



Advice on the new Scottish Climate Change Bill

Committee on Climate Change
March 2017



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Foreword

The Scottish Government has committed to introducing a new Scottish Climate Change Bill. Recognising progress in Scotland and the Paris Agreement, this will include an ambitious new target of reducing emissions by more than 50% against 1990 levels by 2020. Additionally, it will propose a new system of emissions targets for Scotland, based on experience to date with Scotland's existing annual targets regime.

The Committee on Climate Change has been asked by the Scottish Government to provide advice on how the new Bill may look, including the level of ambition of new Scottish climate targets, and the accounting framework within which to measure emissions.

When we look at what is being achieved in Scotland to date, we can also see that substantial progress is being made. Actions are being taken – with most obvious effect in the power sector, but also elsewhere – which are reducing emissions. In 2014 the level of emissions was around 40% below 1990. This is a greater reduction than for the UK as a whole and on track to the existing 2020 target. Scotland has recently published a draft Climate Change Plan and a draft Scottish Energy Strategy, outlining how it intends to meet existing emissions targets over the next 15 years. We will return to make a fuller assessment of these documents, alongside progress in reducing emissions in a report later this year.

In this report we provide advice to the Scottish Government on the form of future emissions reduction targets and the future accounting framework. Additionally, recognising Scotland's climate change leadership to date, we present options for ambitious long-term emissions reduction targets for the Scottish Government to consider.

Our advice takes account of the budget-setting criteria in Scotland's Act, and specific circumstances relevant to Scotland. We have benefited from engagement with interested parties, including at our Committee meeting in Edinburgh in January and responses to our call for evidence. I am grateful for that engagement, for the contributions and guidance of members of the Committee in developing the advice, and to the team within the secretariat who have contributed to its delivery.



Lord Deben
Chairman, Committee on Climate Change

The Committee



The Rt. Hon John Gummer, Lord Deben, Chairman

The Rt. Hon John Gummer, Lord Deben, was the Minister for Agriculture, Fisheries and Food between 1989 and 1993 and the longest serving Secretary of State for the Environment the UK has ever had. His sixteen years of top-level ministerial experience also include Minister for London, Employment Minister and Paymaster General in HM Treasury. He has consistently championed an identity between environmental concerns and business sense. To that end, he set up and now runs Sancroft, a Corporate Responsibility consultancy working with blue-chip companies around the world on environmental, social and ethical issues. Lord Deben is Chairman of the Committee on Climate Change, Valpak Limited, and the Association of Professional Financial Advisors.



Professor Nick Chater

Professor Nick Chater FBA is Professor of Behavioural Science at Warwick Business School, having previously held chairs in Psychology at Warwick and University College London (UCL). He is particularly interested in the cognitive and social foundations of rationality, and in applying behavioural insights to public policy and business. He has served as Associate Editor for the journals *Cognitive Science*, *Psychological Review*, *Psychological Science* and *Management Science*. He co-founded and is a Director of the research consultancy Decision Technology Ltd.



Professor Sir Brian Hoskins

Professor Sir Brian Hoskins CBE FRS is the Chair of the Grantham Institute for Climate Change and the Environment at Imperial College London and Professor of Meteorology at the University of Reading. His research expertise is in weather and climate processes. He is a member of the scientific academies of the UK, USA, and China. He has received the top awards of the American and UK Meteorological Societies, the inaugural Gold Medal of the International Union of Geodesy and Geophysics, and the Buys Ballot Medal of the Royal Netherlands Academy of Sciences and Arts which is awarded every 10 years.



Paul Johnson

Paul is the Director of the Institute for Fiscal Studies and is a visiting professor at UCL. He is widely published on the economics of public policy including tax, welfare, inequality and poverty, pensions, education, climate change and public finances. He is also one of the authors of the “Mirrlees review” of tax system design. Paul has previously worked at the Financial Services Authority and has been Chief Economist at the Department for Education and Director of Public Spending in HM Treasury, as well as Deputy Head of the UK Government Economic Service. He is a member of the council and executive committee of the Royal Economic Society and a member of the banking standards board. Paul has previously served on the council of the Economic and Social Research Council. He was a founder council member of the Pensions Policy Institute and in 2010 he led a review of the policy of auto-enrolment into pensions for the new Government.



Baroness Brown of Cambridge

Baroness Brown of Cambridge DBE FREng (Julia King) is an engineer, a crossbench member of the House of Lords, and Chair of the CCC’s Adaptation Sub-Committee. Energy and climate-related interests include being the UK’s Low Carbon Business Ambassador; membership of the World Economic Forum Global Agenda Council on Decarbonizing Energy; a non-executive director of the Green Investment Bank, and of the Offshore Renewable Energy Catapult. She is Chair of the Henry Royce Institute for Advanced Materials and of STEM Learning Ltd, a non-for-profit company providing continuing professional development for science teachers in UK schools. She is a former Vice Chancellor of Aston University, with an academic and industrial career at Cambridge University, Imperial College, London and Rolls-Royce plc where she held senior engineering and manufacturing posts.



Professor Corinne Le Quéré

Professor Corinne Le Quéré FRS is Director of the Tyndall Centre for Climate Change Research and Professor of Climate Change Science and Policy at the University of East Anglia (UEA). She conducts research on the interactions between climate change and the carbon cycle. She has authored multiple assessment reports by the Intergovernmental Panel on Climate Change (IPCC), and is a member of the Scientific Committee of the Future Earth research platform for global sustainability.



Professor Jim Skea

Professor Jim Skea has research interests in energy, climate change and technological innovation. He has been RCUK Energy Strategy Fellow since April 2012 and a Professor of Sustainable Energy at Imperial College since 2009. He was Research Director of the UK Energy Research Centre 2004-12 and Director of the Policy Studies Institute 1998-2004. He has operated at the interface between research, policy-making and business throughout his career. He is President of the Energy Institute and was elected co-Chair of IPCC Working Group III in 2015. He was awarded a CBE for services to sustainable energy in 2013 and an OBE for services to sustainable transport in 2004.

Executive Summary



Scotland has cut its emissions by around 40% from 1990 to 2014. The legislation governing Scottish action on climate change is being replaced. This provides an opportunity to update the level of ambition following the Paris Agreement and to improve upon the existing framework under the Climate Change (Scotland) Act 2009 and reflect lessons learned.

The Committee on Climate Change (“Committee”) was asked by the Scottish Government to provide independent advice on four elements relating to the new Bill: the appropriate level of future emissions, the form of future emissions targets, the future accounting framework, and flexibility to update emissions targets.

Following the commitment under the Paris Agreement to limit warming to well below 2°C and to pursue efforts to limit it to 1.5°C, there is a case – whether now or at a future date – for ambition that goes beyond Scotland’s existing 2050 target for a reduction of at least 80% on baseline levels (effectively 1990 emissions). Scotland could either enact more ambitious long-term emissions targets now or wait until the evidence base has been strengthened over the coming years. There are also opportunities to improve the way the targets are designed, improving their stability and transparency.

Our key recommendations are:

- **The 2050 target.** Scotland’s existing 2050 target is for a reduction in greenhouse gas (GHG) emissions of at least 80% on 1990. It is designed as a contribution towards a global effort to limit temperature rise to close to 2°C, and is already stretching. Setting more ambitious targets now to align to the aims of the Paris Agreement would require actions that are currently at the very limit of feasibility. We set out two options for the level of long-term ambition but urge that these are considered in light of the wider explanation and considerations set out in this advice (e.g. see Box ES1):
 - **Option 1: Keep the target for a reduction in greenhouse gas emissions of at least 80% by 2050 with subsequent reviews to increase ambition.**
 - This maintains the same level of ambition as the existing Act in Scotland and the UK Climate Change Act, consistent with limiting global temperature rise to around 2°C.
 - The option to go further should be kept open in regard to both policy ambition, (i.e. through suitably ambitious targets to 2030 and by ensuring longer-term markets and technologies are developed) and in legislation, by setting review points at which ambition could be increased. Reviews should be aligned to the pledge-and-review process created by the Paris Agreement.
 - **Option 2: Set a ‘stretch’ target for a reduction in greenhouse gas emissions of 90% by 2050, potentially accompanied by a net-zero CO₂ target for 2050.**
 - A 90% reduction in greenhouse gas (GHG) emissions would be more consistent with the temperature limits set out in the Paris Agreement. Our scenario that achieves such a low level of GHG emissions does so by reducing CO₂ emissions to around zero (non-CO₂ emissions would remain greater than zero). Setting a target now to reach net-zero CO₂ emissions by 2050 would be consistent with a GHG target for a 90% reduction by the same date and would reflect the acknowledgement in the Paris agreement of the necessity for zero global GHG emissions in the second half of the century.
 - However, a reduction in GHG emissions of 90% would require strong progress in every sector and is at the limit of the pathways currently identified to reduce Scottish

emissions.¹ By adopting a more ambitious 2050 target than currently exists for Scotland, or for the UK as a whole, it would be important to identify the areas in which Scotland will go further than the rest of the UK.

- **The Bill should allow for dates to be set to reach net-zero CO₂ emissions and to reach net-zero for all greenhouse gases.** A net-zero CO₂ target could be set now or at a future review point once criteria relating to feasibility, cost and international action are met. A net-zero target for all greenhouse gases should not be set now, but the possibility to set one in the future should be allowed in the new Bill. These review points could accompany a review of the level of the 2050 target and should be aligned with the pledge-and-review process under the Paris Agreement.
- **We recommend that the overall accounting framework shift to one based on actual emissions** rather than adjusting for activity in the EU Emissions Trading Scheme as at present ('net' accounting). A shift to using actual emissions would be more transparent than the existing framework and would encourage decarbonisation in all sectors of the economy. However, consideration should be given to particular provisions for some industrial sectors:
 - It is important that where there is a risk of displacement of industrial activity to other countries with less stringent climate policies (i.e. 'carbon leakage') policy does not encourage a reduction in Scottish industrial output. It will be important that climate policies are designed carefully to avoid this risk.²
 - The level of industrial activity in Scotland could turn out to be higher or lower than that anticipated when setting emissions targets. In the case that this difference in output is large, this could constitute a significant change in circumstances that warrants reviewing the level of emissions targets so as to maintain the level of ambition for emissions reduction across the rest of the economy.
 - Should industrial output be higher than anticipated, causing actual emissions to be higher than the target, it could be reasonable for international emissions credits to be used to offset these additional emissions.
- Beyond the role for purchase of credits in the case of increased industrial output outlined above, **the option to purchase credible, international emissions credits should be retained to provide flexibility** in the case that there is unexpected, sustained under-performance against annual targets. However, **their role should be as a back-up option** rather than their use being planned for and should require prior advice from the Committee.
- **We recommend that Scotland's shares of international aviation and international shipping emissions be included within Scottish targets.** Given our recommendation that emissions accounting be based on actual emissions, rather than 'net' emissions used for UK carbon budgets, their inclusion on the basis of fuel sales would present no practical challenges. Scotland should still pursue international policy action (rather than unilateral action) to reduce emissions in these sectors.

¹ Based on current projections of Scottish population and demand, the current emissions inventory and our current understanding of technology and behaviours.

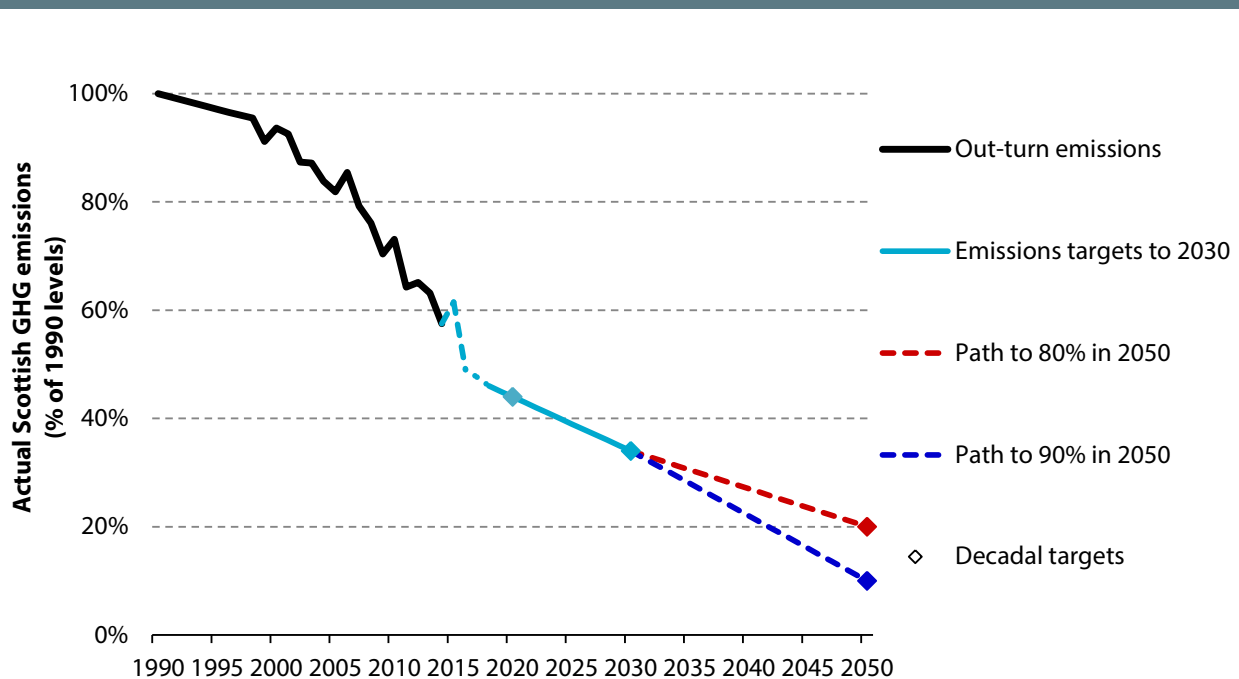
² Our recent report on Energy Prices and Bills looks at UK industry and how climate policies can avoid adding to competitive pressures for industries in highly-traded sectors. It is available at: <https://www.theccc.org.uk/publication/energy-prices-and-bills-report-2017/>

- **A target should be set now for an emissions reduction of 66% by 2030 on 1990 levels, supported by targets for 2020 and 2040.** The reductions would be on track to both an 80% and a 90% emissions reduction by 2050 (Figure ES1), and would therefore help to keep in play the more ambitious targets whether or not they are set in legislation now.
 - **2020 target:** There is little time now to adjust policy action to affect progress towards a 2020 target, and there will be even less by the time the new legislation becomes law. Nevertheless, recognising prior commitments to setting an interim target for 2020, we recommend that this be set at 56% below 1990 emissions, in line with existing plans.
 - **2030 target:** The recommended 2030 target for a reduction of 66% on 1990 emissions is consistent with the ambition embodied by Scotland’s annual targets to 2032 under the existing Act. It differs in the headline reduction as it is based on actual emissions, whereas the annual targets were based on ‘net’ accounting.
 - **2040 target:** An interim target for 2040 would only be helpful once the level of ambition for 2050 has been settled. If not set now, we recommend that the Bill allows for an interim target for 2040 to be set at a later date, as part of a review of 2050 ambition.
- **We recommend that all targets under the new Bill are expressed relative to emissions in 1990** as percentage reductions, rather than on an absolute (i.e. megatonne) basis.³
 - This will ensure the targets are less sensitive to changes in the emissions inventory than use of absolute targets and will therefore be a more stable basis to drive policy action.
 - Using a single basis for targets avoids the situation under existing Scottish targets in which the annual (absolute) targets and interim (percentage reduction) targets have become misaligned (e.g. for 2020).
- **We recommend that a cumulative emissions budget is not included directly within the Bill,** due to the potential for it to come out of alignment with percentage targets for specific years.
 - Our assessment is that a cumulative emissions budget is of less practical use in driving decarbonisation than targets for specific years. However, the Committee will continue to use the principle that cumulative emissions are important as an input to our advice on the future level of Scottish targets.
 - A mechanism to require that shortfalls against annual targets be made up in subsequent years could still be implemented without the link to an explicit cumulative emissions budget. Should cumulative under-performance from unexpected events reach a level that it is not credible to compensate through future out-performance, credit purchase could be considered.
- **Flexibility to update emissions targets.** We have set out our recommendations on the targets that can be set now, including those subject to review, and targets that could be set at a later date and for which the legislation should make allowance. Beyond this, should there be a significant change in circumstances (e.g. as for industry above) or available evidence, it may be appropriate for the Committee to review the levels of the targets.

³ Formally, the reduction under the Climate Change (Scotland) Act is against ‘baseline’ emissions, calculated from 1990 emissions for all greenhouse gases except for HFCs, for which the earliest available data (1995) is used. Throughout this report, unless otherwise specified, references to 1990 emissions should be taken to mean ‘baseline’ emissions for the purposes of putting the targets into legislation.

