



Scotland's centre of expertise connecting
climate change research and policy

ClimateXChange
Centre of Expertise on Climate Change

Annual Report 2018-19

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Report structure

The ClimateXChange (CXC) 2018-19 Annual Report has been drafted in line with the 'Centre of Expertise Annual Report Guidance' provided by our funder, the Scottish Government Rural and Environment Science and Analytical Services (RESAS).

Section 1 is a summary of major changes to CXC's external landscape, and changes to the activities or staffing of CXC in 2018-19.

Section 2 captures CXC's key highlights in 2018-19, covering what has been delivered and what impact this has had.

Annex A provides a summary of all CXC's projects in 2018-19. A short summary is provided for each project, setting out the progress made, outputs, and outcomes and impacts that have arisen for both policy teams and wider stakeholders.

Annex B lists progress ratings, as judged by the CXC Secretariat, and costings for all CXC's projects in 2018-19.

The table sets out six-monthly RAG (Red Amber Green) ratings for each project, i.e. for September 2018 and April 2019. Where a Red or Amber rating has been given for a project, a description of the problem, reason and proposed solution has been provided.

The table also includes associated costs for each project.

1. Executive summary

In 2018-19 CXC has continued to support progress on the Scottish Government's key policy challenges. We have also developed new, and further strengthened relationships outwith the Decarbonisation Division. The key policies for which we have delivered analysis and expert evidence include:

- The Climate Change (Emissions Reduction Targets) (Scotland) Bill – particularly relating to accounting mechanisms and international target frameworks.
- The Scottish Climate Change Adaptation Programme (SCCAP) – continuing to develop a monitoring and evaluation framework, and research relating to the UK Committee on Climate Change (CCC) Adaptation Committee's recommendations.
- Scotland's Energy Strategy - including the development of plans for the regulation of district heating, and exploring the potential resources and technology for bioenergy production in Scotland.
- Implementation and delivery of the Climate Change Plan: Third Report on Proposals and Policies (CCP) - analysing options for land use policy.
- Analysis to support implementation of sustainable flood risk management for both current and future climate.

CXC has responded to requests for research support across the Scottish Government in response to evolving low carbon and climate resilience strategy development and implementation.

Across all parts of our work, the UK policy context has been characterised by challenges and uncertainty around Brexit and its potential implications for climate policy and research.

At an international level, the IPCC's finding that a 1.5°C target is possible only with 'deep emissions reductions', and 'rapid, far-reaching and unprecedented changes in all aspects of society' created renewed urgency in both policy development and implementation.

This was followed by the recent report from the CCC, stating that Scotland could achieve net-zero emissions of all greenhouse gases (GHGs) by 2045, contingent on the UK adopting a target for 2050. The Scottish Government acted on the advice immediately by lodging amendments to the Climate Change (Emissions Reduction Target) (Scotland) Bill to set a legally binding target of net-zero GHG emissions by 2045 at the latest.

Organisational changes

We continue to work to a five-year plan agreed with RESAS in 2016, based on recurrent one-year funding awards. In 2018-19 there was an increase in overall CXC resource, which will be maintained for 2019-20. We will continue to use this additional resource to build our analytical capacity, particularly in terms of transport and land use.

We have worked closely with the Scottish Government Decarbonisation Division, RESAS and the Office of the Chief Economic Advisor (OCEA) on the development of CXC's programme of research. The Decarbonisation Division has coordinated a process of research project prioritisation, informed by evolving policy requirements and discussed with members of the CXC Directorate and Secretariat. This provides the CXC Secretariat with solicited project requests early in the financial year, ensuring we are able to plan across the year and respond flexibly as required.

Directorate and staff changes

Since Prof Andy Kerr's departure from University of Edinburgh, the CXC Policy Director role has been taken up by Dr Mark Winskel (an existing member of the CXC Directorate and Senior Lecturer in the School of Social and Political Science, University of Edinburgh). Prof Dave Reay (Chair in Carbon Management and Education, School of Geosciences, University of Edinburgh) has assumed the position of Principal Investigator.

Niall Kerr, CXC's PDRF on Energy Policy Effectiveness was seconded to the Scottish Government's Heat and Energy Efficiency policy team for six months between October 2018 and March 2019, and is now a part-time secondee until September 2019. CXC has also provided resource to support the Scottish Government's work on flooding with the secondment of Michelagh O'Neill.

