

Managing Climate Risk

Reducing Emissions and Achieving Net Zero Targets

Holyrood Insight Conference – Wednesday 30th October 2019
InterContinental Edinburgh, The George, 19-21 George Street, Edinburgh, EH2 2PB

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Overview

Radical action must be taken now to curb the worst outcome from our current climate crisis. The Scottish Government has been a world leader in climate action as a result of legally binding emissions reductions targets established by the 2009 Climate Change (Scotland) Act. The Managing Climate Risk conference, organised by Holyrood Insight, drew attention to enhancements to the 2009 Act that introduce a legally binding monitored commitment to achieve net zero emissions by 2045. Importantly, the conference pinpointed key areas for action together with the challenges of, and practical opportunities arising from, delivering on commitments.

This report summarises the conference presentations and gives an outline of the questions raised and responses given. This enables up-to-date thinking on this crucial issue to be available to a wide audience. This report was prepared from extensive notes taken during the conference together with available slide presentations. A full draft report was circulated to presenters so that they could clarify points and make amendments prior to this document being made available online.

Delivering on the Scottish commitment requires transformation in the community, public sector and businesses. During the conference approaches to altering structures and strategies were set out alongside a variety of other ways to incentivise and support change in people's day-to-day behaviour. There have been easy wins in electricity generation but now energy efficiency measures must be mainstreamed and the transportation system be completely rethought. Emissions reduction must be part of a coordinated global effort; Scotland can achieve net zero in way that brings communities together and encourages health benefits.

Keywords: climate risk, emissions reduction, net zero, Scottish Government, Scotland

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Abbreviations

CCC	Committee on Climate Change (UK)
COP	Conference of the Parties (of the UNFCCC)
EV	electric vehicle
GDP	gross domestic product (a measure of prosperity)
LHEES	Local Heat and Energy Efficiency Strategies
PM	particulate matter
SO ₂	sulphur dioxide
MSP	Member of the Scottish Parliament
UNFCCC	United Nations Framework Convention on Climate Change
VAT	value-added tax

1. Reviewing Targets for 2045 and Gearing Towards Net Zero

The progress of the last 10 years under current frameworks was reviewed together with the future legislative and policy commitments. This began with the chair Keith Bell's opening remarks (1.1) followed by Tom Russon's overview of action being driven by the Scottish Government (1.2). Questions and discussion followed (1.3) that tried to get to grips with the practicalities of a commitment to achieve net zero emissions by 2045.

1.1 Chair's opening remarks

Professor Keith Bell, Electronic and Electrical Engineering, University of Strathclyde

My specialism, reflecting my professorship in electrical engineering, is in planning and operation of electricity system. In the last few years, with colleagues at other universities, my interest in energy system and decarbonisation has increased including how these fit with broader climate change targets.

In May this year the UK committed to achieving net zero greenhouse gas emissions by 2050. The Scottish Government set a target of net zero by 2045, that is very much part of the delivery of the UK 2050 target because of Scotland's recognised capacity in, for example afforestation or carbon capture and storage. In June, the 2050 target was passed by UK parliament in Westminster and in September the 2045 Scottish target by Holyrood.

These targets bring challenges and opportunities. The next decade must be transformative in respect to greenhouse gas emissions. Action must start now. There has been progress – since 1990 emissions in Scotland have reduced by 47% and at the same time Gross Domestic Product (GDP) has risen. A decoupling of emissions from this measure of prosperity has been achieved but there is a need to encourage that further.

There has been success in electricity generation in renewable energy but more needs to be accomplished in other sectors. In particular, transport. This includes surface transport within Scotland and our share of aviation and shipping emissions. In Scotland, per capita transport emissions are 22% higher than the UK as a whole and in the building industry they are 10% higher. There is much to do but that means lots of opportunities. Net zero means no sector is excused – including really hard to achieve sectors such as agriculture and aviation.

Even with the current levels of emissions there are going to be changes in weather patterns. Clearly, global reductions in emissions need to be achieved. However, there is a lot of good ambition in the recent programme for government – it could go further in relation to agriculture and aviation but strengthening the programme has support across the political spectrum.

An excellent and diverse set of speakers set out the opportunities as well as challenges during this conference – including those related to air quality. Topics range across government commitments, what communities might do, action that Local Authorities and businesses might take, the circular economy together with air quality and policy on transport. This provides a tremendous opportunity for informed debate.

1.2 Ending Scotland's contribution to climate change

Tom Russon, Climate Change Division's Legislation Team Leader, Scottish Government

This presentation sets out elements of the Scottish Government's approach to tackling climate change. The recently passed Climate Change (Emissions Reduction Targets) (Scotland) Bill is a major thing that my team have been working on and are pleased its parliamentary passage is largely complete. This conference is an opportunity for discussion and to listen to opinions on this major enhancement to existing legislation.

Going back 10 years, the Climate Change Scotland Act 2009 was an early significant step in tackling climate change. The 2009 Act made legally binding world leading targets of emissions reductions of 42% by 2020 and 80% by 2050. The interim goals in the Scottish Act were more ambitious than the rest of the UK. Often the headline numbers are discussed rather than the inner workings. Importantly, the 2009 Act also established a rigorous framework for duties around these targets. It was the only bit of legislation around the world to set legally binding annual targets to keep us on track to the longer-term targets. Other things that are unusual (although now not quite unique) is that a fair share of international aviation and shipping is included within the domestic targets. Scotland did that first and now Wales has followed.

The last ten years, as Keith's opening remarks indicate, have seen a lot of progress in tackling emissions. As of today, Scotland has almost halved greenhouse gas emissions from 1990 baseline and, importantly, during that change GDP has continued to grow. Other initiatives, in equalities and social justice, have been delivered. The progress to date suggests we can make deep reductions in emissions while growing the economy and having wider beneficial outcomes. We need to continue this approach.

Scotland's success is partly shaped by being naturally well positioned. Large amounts of natural land provide opportunities for afforestation and peatland restoration. Scotland is a renewable energy powerhouse, with strong expertise in this sector and a well-developed renewable energy industry. The legally binding annual targets of the 2009 Act have also contributed because these necessitate annual statements to parliament on how Scotland is meeting its targets (the 2017 report was published today). This keeps climate change high on the Scottish parliamentary agenda maintaining the profile of this important issue.

Advice on setting of target levels and how they might be met is provided by the independent UK Committee on Climate Change (CCC), including through their annual reports on progress. Over the past four years' there has been an enormous change of pace in scientific, public and policy discourse – this crystallised in the increased international commitments of the 2015 Paris Agreement. The Scottish Government recognises the strong message coming from the scientific Intergovernmental Panel on Climate Change (IPCC), that there are significant differences in the impact of warming at 1.5 and 2°C and that the world is presently not on track to meet either of those goals. All actors now need to increase levels of ambition. The IPCC report came out in October 2018 after the new Bill had entered parliament. In collaboration with the UK and Welsh Government we sought further advice from the CCC which was published in May this year.

The declaration of a global climate emergency by the First Minister in April indicates the very high political recognition of Climate Change's seriousness and urgency. Stage 2 of the Bill in May this year accepted the CCC's recommendation on increased target ambition. The Bill has now completed Stage 3 and will receive Royal Assent tomorrow (31 October 2019). The 26th meeting of the Conference of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC) will happen in Glasgow, November 2020. Scotland is an

appropriate place for this to happen, and indeed Glasgow as a city has committed to emissions reduction.

The new Climate Change Act amends certain parts of 2009 Act but leaves a lot of it in place. The main change is a further increase in the ambition of the emissions reduction targets. The new Act sets an enhanced target of net zero emissions of all greenhouse gases by 2045. That is in line with the CCC's advice. Increased interim targets between now and 2045 are also set for reductions of 56% by 2020, 75% by 2030 and 90% by 2040. The Act retains annual targets for every year between each of these milestones.

This new regime is one of the toughest in the world. Many countries have set aspirational goals but Scotland is amongst few countries to have responded to the Paris Agreement with legally binding targets, our targets are at the very high end of what any country has done. The advice from the CCC tells us that these commitments are in line with what is needed to achieve global climate change goals – to keep warming to 1.5 °C. However, Scotland is small a country and we cannot independently halt climate change. Leading by example is important but the broader outcomes will necessarily depend on similar action by other countries.

In addition to the headline targets, many other features of the new legislative regime are also world leading – including the continuing inclusion of annual targets. The Executive Secretary of the UNFCCC has recognised Scotland's approach to climate change legislation. While the key purpose of the new legislation is to increase targets ambition, it also contains a range of supporting provisions. In particular, it substantially revisits and enhances the 2009 Act duties on the government to set out regular strategic delivery plans for how targets will be met. At the heart is the concept of a 'just transition', that means "achieving net-zero in a way which tackles inequality and promotes fair work".

The hard choices needed to meet the new targets is not something government can do alone. Therefore, there is a new requirement to hold a Citizens Assembly on Climate Change that will report to both Ministers and Parliament by February 2021. The new Act also contains duties to establish a national nitrogen balance sheet – a helpful tool to understand the nitrogen cycle – together with new provisions around international sustainable development and climate justice.

Attention must now shift from target setting to delivery planning – how these new and ambitious targets can be met. This will require transformational change. The Scottish Government has had three strategic plans on Climate Change thus far, the most recent being published in Spring 2018. An update to our current Climate Change Plan will now be made in the next 6 months; this will reflect the increased ambition of the new targets and build from new commitments in the current programme for government. This update to the Plan will be informed by an interim report from the Just Transition Commission early next year. Social engagement is also central to our approach, and in addition to the commitment to a Citizens Assembly, there has recently been The Big Climate Conversation and there will also be a National Forum on Climate Change. We will also support community action through the Climate Challenge Fund that since 2009 has provided over 1,100 grants totalling £104 million.