- It is important to have targets that track progress over specific timescales. **Annual targets are widely accepted by stakeholders in Scotland and we operate under the assumption that the Bill will provide for the continuation of this approach.** However, annual targets and multi-year (e.g. 5-year) carbon budgets, as used under the UK Climate Change Act, each have their advantages and disadvantages.
 - Annual targets ensure robust, regular scrutiny of policy and progress but are more vulnerable to year-to-year fluctuations in emissions (e.g. due to variations in winter temperatures affecting heating demand).
 - These fluctuations are smoothed within multi-year budgets, which provide a more reliable indicator of underlying progress. Multi-year budgets need not result in a loss of annual scrutiny.
 - Retaining annual targets would mean that targets for some years will be missed due to external factors, even if underlying policy action is on track to the decadal targets.
 - Should the Scottish Government choose to change to multi-year budgets, it would be important to retain annual scrutiny of performance against the targets given the need for consistent progress in reducing emissions. One option would be to ensure that the annual reporting from the Committee to the Scottish Parliament continues and that the Government is required to respond to the Committee’s findings.

Figure ES1. Recommended targets for 2020 and 2030 on the path to possible 2050 targets



Source: NAEI (2016); CCC analysis.

Notes: For years prior to the new targets starting, the dashed line shows projected emissions consistent with the subsequent targets. These include an anticipated rebound in emissions in 2015 due to winter temperatures being lower than those in 2014, followed by a sharp fall for 2016 due to the closure of the Longannet coal-fired power station.

Box ES1. Detailed recommendations on long-term climate targets

Should a new 2050 target of 90% be adopted it would be close to the achievable limit supported by existing evidence. It is important to acknowledge the scale of that challenge. We therefore set out two options for the level of long-term ambition under Scottish targets:

- **Option 1: Keep the target for a reduction of at least 80% by 2050 with subsequent reviews about increasing ambition.** Maintain the current level of ambition for 2050 of a greenhouse gas emissions reduction of at least 80% on 1990 levels, while retaining the option to increase ambition in future. The option to go further should be kept open within legislation and in policy decisions:
 - It would be appropriate to identify in legislation specific points in time (e.g. in line with the pledge-and-review process created by the Paris Agreement) at which the levels of ambition for 2050 could be independently reviewed, with one or more dates being set to decide when to reduce emissions to net zero on a CO₂ and/or on an all-GHG basis.
 - The Paris Agreement means that greater global ambition is needed. It is important for current policy to anticipate this change even ahead of a specific date being set. It is therefore appropriate to set targets at least to 2030 that keep open the option of more ambitious longer-term reductions.
- **Option 2: Set a 'stretch' target for a greenhouse gas reduction of 90% by 2050, potentially accompanied by a net-zero CO₂ target for 2050.**
 - The Committee's most ambitious scenario for Scotland achieves a reduction in overall greenhouse gas emissions of around 90% on 1990 levels by 2050. This is at the limit of the measures the Committee has identified to reduce emissions in Scotland and would require strong progress across every area of the economy. The Committee has not, at this time, been able to calculate a total cost associated with a scenario that achieves this target.
 - The scenario that achieves a 90% reduction in GHG emissions in 2050 does so by reducing CO₂ emissions to around zero, with the residual net positive emissions comprising non-CO₂ greenhouse gases (primarily methane and nitrous oxide from farming). Therefore, setting a target now to reach net-zero CO₂ emissions by 2050 would be consistent with a GHG target for a 90% reduction by the same date.
 - The Committee does not currently have a scenario that reduces net greenhouse gas emissions to zero by 2050. The legislation should allow for a target for greenhouse gas emissions to reach net zero to be set at a future date, once the evidence base has been strengthened.
 - In order to achieve a 90% target, strong and well-designed policies would be required. By adopting a more ambitious 2050 target than currently exists for Scotland, or for the UK, it would be important to identify the areas in which Scotland will go further than the UK as a whole, the role for greenhouse gas removal options (including afforestation, use of wood in construction, bioenergy with carbon capture and storage and a range of other options), and whether relevant policy levers are under Scottish or UK Government control.

Given the stretching nature of the more ambitious potential targets, the Committee recognises that it is for Scotland to make a decision on the level of ambition. Should the more ambitious targets be adopted, the decision must take full account of the recommendations set out above.

In developing this advice, the Committee has considered the latest climate science, the implications of the Paris agreement and the feasibility and cost of long-term emissions reductions in Scotland, together with experience to date under the Climate Change (Scotland) Act. The Committee has also taken note of the responses it received to its call for evidence, to the testimony it heard during its hearings in Scotland and to the wider interaction it has with Scottish stakeholders. These are discussed in the rest of this report:

- Chapter 1 reviews the experience under Scotland’s existing climate legislation.
- Chapter 2 considers the appropriate level for Scottish emissions targets in the context of the scientific evidence about climate change, the implications of the Paris Agreement, and our scenarios for reducing Scottish emissions.
- Chapter 3 considers how carbon targets can best be designed in order to achieve cost-effective decarbonisation across the Scottish economy, while minimising the potential for undesirable outcomes.
- Chapter 4 presents our recommendations on the four elements on which advice was requested: the appropriate level of future emissions, the form of future emissions targets, the future accounting framework, and flexibility to update emissions targets.

Chapter 1: Decarbonisation in Scotland



1. Introduction

The Scottish Government has committed to introduce a new Scottish Climate Change Bill, which will include a new target for 2020 to reduce actual Scottish emissions⁴ by more than 50% against 1990 levels. This is partly in recognition of progress to date in Scotland and partly in recognition of the Paris Agreement. In January 2017 the Government published a draft Climate Change Plan and a draft Energy Strategy, which together set out their current thinking about an appropriate decarbonisation strategy.

The Committee on Climate Change has been asked by the Scottish Government to advise on four aspects of the new Bill:⁵

- i) Appropriate level of future emissions,
- ii) The form of future emission reduction targets
- iii) The future accounting framework
- iv) Flexibility to alter emission reduction targets.

This report sets out our advice in each of these areas. Chapter 1 looks at Scotland's experience under its existing climate change targets, and progress towards meeting these. Chapter 2 considers the appropriate level of future emissions (i), Chapter 3 discusses design considerations relating to carbon targets (ii, iii, iv) and Chapter 4 presents the Committee's recommendations.

Stakeholder engagement for this advice

The Committee engages widely with businesses, governments, researchers, non-government organisations, representative bodies and other relevant parties throughout its work. The Committee has gathered evidence specifically for this advice (Figure 1.1):

- On 14 December 2016 we published a call for evidence, containing 13 questions on the appropriate level of future emissions, duration and form of future carbon targets, the future accounting framework and criteria for setting future targets.
- We received nine responses. All responses have been published in full on our website.⁶
- To provide further input we held public Committee hearings, attended by around 50 people, where evidence was provided by Andy Kerr (Edinburgh Centre for Carbon Innovation), Karen Turner (University of Strathclyde), Samantha Barber (2020 Climate Group), Fabrice Leveque (WWF Scotland), Bob Rees (Scotland's Rural College), Jim Densham (RSPB), Andrew Bauer (NFU) and Pat Snowdon (Forestry Commission).
- We have also held meetings with individual stakeholders from a range of sectors, and with Scottish Government departments.
- We have drawn on research we have commissioned on how emissions can be reduced in each sector for previous advice on UK carbon budgets and Scottish annual targets.⁷

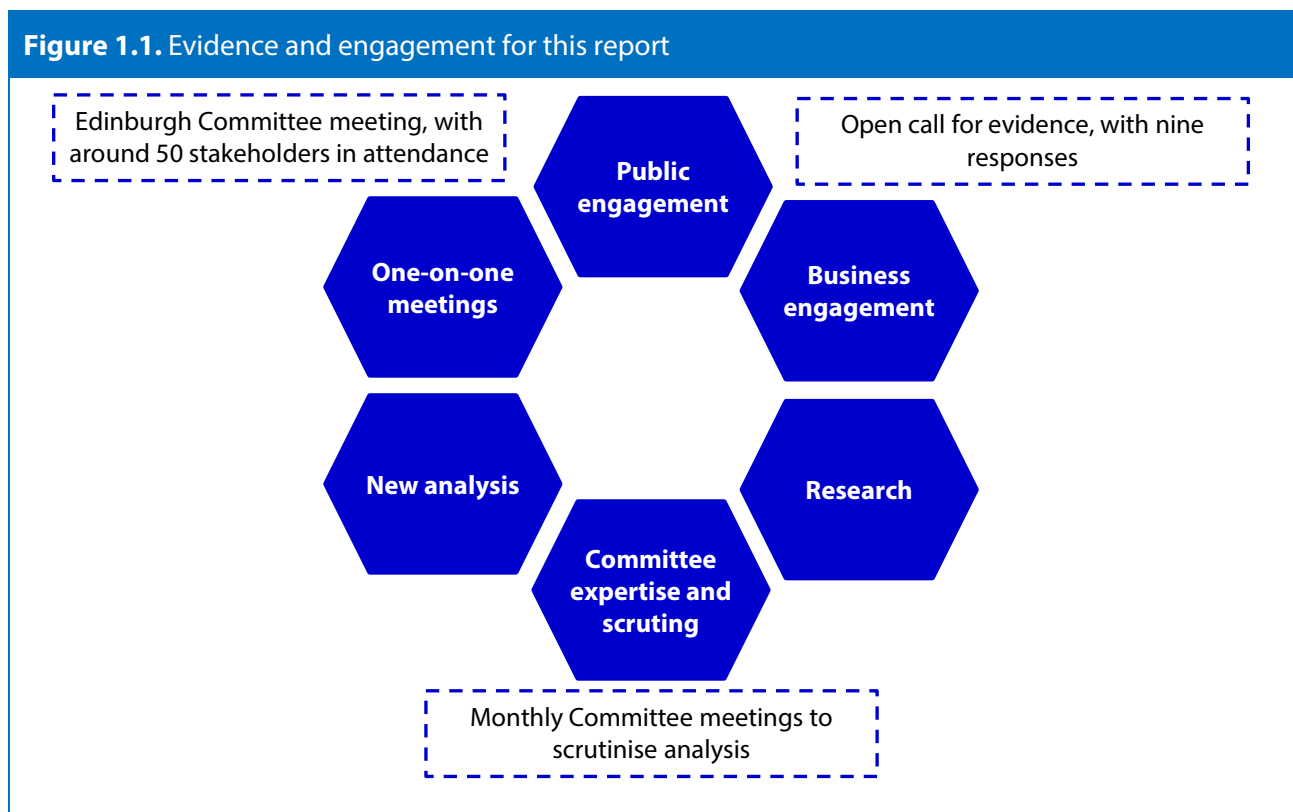
⁴ The existing targets in Scotland are on the basis of 'net' Scottish emissions. See section 2.

⁵ <https://www.theccc.org.uk/wp-content/uploads/2017/01/Specification-for-CCC-advice-on-Scottish-Climate-Change-Bill.pdf>

⁶ <https://www.theccc.org.uk/2017/03/09/responses-to-scottish-climate-change-bill-consultation/>

⁷ For example, see the supporting research for the UK fifth carbon budget advice, available at: <https://www.theccc.org.uk/publication/the-fifth-carbon-budget-the-next-step-towards-a-low-carbon-economy/>

Our engagement has been valuable in gathering views on the design of carbon targets and evidence about the existing policy framework and possible paths for Scottish emissions.



2. Current legal framework

Scotland's existing legal framework, the Climate Change (Scotland) Act, sets a long-term target to reduce net emissions of greenhouse gases by at least 80% in 2050 relative to 1990, with an interim target to reduce emissions by 42% in 2020 on a 'net' basis.⁸ Secondary legislation has also set a series of annual emission reduction targets for 2010 to 2032 (Figure 1.2).

The Scottish Act also places a number of requirements on Scottish Ministers when setting and meeting annual targets. These include:

- For each year in the period 2010 to 2019, targets had to be set by an absolute amount that was consistent with a reduction in the Net Scottish Emissions Account over that period which would allow the interim targets and the 2050 target to be met;
- For each year in the period 2020 to 2050, absolute targets must be set – at least 12 years in advance – by an amount that is:
 - Consistent with a reduction in the Net Scottish Emissions Account (NSEA) over that period which would allow the 2050 target to be met, and
 - At least 3% less than the target for the preceding year.

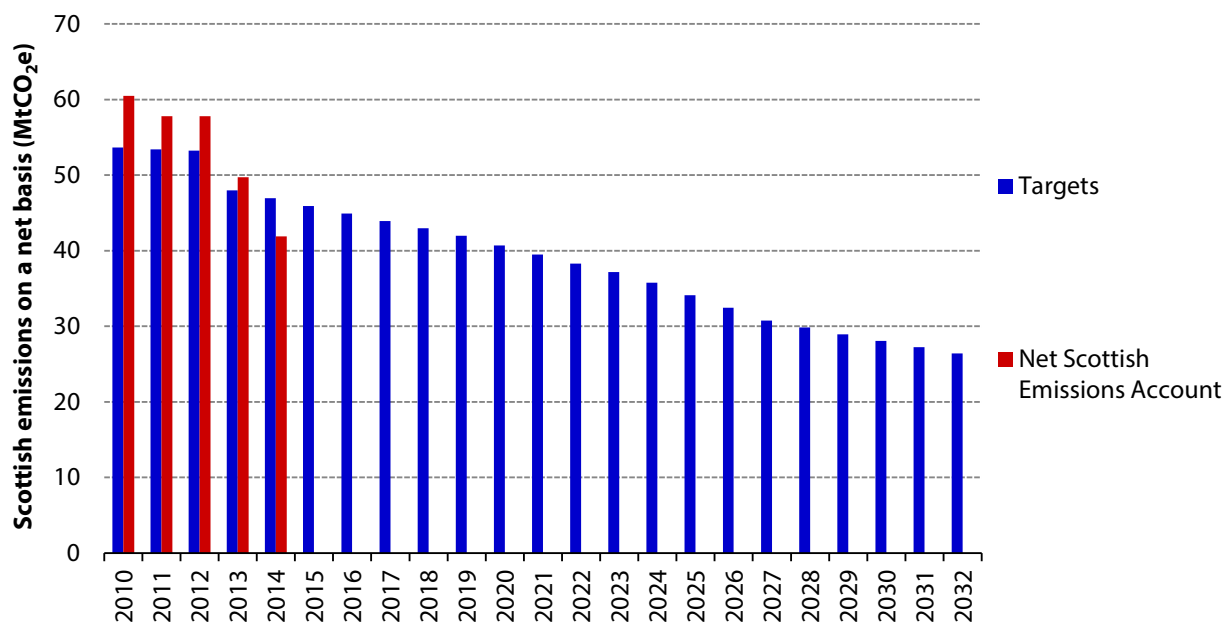
⁸ 'Net' emissions are calculated under the Net Scottish Emissions Account (NSEA), taking into account non-traded emissions, surrendered units and Scotland's assigned EU ETS cap (known as the specified amount). See section 3.

- The Act also contains the concept of a “fair and safe Scottish emissions budget”, this being a cumulative absolute amount of emissions over the period 2010-2050.
- Ministers need to consider how targets could be met through action to reduce Scottish emissions and by the use of carbon units (i.e. international emissions credits).

Scottish annual targets for 2010 to 2013 were missed, but the 2014 target was met by a wide margin (Figure 1.2). In large part this experience reflects changes to the greenhouse gas inventory (see section below), as well as the impact of temporary factors such as winter temperatures and adjustments in the EU Emissions Trading System (EU ETS).⁹

Net emissions in 2014 were 45.8% lower than 1990 levels, outperforming the level of the 2020 interim target of 42%.¹⁰ Scottish emissions on a net basis fell 13% in 2014 to 41.9 MtCO₂e, which is 5.1 MtCO₂e below the level of the 2014 annual emissions target. This sharp fall was largely due to one-off factors: warmer than average winter temperatures reducing the demand for heating in buildings and a fall in Scotland's share of the EU ETS cap. However, a part of the reduction was from domestic action and the target would have been met without these temporary factors.

Figure 1.2. Existing targets and emissions on a ‘net’ basis to 2032



Source: NAEI (2016) *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland 1990-2014*, https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1606140853_DA_GHGI_1990-2014_Report_v1.pdf

Notes: The Net Scottish Emissions Account data presented for each year are those first published, against which the target was assessed (e.g. the level of 2013 emissions as estimated in 2015).

⁹ CCC (2016) *Reducing emissions in Scotland – 2016 progress report*. <https://www.theccc.org.uk/publication/reducing-emissions-in-scotland-2016-progress-report/>

¹⁰ Given the contribution of one-off factors towards the sharp fall in the net Scottish emissions account, it is quite possible that this measure of emissions will rise in subsequent years and may be higher in 2020 than in 2014, even with underlying progress in reducing Scottish emissions.

