the need for greater action to decarbonise and reduce energy demand from aviation and shipping, given the expected growth in emissions from the sector in coming decades

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<sup>8</sup> e.g. see <https://www.theccc.org.uk/publication/heat-and-energy-efficiency-advisory-group-report-making-effective-policy/>

## 6.7 Reductions through avoiding mobility demand

- Unnecessary mobility should be avoided through better planning of land use and the enabling of flexible patterns of working, child care, local service provision and high speed broadband roll out. This requires a strong commitment to the integration of land use planning, economic development, digital economy strategy and decarbonisation of transport.

## 6.8 Reductions through improvement in efficiency of transport modes

- The electrification of the vehicle fleet in combination with ambitious targets for the carbon intensity of electricity supply should be prioritised alongside incremental technology improvements.
- Identify urban locations for the phased introduction of a ban in the use of conventionally fuelled vehicles by 2025.
- Investigate and develop the governance structures (e.g. digital, legislative, organisational) that could facilitate the development of Mobility as a Service (MaaS<sup>9</sup>) companies in Scotland.
- Central and local government should implement appropriate approaches to decarbonising publicly owned or managed transport fleets such as setting a low carbon specification for all vehicles purchased or leased by Government and government-controlled bodies.
- Integrate planning of recharging points with planning of the electricity network.
- Plan the use of scarce bio-resource to be targeted to those sectors with the most challenging routes to decarbonisation such as HGVs, aviation as well as heat.

## 6.9 Reductions through shift in modal share

- Central and local government should implement measures to change the need for mobility (local planning) and to encourage active transport backed up by resource in proportion to the potential number of trips walking and cycling account for.
- Central government should implement measures like improved logistics to reduce the growth in road freight.
- Capitalise on Scotland's diversity in the human and physical environment which make it an ideal hub for demonstrator projects in low carbon and shared mobility.

## 6.10 Electricity

Progress to date in reducing carbon emissions in the electricity sector has been significant and achieved through a combination of energy efficiency, fuel switching away from coal and achieving a share of equivalent consumption from renewable electricity generation in Scotland of over 50%.

Acknowledging the wider potential role of Scotland's electricity system in decarbonising heat and transport, levels of electrification in these sectors should be agreed.

Recognising the potential for increased overall consumption if heat and/or transport are electrified, residual levels of carbon emissions should be driven down further by:

- continuing energy efficiency improvements, in particular where electricity is used for heat production and where it can be used for transport
- increasing focus on absolute demand reduction, not just efficiency, for each particular application
- setting out in the National Planning Framework the strategy for low carbon electricity generation and the associated network developments in Scotland which should then be reflected in the relevant Local Plans and any consenting processes
- making best use of existing infrastructure (e.g. repowering) alongside new build.

Recognising the interactions between Scotland's electricity system and others, it should be ensured that Scotland is actively represented in expert discussions and policy level debates on developments of electricity industry codes and standards and market arrangements at GB and EU levels. Any changes

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<sup>9</sup> This could offer travellers and goods mobility solutions based on individual needs, is already causing a fundamental rethink in business models for transport providers and has the potential to make a step change in the efficiency of the transport system. However, in a world where personalised mobility is 'sold' by aggregators and data is commercially owned, this will require strong governance arrangements to manage and decarbonise demand.

should have due regard to energy, resilience, flexibility and other system services, including such issues as demand side response, storage, transmission and interconnectors.

National planning guidelines like the National Planning Framework as well as Local Plans should be well-aligned with relevant electricity sector codes, incentives and regulatory arrangements in order to minimise obstacles to investments that meet the wider objectives of decarbonisation, security of supply, minimum cost of energy and societal acceptability.

### **6.11 Industry**

Although scenarios often show industry decarbonisation coming relatively late compared to other sectors due to the difficulties of finding suitable alternative energy sources, suitable preparation and a number of early steps must be considered well before 2030 to ensure that they become available thereafter:

- supporting national and international development of low carbon energy sources, in particular carbon, capture and storage (CCS) which may also be developed in other areas, including the power sector and potentially hydrogen production for low carbon heating and transport, to create the necessary infrastructure and lower the costs for industrial use
- developing opportunities to reduce or utilise energy waste from industry processes
- reducing the use of carbon-intensive materials.

## **7 Conclusions**

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This paper has set out a consensus view from a range of stakeholders representing an extensive breadth and depth of relevant experience. It portrays what the energy system in Scotland could look like by 2030 and, in addition, lays out a set of principles to guide the approach as well as a series of policy recommendations which the group believes, taken together, form a credible and coherent means of achieving the desired outcomes.

It is clear that the course of a major programme with such a significant scope and duration cannot be accurately forecast, but it is only by having a clear vision of what the outcome will look like that appropriate decisions can be made and, if necessary, adapted to new and changing conditions in a way that maintains progress towards the objectives.

The participants would like to stress the importance of creating broad consensus for the measures that will be necessary, and therefore that engaging with all stakeholders, and especially the wider public, should form a fundamental part of the Government's approach.