It will undeniably be a huge challenge to deliver on the new targets brought in by the enhanced legislation. Figure 1 indicates we have done really well in reducing emission in the energy sector to date together with waste management.

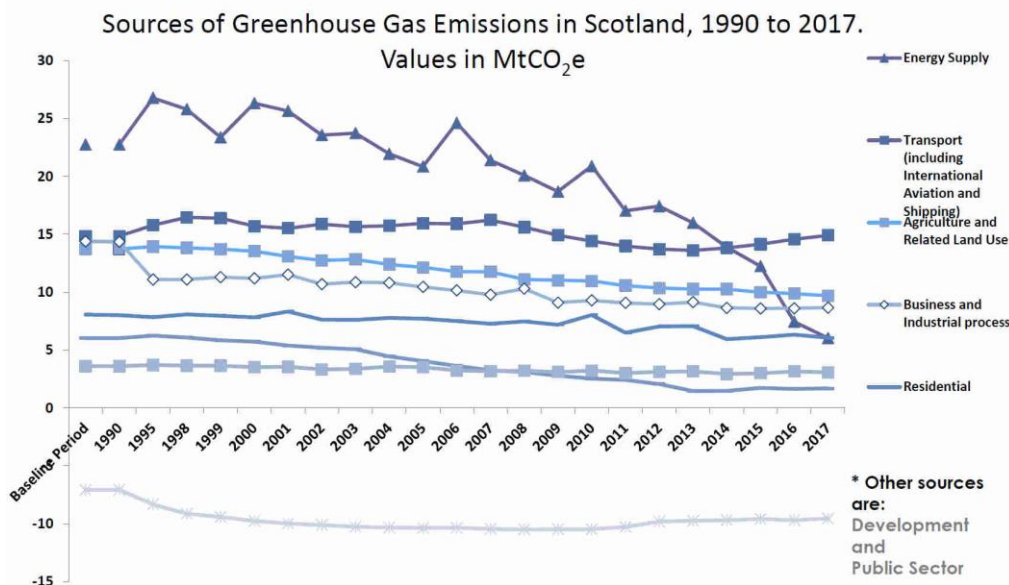


Figure 1 Sources of greenhouse gas emissions in Scotland 1990 to 2017
 (Source: Chart B2 p.14 in *Scottish greenhouse gas emissions 2017*)

There are other sectors that have remained largely flat over the period to date – to get from where we are now to net zero means effectively two things. Firstly, it means further expanding carbon sinks, more trees and new technologies to absorb emissions. Secondly, we will need to substantially reduce emissions from other sectors on this chart; such as transport, agriculture, industry and residential. This is a new and different journey and, in some ways, far more challenging than the one to date. Active changes in people’s day to day lives and behaviour depend on widespread engagement, which returns to the earlier point about the importance of social engagement and just transition.

Please get in touch at climate.change@gov.scot

1.3 Questions and discussion

Question Practically what does net zero that mean? Has substantive guidance has been produced as to what this means in practice? This would be helpful when terms start to get fussy – we could then assess if we were on the same page as the Scottish Government and other organisations.

Response Net zero means that there can be some emissions left in some sectors, if there are sufficient carbon sinks elsewhere in the economy to absorb them. At a country level it is not realistic to get to absolute zero. That would mean no aviation for example. At smaller scales, for example sub national regions or individual public sector bodies, the definitions become more complicated. A body with emissions only from buildings and some forms of transport could perhaps get to near absolute zero emissions, but for others this might not be realistic without access to carbon sinks. This is something we are thinking a lot about in terms of public sector bodies’ contribution.

Question Given that transport is now being recognised as a key area where change is needed does this conflict with Scotland being a player on the world stage? There is a drive to attract people to big festivals and events, a number of organisations are wrestling with the contradictions in the ambition to tackle climate change in relation to encouragement of travel.

Response I spoke about how, at present, the climate change plan is being updated. Another key part of the puzzle is the new *National Transport Strategy* that will follow from the recent

government approval of the Transport Bill. One of the underpinning aims for this will be the commitment to reduce emissions, but it will also recognise other issues. The review of the *National Transport Strategy* is one way that this will be taken into account, consideration of climate change will feed into that review process.

Question Building is identified as a main issue. What about existing buildings? Will there be legislation to effect both new buildings and facilitate upgrade on existing buildings? Will there be a value-added tax (VAT) reduction on refurbishment? One of the biggest generators of emissions is the pressure to demolish existing buildings then rebuild rather than refurbish.

Response You can be put in touch with the officials that lead on specific issues, such as VAT. The residential sector, both the existing and new building stock, is the 4th largest generator of emissions. Therefore, it is likely to be one of sectors where substantial reductions will need to be achieved. One of the main policy vehicles for this is the Energy Efficient Scotland programme. The Climate Change Act does not set targets for specific sectors. This approach means what happens in each sector going forward can be adjusted if the evidence changes. There will be a talk related to Energy Efficient Scotland after the coffee break and we can perhaps come back to some of those points at that stage.

Tom Russon was at the event over lunch to answer further questions.

2. Supporting Communities, Local Authorities and Businesses

This session focussed on the role that can be played by communities, local authorities and businesses. Alastair Seaman from Keep Scotland Beautiful outlined the need for community engagement and the multiple forms this could take together with what happens next for community action (2.1). Jamie Brogan discussed recent modelling work with The City of Edinburgh Council exploring the challenges that Local Authorities face and strategies that can be adopted with limited budgets (2.2). The importance and difficulty of measurement of initiatives and emissions more generally came up in the question and discussion (2.3).

2.1 The role of community action in the journey to net zero

Alastair Seaman Climate Change Manager, [Keep Scotland Beautiful](#)

Community action can play a significant role in the journey to net zero. Keep Scotland Beautiful is a national environmental charity working on Climate change and plastics in water courses and oceans. We promote the circular economy and work with schools (primarily via the Eco Schools programme), businesses and local authorities. The heart of what we do is with communities. For the last 10 years, on behalf of the Scottish Government, we have worked with communities via the Climate Challenge Fund. This presentation shares experiences rooted in that work.

There has been progress on emissions reduction but arguably we have done the easy stuff. Till now the general impact on the choices we make and how we live has been limited. Restriction of choices may now be necessary. The [Climate Change Committee Report](#) from May 2019 looked at a number of different actors. It identified a significant role for government and business but did not focus much on communities. We need to give greater recognition of the role that communities can play.

Who do you trust? Trust in politicians, the media and business are at an all-time low. People tend to trust and listen to people who are like them – people that look like them, dress like them, people from within their community. We are embarking on a revolution – there is a need

to change a lot of practices within our communities. That requires an army of trusted communicators drawn from the communities where change needs to take place.

Once we start to limit choices and freedoms understandably people may wave a placard against restriction – this happened in France in relation to President Macron’s taxing of fuel. Community engagement in Scotland is vital as part of taking people’s concerns seriously and heading off opposition. Scotland is made up of many different communities and we need to communicate with all of them, including the middle classes with their highly polluting lifestyles. Climate change can seem insurmountable and it summons the joke ‘How do you eat an elephant?’ The answer, ‘One bite at a time.’ Community action involves building trust and that requires using the right language. It also means making this issue relevant for people. For many people climate change is polar bears and pacific island – it’s far away. But it is here, as is this picture of Oban in Scotland under water shows (Figure 2).



Figure 2 Oban underwater
(climate change is not just polar bears and pacific islands)

Climate change is not just about prevention of risk – the transition to a low carbon way of living can bring benefits. There can be wins from people moving out of cars into healthier forms of transport and eating more sensibly. Climate action is not something just for the United Nations, it can be highly visible in communities through installing solar panels and planting trees. We are often understood as individuals although we need to look to what other people are doing and how we can act collectively.

What does community action look like? A community in Rutherglen is reshaping understandings of clothes and waste by running a charity shop where you join to be a member – if you take stuff in you have to take other stuff away. They have focussed on making a nice shopping experience. In Shetland, shelters where food can be grown are being built with biproduct pipes from the oil industry, these are now being constructed for other communities. In Dundee, The Gate church has installed the first every community fridge; food comes from supermarkets and individuals and then the fridge is open to everyone. Issues such as health and safety or vandalism had to be considered but solutions were found within the local community.

We have awarded 1,097 grants totalling £101 million to 658 community-led organisations in all 32 Scottish local authorities. The 1000th project supported adults who had never cycled to get onto bikes. Guided rides around Glasgow are offered, bikes can be borrowed and they run free bike maintenance classes. People are also working to make community buildings more energy efficient. This gives an opportunity to talk about home energy. People standing at their

bowling club bar having a pint with friends, it gets them to think about what they are doing at home.



Figure 3 The Climate Change Fund has supported many progressive cycling initiatives

Talking about climate change is vital. All our projects work with, support and inspire conversations. Whether that is via pub quizzes or articles in the media. This has interesting knock on effects and it can have significant impacts on other parts of people's lives: someone began by being involved in community building then ended up restoring a peat bog. There can be lots of social benefits. A recent migrant to Scotland from Syria got involved with local growing project. This makes them feel a part of their community and led to teaching and skill sharing. One lady involved with the cycling programme originally presented with depression but now cycles a 23 miles round trip to work three times a week on e-bike. She has become an advocate for the programme.

There is a need to join up some of this goodness. One way to do this is to use the place making tool and integrate this with higher level planning. Government are continuing the Climate Challenge Fund and The National Lottery want to get behind Community Action. What is happening in Scotland may be rolled out across the rest of the UK. There will be discussion about this at the [2019 Climate Challenge Fund Gathering](#) taking place in Edinburgh on 6 November at Our Dynamic Earth. Over 200 practitioners will be brought together, there is a webinar and case studies on our websites if you cannot get to the events.