The Scottish Government is therefore currently on track to meet the 2020 target and is largely implementing the Committee's recommendations. In some areas Scotland's progress is leading the UK, and providing examples to other parts of the UK on how to raise ambition cost-effectively. However, in order to meet ambitious targets beyond 2020 much more is required to reduce emissions from transport and agriculture and land use, and increased uptake in renewable heat.

3. Experience with targets under the Climate Change (Scotland) Act

Under the existing Act, Scottish emissions are measured on a net basis. The Net Scottish Emissions Account (NSEA) is calculated as the sum of:

- **Non-traded emissions.** Actual Scottish emissions in sectors not covered by the EU Emissions Trading System (EU ETS), such as buildings, transport and agriculture (around 64% of total Scottish emissions); plus
- **Traded sector allocation.** Scotland's share of the EU ETS cap for sectors that are covered by the trading scheme, such as electricity generation and heavy industry.

The NSEA has been subject to considerable variability over the period since 2009 due to revisions to the Scottish greenhouse gas inventory, changes in the EU ETS that affect the Scottish share of emissions in some years and annual variations in winter temperatures:

- **Inventory changes.** There have been several revisions to the Scottish greenhouse gas inventory since annual targets were legislated in 2009. These changes are welcome, and reflect improvements in the methodology for estimating emissions:
 - Revisions apply not just to estimates of recent emissions but also retrospectively to estimates going back to 1990 (Figure 1.3). These revisions have mostly occurred due to improvements in estimating emissions from drainage of grasslands on organic soils and the impacts of research to derive more representative emission factors for nitrous oxide.
 - However, in some years they have made the annual targets difficult to achieve because they were set on an absolute (MtCO₂e) basis.
 - In 2014 the inventory changes reduced estimated emissions for the first time, by 1.8 MtCO₂e for 2013 and by 3.5 MtCO₂e for 1990. However, overall there has been an upward revision to baseline (effectively 1990) emissions of 7.1 MtCO₂e above the estimate in 2010, when the annual targets for 2010 to 2027 were set.
 - Due to a higher share of emissions from sectors in which emissions estimates are less certain (e.g. agriculture), the overall uncertainty for Scottish emissions is relatively high, at ±10%.¹¹ This is considerably higher than the ±3% uncertainty for England and Wales.¹²
 - Currently only a relatively small fraction of peatland emissions are included in the inventory. The future inclusion of all peatland emissions will affect estimates of historical and future emissions. Given the large area of peatland in Scotland, this is likely to affect Scotland disproportionately. We will advise on how this affects Scottish emissions targets when evidence is available on their impacts on emissions estimates and the potential to abate these.

¹¹ With 95% confidence.

¹² NAEI (2016) *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland 1990-2014*, https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1606140853_DA_GHGI_1990-2014_Report_v1.pdf

- **‘Backloading’ in the EU ETS.**

- When the Scottish annual targets were set, it was assumed that Scotland’s share of the EU ETS cap would decline in a steady and predictable manner over time, reflecting the planned decline in the overall EU ETS cap at an annual rate equivalent to 1.74% of 1990 emissions.
- Due to oversupply in the EU ETS, a mechanism was introduced in 2014 by the European Commission that allows some allowances to be removed from the market and placed in a ‘Market Stability Reserve’ (MSR). These allowances may return to the market in later years if certain criteria are fulfilled. In any years in which allowances are put into (or removed from) the MSR, this will affect the size of that year’s cap and therefore the size of Scotland’s share as accounted for under the NSEA.
- In an attempt to limit the near-term oversupply of allowances, in 2014 it was also decided to withhold some auctioned allowances from the EU ETS over the years 2014 to 2016. This ‘backloading’ effect reduced Scotland’s share of the EU ETS cap for 2014 by 3.2 MtCO₂e and will also affect the NSEA for subsequent years. These are not permanent reductions, as the allowances will enter the MSR and may return to the market at a later date, which would have the opposite effect on the NSEA.

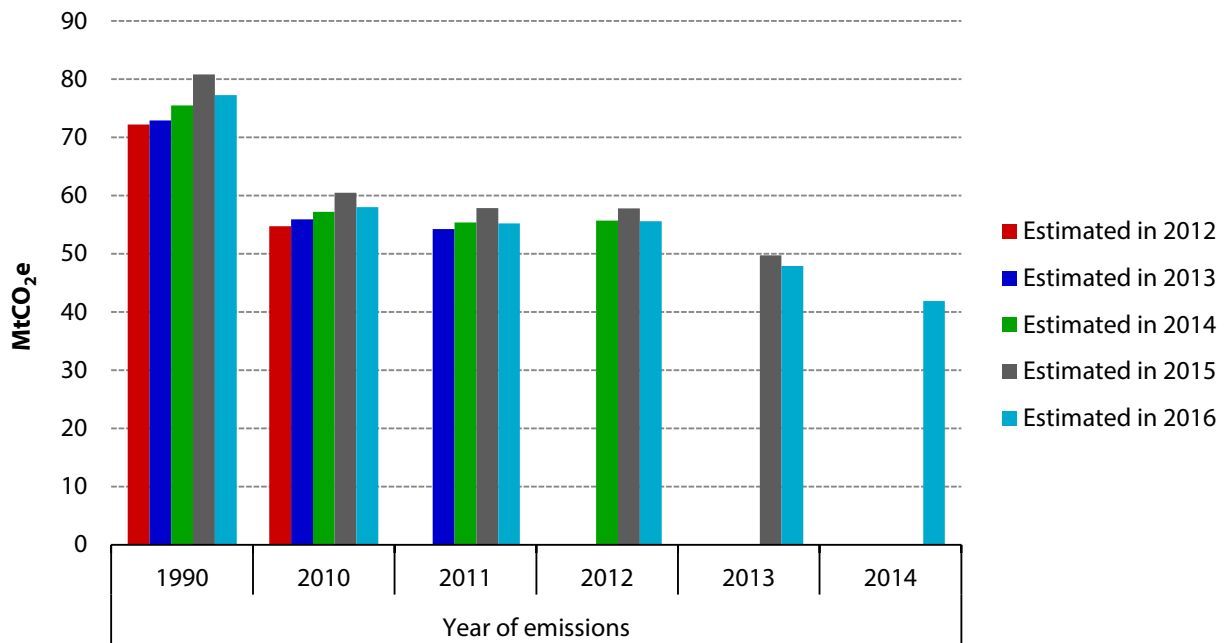
- **Annual variations in winter temperatures.**

- Building emissions fluctuate from year to year depending on the level of winter temperatures, which affect the demand for heating in buildings. Colder winters result in higher fossil fuel consumption for space heating and higher electricity consumption, while milder winters have lower energy consumption.
- Winter temperatures in 2014 were considerably higher than average, resulting in building emissions much lower than expected. Adjusting for differences in heating demand between 2014 and a typical year, residential emissions would have been approximately 20% higher and non-residential emissions (from public and commercial buildings) around 7% higher than reported, equating to a difference of around 1.3 MtCO₂e overall.

In 2014, each of these three effects occurred in a way that reduced the level of the Scottish net emissions (the NSEA). As a result, the estimate for the NSEA for 2014 of 41.9 MtCO₂e made in 2016 was much lower than the estimate for 2013 of 49.7 MtCO₂e made in 2015 (Figure 1.4).¹³ However, the level of annual targets was unaffected by any of these effects and only required a reduction of 1.0 MtCO₂e from 2013 to 2014. As a result, Scotland went from missing its 2013 target by 1.8 MtCO₂e (as assessed in 2015) to outperforming the 2014 target by 5.1 MtCO₂e.

¹³ The 2016 estimate of 2014 emissions is not directly comparable to the 2015 estimate of 2013 emissions, as the inventory changes in 2016 also revised the estimate of 2013 emissions, reducing it from 49.7 to 47.9 MtCO₂e.

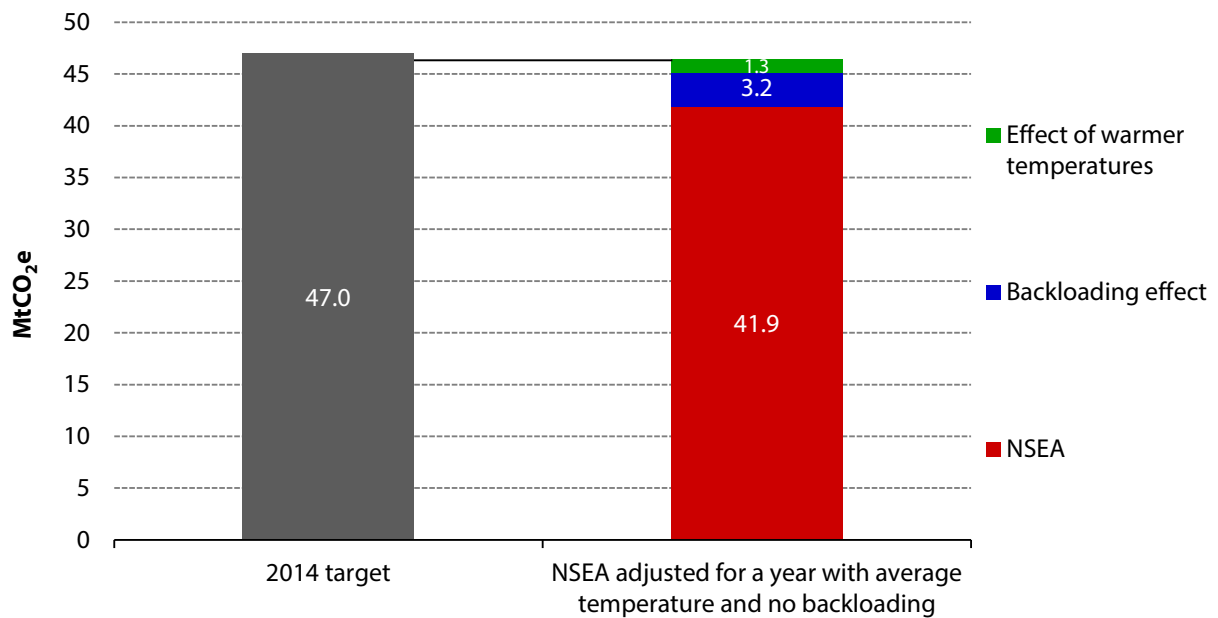
Figure 1.3. Revisions to estimates of Scottish net emissions (1990; 2010-14)



Source: NAEI (2016).

Notes: Emissions presented for 1990 are on the basis of actual emissions, as there was no emissions trading in that year for which to adjust.

Figure 1.4. Performance of the Net Scottish Emissions Account against the 2014 target



Source: NAEI (2016); CCC analysis.

Stripping out the 'one-off' effects of the milder winter temperatures and backloading in the EU ETS, the Net Scottish Emissions Account in 2014 would have been around 46.4 MtCO₂e, with the target still being outperformed by 0.6 MtCO₂e. This reflects domestic action to reduce emissions.

For the years preceding 2014, the main challenge had been that inventory changes had meant that Scottish annual emissions targets were much more difficult to meet. This meant that rather than a steady, achievable, pace of emissions reduction the targets implied some quite extreme levels of emissions reduction. Had the annual targets been set with the same ambition but as percentage reductions instead of absolute (megatonne) emissions levels, it would have been possible to meet the targets in 2011, 2012 and 2013 despite the large changes to the emissions inventory (Figure 1.5).

Cumulative emissions over the period 2010 to 2014 have been higher than the 255.2 MtCO₂e allowed for under the annual targets, whether calculated on the basis of the most recent estimates or the 'assessed' estimates for these years:

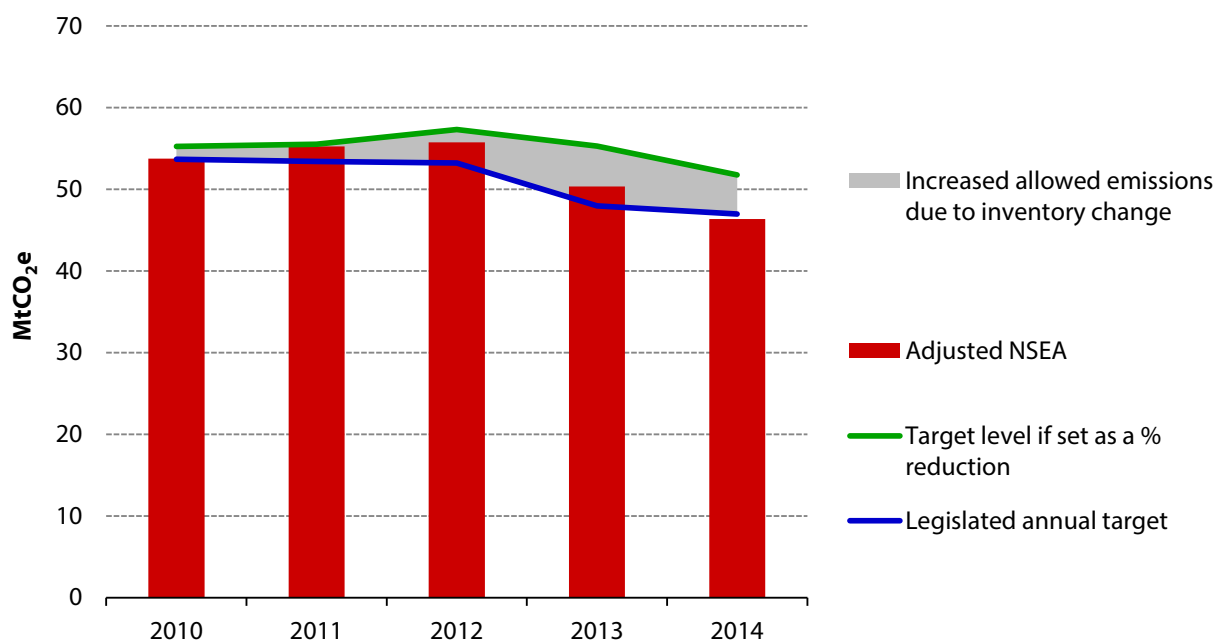
- The latest estimate of net Scottish emissions for each year over the period 2010 to 2014, published in 2016,¹⁴ provides a level of cumulative emissions for these five years of 258.5 MtCO₂e. This is 3.3 Mt higher than the cumulative emissions allowed for under the legislated annual targets for these years.¹⁵
- The level of net Scottish emissions used to assess whether annual targets have been met is that first published around 18 months after the year in question (e.g. the 2013 target was assessed against the emissions data published in June 2015). Adding the level of annual emissions in each of these individual assessments together would suggest cumulative emissions for the years 2010 to 2014 were 256.2 MtCO₂e, 1.0 Mt above the level allowed for under the legislated annual targets for these years.

The level of cumulative Scottish net emissions has been significantly affected by both changes to the emissions inventory and by the impact in 2014 of backloading within the EU ETS.

¹⁴ NAEI (2016) *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland 1990-2014*, https://uk-air.defra.gov.uk/assets/documents/reports/cat07/1606140853_DA_GHGI_1990-2014_Report_v1.pdf

¹⁵ When the Committee gave advice on Scottish annual targets under the existing legislation in March 2016, cumulative emissions on the basis of the latest emissions estimates had been 17.5 MtCO₂e above the target levels across the years 2010 to 2013. The updated emissions inventory published later in 2016 revised the emissions estimates for these years down, so that cumulative emissions for 2010-13 were 8.3 MtCO₂e above the target levels. These cumulative excess emissions were lowered further by 2014 emissions that were 5.1 MtCO₂e below the target.

Figure 1.5. Impact of inventory changes on annual targets set in different ways (2010-2014)



Source: NAEI (2016); CCC analysis.

Notes: The 'adjusted NSEA' is the published level of the Net Scottish Emissions Account (NSEA) in the year in which the target was assessed (e.g. the level of 2013 emissions as estimated in 2015), adjusted to remove temporary effects relating to variations in winter temperatures and backloading in the EU Emissions Trading System (EU ETS). The 'target level if set as a % reduction' is the amount in megatonnes that would have been allowed had the annual targets been set as percentage reductions on 1990 emissions rather than absolute (megatonne) targets; the difference between this and the actual targets, shown as the shaded area, is due to changes in the inventory estimate of emissions in 1990. The increase from 2010 to 2012 in allowed emissions under a percentage reduction approach reflects a combination of small underlying expected progress to reduce emissions (reflected by the flatness of the blue line for those years) and revisions to the greenhouse gas inventory that increased estimates of emissions in 1990 and subsequent years. The large step down in the targets and the NSEA between 2012 and 2013 reflects the large fall in Scotland's share of the EU ETS cap, due to the transition in the EU ETS from Phase 2 to Phase 3; this was allowed for in the setting of the annual targets.