Sarah Beattie Smith joined the team in June 2018 as maternity cover for Ciara O'Connor, who returned to work in April 2019.

Mid-Programme Review

Following the mid-programme review of the Centres of Expertise (CoEs), the CXC Directorate and Secretariat have reviewed the suggestions and recommendations made in the review and are developing approaches in response.

Longer term impacts

In 2018-19 we trialled new methods of monitoring and evaluating our impact beyond the annual reporting cycle. The nature of CXC's knowledge exchange model means that the impacts of our work often take some time to become evident. We plan to reflect on our model, and how in the future CXC could adapt and evolve to better report the outcomes of our work in responding to the Scottish Government's needs.

2. Highlights

Our work in 2018-19 has been dominated by supporting policy implementation while also offering strategic support, in a context of rising policy ambition and urgency, and a rapidly evolving evidence base. We have developed 35 projects, drawing on the expertise of 20 research partners from SEFARI institutes, Higher Education Institutions (HEIs) and the private sector, to feed into these key climate change and energy policy developments.

Adaptation

Scotland's adaptation policy framework offers a unique opportunity to achieve climate change adaptation and resilience outcomes that support wider Scottish Government objectives and also develop adaptation expertise as a competitive advantage.

Adaptation is a cross cutting issue and so, as well as working with the Scottish Government's adaptation team, we are providing support and expertise to the flood risk management and community resilience teams. Highlights include:

- Monitoring and evaluation framework – we worked alongside the Scottish Government policy team to develop a monitoring and evaluation framework that will underpin the second SCCAP (SCCAP2).
- Policy and evidence gaps – we continue to deliver support to the development of the SCCAP through analysing particular evidence and policy gaps identified in the independent assessment and through stakeholder engagement. This has included looking at issues like sea-level rise and methodologies for cross-sector work on pests and pathogens through a case study on Lyme disease.
- Economic appraisal – we delivered research that identifies the barriers to taking a managed adaptive approach to flood risk in Scotland. In 2019-20 this project will continue and test recommendations at case study sites to produce example managed adaptive plans for these locations. This will inform Scottish Government guidance for local authorities.
- Floodplain loss – identifying approaches to estimating floodplain loss, and assess their applicability in Scotland. The proposed methodology will be tested on a large scale catchment.
- Tools for joined up working – this project aims to encourage joined-up working across and between resilience and climate change policy domains in Scotland by recommending tools and techniques, and how these could be applied.

Energy

Our work in the energy field focused on supporting the implementation of commitments made in Scotland's Energy Strategy, the Energy Efficient Scotland Route Map and various consultations. Highlights include:

- District heating regulation – we delivered research on the lessons that Scotland could learn from different models of district heating regulation in other European

countries. The findings will help inform Scottish Government decisions on the type of regulation most appropriate for Scotland's growing district heating sector.

- Bioenergy – our research provides the Scottish Government with a comprehensive overview of the predicted variety, availability and viability of bioenergy resources in Scotland in 2030, as well as uncovering the expected commercial viability of conversion technologies. The research is expected to feed into the Government's bioenergy action plan.
- Energy consumers – we developed two parallel research projects to support the creation of the Scottish Government's Energy Consumers Action Plan – a commitment from the Energy Strategy. Our research included the development of new segmentation of Scottish energy consumers and a set of archetypes for use by policy makers. We also delivered research to examine the planned and likely changes in the energy landscape in the coming years, and used the newly developed archetypes to deliver a distributional impact assessment. This will support policy makers across Government to better understand the likely impact of policy decisions, including decarbonisation policy, on different groups of people.
- Cost effectiveness – our research explored different definitions of "cost effectiveness" in relation to the installation of energy efficiency measures. The findings will help inform Scottish Government policy teams in the development of the Energy Efficient Scotland programme.

Climate change policy

The Scottish Government published plans for a new Climate Change Bill in May 2018. In advance of the publication, CXC undertook a rapid evidence review of the climate legislation and targets across a range of other high ambition countries. Following publication, CXC Director Professor Andy Kerr gave evidence to the Scottish Parliament's Environment, Climate Change and Land Reform Committee on the level of ambition, the proposed new targets and the financial implications of the Bill.

CXC undertook research to support the Scottish Government's review of the Low Carbon Behaviours Framework and the development of new approaches to driving behaviour change. Our research explored different approaches to grouping the public by their attitudes towards and understanding of climate change and their related behaviours across a range of sectors.