We are also spurring behavioural change by equipping people within organisations to take action. We are promoting a day's worth of accredited training as part of the [Carbon Literacy project](#). This was originally for communities but is now being offered to business and also hospitals and local authorities. All of this demonstrates the growing role for community action in taking us to net zero.

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2.2 Exploring how local authorities and businesses can reduce emissions and manage climate risk

Jamie Brogan Head of Innovation and Skills, [Edinburgh Centre for Carbon Innovation](#)

This presentation reaffirms what has already been said about the scale of the challenge, and also some of the opportunities in moving towards a net zero economy. The Edinburgh Centre for Carbon Innovation manages a number of activities, including support for small companies to take forward ideas that can have a positive impact on climate change, and help to reduce climate impact. This talk focuses on demand led ways to accelerate impact, with a particular emphasis on work just being completed with The City of Edinburgh Council.

The City of Edinburgh has committed to achieving net zero emissions by 2030. Clearly this requires working collaboratively, particularly with issues related to budgets, but also necessitates learning from other cities and other institutions. This challenge is not just for The City of Edinburgh *Council*, it confronts everyone who lives and works in the city, all the businesses who are based here, and is a broader challenge for the public sector.

Figures from the economic review show a significant reduction (c. 40%) from peak carbon emissions since 2001. That is largely down to the decarbonisation of the electricity grid, and continuing on that trajectory will not get us to net zero by 2030, we need to change other things and implement other actions. Our review, looking purely at economics, considered the carbon footprint and the costs of addressing those other issues together with the returns.

We found that 56% of the measure we need to take will pay for themselves and deliver a return on investment over the next seven years, this will give health and social benefits. The question that begs of the city is why are these actions not already being taken. Up to 67% of the 2030 target is cost neutral, and taking us up to 68% of the target is quite feasible – the technology exists to make these changes.

The gap from 67% to 100% requires innovation in technology and potentially national policy and taxation. It is easy to be fatalistic but the review helps us to focus on what can be done now or soon. In Edinburgh the biggest emitters are transport followed by domestic heating. Changes in building will give quicker returns but transport is slightly harder to fix. The World Heritage site status of Edinburgh, the many tenements, does pose some difficulties.

It's not about The City of Edinburgh Council finding money but about unlocking investment from across the city. That means supporting people to invest in homes, working with business communities, mobilising institutional investment, and some public sector support. If we unpick all of that there's a need for financial innovation, community engagement – a whole range of measures requiring us all to behave in a city in ways we have never behaved before.

The model we used was originally applied to Leeds and developed by the University of Leeds. Most UK cities would likely be similar in terms of the broad economic results, the level of changes that need to be made, and what initiatives will pay for themselves. The model provides a pretty good guideline of what must be addressed. Some of the things we can do now can be justified in purely economic terms. We now must move research and support onto the wider co-benefits – such as health, wellbeing, environmental, social, etc. We need widespread action now to have long term impact.

2.3 Joint questions and discussion

Question Of the Climate Challenge Fund projects which is the most surprising and most innovative?

Response (Alastair Seaman) Every community is different and the diversity of projects is striking. Projects are tailored to the community so they are all innovative in their own terms. There is someone here from Creative Scotland and we have been involved with arts projects that encourage people to communicate in different ways – for example, an artist had worked with a cycling project for a year. I will send over some case studies.

Question How do you reconcile all the great stories that make you feel fuzzy with the legislative picture? How do you measure the benefits of these projects or is there a need to do that?

Response (Alastair Seaman) The dilemma is whether to invest in communities or in other areas, such as offshore wind, where you can see direct and obvious carbon savings. It is important for every community project to report on carbon saved, but the real outcome of this is building a bank of positive stories and the knock-on effects of practical change at the community level.

Response (Jamie Brogan) Measurement needs to shift to acknowledge the social and health benefit of action rather than just economics, GDP or carbon. Business needs to also be involved in safeguarding the health and wellbeing of employees – encouraging people to walk and cycle more can feed into increased productivity.

In recent conversation with 17 elected member it was clear that people all know we need to do something but struggle with the scale of the challenge. The enhancement to climate change legislation isn't a roadmap but the roadmap comes next. There is no magic bullet.

Response (Tom Russon) Climate change is based in science and therefore it makes sense to have headline targets, as these provide set numbers that people can focus on. However, that does not mean that everything has to, or should, be about numerical targets. Climate change is complex and subtle in terms of how different issues interact with one another and thus what needs to be done in policy terms. Reducing greenhouse gas emissions is a key priority but not our only one, for example we need to safeguard social equality and ensure what we are doing contributes to other national outcomes.

Question The City of Edinburgh has a massive challenge due to central Edinburgh being a World Heritage site. Do you know of anyone that's doing any work on how to upgrade buildings without damage?

Response (Jamie Brogan) In terms of adaptation, Edinburgh does not have a sizable challenge with flooding but the heritage status generates adaptation issues. Edinburgh heritage are unpacking the challenge from landlords etc. They are doing a project over the first 6 months of next year about how to keep Edinburgh unique. Historic Environment Scotland are engaged and there was a conference on this issue last week.

Question Given that emissions from transport are high on the agenda do we need to rethink the provision of charging points for electric vehicles and hybrid vehicles? I am currently using Tesco.

Response (Jamie Brogan) The University of Edinburgh have provided charging points but action is needed by The City of Edinburgh Council. City charging points are needed but also consideration of how to charge your car in between cities or if you travel outwith them, when, for example, driving around the highlands.

Response (Tom Russon) This is outside of my remit but it is being worked on by other policy teams. Indeed, it is an issue that several Members of the Scottish Parliament (MSPs) specifically felt should be looked into during the recent Climate Change Bill process.

Response (Keith Bell) This is a chicken and egg thing. You are not going to buy an electric vehicle if you cannot charge it. One of my PhD students is doing work on destination charging. As the population of electric vehicles grows that will attract people to shop in Tesco or go to the cinema where there are charging points. There is a need to build up confidence that there is no inconvenience, or a convenience parity. See my collaborative article in *Applied Energy* 'On the ease of being green'.

Response (Alastair Seaman) We are overseeing some electric vehicle projects. As part of Stirling's conversation they were thinking of using charging as a way to get people to stop in Stirling.

Question Can you provide more information about Carbon Literacy?

Response (Alastair Seaman) Carbon Literacy was kick started in Manchester at the arts centre HOME where all members of staff went on training no matter whether they were working at the bar or doing the accounts. This changed the thinking around emissions in terms of the scope and the message. The programme is now being rolled out across the UK. It has been separately tailored to arts venue and to consultants. We can now rock up and provide some training that will equip an institution. Local authority staff are now being trained.

Question The model presented by Jamie shows learning from Leeds to Edinburgh and that outputs can be shared. So, a local authority can take models and replicate them?

Response (Jamie Brogan) Similarities can be found in the results. I am happy to share our outputs and those from the people that we work with in Leeds. The cost was not vast and the model could be rolled out pretty easily. The findings from Leeds and Edinburgh were not radically different. The outputs from The City of Edinburgh Council are publicly available as a webcast from their website.

3. Resource Efficient Scotland: Learning how to Implement Successful Strategies

This session presented case studies focussing on the work of Energy Efficient Scotland and an overview of the thinking behind encouragement of the circular economy. Dr Faye Wade reviews the work being done with Local Authorities to develop Local Heat and Energy Efficiency Strategies (LHEES) (3.1). Whereas, Paul Thom gives an overview of the Changeworks programme encouraging energy efficient heating of buildings. Andrew Faulk (3.3) introduces Zero Waste Scotland and how changing the way we manage resources, design and trade goods, and get maximum value from waste materials and energy, can play a central part in tackling the climate emergency. The questions and discussion (3.4) acknowledge the breadth of work on energy efficiency in Scotland.

3.1 Local authorities Local Heat and Energy Efficiency Strategies (LHEES)

Dr Faye Wade ClimateXChange Research Fellow, Energy Efficient Scotland

ClimateXChange runs out of the University of Edinburgh but the programme enables information exchange across Scottish universities and the Scottish Government. The evaluation of Energy Efficient Scotland is led by myself and Professor Jan Webb and part of that work involves a social evaluation of the pilot Local Heat and Energy Efficiency Strategies (LHEES) being taken forward by local authorities. The intention is to decarbonise by 2040, covering all building sectors. The next speaker, Paul Thom, will talk about work taking place to engage the private sector.

The LHEES evaluation helps us understand more about the experiences and strategies within local authorities. Scottish Government have suggested that LHEES should include assessment of local and national strategies and data availability including that related to:

existing building stock, the setting of agreed targets and socio-economic assessment. It should provide an overview of how decarbonisation will be achieved over a 20-year period together with a costing of the planning and delivery programmes.

We are currently evaluating 12 pilot LHEES that were completed from Sept 2017-2019. The second and third rounds of pilots are ongoing. Scottish Government are aiming for all local authorities to have an opportunity to develop an LHEES, to look at the activities and process that will be required if this is made a statutory duty. This is the first time this kind of process has been a requirement for local authorities; there is a need to build their capacity to undertake that work. Cross council working is encouraged and necessary for this programme, but resource (staff time and expertise) within local authorities is limited. Local authorities generally have a silo structure and they often do not communicate with colleagues in other departments. If a commitment for LHEES does not come from a managerial level then it may not make its way into workplans. At present delivering LHEES has relied upon an ad hoc model of good will from colleagues and staff across departments.