Overall, actual Scottish emissions were 40% below 1990 levels in 2014, with further reductions since 2014 not yet reflected in published emissions data. Significant reductions have occurred in some sectors to date, such as industry, power and waste, while the trend in other sectors is broadly flat (Figure 1.6):

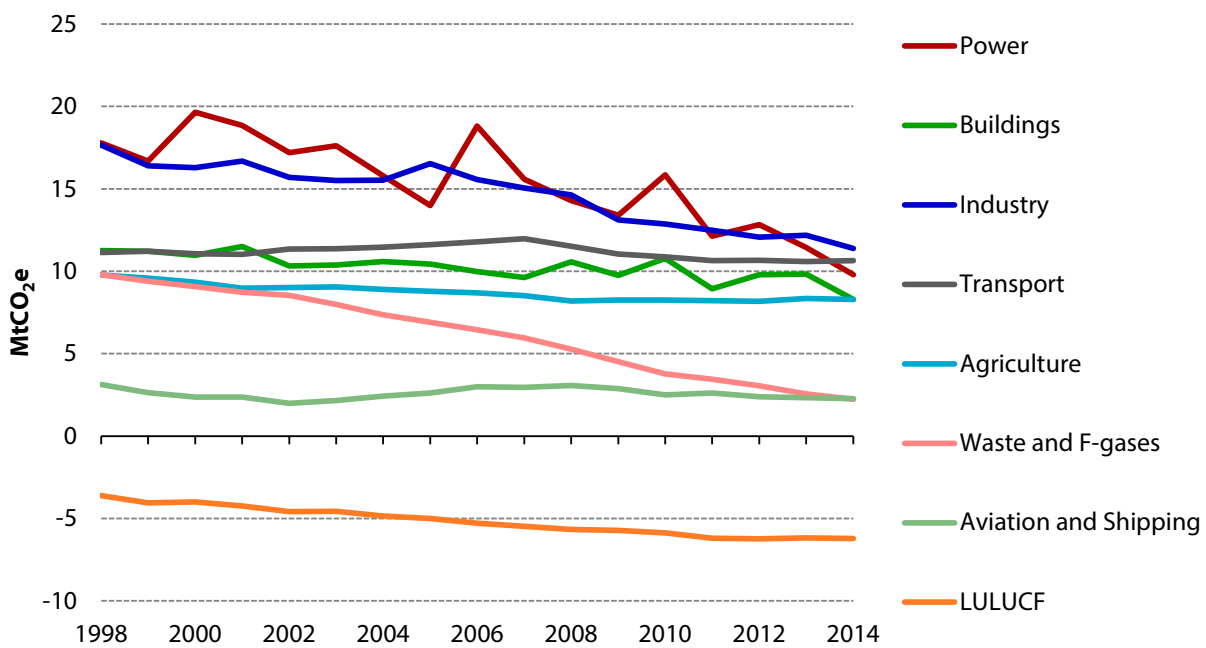
- **Industry.** Industrial emissions in Scotland have fallen 46% since 1990. This is similar to the 45% reduction in industrial emissions for the UK as a whole, during a period in which UK manufacturing output has shown fairly steady slow growth (with the exception of the financial crisis).¹⁶
- **Power.** Although not rewarded under the existing net Scottish emissions targets, reductions in power sector emissions have been large, falling by 38% between 2010 and 2014. Large

¹⁶ Data on Scottish manufacturing output are not available for the full time period since 1990. See <http://www.gov.scot/Topics/Statistics/Browse/Economy>. For more on trends in industrial output and emissions see our report on Energy Prices and Bills: <https://www.theccc.org.uk/publication/energy-prices-and-bills-report-2017/>

further falls will have occurred since 2014, at least in part due to the closure of the Longannet coal-fired plant, but these are not yet reflected in official emissions data.

- **Waste.** Scottish waste emissions in 2014 were 77% below 1990 levels, and fell at an average rate of 12% per year between 2010 and 2014. This mainly reflects a combination of reduction in the amount of waste sent to landfill and action to capture or flare landfill methane.
- **Other sectors.** There remain several sectors in which emissions trends are broadly flat, including transport, buildings and agriculture.

Figure 1.6. Sectoral emissions in Scotland (1998-2014)



Source: NAEI (2016).

Notes: Actual Scottish emissions in each sector, using the latest estimates of emissions for all years.

In addition to the technical difficulties relating to emissions estimates, it is clear that the complicated manner in which the calculations for the Net Scottish Emissions Account have been done mean that the targets and performance have lacked transparency and consequently have been difficult to communicate. Part of the motivation for the proposed change in Scotland from targets based on net emissions to those based on actual emissions is to make the target more transparent and easier to communicate.¹⁷

It is not possible to remove all the complexities from emissions accounting (e.g. adjusting emissions estimates due to improved methodology or taking into account unusual temperatures are likely to be a feature of any system). Different methods will vary in terms of transparency and ease of communication. We consider these issues in Chapter 3.

¹⁷ In committing to introducing new climate change legislation for Scotland, the SNP manifesto highlighted that in order to “increase transparency and accountability, we believe Scotland’s targets should be based on actual emissions from Scotland”. Available at <https://www.snp.org/manifesto>

Chapter 2: Appropriate level of future emission targets



This chapter considers appropriate long-term emissions targets for Scotland, and the path towards meeting them. It does so by: first considering the latest evidence from climate science, then looking at international action and finally considering how Scotland can reduce emissions by 2050 and in the nearer term.

This chapter sets out the CCC's thinking in four sections:

1. The latest climate science and the Paris Agreement
2. The role of emissions scenarios in setting greenhouse gas targets
3. Level of ambition for 2050
4. Ambition on the path to 2050

1. The latest climate science and the Paris Agreement

The existing Climate Change (Scotland) Act requires that the Committee consider scientific knowledge about climate change and international circumstances when providing our advice. Furthermore, the proposed new legislation is intended, in part, as a response to international and scientific developments. In this section we consider those issues.

Climate science

The evidence that climate change is happening, driven by human activity and will have large impacts, is supported by many lines of research and agreed by the world's leading scientific bodies:¹⁸

- Global average temperature has risen around 0.9°C since the late 19th Century, accompanied by rising sea levels and warmer seas, retreating ice and changing extreme weather patterns.
- Many impacts are already being detected across the world.¹⁹
- Further emissions of greenhouse gases will lead to further warming and change. There is no known simple threshold beyond which climate change moves from safe to dangerous. The Intergovernmental Panel on Climate Change (IPCC) has concluded that:²⁰
 - Warming of 1.5°C entails high risk of damage from extreme weather and of losing sensitive ecosystems (such as those in the Arctic, on mountains and coral reefs).
 - Warming of around 2.5°C brings high risk of large-scale singularities (such as irreversible ice sheet loss, leading to more sea level rise) and severe global impacts on the economy and environment.
 - Warming of around 4.5°C would lead to very severe damage and puts global food security in doubt.

Global temperature rise depends primarily on cumulative CO₂ emissions over time. Temperature limits will therefore only be met if global emissions of CO₂ (and probably other long-lived greenhouse gases such as nitrous oxide and some F-gases) reach net zero. Other, shorter-lived

¹⁸ See for instance Royal Society and US National Academy of Sciences *Climate Change Evidence & Causes*: https://royalsociety.org/~media/Royal_Society_Content/policy/projects/climate-evidence-causes/climate-change-evidence-causes.pdf; and the *Climate Communique* written by 24 UK academic societies: http://www.iop.org/news/15/jul/file_65971.pdf

¹⁹ See CCC (2016) *UK Climate Change Risk Assessment 2017 – Synthesis report*. Available at: <https://www.theccc.org.uk/uk-climate-change-risk-assessment-2017/synthesis-report/>

²⁰ IPCC Fifth Assessment Report: <https://www.ipcc.ch/report/ar5>

gases (e.g. methane) drive temperature mainly by their rate of emission; the lower the emission rates, the greater the available cumulative budget for the longer-lived gases.

The Paris Agreement

International negotiations on climate change are governed through the United Nations Framework Convention on Climate Change (UNFCCC). In 2009, when the Climate Change (Scotland) Act was legislated, there was neither a UNFCCC-agreed nor a global quantitative goal for limiting climate change, nor a universal effort to reduce emissions.

The Paris Agreement was reached at the UNFCCC negotiations in 2015, and marks a number of new developments in international climate policy. These include commitments to reduce emissions from around the world, a more ambitious aim for limiting temperature, and an aim to reach net zero global emissions this century:

- The overarching aim of the Paris Agreement is to hold the increase in global temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit it to 1.5°C. Previous UNFCCC texts have referred to the aim of limiting to below 2°C.
- To achieve this it sets a new aim of balancing “anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century” (i.e. net zero global emissions by sometime between 2050 and 2100).
- Each party to the agreement is required to make a national pledge of action, either to 2025 or 2030, to contribute to emissions reduction. Nearly all parties have now made pledges.²¹ The EU (on behalf of Scotland, the UK and the other EU nations) pledged to reduce its emissions by at least 40% below 1990 levels by 2030.

Despite the now-global effort to reduce emissions, current pledges of action to 2030 do not add up to a credible pathway to achieve either 2°C or more ambitious temperature aims. Recognising this, the Paris Agreement creates a ‘ratchet’ mechanism designed to encourage greater action over time:

- The pledges indicate a wide range of ambition from different nations. In aggregate, achievement of the pledges would lower emissions compared to previous expectations, but they would still grow from current levels of around 50 billion tonnes of CO₂-equivalent (50 GtCO₂e) to around 56 GtCO₂e in 2030.²²
- Parties to the Paris Agreement recognised 40 GtCO₂e as the 2030 level consistent with a path below 2°C.
- The Agreement sets a five-yearly 'ratchet' system to review pledges, starting in 2023, with the intention that their ambition will rise over time in a nationally-determined manner. Ahead of this, nations agreed to a "facilitative dialogue" in 2018 to take stock of the current pledges.

Consistency of existing Scottish targets with ambition under the Paris Agreement

Scotland’s current statutory target for 2050, for a reduction of at least 80% on 1990 emissions, is based on a global path that keeps central (i.e. 50% likelihood) estimates of global temperature rise close to 2°C. The options to reduce emissions underpinning the advice on annual targets for

²¹ <http://www4.unfccc.int/Submissions/INDC/>

²² UNFCCC 2016) Updated synthesis report on the aggregate effect of INDCs: http://unfccc.int/focus/indc_portal/items/9240.php

2028 to 2032 are on the cost-effective path to the current 2050 target. These measures also keep open the possibility of further actions that would allow for deeper reductions by 2050.

Aligning to the aims of the Paris Agreement would entail a steeper downward path for global emissions, and hence tighter targets for Scotland to 2050 and beyond (Table 2.1), assuming countries have approximately equal per-capita emissions in 2050:²³

- Scotland and the UK's current targets are already at the more ambitious end of the range of international pledges to 2030 (in terms of percentage reduction below 1990 levels).
- Nevertheless, we concluded in our report on UK climate action following the Paris Agreement²⁴ that aligning more closely to the 1.5°C ambition implies UK emissions of greenhouse gases in 2050 at least 86-96% below 1990 levels. For Scotland, this equates to a reduction of 89-97% on 1990 levels, as Scottish per-capita emissions in 1990 were above the UK average.
- Aligning to the 1.5°C ambition also implies reaching net zero CO₂ emissions by 2050.
- Global emissions may have to reach net zero sooner than shown in Table 2.1. The paths assume significant net CO₂ removals (i.e. net negative emissions) after reaching net zero (through afforestation, bioenergy with carbon capture and storage, direct air capture or other methods). To the extent that significant net removals cannot be achieved, emissions will have to reach net zero even sooner to stay within a global CO₂ budget. Also, global paths consistent with 1.5°C overshoot on the median temperature increase (i.e. entail temporary temperature increases of more than 1.5°C) before returning to 1.5°C by 2100.

Table 2.1. Scottish emissions in 2050 and time to reach net zero emissions for paths consistent with the range of ambition implied by the Paris Agreement, assuming Scottish emissions per person equal the global average (the basis of the current 2050 target)

	Below 2°C	Return to 1.5°C
Scottish 2050 GHG emissions (reduction on 1990 levels)	78-87%	89-97%
Year to reach zero Scottish CO ₂ emissions	2055-75	2045-50

Source: CCC calculations based on UNEP (2015) *The emissions gap report 2015*.

Notes: The reductions for Scotland 2050 of 78-87% and 89-97% on 1990 levels are greater in percentage terms than the UK equivalents (for reductions of 71-83% and 86-96% respectively), as Scotland had higher per-capita emissions in 1990 than the UK as a whole.

The UK Government has signalled an intention to set a new target in the future that reflects the global need to reach net zero emissions. We agreed with this in our report to the UK Government in October 2016.²⁵ However we made it clear that, to be credible, a new target

²³ The assumption of equal per-capita emissions in 2050 is equivalent to that made when the Committee recommended the UK 2050 target in 2008, enacted within the Climate Change Act, for an emissions reduction of at least 80% on 1990 levels. See <https://www.theccc.org.uk/wp-content/uploads/2013/03/Interim-report-letter-to-DECC-SofS-071008.pdf>

²⁴ <https://www.theccc.org.uk/publication/uk-action-following-paris/>

²⁵ <https://www.theccc.org.uk/publication/uk-action-following-paris/>

needs to be evidence-based, accompanied by strong policies to deliver existing targets and a strategy to develop technology that is likely to be important to meeting any such target (notably greenhouse gas removals). Such measures are not yet in place for the UK, although we noted the need for them and for a new UK long-term target to be kept under review. Early action will allow the UK to fulfil its commitment under the Paris Agreement and position it to take competitive advantage in the global shift to a zero-carbon world.²⁶

To date, a number of countries have set targets that match or go beyond existing ambition at Scottish and UK levels (Box 2.1).

Box 2.1. Targets in other countries for 2050 ambition and/or net-zero emissions

Several countries have set stretching greenhouse gas emissions reduction targets for 2050. Emissions of around 2 tCO₂e per capita in 2050, as embodied in the UK 2050 target and under the existing Scottish Act, are consistent with limiting temperature change to 2°C.

- The European Union has a non-legislated GHG emissions reduction target of 80-95% below 1990 levels by 2050, equivalent to 2.1 to 0.5 tCO₂e per capita in 2050.
- Mexico has a legislated 2050 GHG target of a 50% reduction below 2000 levels (equivalent to a 31% reduction below 1990 levels, excluding LULUCF). This is equivalent to emissions of less than 2 tCO₂e per capita in 2050.
- France has a legislated GHG emissions reduction target for 75% below 1990 levels by 2050, equivalent to reducing emissions to less than 2 tCO₂e per capita.
- Finland has a legislated 80% GHG emissions reduction target for 2050 for sectors outside the EU ETS, and has a ministerial ambition for a net zero target for 2045.
- Sixteen US states also have legislated 2050 targets.

Some countries have proposed target dates for zero emissions of between 2030 and 2050, to be met through a combination of domestic action and international emissions trading:

- Sweden has a legislated net zero greenhouse gas emissions target for 2045, with a maximum contribution of 15% from international credits (i.e. it requires domestic reductions of at least 85% by 2045).
- Norway has set a target for net zero GHG emissions by 2030, which is to be met through a mix of domestic action and the EU emissions trading market, international cooperation on emissions reductions, emissions trading and project-based cooperation. This target is conditional on other developed nations also undertaking ambitious commitments, in line with the Paris Agreement.
- New York State has proposed legislation for net zero by 2050 (which has passed the state assembly, but is yet to pass the state senate). Some Australian states (Victoria, New South Wales) are developing net-zero 2050 targets.

Source: Centre for Climate and Energy Studies (2016) *Greenhouse Gas Emissions Targets*, available at: www.c2es.org; Climate Action Tracker (2016) *Norway*, available at: www.climateactiontracker.org; World Bank (2016) *CO₂ emissions (metric tons per capita)*, available at: data.worldbank.org; French Environment Ministry (2016) *Loi de transition énergétique pour la croissance verte*, available at: www.developpement-durable.gouv.fr; LSE (2015) *The Global Climate Legislation Study: Finland*, available at: www.lse.ac.uk; Environment Victoria (2017) *Stronger Climate Change Act welcomed*, available at: www.environmentvictoria.org.au

²⁶ See Chapter 3 of our report on Energy Prices and Bills: <https://www.theccc.org.uk/publication/energy-prices-and-bills-report-2017/>

2. The role of emissions scenarios in setting greenhouse gas targets

In order to drive action effectively, the emissions targets should balance ambition with feasibility. They must be sufficiently ambitious to ensure they are genuinely on track to the long-term target, but also feasible given what is known today.