Looking to next financial year, the CXC Secretariat has been developing new focus areas which will be key to supporting the Scottish Government in meeting its ambitious emissions reduction targets. These include exploring the potential applicability and implementation pathways for greenhouse gas removal (GGR) approaches in Scotland, and issues around the adoption of Ultra-Low Emissions Vehicles (ULEVs) such as public perception, and potential market.

Agriculture

Over the course of the year, CXC has done a significant amount of work in sectors where the CCP sets out considerable emission reductions in the years ahead. To help delivery of these commitments, we have explored several areas that will underpin the ambition to move to a low carbon farming system. Highlights include:

- Benchmarking emissions intensity – the CCP includes a key commitment to explore how the emissions intensity of red meat and dairy production can be reduced. We worked closely with the Scottish Government policy team to design and deliver a report that can inform discussions with industry stakeholders.
- Comparative analysis of farm-based carbon audits – the CCP identifies a key milestone relating to the use of on-farm carbon audits. This report was commissioned to capture at an early stage a comparison of the available tools and how they might be applied by Scottish farm businesses.
- Mitigation measures in the SMART Inventory for agriculture – In response to the recent revision of the agricultural inventory methodology, we worked with the Scottish Government policy team to explore how specific agricultural practice changes in Scotland are - or could be - recognised.

Land use, land use change and forestry

There has been less emphasis this year on wider land use issues, and we have focused on soils and effective management of peatlands.

Highlights include:

- Climate benefits of forest-to-bog restoration on deep peat – Following detailed primary research, we worked with Scottish Government policy and analytical colleagues to synthesise results of three parallel research projects, to understand the process of peatland restoration and help to deliver long term benefits. The results confirmed the benefits of forest removal on deep peats where conifer yields have been low.
- Rapid Evidence Assessment of the Market in Peat-Free Sustainable Growing Media – to support the long-term ambition to eliminate the use of peat in horticulture, we commissioned an assessment of current knowledge of the market in peat-free alternatives for horticulture in Scotland. This will help Scottish Government policy teams better understand the challenges and how policy can be designed to address them.
- The contribution of soil to Scotland's Natural Capital - we were asked by Scottish Government to explore how soils were currently captured as part of the natural capital approach, which is framed around biodiversity and ecosystems. There is widespread interest in this issue across research and policy colleagues, and our first step was to bring everyone together to share areas of common understanding and considering shared priorities for further research.

Communications and outreach

We continue to publish all our research reports, creating a synthesis of knowledge and understanding of key policy issues, best practice and experience in other jurisdictions, and policy challenges across a broad range of research topics.

Members of the CXC Secretariat are increasingly sought after as facilitators, for example in supporting research projects on natural capital and peatland. This demand is testament to our ability to create space for constructive discussion and knowledge exchange. In addition, the Secretariat provides knowledge exchange training for the CXC Postdoctoral Research Fellows (PDRFs).

CXC is also running more events and workshops to facilitate discussion of key policy challenges and present our research and analysis to customers. CXC co-hosted with the UN's Intergovernmental Panel on Climate Change (IPCC) a [panel discussion](#), attended by 275 people, on climate change action in small countries and regions. Prof Jim Skea, co-Chair of IPCC WGIII, said after the event: *'It was a delight to work with ClimateXChange and the Scottish Government. The panel gave us the opportunity to connect with the public and enabled local Scottish residents to discuss and examine climate change action from the distinct perspective of small countries and regions.'*

Alongside Adaptation Scotland and the Met Office, CXC hosted Scottish stakeholders at an [event](#) to hear about UK Climate Projections (UKCP18) and discuss how to use them, for example how they might be communicated to the public.

We also facilitated a roundtable between UK Energy Research Centre (UKERC) and the Scottish Government to share findings from a UKERC project on Continuity and Disruption in energy policy and explore new UKERC work packages in the context of Scotland's Energy Strategy. A follow-up meeting with UKERC, CXC and Scottish Government policy teams will be held in June.

Working with SEFARI

We continue to work closely with SEFARI, and supported successful SEFARI Gateway Responsive Opportunity Fund Bids for workshops on climate change projections for Scotland, and the SEPA Crop Sector Plan. We also collaborated to present the work of the CoEs at the [Royal Highland Show](#).