LHEES require multiple skill sets. There are elements of strategic management that encompass a broad spectrum of experience. People involved in the pilots recognised a limited capacity, particularly for data analysis. Some in councils were using geographical information systems (GIS), but they might not have been able to be involved in the pilot work. There is a lack of data for some sectors of the built environment. For example, in one case, a local authority officer noted that fuel type for 93% of non-domestic properties in their area was unknown.

Information is needed to decarbonise in a strategic way. Often data is not shared across a local authority. There is consequently a need to have someone with the remit of finding and compiling data. This can be quite specialised. All of the local authorities engaged with external consultants for some parts of the work. Several of the pilots used the same consultant who had originally been procured by the Scottish Government. This led to a situation where the consultant responded to the requirements of their client (Scottish Government) rather than the needs of different local authorities. The wider roll-out of the LHEES programme requires clearer contractual relationships together with more direct dialogue between local authorities and consultants.

This structure also impacted on how local knowledge was used. In some cases, the LHEES became a standardised process and thus was not necessarily tailored to a specific area as much as it could have been. Indeed, sometimes local areas were not visited by consultants. Local knowledge needs to be incorporated into an LHEES; for example, local authority officers may be aware of existing district heating schemes and the feasibility of extending them, whilst external consultants might not. There is support amongst local authority officers for LHEES becoming a statutory duty but this would require additional resources to deliver in-depth and useful strategies. That includes more detail and guidance on what is to be expected. Support is also needed in establishing chains of accountability – engaging with senior managers and councillors and in facilitating development of skills.

There are a number of key lessons particularly if this is to become a statutory duty. There is a need for shared framings between any kind of partners or consultants and Scottish Government. LHEES must integrate with local authorities and planning authorities' existing duties. Data is required by local authorities to enable them to populate the LHEES; this data needs to be made available and accessible. The assessment must incorporate the geographical (including rural/urban) specifics of the area it is being applied to. Importantly, the development and interpretation of the LHEES must be accompanied by resources being assigned for its delivery.

3.2 Changeworks

Paul Thom Technical Director

Changeworks is an environmental charity that has been active for more than 30 years. It focuses on decarbonisation, fuel poverty, social equality, and more recently behaviour change. This presentation provides a route map for the transition to an Energy Efficient Scotland in relation to the climate emergency and the potential of the enhancements to the Climate Change Act.

Everyone is talking about climate change but many people do not associate it with what they do at home. They might recycle but leave the heating on all day – so there's a disconnect. The early adopters have already changed their behaviour and we now need to think about how to motivate other people. Changeworks takes an area-based approach to the self-funding market on energy efficiency including the domestic and non-domestic. We focus on anyone who has to pay for the changes they make. We encourage uptake of energy efficiency measures; heat demand is a big current part of our footprint. However, people may be in recently built energy efficient houses but they can have the thermostat set up high and use lots of energy.

We have five pilot projects, each with different requirements. Changeworks Argyle is in a large rural area. The Old town energy project in Edinburgh is densely populated and throws up real challenges in the fixity of the city centre environment. In Penicuik many people are in energy efficient homes, but lots commute and are not engaged with their local community. In Burntisland the situation is mixed with some of the poorest housing right next to more energy efficient developments; here a masterplan existed and some of its findings are being resurrected. In Peebles, energy use is 14% greater than anywhere else in the borders although it has good bus routes and engaged groups that receive support from the Climate Change Fund.

We are still delivering and have learned some lessons. There are many different agencies involved (local authorities, Scottish government, Changeworks community groups) and to the customer the organisation can seem convoluted – we chose to give each pilot project an identity to prevent any confusion about whether it is Scottish Government or Changeworks. Monitoring and evaluation must be embedded right from the start but, with many agencies involved, data is not always fit for purpose.

It takes resources to achieve community buy-in. The project was initially resource heavy, we accessed government funding but had a short window to deliver it. The loan process is complex. If someone is fuel poor and gets a grant to make changes that differs considerably from someone already being in a warm home then needing to spend their own money without grant support. There are engaged and unengaged people – often the same people come to the focus groups and it is a task to get beyond the early adopters. People do not tend to do all the work instantly, having a hub means people can come back 5 or 6 times and we can take them along that journey. It's a real period of learning in Energy Efficient Scotland.

Our work is split into delivery, domestic, non-domestic. So far there have been 2109 domestic engagements – half of that is in Peebles which has been on the ground for a year longer than the other projects. This has resulted in a 5% increase in referrals to Home Energy Scotland. There have been 224 non-domestic engagements – these are engagements, not just reach. 1360 people have signed up to newsletter. There have been 750 referrals to Home Energy Scotland (HES), 51 referrals to Resource Efficient Scotland (RES) and circa 100 people self-funded. That combines to £270k worth of energy efficiency installs. With 246 domestic households engaged in the process towards installs.

Potential next steps are evaluation then generating momentum and fostering trust. Stopping to consult will increase the time taken so rather we are going to widen delivery to support households and business to offer them the assistance they need. The Scottish Government must resource building and make sure that communities are supported to assist with delivery on the ground. The project so far is a test where we have been talking to people about radically changing their lives rather than tweaking just one aspect.

The Committee on Climate Change recommend 600,000 buildings need to be made energy efficient between 2020-2030. There is legislation being developed to deal with this across the private rented sector. The volume of domestic building in Scotland that need to change is going to come at a cost and funding must be increased. Engagement with wider stakeholders would suggest that some of the forthcoming demands require a doubling of the resources put into this area. The Scottish Government will have to bear some of that increase but there are opportunities to be quite imaginative about how bring in other resources.

3.3 The circular economy and climate change in Scotland

Andrew Faulk, Policy Manager, [Zero Waste Scotland](#)

Zero Waste Scotland works to ensure uptake of the circular economy so that nothing is wasted. If we take a straightforward view of the economy as **linear**, materials are used but not then reused and we end up with a big pile of waste. Having a **recycling** economy means perhaps some materials, such as glass, can be reconfigured into others, in this case primary aggregates. However, value is lost through this process. A **circular** economy is much more self-contained. Rather than conceiving of materials as being from cradle to grave, it conceives them as cradle to cradle – materials go back to being reused as the same thing.

At present we are in an economy that recycles, rather than being circular. We are now in the top line 50% of what can be recycled. So, as with energy, we have picked the low hanging fruit. In some places people are resistant to recycling because the collections are not working well – partly due to confusion over what can or cannot be recycled. So, there are limits to this voluntary approach in terms of meeting targets. Therefore, the Scottish government are now moving to considering deposit return schemes.

Our mission statement is: “Zero Waste Scotland exists to lead Scotland to use products and resources responsibly, focusing on where we can have the greatest impact on climate change.” This required us to tackle embodied or embedded carbon. Scotland’s carbon footprint is now primarily in heat and transport. Beyond that there is emissions from goods and services – energy usage that goes into their production need to be counted but measurement of this requires a lot of data and thought.

We are taking an international perspective and framing our work in terms of the Sustainable Development Goals (Figure 4). Rather than solely focussing on number 13, climate action, we must address the others – including the key goal of ending poverty. Poverty is not being able to afford things or services. We are trying to reuse, for example by working to address food waste. We can reuse materials as a substitute for those that are currently imported.

SUSTAINABLE DEVELOPMENT GOALS



Figure 4 All of the Sustainable Development Goals must be taken into account as part of action on climate change

If we consider zero energy, we need to be honest about embodied emissions. A lot of steel that goes into making offshore wind turbines is imported from Asia. We can take steel from oil rigs here, but economics, costs, play a part in making this possible. Action to encourage a circular economy often require thinking about design. By the time a product hits the consumer there is a lock in to a system of processing or disposal – it is the system that needs to change.

That systemic change requires concentrating on production and consumption and trying to find beneficial impacts of changes. We work in partnership with 17 organisations and this helps to expand our reach. Here are some examples: REVOLVE is a re-use quality standard for shops who sell second hand goods in Scotland, thus improving the quality of those goods This has impacts for employment and job creation. A tonne of waste going to landfill or incineration generates .001 of a job – whereas reusing materials is generative of work. Procurement is one area that the Scottish government can play a bigger role. We can buy things that are better in environmental terms, encouraging businesses to produce new products and services that are sympathetic to our environment.

Until recently there have been no incentives to consider the waste element of coffee consumption. Recent trials in NHS settings have separated out the cost of coffee (£1.75) and soup from the cup (25 pence), most cafes now give discounts if you use your own cup. Re-usable cup usage increased during the trial as did hot drink and soup sales. So, this was good for business as well as the environment. We support businesses in resource efficient processes. Egg light (Figure 5) were supplying and fitting LED lighting. They realised that quite a lot of material did not need to be replaced so they redesigned the product to just supply necessary parts. As a result of that they reduced costs and now have a service contract. This is a great example of how industry can innovate to reduce waste and begin to make our economy circular.



Figure 5 EGG lighting are a technology company that specialises in identifying, developing and installing energy saving solutions

3.4 Joint questions and discussion

Question The example of coffee cups was used to discuss pricing incentives. It is possible to improve people's food choices by indicating nutritional standards such as a high, medium, low rating?

Response (Andrew Faulk) Voluntary approaches work for some people. In relation to the coffee cup the incentive does not directly relate to environmental consciousness. Small price signals can really work – for example the 5p on carrier bags has made a huge difference to waste volumes.

Response (Faye Wade) In terms of energy efficiency it may not be possible to rely on pricing signals to get people to take action. There are associated non-financial costs (time, disruption, uncertainty) and perhaps it requires supporting people to take those journeys.

Question A rural/urban divide was discussed in both Faye and Paul's presentations. Can you say more about this?

Response (Faye Wade) There are different challenges and solutions. For example, densely built up environments may be more suited to district heating system whereas in a less dense area communities that are off grid could make more of heat pumps. It is important to take account of local knowledge and make sure we find ways to tap into the pre-existing wealth of expertise about energy efficiency that already exists across Scotland.