The Committee develops scenarios to help judge what to recommend. These are constructed on a bottom-up sectoral basis, combining evidence about new technology and investments (e.g. new vehicle purchases, heating system replacements, energy efficiency improvements, power plant investments) and how consumers behave (e.g. how vehicles are driven, how buildings are heated). Our scenarios are informed by an assessment of the costs and barriers for different options (both technologies and behaviours, including fuel poverty and competitiveness issues), by the need to reduce emissions on the path to 2050 and by our projections of demand for energy services (e.g. comfort and mobility) and of emissions in the absence of policies to reduce them.²⁷

The Committee's advice to the Scottish Government about the annual targets from 2028 to 2032 was based on two scenarios for Scottish emissions: a Central scenario and a High Ambition scenario (Figure 2.1, Box 2.2 and Annex 1):

- The **Central scenario** adapts our best assessment of the cost-effective path to the UK's 2050 target to specific circumstances in Scotland and the requirements under the Scottish Act. It represents a steady rate of decarbonisation. The Central scenario for Scotland is an estimated Scottish contribution towards meeting to the UK's 2050 target. The share is estimated by taking Scotland-specific projections, the criteria in the existing Scottish Act and estimates of Scottish abatement potential.
- The **High Ambition scenario** goes further in a number of areas where we judge that to be feasible in Scotland. It is not an absolute upper bound, but is very challenging. It demonstrates that there are areas with potential to go further than the Central scenario.

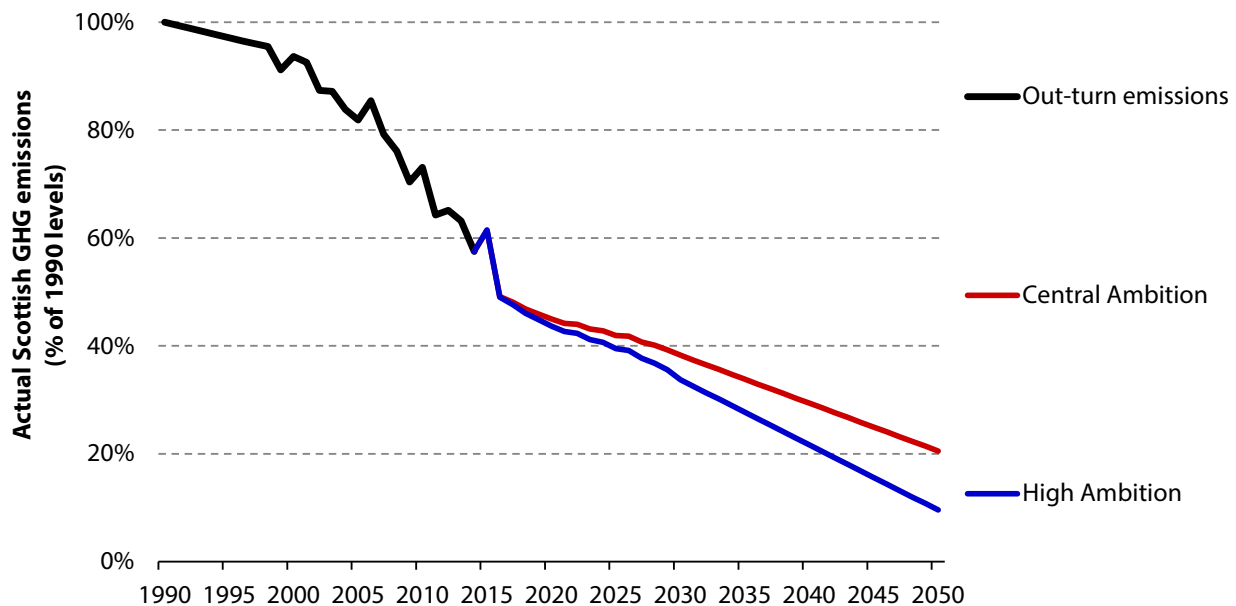
The scenarios are not intended to be prescriptive, but rather give an indication of the overall level of emission reduction that could be achieved and the sorts of changes that are likely to be appropriate to meet Scottish carbon targets.

Scotland could pursue a different balance of effort across sectors consistent with the same levels of emissions. Scotland's draft Climate Change Plan – required under the existing Climate Change (Scotland) Act to meet legislated annual emissions targets to 2032 – differs from the Committee's scenarios in a number of areas.

²⁷ For more detail, see Chapter 3 of our 2016 advice on Scottish emissions targets: CCC (2016) *Scottish emissions targets 2028-2032 – The high ambition pathway towards a low-carbon economy*. Available at:

<https://www.theccc.org.uk/publication/scottish-emissions-targets-2028-2032-the-high-ambition-pathway-towards-a-low-carbon-economy/>

Figure 2.1. Central and High Ambition scenarios to 2050



Source: NAEI (2016); CCC analysis.

Notes: Near-term changes to actual emissions include an anticipated rebound in emissions in 2015 due to winter temperatures being lower than those in 2014, followed by a sharp fall for 2016 due to the closure of the Longannet coal-fired power station.

Box 2.2. Main differences between Central and High Ambition scenarios

The Committee’s ‘High Ambition’ scenario for 2050 involves reducing emissions by a further 8 MtCO₂e beyond that in our ‘Central’ scenario. The difference between the two scenarios largely reflects the differences between ‘Central’ and ‘Max’ UK-wide scenarios in our Fifth Carbon Budget analysis.²⁸

For sectors close to their full decarbonisation potential by 2050 – such as power, bioenergy with CCS, waste, aviation, shipping and F-gases – there are no differences between our scenarios. However, we have identified further abatement potential in some sectors of the economy:

- **Industry.** We assume some initial deployment of industrial CCS by 2030, and that by 2050 application and geographical barriers have been overcome (either through low-cost transport or use of captured carbon) meaning that CCS is applied to all iron & steel, chemicals, cement and refineries, plus larger CHP units in the food & drink and paper & pulp sectors. This provides 1.5 MtCO₂e of further abatement beyond our ‘Central’ scenario, where CCS wasn’t deployed as widely by 2050.
- **Surface transport.** We assume deployment of 0.7m more fully electric cars (instead of plug-in hybrids), equivalent to over 95% of cars being electric vehicles in 2050, and further deployment of electric and hydrogen fuel cell vehicles in road freight, beyond what was considered in our ‘Central’ scenario. This provides 1.1 MtCO₂e of further abatement.
- **Residential buildings.** For residential buildings we assume deployment of heat pumps in around

²⁸ CCC (2015) *The fifth carbon budget – the next step towards a low-carbon economy*. Available at: <https://www.theccc.org.uk/publication/the-fifth-carbon-budget-the-next-step-towards-a-low-carbon-economy/>

Box 2.2. Main differences between Central and High Ambition scenarios

65% of households and 1.1m solid and cavity wall insulations by 2050, providing a further 1.9 MtCO₂e abatement beyond our 'Central' scenario.

- **Agriculture and LULUCF.** We assume a further 3.6 MtCO₂e of abatement from afforestation, in line with our UK wide 5th Carbon Budget scenarios. This involves tree planting of 16,000 ha/annum in Scotland, around double the level of tree planting in our 'Central' scenario. In addition, we include a small amount of additional abatement (0.3 MtCO₂e) from agro-forestry, GM crops and triticale.

3. Level of ambition for 2050

The sectoral scenarios provide an indication of the emissions reductions that can be achieved at a sectoral level in Scotland. A 2050 target for an 80% reduction, as under the existing Climate Change (Scotland) Act, could be met by achieving sectoral reductions commensurate with our Central scenario across the economy. The High Ambition sectoral scenarios offer alternative options to meeting the target should other sectors fall short of the Central reductions. The Central scenario is already challenging to achieve and will depend on effort by the Scottish Government, UK Government, EU and globally.

A 90% reduction would be considerably more stretching and would require further policy and funding in order to be feasible. We currently estimate that it could be met by delivering the High Ambition scenario in all sectors (Figure 2.2). Our scenario that is able to meet a 90% reduction in greenhouse gas emissions reaches CO₂ emissions of around net zero by 2050 (Figure 2.3).²⁹ A 90% reduction is at the limits of our understanding of what is achievable based on current projections of population and demand, the current emissions inventory and our current understanding of technology and behaviours and provides no flexibility to underachieve anywhere.

We have not been able to estimate the costs associated with meeting a 90% reduction by 2050. This partly reflects that we only have one economy-wide scenario that can achieve such a deep reduction – for some measures included in this scenario we can be more confident of the potential to reduce emissions than the cost of doing so (e.g. we assume emissions savings from behavioural change but do not have evidence on the costs of delivering this).

As evidence about how to meet targets consistent with the ambition under the Paris Agreement develops, we will be better able to provide cost estimates.

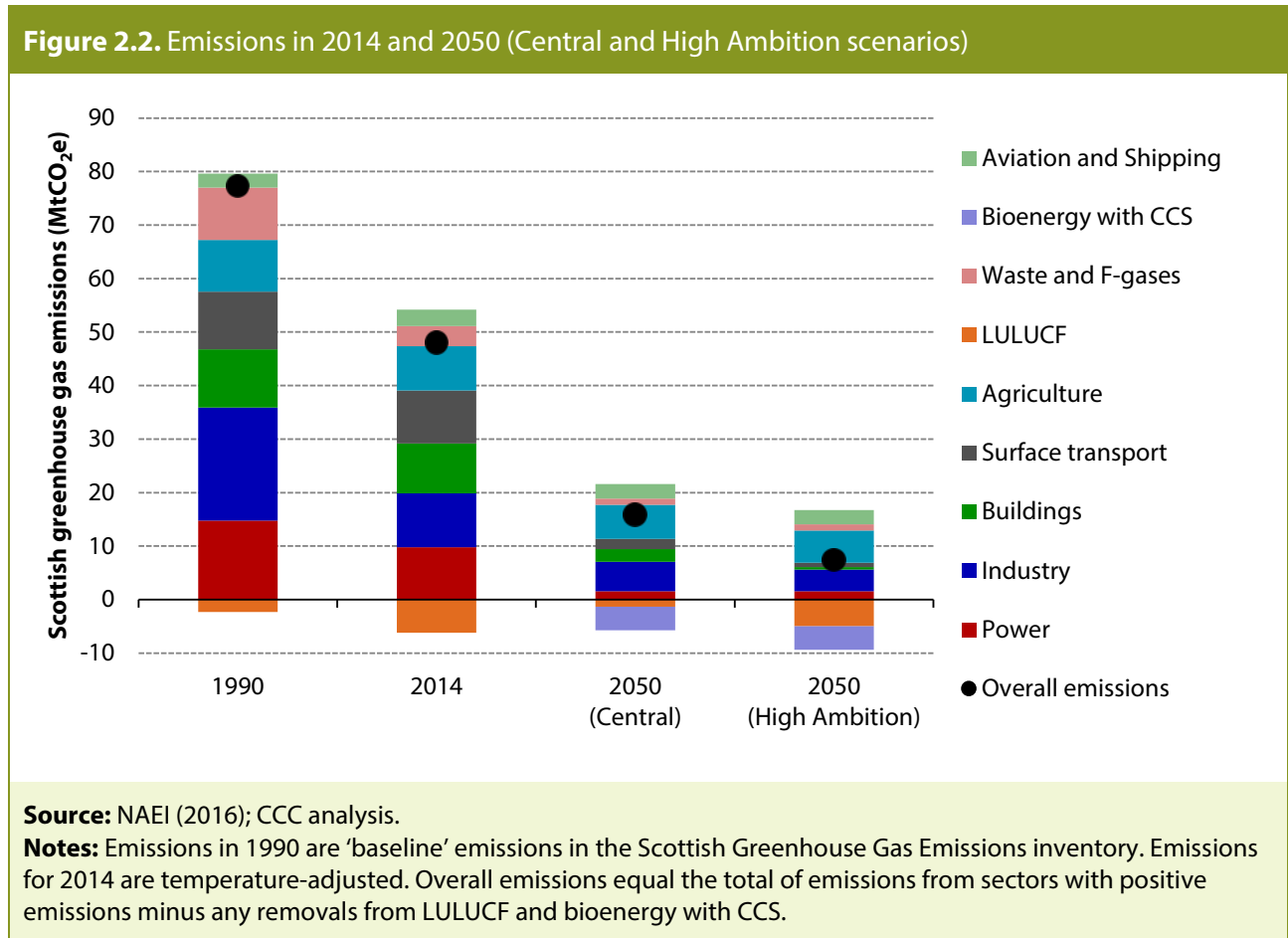
There are various broader benefits associated with cutting emissions in Scotland. For example, our scenarios imply improved air quality from reduced burning of fossil fuels; reduced noise pollution resulting from improved glazing, electric vehicle use and reduced traffic; improved health and reduced congestion from rationalisation of car journeys and more active travel (i.e. walking and cycling).³⁰ In some locations people may also feel there are negative impacts, such

²⁹ Our analysis assumes that negative emissions from the use of sustainable biomass with carbon capture and storage are reflected within emissions accounting practices. Current international practices do not necessarily reflect this comprehensively.

³⁰ We reviewed these co-benefits of reducing emissions in 2013 for the review of the fourth carbon budget (available at <https://www.theccc.org.uk/publication/fourth-carbon-budget-review>). Monetisation of the benefits relating to improved air quality, more active lifestyles and reduced noise at UK level were sufficient to offset at least

as the visual impact of wind turbines. Wider costs and benefits should be considered by local and national authorities within the context of the overall ambition to reduce emissions.

We discussed the wider environmental risks from climate change in the Climate Change Risk Assessment published in July 2016,³¹ which was followed by specific advice to the Scottish Government on its adaptation programme in September 2016.³²

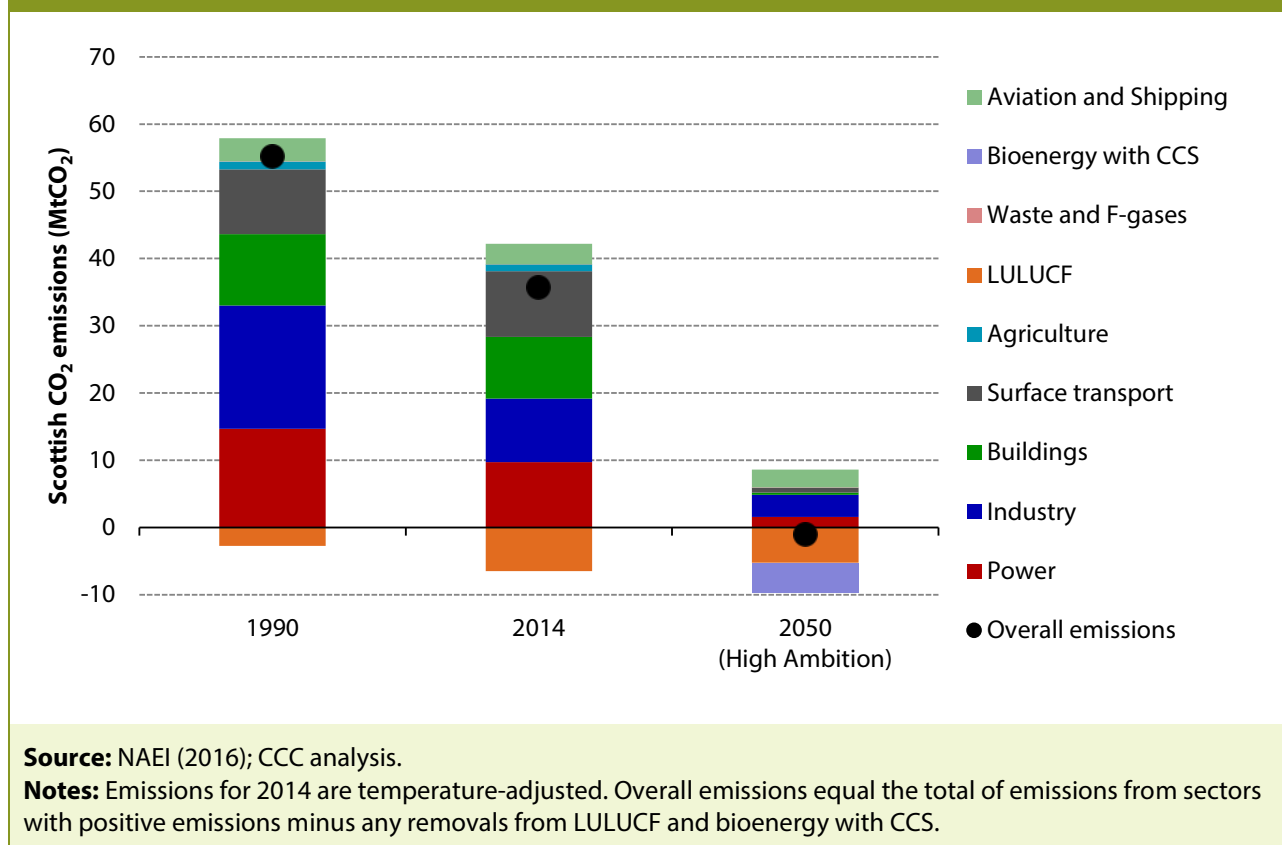


35% of the costs of the measures to reduce greenhouse gas emissions. We have not produced an updated assessment of these co-benefits, nor have we quantified these benefits specifically for Scotland.