3. ANNEX A: Summary of all projects

3.1 Energy

In 2018-19, our energy work focused on supporting the implementation of Scotland's Energy Strategy, the CCP and the Energy Efficient Scotland Programme. This included the development of research on the regulation of district heating and exploring the potential resources and technology for bioenergy production in Scotland. We also began work with new policy teams, including the Consumer Policy and Interventions team, examining ways in which policy decisions and external changes to the energy landscape might affect Scotland's consumers.

Our post-doctoral research fellows undertook original research, ranging from modelling the likely impacts of increasing electricity demand and supply on local electricity infrastructure, evaluating the Energy Efficient Scotland pilots, and reviewing the international evidence on effective policy support for household energy efficient refurbishment. Researchers also explored ways of using modelling tools such as TIMES and CGE to better understand the potential impacts of policy decisions, including in the field of energy efficiency.

3.1.1 Energy systems and policy

Commissioned Project – The potential contribution of bioenergy to Scotland's energy system (Contact: Anna Kynaston)

- This project was commissioned by the Energy Division and OCEA to support the development of the Scottish Government's bioenergy action plan. The research set out an evidence base on the nature and quantities of biological resources within Scotland that could be used for bioenergy, and the conversion technologies that could be deployed to utilise them. The timescale of the report is through to 2030 to reflect the focus within the Energy Strategy on near term actions.
- The project report provides a comprehensive picture of the predicted variety, availability and viability of bioenergy resources in Scotland in 2030, as well as uncovering the expected commercial viability of conversion technologies. The final report will be published in May.

Commissioned Project – Domestic energy consumer types and Changes to the energy landscape and potential impacts on Scotland's consumers (Contact: Karen Dickson, Cheryl McNulty)

- This commissioned research consisted of two parallel projects. The first explored different approaches to grouping energy consumers in order to build a new set of energy consumer archetypes for the Scottish Government. The second reviewed the planned and likely changes to the energy landscape in the next five years, including many driven by a decarbonisation agenda. The research then used the newly developed archetypes to undertake a distributional impact assessment of these planned changes on different groups of Scottish energy consumers.

- These projects were commissioned by the Consumer Policy and Interventions team in conjunction with OCEA.
- The results of the research will help policy makers to consider the potential impacts of policy on different groups of energy consumers and to identify and mitigate any potential detriment caused to certain groups.

Commissioned Project – [A survey of energy experts, working with UKERC's Continuity and Disruption project](#) (Contact: Mike King, Kat White)

- The Scottish Government and CXC supported an extension to UKERC's large scale expert survey sub-project, to consider the emerging results in the context of the Scottish Energy Strategy (2017) and CCP (2018).
- Activities supported during the extension included the development of policy recommendations and a briefing note. The results were published as a Briefing Note at the start of April 2019, and a detailed working paper on the results was made available to staff within the Scottish Government's Energy Directorate.
- A follow-up discussion of the implications of the work involving CXC, UKERC and Scottish Government is planned for June.

PDRF Project – Energy economics (Contact: Sasha Maguire, Stephen Cox)

- This post-doctoral research examined the economic impacts of Scottish Government energy policies, linking the multi-sectoral economic model and the Scottish Government TIMES system. The research also modelled the potential impacts of Energy Efficient Scotland, using TIMES.
- The researcher continues to collaborate with the CXC PDRF working on the energy system impact on energy efficiency including a workshop to present the TIMES/CGE part of the project, planned for May 2019.
- The researcher worked closely with analysts in OCEA, and research is expected to inform Scottish Government approaches to energy modelling.

PDRF Project – Energy Policy effectiveness (Contact: Gareth Fenney, Suzie LeMiere)

This research is aimed at building an understanding of the effectiveness of energy policies and interventions, particularly in relation to heat and energy efficiency programmes. It developed a method for Scottish energy policy assessment based on systematic evidence review.

- The [Private household investment in home energy retrofit: reviewing the evidence and designing effective public policy](#) report was published in June 2018. The review considers both policy effectiveness, in terms of the overall amount of energy and carbon savings achieved; and policy efficiency, in terms of maximising the ratio of private-to-public spending and the number of measures that otherwise would not have happened.

- The [‘Household investment in home energy retrofit – designing effective policy’](#) event was hosted in May 2018 on the role of evidence and evidence review in energy policy
- This project was commissioned by energy teams, and the post-holder was seconded to the Scottish Government in 2018-19 to work on off-gas-grid low carbon heat. He is now continuing his CXC fellowship research, while also working as a part-time secondee in Government.