Question As discussed earlier, is it possible to take solutions to the community?

Response (Paul and Keith) A great deal, 38% of innovation, is still to come. There are huge opportunities, for example, many buildings could use ground source heat pumps. A plethora of organisations are contributing to the programme and that will boost innovation and action.

Question The private sector has got big chunks of money that could be invested; can that be used to boost the process perhaps through government support?

Response (Paul Thom) There may be money, but businesses will want a return on investment and we have not quite figured out how that will work. It is important to consider the embodied carbon and other emissions that are associated with industry – including seemingly environmentally friendly windfarms. Similar to the electric car, we need to consider where the materials come from, the steel, to build the windfarms.

Question There was a discussion about procurement being important and also the LHEES interaction with other forms of planning. In terms of procurement there is best value regimes and other EU regulations on competition, in relation to LHEES there is existing systems of assessment (equalities, social, environmental, economic) – How does all of this fit together?

Response (Andrew Faulk) In procurement there has been a longstanding awareness of the difficulties but colleagues are now getting to stage of figuring out what can be done. There are barriers to the way the finance system works and we hope the programme for government is going to address this through consultation and further conversations.

Response (Faye Wade) LHEES may become a statutory duty but there is still not always the communication across local authority departments to take this forward. Planners know a great deal, but it does not necessarily get translated to sustainability teams. It may be that the Scottish Government needs to review how the LHEES commitments relate to existing requirements in planning.

General response (Tom Russon) These presentations and discussions demonstrate concerted action on energy efficiency in Scotland and a relatively mature appreciation of complex issues. The specifics of funding going forward are not matters I can directly comment upon. As stated previously, over the next six months we will be updating the current Climate Change Plan. There is also going to be a review of the National Planning Framework, the National Transport Strategy and a range of other key documents; the global climate emergency will be reflected in all of these. The National Planning Framework will be particularly important to how we look to balance up the very different demands on the built environment and wider planning. We are very fortunate that the enhanced climate commitments have come at a time when they can be interpreted into these processes. This also provides lots of ways for people to get involved – I'm very happy to be sent questions by email and to redirect these to the relevant policy teams.

4. Joining Up Policy

Andrew G Taylor (4.1) reviews the success and impact of the Cleaner Air for Scotland strategy discussing how both greenhouse gas and air pollution reductions can be achieved through joined up policy. Questions and discussion (4.2) focussed on biomass and the efficacy of wood burning stoves.

4.1 Delivering co-benefits for air quality and climate change through effective policy co-ordination

Andrew G Taylor, Air Quality Policy Manager, Scottish Government

Climate change is now high up on the public agenda. However, often the same news article or item will understand air quality and climate change as being interchangeable. Air quality and climate change are different but closely connected; an understanding of their interrelationship is essential for effective policy coordination. The first half of this presentation deals with the Scottish Government's Cleaner Air for Scotland strategy and its recent review.

The second, focuses on the linkages between air quality and climate change – both involve greenhouse gases and require effective policy coordination

Strategic planning for air quality in Scotland used to come under a combined UK strategy but divergence in approaches made a dedicated Scottish strategy necessary. Cleaner air for Scotland: the road to a healthier future published in 2015 is Scotland's first air quality strategy. This strategy brings together policies on transport, health (both human and environmental), placemaking and communications in a single framework. Overall policy for climate change requires Scotland to reduce greenhouse gas emissions and achieve renewable energy targets.

The overall vision is that Scotland's air quality can be the best in Europe. In general terms it compares very well. However, there are issues to tackle in cities and towns, many of which are transport related. Clean Air for Scotland sets out the policy framework till 2020 – but action must continue after 2020 onto the next stage of the process. Therefore, we commissioned an independent review of the strategy to determine how it has performed so far. The two key aims were, to firstly review progress and, secondly, to identify priorities for additional actions that would deliver further air quality improvement to 2025.

A steering group, chaired by Professor Campbell Gemmell, was appointed and was supported by four expert working groups: health and environment; placemaking; transport; and, agricultural, domestic and industrial. Each group produced a report submitted to government. Key findings are that Scotland is performing well by European Union and international standards with major air pollutants declining year on year. Additional action is still needed as our understanding of human health and environmental impacts improve. On transport there is a need to up our game considerably and encourage modal shift.

The report makes 10 high level and 38 detailed recommendations. The Scottish Government will seek wider views and develop a draft revised air quality strategy for consultation in the first part of 2020 to be published by the end of that year. A couple of recommendations are relevant for today. Firstly, the need for integrated and thematic organisational strategies; where strategies, plans and programmes are devised at national and local levels for climate change and mitigation and adaptation (and related purposes such as noise reduction) they should be closely coordinated and aligned with air quality. Secondly, there is a requirement to screen air quality actions so that they generate co-benefits with climate change mitigation and adaptation.

This presentation now considers the connection between climate change and air pollution. They share common sources – energy generation and transport and some air pollutants can act as greenhouse gases – but they tend to impact at different levels in the atmosphere. The relationships and trade-offs are complicated. Black carbon is a significant component of particulate matter – but a decrease in black carbon has a positive impact on air pollution and climate change. In contrast, reducing Sulphur Dioxide (SO₂) can have positive effects on the local environment. SO₂ can also have a beneficial impact on climate change as it can be involved in formation of secondary particles in the atmosphere that have a global dimming effect. So, decreased SO₂ can lead to increased warming. As such, there is a need to be careful in managing climate change and air quality policies as figure 6 indicates.

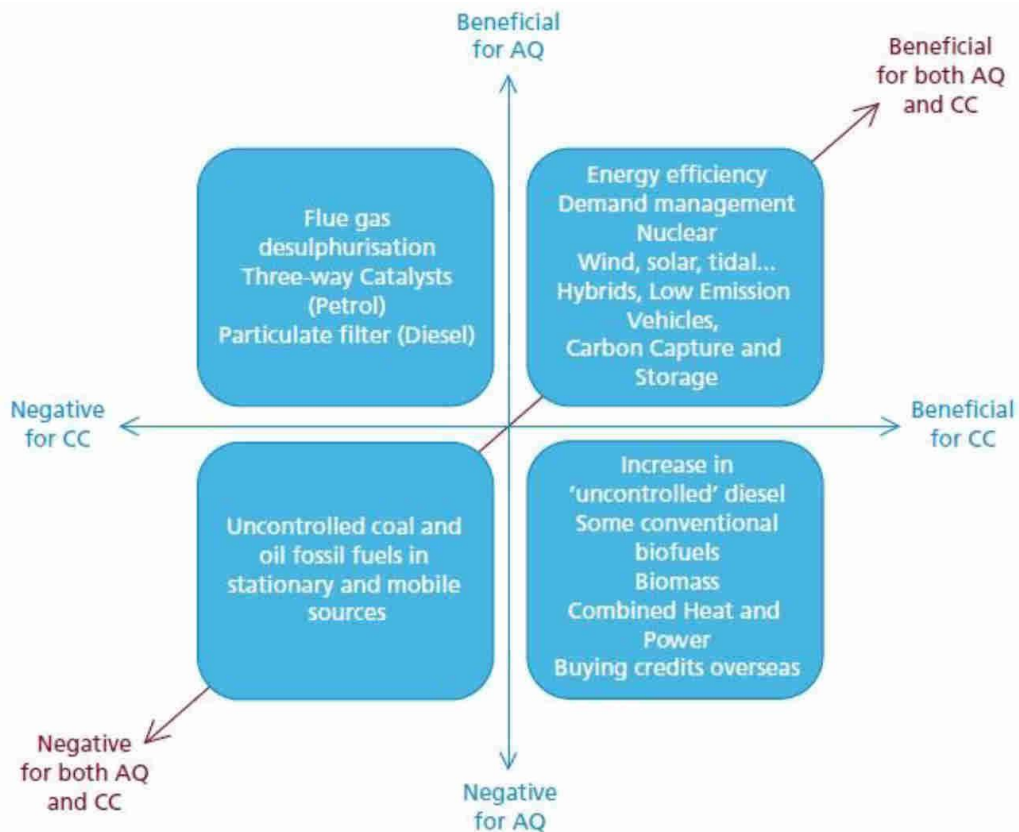


Figure 6 Air quality/ climate change co-benefits can be maximised through careful policy choices

Here are two hypothetical scenarios; this is not Scottish Government policy but just an illustration of some of the complexities. Scenario A: Climate change action brings additional costs through the deterioration of air quality. This could happen if policies to introduce bio diesel or bioethanol is used for road transport and localised combined heat and power plants are used to heat homes and businesses; where biomass is widely used to heat homes and nitrogen from agriculture is controlled through manure management only. Introducing some or all of these policies to reduce greenhouse gasses is likely to result in large costs in terms of additional air pollution damage, bringing new emissions sources.

Scenario B: Climate change action brings additional benefits through air quality improvement. Cars and goods vehicles are powered by electricity hydrogen fuel cells or biomethane with homes and businesses heated by air and ground sources or electric heating. A mix of fuel sources including renewables is used to heat homes. Remaining hydrocarbons are confined to chemical processes (such as plastics production) and agricultural demand for nitrogen is reduced. This would likely result in additional co-benefits from air pollution reduction of many billions of pounds per year.

This final part of presentation focuses on biomass, air quality and climate change. Later presentations will consider transport as it is the biggest source of greenhouse gases and air pollution. Solid biomass as a fuel (i.e. wood and derived produce) in general has benefits over fossil fuels for carbon emissions. But it depends on the fuel it replaces whether the air quality impacts are positive or negative. Biomass with emission of 20 - 60 g/GJ has significant benefits where it replaces a coal fired boiler, but if it replaces a natural gas boiler it may have benefits for climate change but is likely to lead to deteriorations in air quality. We are increasingly seeing such changes in big installations such as schools and hospitals.