³¹ CCC (2016) *UK Climate Change Risk Assessment 2017*. Available at: <https://www.theccc.org.uk/publication/uk-climate-change-risk-assessment-2017/>

³² CCC (2016) *Scottish Climate Change Adaptation Programme: An independent assessment*. <https://www.theccc.org.uk/publication/scottish-climate-change-adaptation-programme-an-independent-assessment-for-the-scottish-parliament/>

Figure 2.3. How Scotland could achieve net-zero CO₂ emissions in 2050



4. Ambition on the path to 2050

The possibility of greater ambition to 2050 should be retained, whether or not further ambition is legislated in the new Bill. This is important both in a legislative sense (e.g. setting points in time at which the level of ambition for 2050 could be increased) and in terms of policy ambition:

- **Legislation.** If it is deemed premature to set a 2050 target now for a reduction of more than 80%, the new Bill should specify points in time (e.g. in line with the pledge-and-review process created by the Paris Agreement) at which the levels of ambition for 2050 could be increased, and to review one or more dates to reduce emissions to net zero on a CO₂ and/or all-GHG basis.
- **Policy ambition.** Given the likelihood that greater ambition will be required at some point in the future it is important for policy to drive sufficient progress in reducing emissions and in ensuring longer-term markets and technologies are developed to make it feasible to meet future increases in ambition.

While the former consideration is a matter for the design of the legislation, the latter has implications for the level of targets on the path to 2050. In order to keep in play reductions by 2050 consistent with our High Ambition scenario, it will be important to take actions over the period to 2030 (e.g. on low-carbon heat, ultra-low emissions vehicles, carbon capture and storage) that allow those very low levels emissions to be feasible in the longer term.

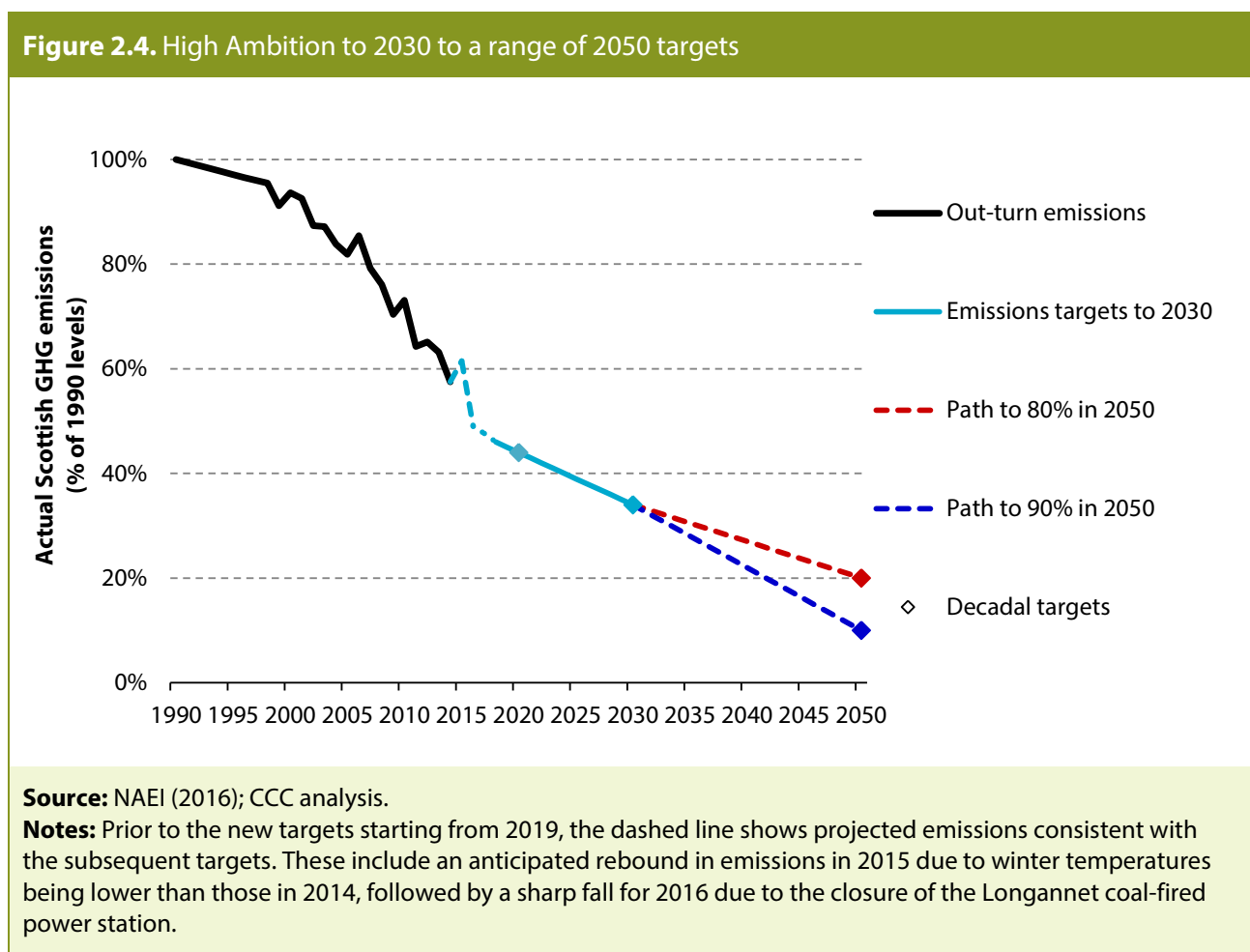
It would therefore be appropriate to set targets to 2030 consistent with our High Ambition scenario, which would keep in play a range of 2050 emissions, regardless of the immediate decision on the level of the 2050 target within the new legislation (Figure 2.4).

In addition to a 2020 interim target, it is therefore also sensible to set in legislation now an interim target for 2030. The value of setting in legislation now an interim target for 2040 depends on how likely it is that the level of ambition for 2050 will be revised in future:

- If the legislative process anticipates a future increase in 2050 ambition then an interim target for 2040 has little value, given the uncertainty in the emissions path between 2030 and 2050.
- Conversely, should the 2050 target be set such that it is unlikely to be changed in future there would be value in setting an interim target for 2040 as a staging post between 2030 and 2050.

It may therefore be appropriate for the new legislation to allow for a 2040 interim target to be set at a later date, should the level of the 2050 target be open to revision in future.

The level of a 2040 target for 73% reduction on 1990 emissions would be consistent with a settled 80% target for 2050. A 2040 target of 78% would be consistent with a 2050 target for a 90% reduction on 1990 levels.



Chapter 3: Design considerations for carbon targets



Setting emissions targets is not an end in itself. The targets are a means to drive the action that is necessary to reduce emissions by the required amount. The design of the targets must take account of the outcomes they are seeking to achieve.

In order to be effective, well-designed carbon targets should be transparent, stable, feasible and evidence-based. They should drive cost-effective decarbonisation across the economy, while minimising the risk of perverse outcomes. These principles, combined with experience about what has been effective, inform our consideration of how best to design Scottish carbon targets.

This chapter considers:

1. Percentage reductions or absolute targets
2. Emissions accounting for power and heavy industry
3. Inclusion of Scotland's share of emissions from international aviation and international shipping
4. Inter-year flexibility and making up for underperformance
5. Use of international emissions credits

1. Percentage reductions or absolute targets

When carbon targets are set, the level of ambition embodied within them does not depend on whether they are set in a percentage form (e.g. a 42% reduction on 1990 levels by 2020) or in absolute terms (e.g. a reduction to 40.7 MtCO₂e by 2020). The two targets do diverge if the estimate of the baseline (1990 level of emissions) changes. That estimate is based on the inventory of emissions.

Over time, changes in the estimates of emissions under the Scottish greenhouse gas emissions inventory affect different forms of targets in different ways. Changes to the inventory reflect improvements in the methodology for estimating emissions. It is neither possible nor desirable to stick with the emissions inventory methods in use when a target was first set. The methodology is continually updated as scientific understanding evolves. Emissions targets are generally set more than a decade in advance.

The existing Climate Change (Scotland) Act has a combination of percentage and absolute (megatonne) targets. These were originally set to be equivalent but changes to the emissions inventory now leave them misaligned (Chapter 1).

There is no single best basis on which to set targets. Percentage targets tend to mean that the amount of policy effort required to meet a target is less affected by changes to the emissions inventory, while absolute targets remain more aligned to the underlying climate science that links megatonnes of emissions to the extent of climate change.

The extent to which changes to the emissions inventory affect the amount of action required to meet a future target depends on whether that target is framed as a percentage target or in absolute terms. Taking the example of the Scottish targets for 2020, the existing Act has both a percentage target and an absolute (MtCO₂e) target for this year, but the latter is now significantly more difficult to meet following changes to the emissions inventory:

- For 2020, the Act sets an interim target for a 42% reduction in emissions against 1990 levels. When originally legislated, this implied emissions of 40.7 MtCO₂e. However, as the

methodology for estimating emissions has improved, estimates of 1990 emissions have tended to increase (see Chapter 1); current estimates of 1990 emissions are 77.3 MtCO₂e, an increase of over 7 Mt on the estimate when the targets were set. A 42% reduction on 1990 emissions would now imply emissions of 44.9 MtCO₂e.

- The annual targets under the Act were set on an absolute basis for a certain allowed number of megatonnes of emissions. The annual target for 2020 was 40.7 MtCO₂e. When originally set this implied a reduction of 42% on 1990 emissions. However, due to the revisions to the estimate of 1990 emissions, reaching this level of emissions would imply a reduction of over 47% on 1990 levels.

Neither method is clearly correct or incorrect. However, the situation under the existing Act in Scotland, which has a mix of the two applying to the same time period, is unsatisfactory. It is therefore preferable to specify targets on one basis or the other.

The Committee's assessment is that percentage reduction targets provide a more consistent, stable basis from which to drive decarbonisation, as changes to the emissions inventory have a smaller impact. Should there be a major divergence between the underlying scientific basis and the legislated targets in place at any time, this could be a significant change in circumstances that justifies revisiting the level of ambition in the targets.

Conclusion: The Act should not specify targets for any time period on both a percentage and an absolute basis. We recommend use of a percentage reduction basis for all targets, as these provide a more stable means of driving policy action to reduce emissions.

2. Emissions accounting for power and heavy industry

The Committee was asked to provide the Scottish Government with advice about how carbon budgets are accounted for. Broadly, there are two accounting options:

- **Actual (or 'gross') emissions.** Emission reduction only counts towards meeting domestic carbon targets if that emission reduction has taken place within Scottish territory. This has been the approach to date for sectors outside the EU Emissions Trading System (EU ETS) – transport, buildings, agriculture, land use and parts of industry – but could be used more widely. The SNP election manifesto included a commitment to moving to this approach across the economy.³³
- **'Net' emissions.** For sectors within the EU ETS, an adjustment is made to the actual level of emissions to account for net trading by Scottish installations within the EU ETS. These 'net' emissions essentially reflect Scotland's share of the EU ETS cap. If actual Scottish emissions are above the Scottish share of the cap, this implies that Scottish installations are net buyers of EU ETS allowances; conversely, if actual emissions are below the share of the cap, Scottish installations are net sellers of allowances. This method is used for the existing Scottish targets and for UK carbon budgets.

In assessing the best choice of how to account for emissions covered by the EU ETS – the power sector and heavy industry – we first consider the set of issues that apply to both sectors. We then draw conclusions for those sectors in the context of the design of Scottish emissions targets.

³³ In committing to introducing new climate change legislation for Scotland, the SNP manifesto highlighted that in order to "increase transparency and accountability, we believe Scotland's targets should be based on actual emissions from Scotland". Available at: <https://www.snp.org/manifesto>

Considerations for the choice of accounting approach

The choice of accounting approach depends on a number of considerations, relating to transparency, ensuring efficient outcomes, whether it drives cost-effective decarbonisation and changes in the output of large emitters:

- **Transparency.** It is important in designing emissions targets that they provide a clear signal to policy-makers, investors and the wider public about the extent of the emissions reductions that are required. Experience with 'net' carbon targets under the existing Scottish framework, and at a UK level, suggests that this accounting method does not provide that clear signal. The most transparent method is to account for actual emissions in all sectors.
- **Efficiency.** If targets are based on actual emissions, it is important that climate policy is designed to avoid reducing Scottish industrial output or distorting decisions on the location of new generating capacity or industrial installations:³⁴
 - **Carbon leakage** is the risk of closure or reduced output from an industrial installation, with production moving elsewhere, accompanied by a commensurate increase in emissions overseas. This is something that climate policy in the UK and Europe has consistently striven to avoid (e.g. through allocation of free allowances within the EU ETS and through compensation to electricity-intensive companies for increased power prices). Having emissions accounting for vulnerable sectors based on actual emissions need not raise the risks of carbon leakage, given that it is possible design policies to minimise such impacts.
 - **Siting of new plant.** Should some parts of the UK account for actual emissions in power or industry, while other parts use the UK carbon budget treatment on a net basis, in principle there is the potential for new sources of emissions to be sited in areas that do not have targets based on actual emissions. However, policy can be designed to avoid such outcomes.
 - **Effort leakage.** If emissions are covered by a well-functioning emissions trading scheme covering a number of countries that has a 'hard' (i.e. inflexible) cap on emissions, it can be argued that additional policy effort to reduce actual emissions in one country will simply create headroom within the cap that leads to corresponding higher emissions in other countries (sometimes known as the 'waterbed effect'). In principle, this is a strong argument, but it relies on the emissions trading scheme having a hard cap, so that extra policy effort in one country will lead to lesser reductions elsewhere. In practice, the EU emissions trading system (EU ETS) is oversupplied and has a mechanism by which emissions permits can be taken out of the market, so for the time being the cap is 'soft' and significant offsetting reductions in effort elsewhere are unlikely.³⁵
- **Cost-effective decarbonisation.** Targets can fail to drive the policy effort required to follow the cost-effective path for economy-wide decarbonisation if emissions reduction in particular sectors is not counted towards meeting the target.

³⁴ The choice of emissions accounting approach need not be tied to the policy instruments by which emissions are reduced. Being part of an emissions trading scheme does not necessitate accounting for emissions on a 'net' basis, especially when the emissions cap in that trading scheme is 'soft' (i.e. over-supplied or subject to unpredictable policy adjustments) as is currently the case for the EU ETS.

³⁵ Analysis by Sandbag suggests that only 2-8% of emissions allowances freed up by additional action to reduce emissions covered by the EU ETS will be used elsewhere in the system. See *Puncturing the Waterbed Myth*, available at <https://sandbag.org.uk/project/puncturing-the-waterbed-myth/>

- Scotland has reduced emissions from the power sector by a large amount. However, this policy had to be conducted within a carbon accounting framework that did not directly recognise many of these domestic changes.
- Whilst some important policy levers are in the hands of the UK Government, there is an important role for the Scottish Government to drive emissions reductions by using the levers under its control (e.g. planning) or by working with the UK Government.
- Long-term decarbonisation of the economy will require contributions from all sectors, although the timing and extent of these will depend on the relative costs of opportunities to reduce emissions. Emissions accounting approaches that treat some sectors differently may lead to an unbalanced decarbonisation strategy (e.g. use of finite bioenergy resources in sectors where emissions reductions ‘count’ rather than where they are most cost-effective).
- Carbon capture and storage (CCS) is crucial to meet long-term emissions targets at reasonable cost³⁶ and to reach net-zero emissions. Its potential to reduce emissions largely applies to sectors covered by the EU ETS. A net emissions accounting approach that does not reward reductions in these sectors could provide insufficient focus on CCS to overcome the initial barriers to its implementation.
- **Changes in operational capacity.** The possibility that large industrial emitters or fossil-fired power stations might have output considerably higher or lower than anticipated when setting emissions targets creates the potential for the emissions reduction required in the rest of the economy either to be much stronger or weaker than originally intended. In the case that stronger action is required elsewhere, this could lead to excessive costs. Where weaker action is sufficient, this ‘hot air’ can undermine long-term progress in decarbonisation.³⁷

Having considered the general principles for the accounting framework, it is then necessary to consider them in the context of the specific sectors in Scotland.

Power sector

For the power sector, targets based on actual emissions can help to drive the necessary action in Scotland to help bring forward cost-effective forms of low-carbon generation, for example through the planning system. The risks of such targets are relatively low:

- **Transparency.** Targets based on actual emissions are easier to understand than those based on net emissions. Given the potential for low-carbon generation in Scotland, it is important that emissions reductions in the power sector are rewarded within Scottish targets.

³⁶ The importance of CCS in achieving an 80% reduction by 2050 reflects its applicability across heavy industry and power, together with its importance in options for heat decarbonisation (e.g. hydrogen) and in maximising the emissions reduction from sustainable bioenergy.