PDRF Project – Energy system implications of a shift to more localised energy production (Contact: Anna Kynaston, Christine McKay, Heather Stewart, Stephen Cox)

- This research seeks to investigate the technical and regulatory implications of moving to a local, decentralised energy system. In particular, it explored the likely impact on electricity infrastructure of increases in both demand (e.g. from electric vehicles and increasing electric heat) and supply (e.g. from increasing renewable generation). The research developed a toolkit used to model local demand and generation up to 2030.
- This project is managed by energy policy teams and by OCEA and will support the Scottish Government and network operators to understand and plan for potential impacts of decarbonisation on electricity infrastructure.
- A [summary report](#) on the Year 2 outputs from this research was published in December 2018.
- A closer engagement with Scottish electrical Distribution Network Operators (DNOs) is being pursued to ensure that model outputs are contextualised inline with their operational procedures and are reflective of their current approaches to grid management (e.g. Flexibility First).

3.1.2 Energy efficiency and heat

Commissioned Project – [Lessons from European regulation and practice for Scottish district heating regulation](#) (Contact: Jack Causley, Ross Loveridge)

- This commissioned research explored the different models of regulation of district heating employed in seven different European countries, and uncovered key lessons for Scotland as the Government develop plans for regulation.
- The project was commissioned by the heat policy team and OCEA
- The findings will help inform Scottish Government decisions on the type of regulation most appropriate for Scotland's growing district heating sector.

Commissioned Project – Literature review of the definition of cost effectiveness in relation to energy efficiency (Contact: Allie Clarkson, Jack Causley)

- This research consisted of a literature review to identify the range of definitions of cost effectiveness which exist in theory and in practice in relation to energy

efficiency. The research explored the pros and cons of each definition where the literature allowed, and identified common themes.

- This project was commissioned by Housing Quality and Sustainability Analysis in conjunction with OCEA
- The research is expected to inform the development of the Energy Efficient Scotland Programme.

PDRF Project – Evaluation of the Energy Efficient Scotland pathfinder pilots (Contact: Kathleen Robertson, Jack Causley)

- This post-doctoral research includes an evaluation of the Local Authority-led integrated energy efficiency pilots contributing to Energy Efficient Scotland. The research examines project governance, management, partnership structure, and resulting behavioural impacts.
- As part of this research a workshop on [Scottish policy for energy efficiency and buildings](#) was held in June 2018. A [report](#) on Phase 1 of the pilots evaluation was published in November 2018.
- The researcher [responded](#) to the Scottish Government's 'Energy Efficiency Scotland Consultation: Making our homes and buildings warmer, greener and more efficient' in July 2018.
- This project was commissioned by energy teams and is carried out in conjunction with Heat and the City. The research is expected to inform the design and delivery of Energy Efficient Scotland.

PDRF Project – Energy system impacts of energy efficiency (Contact: Sasha Maguire)

- This research is exploring the impacts of energy efficiency changes linked to Energy Efficient Scotland and considers how TIMES and AMOS may be used to provide additional insights on co-benefits of energy efficiency improvements.
- A report published in October 2018 looked at different approaches to modelling energy efficiency within TIMES, and examined the implications of these different approaches, discussing best practice to inform energy efficiency policy.
- The researcher continues to work in collaboration with the CXC Economics PDRF on comparability and potential interactions of TIMES with economy-wide CGE models.
- This research was referenced by the Scottish Parliament Environment, Climate Change and Land Reform Committee in their Stage 1 Report on the Climate Change (Emissions Reduction Targets) (Scotland) Bill.

3.2 Forestry

The CXC Forestry input in 2018-19 was mainly in support of the Forestry Commission Scotland (FCS) focus on implementing the Forestry and Land Management (Scotland) Act 2018. In particular, building on a CXC workshop in the previous year, Forest Research

worked closely with FCS staff to produce an 'Evidence Report' on Adaptation strategies to build resilience to pests, diseases and climate risks in Scotland's forest resource. We have remained in regular contact with policy colleagues and continue to discuss priorities.