The Scottish Energy Strategy was published in 2017 and contains challenging targets for 2030. The equivalent of 50% of the energy for Scotland's heat, transport and electricity consumption has to be supplied from renewable sources. This commitment could result in a significant reliance on biomass for power. Careful consideration is needed of how we can deliver win-win scenarios. It could be positive if all new biomass plants are of high-quality corresponding to the best performing standards currently; if the majority of biomass heat displaces coal or oil-fired heating that is off the gas grid and away from urban areas. Levels of uptake would need to be away from existing Air Quality Management Areas. If biomass has to be deployed in urban areas there is a need for larger and more efficient plants with advanced filtration. Scotland has improved significantly over recent decades and the Cleaner Air for Scotland strategy has provided a renewed focus. There is still more to do to effectively co-ordinate policy that simultaneously improves air quality and tackles climate change.

4.2 Questions and discussion

Question This presentation seems to suggest that biomass has an uncertain role in tackling climate change – is that correct?

Response Biomass may have some role in delivering reductions in greenhouse gas emissions but it cannot be relied upon. It is not supported by the Committee on Climate Change because land is a finite resource and where land is used for biomass it may not really contribute to decarbonisation.

Comment The growing of biomass can be problematic – for example many farms were subsidised to grow biomass in the Scottish borders and that encouraged convoys of tractors burning red diesel for 20 hours. I believe that the ten-year growing subsidies will not be renewed.

Response There are unintended consequences of biomass and now there is increasing awareness of how to take note of whole lifecycle emissions and not just point based emissions. Stopping the subsidies is a step in that direction.

Question Can you comment on the rise of the woodburning stove?

Response The review of Scotland's Clean Air Strategy noted that the impact that stoves are having on air quality is hard to come by. Mass emissions data for Scotland as a whole suggests particulate matter is increasing in urban areas – this is based on modelled data. The number of air quality complaints received from local residence is growing year-on-year which suggests this is an increasingly important issue – although this is not an objective measure. To a certain extent this can be regulated through the planning system by attaching planning requirements but at the moment it's not part of Scottish policy. Sending a set of inspectors into peoples' homes is impractical but it would be useful to have better information about stoves and details about their impacts in urban areas. Most people that run them will be conscientious but some people will bung any old rubbish on the fire just to get rid of it.

Response (Keith Bell) Some stoves are better than others and the quality of the fuel is important. As with all technology, modern burners that are installed properly, maintained correctly and burning the right fuels will work well. Wood burning stoves can play a role as a back-up.

5. Air Pollution and Transport

Dr Mark R. Miller provided an overview the health risks associated with air pollution focussing on his recent research (5.1) Cllr Anna Richardson (5.2) discussed the situation in Glasgow and the initiatives that are on stream to support climate change targets. The questions and discussion (5.3) revolved around the impacts on cyclist of air pollution and the structural

changes needed to bring beneficial change to the transport network. Closing remarks by the chair, Prof Keith Bell, considered how some of these issues relate to the broader international context (5.4).

5.1 Evaluating the health risks of air pollution

Dr Mark R. Miller Senior Research Fellow, Edinburgh University/BHF Centre for Cardiovascular Science

Keith Bell has already discussed health and educating the public and we have had some in-depth talks about policy and community engagement. This talk focuses on the health risks of air pollution and largely draws from research work at the University of Edinburgh. While most people are aware that air pollution has health effects, it is important to emphasise that the health effects of air pollution are staggering and are only just becoming clear to scientists, far less the general public.

When people think about air pollution in the UK, they think about London's great smog also known as the 'Big Smoke' of 1952 that was associated with high levels of mortality (death). Statistics indicate that across the world, in Europe and in small countries such as Scotland, air pollution is associated with huge numbers of premature deaths. Worldwide it is estimated that air pollution is responsible for 3-7 million deaths every single year. A study by the Global Burden of Disease group ranked air pollution as the fifth greatest risks for all-causes of disease.

It is estimated that 90% of world's population live in places with air pollution above guideline levels. However, scientists consider that there is no safe level of air pollution. As figure 7 indicates, air pollution has effects on most of the bodily organs: it can seriously affect the lungs worsening asthma and promoting chronic lung disease, but it is linked with effects on the liver, the kidney, gut and brain, and to Alzheimer's disease and diabetes. Exposure in pregnancy leads to worse outcomes at birth and can result in detrimental health impacts in offspring later in life.

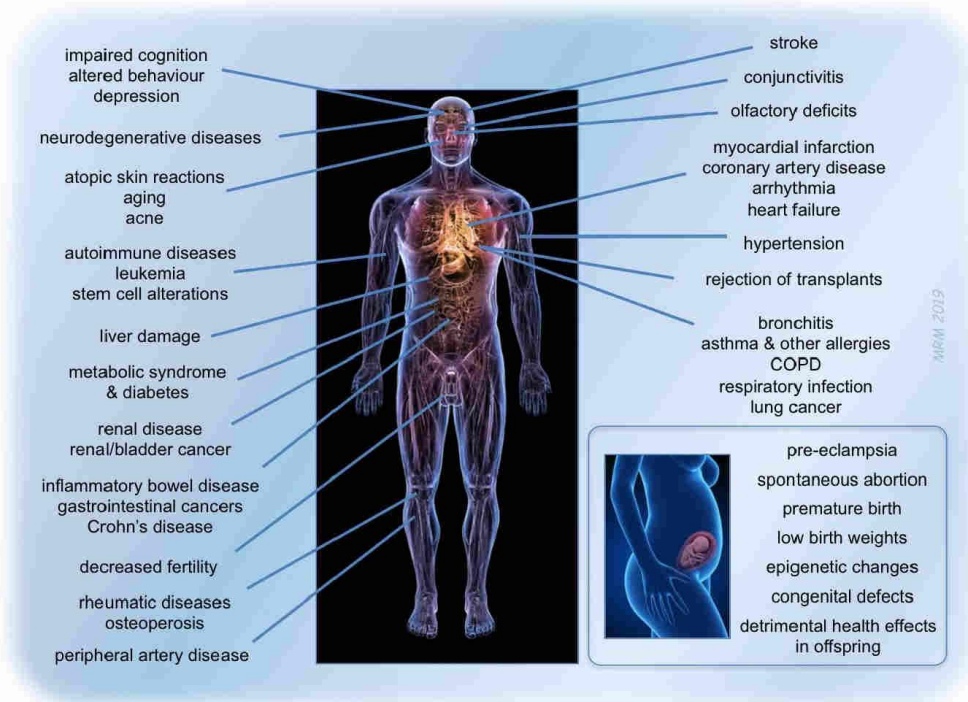
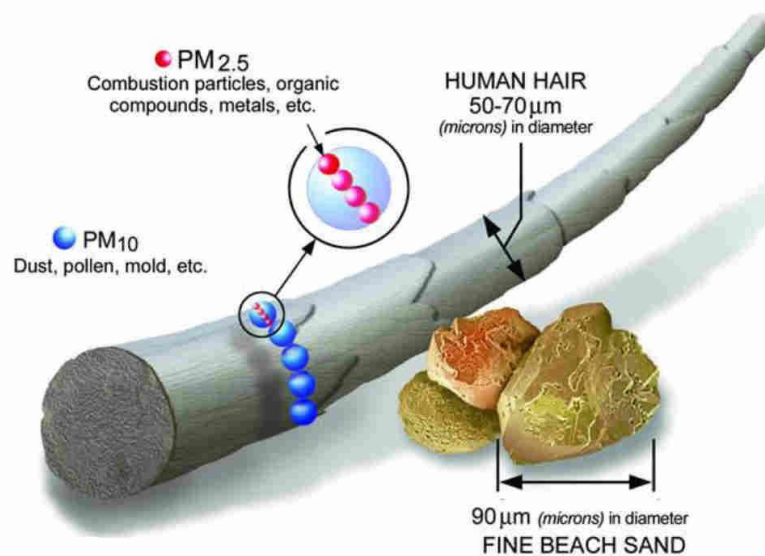


Figure 7 Systemic effects of air pollution

One of the most important impacts of air pollution is on the cardiovascular system (the heart, the blood and the blood vessels) as this is the major cause of most of the associated early mortality. The associations are strongest for particles in the air known as particulate matter or PM. The biological effects of PM can differ depending on what the PM is made of and their size. While still invisible to the eye, most PM that is measured and regulated in our environment is PM10s and PM2.5s (particles with a diameter of less than 10 or 2.5 micrometres respectively). PM10 and PM2.5 are measuring by the weight of particles in the air. Figure 8 gives some indication of the relative size of these particles.

“Coarse”: **PM₁₀** ——— less than 10 μm (0.01 mm)
“Fine” **PM_{2.5}** ——— less than 2.5 μm (0.0025 mm)



mass metrics: particles collected and weighed

Figure 8 Particulate matter: PM₁₀ and PM_{2.5}

The UK has relatively clean air; in most places the average levels are below recommendations, and levels of PM2.5 have fallen substantially over the last 50 years. However, this overlooks the large increase in road vehicles during this time which is associated with emissions from exhaust. Exhaust generates tiny particles called “ultrafine PM” or “nano-particles” that are even smaller than PM10 and PM2.5. These particles get deep down into lungs and potentially further into body. They weigh almost nothing yet can have big reactive surface areas and can carry damaging chemicals into the body.