³⁷ Hot air – lower emissions in one area leading to the allowed emissions for other areas being too high – could arise in a variety of ways. Under targets based on actual emissions, the closure or reduction in output of a large emitter can allow excessive emissions for other sectors. Under net emissions targets at UK level, hot air has arisen due to a failure to accurately estimate the share of the trading system cap in advance (see our letter to the Secretary of State in 2015: <https://www.theccc.org.uk/wp-content/uploads/2015/03/CCC-DECC-letter-re-emissions.pdf>). However, as we recommended in our advice on the UK’s fifth carbon budget (<https://www.theccc.org.uk/publication/the-fifth-carbon-budget-the-next-step-towards-a-low-carbon-economy/>) steps can be taken to avoid this, by fixing the level of the traded sector part of the budget, rather than using the out-turn share of the EU ETS cap. The UK Government did not accept this recommendation.

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- **Efficiency.** It makes sense to optimise power sector decarbonisation at the level of Great Britain, while allowing for an important role for interconnection to other countries primarily to provide flexibility. An accounting approach based on actual emissions for Scotland would help to drive decarbonisation (e.g. through supportive planning decisions), with limited potential for perverse outcomes.
 - Within this GB-level optimisation, policy levers sit at both UK Government (e.g. contracts for difference) and devolved levels (e.g. planning). It therefore makes sense to have targets based on actual emissions for the power sector for Scotland to help facilitate the deployment of low-carbon capacity.
 - Given that UK carbon budgets are currently based on a net approach for the power sector, there is theoretically some scope for incentivisation of fossil-fired back-up plants to be located in England rather than in Scotland or conversely for bio CCS power plants to be located in Scotland. In practice, there are other reasons for power station siting (e.g. grid stability) that are likely to be given greater consideration.
 - **Cost-effective decarbonisation.** Scotland has a considerable contribution to make in providing low-carbon generation as part of cost-effective decarbonisation within Scotland and at UK and EU levels.
 - Targets based on actual power sector emissions could be a problem if lack of cost-effective options meant that Scotland had to resort to high-cost options in order to decarbonise its power sector. However, given the volume of relatively low-cost options, this is not a great concern.
 - In order to achieve overall emissions reductions in the most cost-effective way at Scottish, UK and EU levels, it is important to unlock the potential for lower-cost forms of low-carbon generation in Scotland. This would be the case even if the EU ETS were functioning as originally intended; given its current weakness, it is all the more important to drive Scottish electricity decarbonisation.
 - While Scottish emissions targets can drive progress in Scotland meeting its own electricity needs from domestic generation, they do not provide a driver to become a substantial net exporter of low-carbon power.
 - **Changes in operational capacity.** Risks relating to ‘hot air’ from a large emitter closing are not material in the case of Scotland, as the last large coal-fired plant, Longannet, closed in 2016. The size of future effects, such as further closures of fossil-fired plant or the siting of a new thermal plant to provide back-up to renewables should be of a small enough scale to be managed within the overall targets.

Power sector conclusion: We recommend that the power sector be accounted for on the basis of actual Scottish emissions. This will reward action to reduce power sector emissions within Scotland, and provide transparent accounting for those emissions.

Industry

The best solution for the parts of industry covered by the EU ETS is less clear-cut. Although there are clear benefits to multi-country emissions trading, long-term decarbonisation would ideally proceed more quickly than is likely under the EU ETS. Targets based on actual emissions would be more transparent and need not lead to risks of carbon leakage if policy is designed well, but uncertainties in the levels of future industrial output present a challenge to setting targets:

- **Transparency.** Targets based on actual emissions are easier to understand than those based on net emissions. However, there may be presentational challenges should the closure of a significant emitter make the difference between meeting targets and not doing so, even if this closure was not due to climate policy.
- **Efficiency.** Many industries are international in nature. Reducing output in Scotland will not necessarily lead to a reduction in global greenhouse gas emissions. There are potential risks to industrial competitiveness if one country pursues more ambitious climate policies than competitor countries and if the additional costs relating to decarbonisation are borne by the relevant companies.
- **Cost-effective decarbonisation.** While a net emissions approach would protect industry from extra costs of decarbonisation, it is unlikely to lead to the necessary long-term decarbonisation where the market for emissions allowances is not functioning well. Targets based on actual emissions could help to support actions to decarbonise Scottish industry, but policy would have to be designed carefully to avoid undermining competitiveness, which may imply significant Government expenditure.
 - In order to achieve the challenging long-term emissions targets, the industrial sector in Scotland will need to make significant emissions reductions. While the EU ETS provides an incentive to undertake some incremental improvements in energy efficiency it looks unlikely to drive the more significant measures that will be required.
 - Targets based on actual emissions in industry would mean that the Scottish Government has a reason to find and incentivise ways of reducing industrial emissions. While there are ways to incentivise more ambitious policy action without imposing the extra costs on companies, such measures may imply significant expenditure by the UK or Scottish Government.
- **Changes in operational capacity.** Were major changes in industrial output to occur, either upwards or downwards, it would be possible to address this through reconsidering the level of the targets, as a result of a significant change in circumstances. It would also be possible to allow flexibility for the Scottish Government to buy international emissions credits in the case that higher than anticipated industrial output led to actual Scottish emissions being above the target. Risks relating to ‘hot air’ from reductions in industrial activity within Scotland are limited, but for the few installations with emissions large in comparison to the economy-wide total would need to be monitored.

Industry conclusion: Rather than accounting for industrial emissions in a more complex, less transparent, way it is preferable to keep the emissions accounting simple and deal with areas of concern in other ways. **We therefore recommend that accounting for industry emissions is on the basis of actual Scottish emissions.** This would encourage decarbonisation and be more transparent than under the existing framework. **However, consideration should be given to particular provisions for some industrial sectors:**

- It is important that where there is a risk of displacement of industrial activity to other countries with less stringent climate policies (i.e. ‘carbon leakage’) policy does not encourage a reduction in Scottish industrial output. Climate policies should be designed carefully to avoid this risk.
- The level of industrial activity in Scotland could turn out to be higher or lower than that anticipated when setting emissions targets. In the case that this difference in output is large,

this could constitute a significant change in circumstances that warrants reviewing the level of emissions targets so as to maintain the level of ambition for emissions reduction across the rest of the economy.

- Should industrial output be higher than anticipated, causing actual emissions to be higher than the target, it could be reasonable for international emissions credits to be used to offset these additional emissions.

The Scottish Government should work with the UK Government to ensure that compensation for, and exemptions from, the costs of low-carbon policies remain so long as there are differences in low-carbon policy costs between Scotland and international competitors.

3. Inclusion of Scotland's share of emissions from international aviation and international shipping

Under the UN Framework Convention on Climate Change (UNFCCC), emissions from international aviation and international shipping (IAS) are accounted for separately from those of individual countries.³⁸ Countries provide supplementary information regarding the emissions resulting from the consumption of the fuel sold for shipping and aviation ('bunker fuel' sales). This raises an issue of whether Scotland's shares of emissions from these sectors should be included within legislated targets.

These emissions contribute to climate change and in principle should therefore be included within the scope of national emissions targets, unless there are strong practical considerations which prevent this. Considering aviation and shipping in turn:

- **International aviation.** For international aviation, the complications that affect inclusion at a UK level relate to emissions targets that are accounted for on a net basis (e.g. the inclusion of aviation in UK carbon budgets has been constrained by the limited geographical scope of aviation included in the EU ETS). As we have recommended that Scotland move to targets based on actual emissions, this barrier does not apply.
- **International shipping.** There is no reason to exclude Scotland's share of international shipping emissions from the targets. International shipping is included in the existing Scottish targets and we have recommended inclusion within UK carbon budgets.³⁹

Accounting for these emissions formally within national emissions targets is clearer and more flexible than excluding them from this framework while taking them into account indirectly.

Inclusion of a sector within emissions targets does not automatically mean that strong carbon policies should be enacted at national level to limit them. As we have set out previously,⁴⁰ appropriate approaches to reducing international aviation and shipping emissions are at the global, or possibly EU, level rather than unilateral action at the country level. A unilateral approach would have limited impact reducing emissions and could result in perverse outcomes or leakage, given the specific characteristics of these sectors:

³⁸ The emissions attributed to individual countries under the UNFCCC are those occurring within that country's territory, including energy system CO₂ emissions, CO₂ process emissions (e.g. from chemical reactions in cement production), non-CO₂ emissions (e.g. landfill methane) and those relating to land use, land-use change and forestry.

³⁹ CCC (2015) *The fifth carbon budget – the next step towards a low-carbon economy*. Available at:

<https://www.theccc.org.uk/publication/the-fifth-carbon-budget-the-next-step-towards-a-low-carbon-economy/>

⁴⁰ CCC (2012) *Scope of carbon budgets – Statutory advice on inclusion of international aviation and shipping*. Available at: <https://www.theccc.org.uk/publication/international-aviation-shipping-review/>

- Unilateral policy action would not result in technology innovation as regards aircraft or ships, given that these industries are international, and require a critical mass of countries to support innovation.
- A Scotland-only policy in shipping, such as a bunker fuels tax or a cap-and-trade scheme, could displace bunkering to elsewhere in Europe, and result in transshipment via other European ports, with no overall reduction in emissions or increased incentive for efficiency improvement.
- A unilateral approach to aviation could result in displacement of hubbing to other airports in Europe (e.g. passengers might fly short-haul to other EU airports and connect to long-haul flights) without an overall reduction in emissions.

As an estimate of emissions based on bunker fuel sales is reported to the UNFCCC as a memo item, this is the simplest and most transparent basis for inclusion. Evidence suggests that this is a good proxy for a country's share of international transport emissions.⁴¹

Conclusion: Scotland's shares of international aviation and international shipping emissions should be included within the scope of Scottish gross emissions targets, as measured by bunker fuel sales. Scotland should pursue cost-effective policies to reduce emissions in these sectors, including international action (rather than unilateral action) where appropriate.

4. Inter-year flexibility and making up for underperformance

In addition to the emissions reduction targets for 2020 and 2050, the existing Act in Scotland contains provision for annual emissions targets, which have been set for the period out to 2032. The fluctuations in emissions relating to heating as a result of year-to-year fluctuations (e.g. variations in winter temperatures) mean that meeting or missing an annual target can be dependent on the weather rather than a function of policy action (see Chapter 1).

Performance against annual emissions targets will inherently be subject to significant external factors that will vary from year to year. Whilst variations in winter temperatures are a factor of particular importance in Scotland given the cold climate, other factors can also have a significant impact (e.g. strong GDP growth). It is important to distinguish between temporary factors that will tend to largely balance out over time (e.g. the effect of variations in winter temperatures) and those relating to underlying progress in reducing emissions.

There are a number of ways to address annual fluctuations in emissions, in order to reflect underlying progress on decarbonisation:

- **Multi-year (e.g. 5-year) carbon budgets** are used under the UK Climate Change Act and the Environment (Wales) Act. As they cover multiple years, year-to-year fluctuations in emissions from factors outside the control of policy (e.g. winter temperatures, which affect heating demand) are smoothed to some extent. This provides a more reliable indicator of underlying progress.
- **'Banking and borrowing'**. The ability to carry over outperformance of a target from one period to another ('bank') or to 'borrow' allowed emissions from a future period can also provide the flexibility to cope with annual fluctuations. This is allowed under UK carbon budgets but not under the Climate Change (Scotland) Act.

⁴¹ See Chapter 2 of CCC (2012) *Scope of carbon budgets – Statutory advice on inclusion of international aviation and shipping*. Available at: <https://www.theccc.org.uk/publication/international-aviation-shipping-review/>

- **A cumulative emissions budget.** Under the existing Scottish framework, the cumulative emissions budget plays two roles: as well as providing a link between the underlying science and allowed emissions, it also requires underperformance against annual targets to be made up with outperformance of targets in subsequent years. However, a cumulative budget framed in megatonnes has the potential to diverge from emissions targets based on percentage reductions (see section 3).
- **Cumulative performance mechanism with annual targets.** Should annual targets be kept, other mechanisms can be designed to require underperformance against annual targets to be made up in subsequent years. If such a mechanism is sought, we would recommend:
 - The mechanism should track cumulative under-performance against annual targets and require subsequent outperformance within a set period (e.g. five years).
 - This would only operate if there has been cumulative under-performance to date. If targets to date have been out-performed, subsequent under-performance should not be allowed – any reduction in future effort would not be appropriate given the stretching nature of long-term emissions targets.
 - The cumulative underperformance against annual targets could be accounted for either in absolute terms (i.e. MtCO₂e) or on a percentage basis (i.e. as a % of 1990 emissions).
- **Temperature-adjusted annual targets.** In principle it would be possible to adjust out-turn emissions to account for winter temperatures that are colder or milder than average. However, this introduces complications into emissions accounting, reducing transparency. It also only addresses fluctuations due to variations in winter temperatures and not those due to other factors (e.g. output of power stations or industrial installations).

The alternative to adopting any of these approaches is to continue with annual targets and accept that some annual targets will be missed even when underlying progress on decarbonisation is on track. The Committee will continue to assess underlying progress in reducing emissions and the impact of temporary factors on Scottish emissions in our annual Scottish progress report, including presentation of both actual out-turn emissions and temperature-adjusted emissions.

Conclusion: Annual targets are widely accepted by stakeholders in Scotland and we operate under the assumption that the Bill will provide for the continuation of this approach. The Committee will continue to report the rate of underlying progress. A mechanism to require that shortfalls against annual targets be made up in subsequent years could still be implemented without a link to an explicit cumulative emissions budget. Should a multi-year approach be adopted it should include a mechanism for annual assessments (e.g. through annual reports by the Committee to the Scottish Parliament).

Our conclusion (section 1) is that percentage reduction targets are preferable to absolute targets in providing a stable basis to drive decarbonisation. The scope for a cumulative emissions budget – which would naturally be set in megatonnes – is therefore limited. **Our assessment is that a long-term cumulative emissions budget is less practical as a policy tool to drive the necessary reductions in emissions than targets for specific years.** However, the Committee will continue to use the principle that cumulative emissions are important as an input to our advice on the level of Scottish targets.

5. Use of international emissions credits

Emissions trading can help to achieve emissions reductions at the lowest overall cost across a group of countries. This is particularly important for the industrial sector, where carbon-intensive installations may be clustered in particular countries and where a collective approach can reduce the risk that unilateral climate policies will lead to industrial output moving overseas (see section 2).

The Committee's view is that national targets for emissions reduction should focus primarily on measures to reduce domestic emissions. We have previously stated that the aim should be to meet the 2050 target through domestic action, given that international credits may be expensive in a world of low emissions. It follows that nearer-term targets need to drive domestic action in order to stay on track to achieving this by 2050. However, at the margin, the ability to purchase emissions credits can provide useful flexibility in meeting the targets.

Conclusion: In addition to their potential use in case of high industrial output (see section 2), ***the option to purchase some credible, international emissions credits should be retained to provide a flexibility mechanism.*** However, their role should be as a back-up option rather than their use being planned for and should require prior advice from the Committee.

Chapter 4: Recommendations



The Scottish Government requested advice from the Committee on four aspects of the new Bill: the appropriate level of future emissions, the form of future emission reduction targets, the future accounting framework and flexibility to alter emission reduction targets.

We set out our recommendations on each of those aspects in this Chapter. As some of these issues are inter-related, we have provided the advice in six sections:

1. The level of the 2050 target and the possibility of a net-zero target
2. The emissions accounting framework
3. Interim and post-2050 targets
4. Form of targets
5. Near-term emissions targets
6. Making up for underperformance against targets

1. The level of the 2050 target and the possibility of a net-zero target

The Climate Change (Scotland) Act 2009 set a target for 2050 to reduce emissions by at least 80% on 1990 levels, the same as that for the UK in the Climate Change Act 2008. This was derived as a contribution to a global emissions path aimed at keeping global temperature rise by the end of the century close to 2°C.

The Paris Agreement's ambition to limit warming to "well below 2°C, and to pursue efforts to limit it to 1.5°C" and to reach global net zero emissions in the second half of the century goes beyond that embodied in the UK and Scottish 2050 targets. There is a question over whether it is appropriate to legislate now for a more ambitious 2050 target and/or set a date for emissions to reach net zero, or better to wait until the evidence to support these targets is stronger.

The 'ratchet' mechanism created by the Paris Agreement sets a schedule of global stocktaking intended for nations to revisit their commitments and increase them when possible. At UK level, this creates a number of decision points over the next two Parliaments (Figure 4.1).

In our October 2016 report on *UK Climate Action Following the Paris Agreement*,⁴² we concluded that it is too early for the UK to set new, more ambitious, emissions targets. We do not currently have scenarios of the technologies and behaviours that the UK should deploy to play its part in a zero-emissions world, and there is already a significant shortfall in action to meet existing UK carbon budgets. In order for a new target to be credible it would need to be evidence-based, accompanied by strong policies to deliver existing targets and a strategy to develop greenhouse gas removals. These steps should be the priority for the UK Government.