## 8 About the taskforce

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This paper was produced collaboratively by a group of energy experts, convened by WWF Scotland and facilitated by an independent consultant, Keith MacLean. The views expressed in this paper may not necessarily reflect those of the organisations represented.

The members of this group are:

**Jillian Anable**                      **Professor of Transport and Energy, University of Leeds**

Jillian (previously at the University of Aberdeen until end 2015) focuses on demand-side solutions to a decarbonised transport sector. This includes accelerating the adoption of alternatively fuelled vehicles and changing mode choice behaviour.

**Keith Bell**                              **Professor of Smart Grids, University of Strathclyde & UK Energy Research Centre (UKERC)**

Keith has been at the University of Strathclyde since 2005 and before that worked in the electricity supply industry in Britain. He is a Chartered Engineer and, at different times, has advised the Scottish Government, the Republic of Ireland government, the Northern Ireland Executive, Ofgem and the UK Department of Energy and Climate Change on power systems issues as well as leading a number of engineering research projects in collaboration with UK and European partners.

**Sam Gardner**                          **Head of Policy, WWF Scotland**

Dr. Sam Gardner is the Head of Policy for WWF Scotland, leading a programme of work to help secure the full implementation of Scotland's Climate Change Act and deliver Scotland's renewable energy potential. Sam has worked for WWF for nine years on a range of topics including electric vehicles, renewable heat, whole energy system modelling, energy efficiency and the electricity sector.

**Ciaran Higgins**                        **Director, Derryherk Ltd**

Ciaran has been director of Derryherk Ltd since 2014, having worked in energy for a range of organisations including SP Energy Networks and Glasgow City Council. He is an experienced engineer who has worked across the energy sector, from the commissioning of windfarms, through to demand-side management in the city-centre buildings, and who has a particular interest in the development and deployment of *Smart* energy systems having been jointly responsible for the energy efficiency work stream of the *Future City Glasgow* project and currently acting as lead technical architect on both Scottish Government-funded and EU-funded *Smart City* projects.

**Jenny Hogan**                            **Director of Policy, Scottish Renewables**

Jenny has been in her current role at Scottish Renewables, the voice of Scotland's renewable energy industry, since 2010 and has worked in renewables and sustainable development since 2004. One of two senior managers in the organisation, she leads the five-strong policy and membership team to create the optimal conditions for the sustainable growth of Scotland's renewable energy sector.

**Fabrice Leveque**                        **Energy & Climate Policy Officer, WWF Scotland**

Fabrice supports WWF Scotland's work promoting timely and effective action on climate change, acting as advisor and spokesperson on renewable heat, electricity and energy efficiency. He previously worked as a policy advisor to WWF-UK, an energy researcher at the think-tank Policy Connect and as a solar energy consultant.

**Keith MacLean**                         **Providence Policy**

Keith worked for 20 years at SSE, latterly as Policy and Research Director. He has acted as an advisor to both UK and Scottish Governments and Chairs the Energy Research Partnership and the UK Energy Research Centre. As Managing Director of Providence Policy, he now acts as an independent advisor on energy and climate change policy.

**Chris Morris                      Manager, Local Energy Scotland**

Chris Morris has managed Local Energy Scotland since summer 2013 and is responsible for the delivery of the Scottish Government's Community and Renewable Energy Scheme (CARES). Chris has delivered energy efficiency and renewable energy programmes in Scotland since 1998.

**David Pearson                      Director, Star Renewable Energy (Star Refrigeration Ltd)**

Dave leads the innovation of the UK's largest industrial refrigeration contractor into renewable heat; principally with high temperature water source heat pumps. Dave represents the European Heat Pump Association as Chair of the heat pump panel in the Renewable Heating and Cooling Platform in Brussels and a board member of CEED-Scotland (a business to business knowledge sharing platform)

**Neal Wade                      Senior Research Associate, Newcastle University**

Neal researches energy supply infrastructure and its use, to evaluate the changes needed to meet objectives defined by climate change, affordability and security of supply. Working with partners across the sector for the last ten years, modelling and demonstration activities are being used to produce new evidence for this debate.

**Jan Webb                      Professor of Sociology of Organisations, Edinburgh University**

Jan has been at University of Edinburgh since 1986, working on organisational change, economy and society. Her current research is about comparative European heat and energy efficiency policy and practice, and she has advised UK and Scottish Governments and UK Committee on Climate Change.

**Mark Winskel                      Research Fellow, Energy Innovation, University of Edinburgh & UKERC**

Mark Winskel is Chancellor's Research Fellow on Energy Innovation in the School of Social and Political Science, University of Edinburgh. He analyses future energy pathways for the UK Energy Research Centre (UKERC) and ClimateXChange, Scotland's national centre for expertise on climate change, and has an interdisciplinary background with degrees in physical, environmental and social sciences.

**Observers**

David Joffe                      Committee on Climate Change

Katherine White                      Scottish Government