One reason to study diesel is that this exhaust generates a much higher proportion of nano-particles than petrol. The University of Edinburgh team carried out an experiment where volunteers were exposed to dilute diesel exhaust in a carefully controlled manner. Each volunteer is enclosed in a chamber, cycling on an exercise bike for 2 hours, and breathing diesel exhaust fumes that have been set at levels in the upper range of that of a busy road side in a heavily polluted city. Afterwards, the researchers look at the effects of the exposure on the cardiovascular system. For example, the group looks at relaxation of vessels in the forearm and how they control the flow of blood.

Exposure to diesel leads to substantial impairment to how the blood vessels relax. This impairment is still there the next day suggesting that even short-term exposure to diesel

exhaust causes long lasting damage to the blood vessels. The group also shows that diesel exhaust makes the blood more likely to clot, and can change heart rhythm. It was the particles rather than the gases that cause these effects. Overall, these effects would make it more likely that a person would develop cardiovascular disease long term, and if you already had cardiovascular disease, it would make you more likely to have a cardiovascular event such as a heart attack or stroke.

The biology that links particles being inhaled into lungs to that of impacts on the cardiovascular system is not fully understood. One suggestion is that the smallest nanoparticles might be able to pass through the lungs and into the blood, which then could carry them around the body. This is called “particle translocation”. It is currently impossible to study this with diesel exhaust particles but the group did manage to study this using gold nanoparticles as a model particle that is the same size as a diesel exhaust particle. People can be safely exposed to gold particles and sensitive lab techniques can measure them in the blood. After inhalation, gold in the blood starts to appear after about 15 minutes with levels getting higher by 24 hours after. Volunteers were invited back 3 months later and gold was still in the blood suggesting these particles stay in the body for very long periods of time.

Only very low amounts of nanoparticles will translocate but this could still be an important issue depending on where they go. Do they reach areas of the body that could be really susceptible to the effects of the particles, such as areas of the body where there is disease? One reason people can have a stroke is where the artery in the neck becomes blocked with disease. One of the treatments for this is to operate on the artery to remove the disease surgically. The group recruited a small number of people to inhale gold the day prior to the surgery. They found that the gold particles appear to congregate in areas of disease, in fact they may preferentially build up here. While gold is safe, diesel exhaust particles are very reactive, so if they also reached areas of disease like the gold particles did, it is highly likely they would make the disease worse and could even trigger a cardiovascular event.

In summary, diesel exhaust particles can cause harm to the cardiovascular system in many different ways. Inhaled nanoparticles can cross into the blood and be carried to areas of disease. Currently it is not possible to measure nanoparticles in the environment in the same way that we can do for PM10 and PM2.5. However, this research suggests that this could overlook nanoparticles from traffic that are causing great harm to the body. The research suggests that if we can effectively tackle emissions from vehicles then this would be accompanied by a reduction in cardiovascular disease.

Thanks to all of the team involved in this research, particularly Professor David Newby who established the Edinburgh Air Pollution Programme. Thanks also to the volunteers of the clinical studies, and the British Heart Foundation (BHF) who funded the bulk of this work and makes considerable effort to promote this issue with the general public and policy makers.

5.2 Exploring strategic approaches to reducing transport emissions

Cllr Anna Richardson City Convener for Sustainability and Carbon Reduction, Glasgow Council

This presentation sets out some of the principles that underpin our approach to air quality in Glasgow. We need to try and improve air quality and evidence tells us there is no safe levels of air pollution. Air pollution exacerbates existing health inequalities, something we are keenly aware of in Glasgow. This affects everyone, although we know the impacts are greatest on children and the elderly. We are acting upon this knowledge. Scotland’s first low emissions zone came into force in 2018 and we continue to require upgrades to bus services. By 2022 all vehicles that enter the city will have to be a minimum of euro 6 diesel and euro 4 petrol.

The motorway carries a significant amount of traffic but is an important part of our infrastructure as it brings goods into the city.

Achieving net zero targets by 2045 for the whole of Scotland requires focussing on heat but also transport. The cleaner vehicles now on stream have reduced Nitrous Oxides (NOx) gases by 20 tonnes and we will see improvements year on year. We cannot see NOx gases but we can see the new buses now on our streets giving greater passenger comfort as well as cleaner air. The public's awareness of climate change and calls for swifter action must influence the air quality work. In terms of transport emissions – the Transport Bill links directly to this new work on climate change. Glasgow has declared a climate emergency and a desire to reach net zero by 2030.

Glasgow City Council's own fleet of 2000 vehicles will be replaced by electric and hydrogen ultra-low emission vehicles by 2029. We are building an electric vehicle (EV) infrastructure as part of an EV strategy. Concerns about running an EV often revolve around charging – alongside these installations alternative charging points will be incentivised. Building an EV network is complex – we need to consider how it works for tourists, commuters and businesses. Meaningful solutions need to be close to home with possibilities for long stay EV charging bays being for residents only. We are mindful of impacts on pedestrians and there is a need to prevent pavement clutter caused by payment technologies. There is no more sustainable transport than walking and we need to protect and promote that throughout the city. We hope our work will enable that.

EV is not the solution for cities and we need to change how people move and what journeys they take – this gives us a real opportunity to shift people onto sustainable modes: walking, cycling and public transport. We are drafting a transport strategy that aims to be a key document in taking us to a net zero position in a decade. This strategy will include all feasible options open to us, including the possibility of a workplace strategy. Fewer than half of our households have access to a car – we must act to ensure that everyone can access work, education and services without encouraging greater car use.

We are in the midst of a complete transformation. This City Deal Programme is worth over £150 million investment and offers a real opportunity to show how green infrastructure adds to the public realm. Sauchiehall street avenues project is one example. It is not enough for a city to look more appealing, behind the avenues project runs the public transport plan that ensures public transport continues to move as efficiently as possible. Reducing the amount of road space open to vehicles means there will have to be a significant reduction in traffic. The Scottish Government bus partnership fund is in place to support the bus network. A critical part of the avenues themselves are reduction in traffic. Such reduction can only be achieved by modal shift.

Often the focus is on city centres. The next challenge is to take that work from the city to consider the neighbourhood. At present some communities do not link to the centre and cross neighbourhood connections are more important. A significant number of car journeys are a short distance within neighbourhood, some of that movement needs to be made on foot and by bike. We are looking holistically across the city and developing our first liveable neighbourhood strategy. This will give streets back to our people in every community to reduce traffic and incentivise walking and cycling. These are plans that will benefit both air quality and the environment.

This will bring further benefits – when we improve the streets where people live, play, relax and form communities that's when the magic really happens. The health and wellbeing impacts of that could be significant; allowing all sectors to feel more freedom from the youngest to the elderly. So, this is just a flavour of our transport work across Glasgow. Behind each of

these projects lies a huge amount of complexity, data gathering and consultation work – we have a considerable task ahead of us. By getting the strategies right and ensuring they interconnect seamlessly we will be in a strong position to bring about the transformational change to our transport network that will deliver on our climate ambitions.

5.3 Joint questions and discussion

Question Glad to hear that EVs are not considered to be the only answer. Do we need more radical action? For example, bringing the buses into regional control or closing the M8?

Response (Anna Richardson) We have established a bus partnership but Glasgow City Council is exploring the feasibility of taking over the First Bus operations but there is no firm commitment on that as yet.

There is no new road building. In comparison to other similar sized cities the roads in Glasgow could be put on a diet, rationing the space for private vehicles with more allocation to walking and cycling. Every policy decision is making it more difficult to drive. In terms closing motorways that is an issue for Transport Scotland.

Question Do particles from unleaded [petrol] fuel move around the body in the same way as diesel particles? How does the body get rid of particles?

Response (Mark R. Miller) The first question is difficult to answer because it is not possible to trace where exhaust particles go in the body – we are limited to using proxy particles such as gold that are the same size and have similar characteristics. We know that diesel exhaust generates more nanoparticles than unleaded petrol, and since it is the nanoparticles that we are especially worried about, this is one of the reasons we have focused on diesel exhaust rather than petrol exhaust (although ultimately both will be harmful to some extent). Some of the particles that come in via the lungs will eventually be cleared out of the body, for example by going out as bodily waste, but this can take a long time.

Question Are urban cyclists exposed to more air pollution and can they wear masks to protect themselves?

Response (Mark R. Miller) A lot of the particles will get trapped by the material of the masks. However, some nano-particles may get through or, more likely, will go through any gaps between the mask and face. Overall, studies have shown that there does appear to be some benefit from masks but more testing is needed.

People cycling may be breathing faster and so getting a bigger dose of air pollution than someone not exercising. However, people sitting in a car may be exposed to higher levels of emissions, unless the car has specialised cabin filters, as the particles can sometimes build up in a car to be 3-10 times higher than outside.

Cyclists can (to an extent) choose their route and try to avoid streets with higher levels of pollution or traffic. Provided the cycling is safe, generally the benefits of doing physical exercise will outweigh the detrimental impact felt from UK levels of air pollution.

Question How does Glasgow work with other local authorities that make up the conurbation? Glasgow seem quite go ahead but how is it working with councillors from other local authorities?

Response (Anna Richardson) Sitting on the board of Strathclyde Partnership for Transport (SPT) gives a regional perspective. The travel to work area is crucial to achieving our strategy that in itself parallels the National Transport Strategy: acting on climate, inequalities, health and keeping people moving. There is some dissent from authorities surrounding Glasgow about the workplace parking levy – but neighbouring authorities can help us to clean up our air and decrease carbon emission. Big cities have a responsibility and moral duty to lead on climate change.

Comment It is really important to get the infrastructure right if we are going to get people out of cars and onto bikes. Cycling has to be attractive to people, has to be feel safe.

Response (Anna Richardson) We are not building infrastructure for people who are already cycling. For many people including women, young children, ethnic minorities the main barrier is feeling unsafe. Until people see themselves as being capable of being on a bike they are not going to try it out. Making safe cycle spaces on the road upsets some people as they think we are doing for the existing small number of cyclists – once it's done they see it was for their kid or aunty or granpa to use.