PDRF Project – Adaptive forest management (Contact: Maida Ballarini, Bob Frost – FCS)

- This project has been developing wind risk assessment tools for the Scottish forestry sector, to understand vulnerability in particular locations and how tree stands can be used to manage risk and enhance adaptation. A [report](#) was published highlighting opportunities for the forestry sector to learn from risk measurement and management approaches in the finance sector, some of which may be helpful in climate change adaptation in forestry.

3.3 Peatlands and Soils

CXC's support for peatland research continued this year, reflecting the Scottish Government's priorities set out in the CCP to minimise emissions through restoration of peatlands. Our focus this year was in supporting communication of baseline knowledge on forest-to-bog restoration and on the current state of the market in alternatives to horticultural peat products.

We have also been asked to bring our facilitation expertise to this field, with a particular focus on steps to develop a research and monitoring framework for peatlands in Scotland.

Commissioned Project – Climate benefits of forest-to-bog restoration on deep peat (Contact: Sandra Marks)

- This project has synthesised results of parallel research projects on forest-to-bog restoration, inclusive of wider understanding of the restoration proves and how restoration helps to deliver long term benefits.
- The project collated data of the response of GHG emissions and losses of aquatic carbon when trees are removed from former conifer plantations on deep peat and the drainage channels are blocked as part of peatland restoration management.
- The results confirmed the benefits of forest removal on deep peats where conifer yields have been low. In addition to habitat improvements there is a long-term climate benefit that is unlikely to be matched by forestry.

Commissioned Project – Rapid Evidence Assessment of the market in peat free sustainable growing media (Contact: Heather McCabe)

- CXC was asked to commission an assessment of current knowledge of the market in peat-free alternatives for horticulture in Scotland, using the rapid evidence assessment approach.
- It assessed the evidence base for peat-free alternatives in the market for sustainable growing media in order to understand the state of confident knowledge (what is known, what is not known and what is currently under active debate).

- The project was commissioned on behalf of the Environmental Quality Division of Scottish Government and supports delivery of their long term ambition set out in the CCP for a thriving and sustainable expanded peatland resource.

Programmed Work - Research and Monitoring Framework for Peatlands (Contact: Heather McCabe, Andrew Coupar – SNH)

- CXC was asked by Scottish Government and Scottish Natural Heritage (SNH) to commission a scoping exercise for a National Peatland Monitoring Framework, to inform the design of a peatland monitoring process for Scotland.
- A first step was to facilitate a cross-sectoral, inter-disciplinary workshop of key stakeholders to explore priorities that should be addressed. This project formed a first phase of work and generated a scoping paper based on the agreed policy provisions to capture the current and potential delivery mechanisms for monitoring and reporting progress.
- A second step is an ongoing project that will produce a summary paper of current monitoring efforts and existing datasets in relation to indicators for current policy targets, alongside SWOT and gap analysis. This work will help to inform Scottish Government and SNH of options to monitor peatland condition over the longer term.

Programmed Work – The contribution of soil to Scotland's Natural Capital (Contact: Heather McCabe, Chris Dodds)

- This project was commissioned in response to a request from Scottish Government to explore how soils were currently captured as part of the natural capital approach, which is framed around biodiversity and ecosystems.
- As a first step, a workshop of researchers and policy officials was held to explore the current state of knowledge on the contribution of soils, and how this might support the needs of Scottish Government in their application of the Natural Capital Accounting approach.
- A report of the workshop is in preparation, and will inform further discussions.

3.4 Agriculture

The CXC focus on agriculture has been driven by the CCP, published in February 2018 and including five priority policy outcomes designed to deliver considerable emission reductions in and a shift to a low carbon farming system.

Programmed Work – [Comparative analysis of farm-based carbon audits](#) (Contact: Keith McWhinnie)

- Farm-based carbon audits are one of the tools that could help reduce GHG emissions in the farming sector. CXC was asked by Scottish Government to commission a

comparative analysis of the available tools to assess their potential application in Scotland.

- This project informed a first step in Scottish Government's delivery of a key CCP milestone (page 197).

Commissioned Work – A framework for benchmarking GHG emissions intensity in Scottish farming (Contact: Keith McWhinnie)

- This project presents a framework methodology to guide the assessment of GHG emissions intensity in beef enterprises in Scotland, and includes a method for scaling up to obtain an estimate of beef GHG emissions intensity for Scotland. It relies on existing tools that have been widely tested.
- This project was commissioned for Scottish Government, and is one of the steps towards delivery of CCP policy outcomes in reducing emissions from red meat and dairy production.