Response (Mark R. Miller) Motorists could be annoyed if they feel they are being unfairly treated over bikes, buses or other active travel, but some unpopular decisions need to be made. It was not that long ago that we had the indoor smoking ban, which was unpopular before it was implemented. It has now been shown that this policy made huge improvements in health, and nobody in their right mind would go back on that. Similar tough decisions are needed for air pollution.

Response (Anna Richardson) I am not convinced that the health message is the best way to promote active travel and perhaps a more forceful message is that it can actually be quicker, easier, cheaper, good fun. When driving takes 12 minutes and cycling takes you 4 – people perhaps more readily make decisions on cost, reliability, and the easiest way to get to their destination. Lots of people drive so called 'irrational' journeys but when you look at the road network in Glasgow they are being completely rational – we need to change the infrastructure to make sustainable travel possible.

There are possibilities for restricting car use in the city centre grid system. In Scandinavian examples every third or fourth street was pedestrianised to generate separation between motorists and walking and cycling. There is potential to shut off whole streets.

Comment In terms of EVs, there is a massive amount of emissions (almost half) caused by non-exhaust emissions, as well as pollution from the making of the car. I am worried that people put a lot of energy into touting this as a solution when reducing travel or encouraging other modes (walking and cycling) will have more impact.

Response (Mark R. Miller) It is true that moving to EVs over combustion engines will not solve all particulate matter – there is still tyre and brake wear and re-suspended road dust. There are also other particulate emissions beyond those from transport. However, in some of these cases the particles are larger or less reactive than exhaust particles, so they may not cause the same health effects. Ultimately, you are right that it would be better if everyone could walk or cycle instead of using electric vehicles – there would be less particles and the physical and mental benefits of active travel would be huge. However, I would not totally dismiss EVs. In the end, we will need to implement many solutions to reduce air pollution effectively, and there is a role for EVs alongside improving facilities to help people use active travel.

5.4 Chair's closing remarks

This last session has shown that there can be co-benefits to policies that reduce climate change or other emissions in terms of positive impact on public health. This is of relevance globally, and does not just apply to urban areas. Beyond the example of transport in the UK, in other parts of the world there are impacts of particulates from cooking on open fires. A lot of action on this is driven by reducing air pollution in cities but this can have beneficial effects on the climate too. These presentations have communicated a positive message where policies can converge in an approach that seems to be going in the right direction.

Appendix: Speakers' Biographies

Professor Keith Bell

Keith Bell holds the ScottishPower Chair in Smart Grids at the University of Strathclyde and is a co-Director of the UK Energy Research Centre (UKERC). He is a Chartered Engineer and, since April 2019, a member of the Committee on Climate Change. In addition to teaching, and being involved with energy system research in collaboration with many academic and industrial partners, he has a number of additional roles including with the Offshore Renewable Energy Catapult, The IET Power Academy and CIGRE, the Conseil International des Grands Réseaux Electriques. In recent years, has given advice on electricity system issues to the Scottish Government, Ofgem, BEIS and the Government of Ireland.

Jamie Brogan

Head of Innovation and Skills, Edinburgh Centre for Carbon Innovation

Jamie is the Head of Innovation and Skills at the Edinburgh Centre for Carbon Innovation (ECCI), and currently develops and delivers ECCI's innovation and skills portfolio. This includes a cleantech business accelerator programme supporting entrepreneurs through from ideas to scalable businesses, and a range of projects to deliver climate impact innovation at a scale that ensures ECCI leads Edinburgh and Scotland in their ambition to deliver some of the most stretching climate targets in the world. Jamie has spent more than 20 years advising high-growth businesses and supporting them through change and growth. His clients range from small start-ups to senior management teams in some of Scotland's fastest growing companies, and his previous experience has focussed on innovation and business performance from the adoption of digital technologies. In parallel, he has also spent over 10 years leading innovation in the delivery of higher education, and in particular in bringing learning and teaching delivery into industry by developing tailored programmes for skills and development for industry partnerships. His work has focussed on bringing specialist skills into emerging industries and drive transformative change, in areas such as leadership, data, security, engineering, healthcare, social care, and sustainable construction.

Andrew Faulk Policy Manager, Zero Waste Scotland

Andrew is the Policy Manager at Zero Waste Scotland. The policy team provides support to the Scottish Government on a wide range of issues, including the development of the forthcoming Circular Economy Bill, Scotland's input to Extended Producer Responsibility, and the work of the Expert Panel on Environmental Charges and Other Measures. Andrew previously worked on the mainstreaming of environmental issues into EU Structural Fund programmes in both the public and private sectors, and more recently, on energy policy for Consumer Focus Scotland. He has been a member of the Scottish Water Customer Forum since June 2017. Andrew is also involved in rural regeneration through the Board of his local development trust.

Dr Mark R. Miller Senior Research Fellow, BHF Centre for Cardiovascular Science, Edinburgh University

Mark Miller is a Senior Research Scientist working in the Centre for Cardiovascular Science at the University of Edinburgh, United Kingdom. Mark's research investigates the effects of air pollution on the cardiovascular system (the heart, blood vessels and blood). His main focus determining how the particles in vehicle exhaust can cause heart disease. He also has an interest in the potential for manufactured nanoparticles to cause harm to the cardiovascular system. Mark's research findings have received extensive coverage in the national and international media. His work contributed to the Department of Cardiology's Queens Anniversary Award 2014-16 for outstanding contribution to scientific research. He is an Editor of the journals Particle & Fibre Toxicology and Frontiers in Cardiovascular Medicine, Mark is an Expert Member of COMEAP, the UK governmental advisory Committee on the Medical

Effects of Air Pollution, and the World Heart Federation Air Pollution Expert Group. His work was recently highlighted as a case study in the 2019 DEFRA Clean Air Strategy. His work is predominantly funded by grants from the British Heart Foundation.

Cllr Anna Richardson City Convener for Sustainability and Carbon Reduction, Glasgow Council

Anna graduated with an MA (Hons) in Geography in 2001 from the University of Glasgow and an MSc in Human Resource Management in 2005 from the University of Strathclyde. She worked in various public sector administrative roles before spending 9 years at home raising her three children. During that time she gained an HND in Antenatal Education and worked part time for the national parenting charity NCT. Anna was elected as Councillor for Langside ward in Glasgow in 2015, and again in 2017. She is currently Convener for Sustainability and Carbon Reduction, with a particular interest in transport, equalities and the mainstreaming of sustainability across all Council functions.

Tom Russon Climate Change Division's Legislation Team Leader, Scottish Government

Tom is the policy lead for climate change legislation in the Scottish Government. Prior to becoming a Civil Servant, he completed a PhD in climate science and worked in academia for several years.

Alastair Seaman Climate Change Manager, Keep Scotland Beautiful

Alastair is a senior leader in the fields of environment and community development with experience in both business and charitable sectors in Scotland and internationally. As KSB's strategic lead for Climate Change he leads a multi-disciplinary team of 13 staff who support communities, government and businesses to understand and respond to the climate emergency. KSB have managed the Scottish Government's innovative Climate Challenge Fund since its inception over a decade ago. Through this world-leading programme KSB have supported more than 1,100 community-run climate projects from the Northern Isles to the Scottish Borders through an investment of over £100 million. Alastair holds degrees from Oxford and Edinburgh Universities, is a member of the Association of Chief Officers of Scottish Voluntary Organisations (ACOSVO) and enjoys camping, hills, cutting firewood and any excuse to be outdoors.

Andrew Taylor Air Quality Policy Manager, Scottish Government

Andrew has worked in air quality policy since 2001, Air Quality Policy Manager at Scottish Government since 2010. Prior to that he worked as a soil scientist for Scottish Natural Heritage, the Macaulay Land Research Institute and in consultancy. BSc in Physical Geography & Botany and MSc in Pedology and Soil Survey.

Paul Thom Technical Director, Changeworks

Paul has a strong background in project management having successfully delivered numerous construction projects around the UK. He has gained experience in dealing with a wide variety of contractors through the tender process to project delivery and the dissemination of information to project stakeholders. Paul joined Changeworks in October 2015 as Programme Manager of the Development and Delivery team delivering procurement, project management and quality assurance services to Councils in the South East of Scotland as well as providing services to housing associations. Now as Technical Director, Paul builds on the strong relationships that Changeworks has developed with local authorities, the Scottish Government, housing associations and contractors.

Dr Faye Wade ClimateXChange Research Fellow, University of Edinburgh

Dr Faye Wade is an interdisciplinary energy researcher, applying a range of techniques as appropriate to understand aspects of the energy challenges of contemporary society. Together with Prof. Jan Webb, Faye is currently working on a social evaluation of the Energy

Efficient Scotland programme; the Scottish Government's cornerstone strategy for reducing energy consumption and decarbonising heat in the built environment. This project involves interviewing members of local authorities across Scotland; conducting a social survey with building occupants; and working closely with policy makers. This is a collaboration with the Energy Saving Trust, who are managing a package of technical monitoring for the properties receiving interventions under the scheme. Faye's previous work has included an ethnographic investigation of how, through their work, heating engineers can shape the central heating technologies installed in homes and how they come to be used, and the application of qualitative approaches to better understand the changing nature of construction work with the introduction of new technologies. Faye is a member of the Heat and the City team, and the Energy and Society Research Group which brings together energy research in sociology, geosciences, science, technology and innovation studies (STIS), social anthropology and political science. Faye is also part of Construction Edinburgh, which facilitates collaboration between academics and organisations to tackle the intellectual and practical challenges posed by industry and government.