Programme Work - Mitigation measures in the SMART inventory for agriculture (Contact: Keith McWhinnie)

- This report summarised the extent to which certain agricultural practice changes in Scotland are recognised in the smart inventory for agriculture (recently revised to better reflect the relationship between agricultural management and GHG emissions).
- This assessment will inform Scottish Government about the agricultural practices that are reflected in the UK GHG inventory, and what further steps could be made to represent Scottish circumstances more accurately.

Programmed Work – Potential for nitrogen fixing crops in Scottish agriculture (Contact: Keith McWhinnie)

- Scottish Government asked CXC to commission a research briefing to capture the current state of confident knowledge on the practical benefits of nitrogen-fixing crops in Scottish agriculture.
- This report is intended to inform the process for delivery of the CCP policy outcome on the reduction of emissions from nitrogen fertilisers.

Programmed Work – Payment for carbon sequestration in soils scoping study (Contact: Keith McWhinnie)

- This project examined the state of confident knowledge on how carbon is sequestered in soil, the potential for carbon sequestration in Scottish agricultural soils, and how this might be incentivised in practice through land management support.

- It was commissioned by Scottish Government to inform delivery of the CCP policy outcome on how carbon sequestration on agricultural land might help to increase our national carbon sink.

3.5 Adaptation

We continue to work closely with the Scottish Government Adaptation team to realise the potential of climate change adaptation in reaching wider Scottish Government objectives and realising climate change adaptation as a competitive advantage. A cornerstone has been supporting the development of an outcomes focused framework for the second SCCAP and following up on the recommendations made in the Committee on ClimateChange Adaptation Committee's assessment.

We are increasingly providing adaptation research support across the Scottish Government and are providing support and expertise to the flood risk management and community resilience teams, in addition to working with the adaptation team.

Commissioned Project – [Climate change and Scottish businesses: scoping likely direct and indirect impacts, and the sector's awareness, approaches and risk assessment procedures](#) (Contact: Lorraine Gormley)

- Project developed methodology for assessing risk and awareness. The work is referenced in the final assessment of the SCCAP.

Commissioned Project – [Using climate projections in economic appraisal for flood risk management measures](#) (Contact: Claire McCraw)

- Phase 1 has reviewed Scottish practice of using a managed adaptive approach in flood risk management in relation to international best practice.
- A Phase 2 will test a best practice approach on selected Scottish case study flood risk management projects.

Commissioned Project – [Encouraging joined-up working across resilience and climate change policy domains](#) (Contact: Ralph Throp)

- Climate change risks are increasingly important in resilience planning. This project is looking at tools and techniques for joined-up working across policy areas involved in emergency and longer term resilience planning.
- It is anticipated that a selection of tools/techniques can be tested in implementing SCCAP2 and other resilience planning.

Commissioned Project – Direct and indirect effects of climate change on social care delivery
(Contact: Lorraine Gormley)

- A phase 1 literature review has mapped current gaps in data on the social care sector's vulnerability to climate change.
- Further work is being considered in light of the Adaptation Committee's recommendations in the final assessment of the first SCCAP.

Commissioned Project - The impact of incremental and piecemeal reduction in functional fluvial floodplain on flood risk management in Scotland (Contact: Claire Dodd)

- As climate change increases flood risk the impact of incremental loss of flood plain becomes more important.
- Phase 1 of this project has developed a methodology for a pilot catchment study in Scotland.

PDRF Project – Adaptation Science (Contact: Gavin Barry)

- The fellowship has supported the outcomes focused framework for SCCAP2 with a particular focus on monitoring & evaluation, and adaptation governance. The fellow, Dr Anna Moss, University of Dundee, attends the Scottish Government adaptation team's regular SCCAP checkpoint meetings.
- The fellow has developed detailed proposals for indicators relating to the objectives and actions identified to date. This work will continue following public consultation on the draft SCCAP2 in spring 2019.
- [Preparatory research](#) has been published on the CXC website.

PDRF Project – Adaptation Policy (Contact: Gavin Barry)

- Support to fill evidence gaps for SCCAP2.
- The fellow has delivered reports analysing evidence and policy gaps identified in the Adaptation Committee's independent assessment and through stakeholder engagement.
- Two separate reviews delivered on sea-level rise and methodologies for cross-sector work on pests and pathogens (a case study on Lyme disease).

Climate change adaptation indicator updates 2018

- A total of 25 adaptation indicators across the natural environment, buildings and infrastructure networks, and the society theme were updated for the final assessment of progress by the Committee on Climate Change Adaptation Committee.
- Both adaptation fellows worked on these [updates](#) which have been published on the CXC website.

Stakeholder event – CXC report on incorporating climate change adaptation in housing policy delivery (Contact: Lorraine Gormley)

- Based on the case studies identified in the above project we held a stakeholder event to identify ways the lessons could be incorporated into their plans and practices.
- A number of suggestions will be considered in relation to implementing SCCAP2 policies and testing tools/techniques for better joined up working across policy areas.

3.6 Behavioural and social change

Programmed Work – Climate Challenge Fund – three year study of the behaviour change outcomes (Contact: Penny George, Emily Creamer)

- Year two of three. A study of effectiveness of the Climate Challenge Fund (CCF) in engendering behaviour change. This three-year project was commissioned to examine how community-based initiatives can effectively improve engagement with climate change (including behaviours of individuals) to mitigate climate change.
- The research team are liaising with policy colleagues in Scottish Government to communicate what they are learning as the project evolves. It is due to report in full in March 2020. Three interim progress reports have been submitted and will be published on the website.

3.7 General – climate policy

Commissioned Project – Quality assurance of comparison of international climate change target framework table (Contact: Alistair Montgomery)

- The Scottish Government prepared comparisons of GHG emission reduction targets for leading climate change jurisdictions, and requested CXC conduct a [review](#) of the accuracy of the comparisons and research additional relevant information.
- CXC commissioned a desk review of online sources on domestic GHG emission reduction targets for the selected entities in order to confirm the assessment, which was found to be accurate subject to minor clarifications.

Commissioned Project – Preparation of a climate change knowledge account (Contact: Tracy McCollin)

- This research involves the development of a knowledge account on climate change.
- It will complement a series of accounts already published in draft from by the Scottish Government as part of their discussion paper on the development of an environmental strategy for Scotland.

Commissioned Project – Approaches used to develop national plans for climate change mitigation commitments (Contact: Sara Grainger, Tracy McCollin)

- This research builds on previous CXC assessments which examine climate change target frameworks elsewhere. This research is being commissioned to explore the design, implementation, governance and monitoring of nationwide climate plans elsewhere.
- The research is examining the details of climate mitigation plans in other jurisdictions; the key similarities and differences between these plans and the Scottish Government's proposed Climate Change Bill and 2018 CCP and the internal and external processes used to develop climate mitigation plans in other jurisdictions.
- This project will conclude in May 2019.

Commissioned Project – Climate change behaviours – segmentation study (Contact: Hannah Garrow, Gill McCrum)

- This research has been commissioned to explore public attitudes and behaviours related to climate change, and the ways that these could be used to group the public for policy and engagement purposes.
- The research reviews the latest evidence on the relationship between awareness of climate change, climate literacy, attitudes towards climate change and low-carbon or pro-environmental behaviours.

4. List of acronyms

CCC – Committee on Climate Change

CCF – Climate Challenge Fund

CCP – Climate Change Plan: Third Report on Proposals and Policies 2018 – 2032

CGE – Computable General Equilibrium

CoEs – Centres of Expertise

CXC – ClimateXChange

DNOs – Distribution Network Operators

FCS – Forestry Commission Scotland

FR – Forest Research

GGR – Greenhouse Gas Removal

GHG – Greenhouse Gas

HEI – Higher Education Institutions

IPCC – The Intergovernmental Panel on Climate Change

IPCC WGIII – Working Group III of the IPCC

PDRF – Post Doctoral Research Fellow

RESAS – The Scottish Government's Rural and Environment Sciences Analytical
Services

SCCAP – Scottish Climate Change Adaptation Programme

SCCAP2 – The Second Scottish Climate Change Adaptation Programme

SEFARI – The Scottish Environment, Food and Agriculture Research Institutes

SEPA – Scottish Environment Protection Agency

SNH – Scottish Natural Heritage

SRUC – Scotland's Rural College

SWOT – Strengths, Weaknesses, Opportunities and Threats

TIMES – The Integrated MARKAL-EFOM System

OCEA – The Scottish Government Office of the Chief Economic Advisor

UKCP18 – UK Climate Projections 2018

UKERC – UK Energy Research Centre

ULEV – Ultra-Low Emission Vehicle