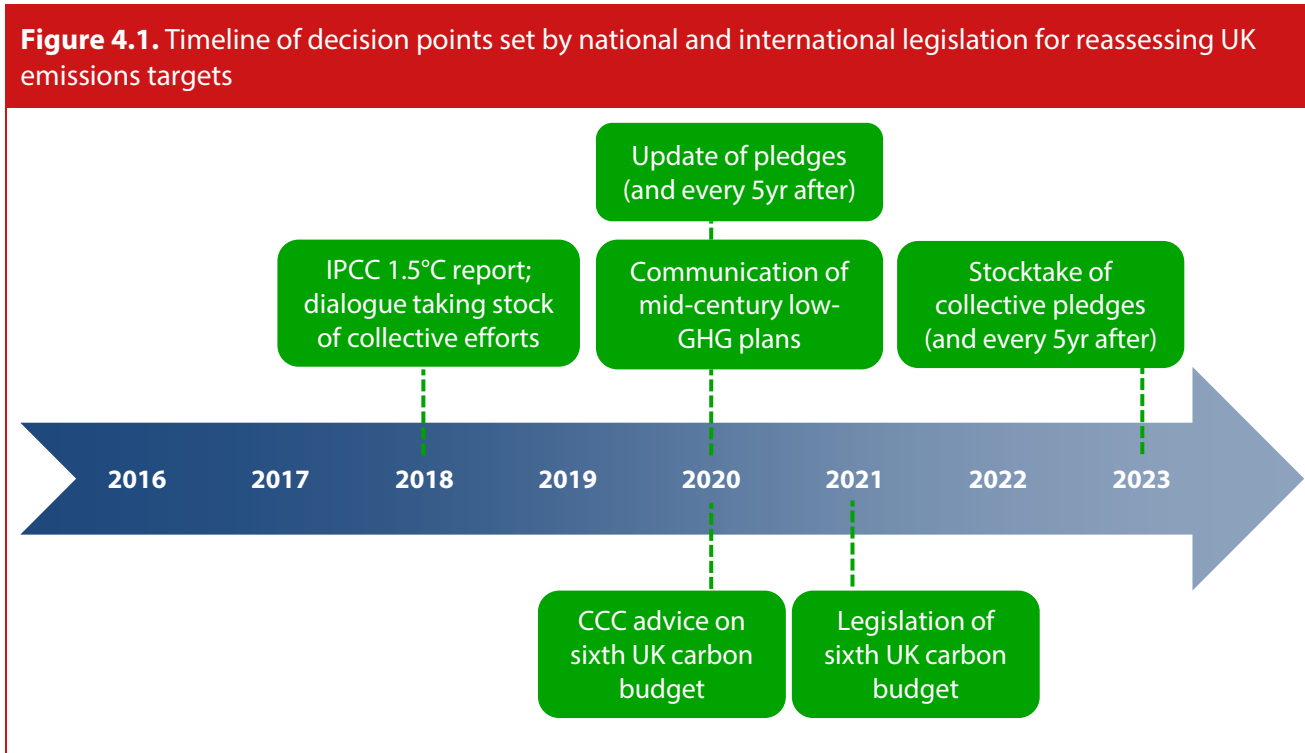
In the case of Scotland, there are important differences to the situation at UK level:

- **New legislative process.** Scotland is enacting new climate change legislation, and therefore has the opportunity to set more ambitious targets as part of that process.
- **Evidence base.** In our UK-level report on post-Paris ambition, our most ambitious scenario was able to achieve a reduction of around 90% in emissions by 2050, but was not able to reach net-zero (either for CO₂ only or for all greenhouse gases). In contrast, our most

⁴² Available at: <https://www.theccc.org.uk/publication/uk-action-following-paris/>

ambitious scenario for Scotland is able to reach net zero CO₂ emissions as part of an overall greenhouse gas reduction of 90% on 1990 levels by 2050.⁴³

- **Scotland’s high ambition.** Scotland has already made good progress, having already reduced emissions by 40% since 1990, and there is strong support for ambitious Scottish action on climate change to lead by example internationally.⁴⁴ This raises the possibility that Scotland could choose to set highly ambitious emissions targets, towards the limit of what is considered achievable, as ‘stretch’ targets.



An increase in the ambition of legislated Scottish long-term emissions targets could therefore be incorporated now within the new Bill. Alternatively, Scotland could wait until the evidence is stronger before deciding whether to make long-term emissions targets more ambitious. In either case, near-term ambition should be sufficiently strong to allow for greater ambition to 2050 than is currently legislated.

We set out below our recommendations on the targets that can be set now, including those subject to review, and targets that could be set at a later date and for which the legislation should make allowance. Beyond this, should there be a significant change in circumstances or available evidence, it may be appropriate for the Committee to review the levels of the targets.

⁴³ Based on current projections of Scottish population and demand, the current emissions inventory and our current understanding of technology and behaviours.

⁴⁴ In November 2016, the First Minister said “It is further evidence of Scotland’s determination to show leadership on climate change - the biggest environmental, economic and moral issue currently facing the planet. It demonstrates our desire to lead by example at home, and exert a positive influence overseas.” (<http://news.gov.scot/speeches-and-briefings/first-minister-address-to-seanad>). Scotland is also a member of the Under2MoU Coalition, the subnational global leadership group with the goal of limiting warming to below 2°C.

Should a new 2050 target of 90% be adopted it would be close to the achievable limit supported by existing evidence. It is important to acknowledge the scale of that challenge. We therefore set out two options for the level of long-term ambition under Scottish targets:

- **Option 1: Keep the target for a reduction of at least 80% by 2050 with subsequent reviews about increasing ambition.** Maintain the current level of ambition for 2050 of a greenhouse gas emissions reduction of at least 80% on 1990 levels, while retaining the option to increase ambition in future. The option to go further should be kept open within legislation and in policy decisions:
 - It would be appropriate to identify in legislation specific points in time (e.g. in line with the pledge-and-review process created by the Paris Agreement) at which the levels of ambition for 2050 could be independently reviewed, with one or more dates being set to decide when to reduce emissions to net zero on a CO₂ and/or on an all-GHG basis.
 - The Paris Agreement means that greater global ambition is needed. It is important for current policy to anticipate this change even ahead of a specific date being set. It is therefore appropriate to set targets at least to 2030 that keep open the option of more ambitious longer-term reductions (e.g. based on our High Ambition scenario).
- **Option 2: Set a 'stretch' target for a greenhouse gas reduction of 90% by 2050, potentially accompanied by a net-zero CO₂ target for 2050.**
 - The Committee's most ambitious scenario for Scotland achieves a reduction in overall greenhouse gas emissions of around 90% on 1990 levels by 2050. This is at the limit of the measures the Committee has identified to reduce emissions in Scotland and would require strong progress across every area of the economy. The Committee has not, at this time, been able to calculate a total cost associated with a scenario that achieves this target.
 - The scenario that achieves a 90% reduction in GHG emissions in 2050 does so by reducing CO₂ emissions to around zero, with the residual net positive emissions comprising non-CO₂ greenhouse gases (primarily methane and nitrous oxide from farming). Therefore, setting a target now to reach net-zero CO₂ emissions by 2050 would be consistent with a GHG target for a 90% reduction by the same date.
 - The Committee does not currently have a scenario that reduces net greenhouse gas emissions to zero by 2050. The legislation should allow for a target for greenhouse gas emissions to reach net-zero to be set at a future date, once the evidence base has been strengthened.
 - In order to achieve a 90% target, strong and well-designed policies would be required. By adopting a more ambitious 2050 target than currently exists for Scotland, or for the UK as a whole, it would be important to identify the areas in which Scotland will go further than the UK as a whole, the role for greenhouse gas removal options (including afforestation, use of wood in construction, bioenergy with carbon capture and storage and a range of other options), and whether relevant policy levers are under Scottish or UK Government control.

Given the stretching nature of some of these more ambitious potential targets, the Committee recognises that it is for Scotland to make a decision on the level of ambition. Should the more ambitious targets be adopted, the decision must take full account of the recommendations set out above.

2. The emissions accounting framework

There is an opportunity with the new legislation to increase the transparency of emissions accounting.

Emissions accounting for the power sector

The power sector is of major strategic importance to economy-wide decarbonisation, both in displacing fossil generation and providing the means to decarbonise other sectors (e.g. through electric vehicles). Power consumption within the GB system is likely to increase between now and 2050, by which time virtually all generation will need to be low-carbon. It is therefore especially important that substantial progress is made now on investment in low-carbon generation capacity. Scotland is very well placed to contribute strongly to a cost-effective supply mix.

The primary policy levers to encourage low-carbon electricity generation are held at UK level, both for large-scale projects (contracts for difference) and smaller scale (feed-in tariffs). However, there is also an important role at devolved and local government levels in facilitating the addition of new generating capacity, especially relating to the planning system.

We therefore recommend that the power sector be accounted for on the basis of actual Scottish emissions, rather than the ‘net’ approach under existing Scottish climate targets and UK carbon budgets. This will reward action to reduce power sector emissions within Scotland, and provides a transparent basis for accounting for those emissions.

Emissions accounting in industry

The arguments for and against different ways of accounting for industry emissions are more finely balanced (see Chapter 3). The method of accounting under the existing framework is difficult to understand and does not reward emissions reductions across the whole economy. However, in moving to a different approach it is important that this does not introduce risks of undesirable outcomes.

The most transparent way to account for emissions in the industry sector is to include them on the basis of actual emissions. Including them in this way would also reward actions to reduce emissions in Scottish industry. However, it would raise questions over two aspects: the risk of displacing Scottish industrial production overseas (i.e. ‘carbon leakage’) and concerns that unanticipated changes in industrial output – upwards or downwards – should not lead to emissions targets for the rest of the economy that are too tight or too loose.

The Committee’s view is that rather than accounting for industrial emissions in a more complex, less transparent, way it is preferable to keep the emissions accounting simple and deal with areas of concern in other ways. ***We therefore recommend that the industry sector be accounted for on the basis of actual Scottish emissions.***

In order to limit the potential for carbon leakage or other perverse outcomes, we make three accompanying recommendations:

- **Design of climate policies.** It is important that where there is a risk of displacement of industrial activity to other countries with less stringent climate policies (i.e. ‘carbon leakage’)

policy does not encourage a reduction in Scottish industrial output. It will be important that climate policies are designed carefully to avoid this risk.⁴⁵

- **Maintaining ambition in other sectors.** The level of industrial activity in Scotland could turn out to be higher or lower than that anticipated when setting emissions targets. In the case that this difference in output is large, this could constitute a significant change in circumstances that warrants reviewing the level of emissions targets so as to maintain the level of ambition for emissions reduction across the rest of the economy.
- **Purchase of emissions credits.** Should industrial output be higher than anticipated, causing actual emissions to be higher than the target, it could be reasonable for international emissions credits to be used to offset these additional emissions.

Use of international emissions credits

The Committee's view is that national targets for emissions reduction should focus primarily on measures to reduce domestic emissions. We have previously stated that the aim should be to meet the 2050 target through domestic action, given that international credits may be very expensive in a world of low emissions. It follows that nearer-term targets need to drive domestic action in order to stay on track to achieve this by 2050. However, at the margin, the ability to purchase emissions credits can provide useful flexibility to meet the targets.

Emissions trading can help to achieve emissions reductions at least cost across a group of countries. This is particularly important for the industry sector, where carbon-intensive installations may be clustered in particular countries and where a collective approach can reduce the risk that unilateral climate policies will lead to industrial output moving overseas (i.e. 'carbon leakage'). In principle, emissions trading could lead to Scottish industrial emissions increasing as part of a least-cost approach to reducing emissions across multiple countries (e.g. within the EU emissions trading system).

Therefore, whilst the recommended targets relate to reductions in actual Scottish emissions, purchase of emissions credits could be appropriate:

- **To cover increased industrial output.** As outlined above, should Scottish industrial output exceed that anticipated when setting the targets, causing actual Scottish emissions to be above the target levels, it could be reasonable for international emissions credits to be used to offset these additional emissions.
- **To provide flexibility.** The option to purchase some credible, international emissions credits should be retained to provide a flexibility mechanism. However, their role should be as a back-up option rather than their use being planned for and should require prior advice from the Committee.

The role for emissions trading to meet net-zero targets is less clear at this stage, as this depends on international progress in decarbonisation and on the development of greenhouse gas removal technologies:

- If greenhouse gas removal options are scaled up successfully there may be greater scope for trading in 2050 and beyond. The relative cost of removals will likely vary around the world, depending on different national resources such as land and geological stores.

⁴⁵ See our report on Energy Prices and Bills: <https://www.theccc.org.uk/publication/energy-prices-and-bills-report-2017/>

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- While Scotland's access to large geological storage sites for CO₂ may mean it is well-placed to sell removals to other countries, it is possible that there may be a role for credit purchase as part of a global solution to reach net-zero emissions.

Given current uncertainties over the role for emissions trading in the long term it therefore remains appropriate for Scotland to plan to meet long-term targets through domestic action.

Inclusion of international aviation and international shipping

We have previously recommended that in principle the relevant shares of international aviation and international shipping emissions should be included in emissions targets.⁴⁶ The issue therefore relates to the practicality of inclusion:

- **International aviation.** In practice, complexities relating to the inclusion of aviation within European emissions trading and accounting for this within net emissions targets have meant that we have recommended against inclusion to date. However, such a barrier is only relevant where emissions targets are based on 'net' emissions accounting; there is no barrier to inclusion in targets based on actual emissions.
- **International shipping.** There is no practical barrier to including the share of international shipping emissions within targets, regardless of the form of emissions accounting (e.g. as part of the Committee's advice on the UK fifth carbon budget⁴⁷ we recommended that the UK share of international shipping be included in UK carbon budgets).

Given the recommendations to account for Scottish emissions based on actual emissions, ***we recommend that Scotland's emissions targets should include the relevant shares of international aviation and international shipping emissions***, using emissions estimates calculated from bunker fuel sales. However, this should not necessarily mean that Scotland pursues unilateral policy action to reduce emissions in these sectors (see Chapter 3).

3. Interim and post-2050 targets

The Scottish Government has committed that the new Bill will establish a new target for emissions reduction by 2020 that is more ambitious than the one under the existing Act. However, it is anticipated that the new Act will not be passed until 2019, by which point the scope for new policies to affect the level of emissions in 2020 will be extremely limited.

Clearly, it is possible for the Scottish Government to make an earlier, non-legislative, commitment to a 2020 level of ambition (e.g. later in 2017), and then enshrine it in legislation subsequently. Even then, the scope to enact new policies that go beyond those set out in the Climate Change Plan will be quite limited.

Nevertheless, given the prior commitment to set a new target for 2020 within the new Bill, ***we recommend the level for a 2020 target of a 56% reduction on 1990 emissions*** in line with existing plans.

In addition to targets for 2020 and 2050, the Committee recommends that the new legislation includes an interim target for 2030, in order to provide sufficient medium-term clarity on the

⁴⁶ CCC (2012) *Scope of carbon budgets – Statutory advice on inclusion of international aviation and shipping*. Available at: <https://www.theccc.org.uk/publication/international-aviation-shipping-review/>

⁴⁷ CCC (2015) *The fifth carbon budget – the next step towards a low-carbon economy*. Available at: <https://www.theccc.org.uk/publication/the-fifth-carbon-budget-the-next-step-towards-a-low-carbon-economy/>

level of action required. This will be especially important should the Bill includes review points at which the level of 2050 ambition might be increased, in order to minimise the nearer-term impact of any uncertainty over the level of long-term ambition.

We therefore recommend that a 2030 interim target is put in legislation now for a reduction of 66% on 1990 emissions, regardless of the option chosen for the 2050 target. This is consistent with the level of ambition embodied in the existing annual targets, but on the basis of actual rather than ‘net’ emissions.⁴⁸

The value of setting in legislation now an interim target for 2040 is dependent on how likely it is that the level of ambition for 2050 will be revised in future:

- If the legislative process anticipates a future increase in 2050 ambition then an interim target for 2040 has little value, given the uncertainty in the emissions path between 2030 and 2050.
- Conversely, should the 2050 target be set such that there is little room to make it more ambitious in future there would be value in setting an interim target for 2040 as a staging post between 2030 and 2050.

Should the new Bill set an interim target for 2040, it would be reasonable for it to be set halfway between the 2030 interim target and the 2050 target (i.e. assuming a straight-line trajectory for emissions reduction between 2030 and 2050).⁴⁹

If an interim target for 2040 is not set initially, it would be appropriate to allow for such a target to be set at a later date, once the level of the 2050 target has been settled. The level of a 2040 target for 73% reduction on 1990 emissions would be consistent with a settled 80% target for 2050. A 2040 target of 78% would be consistent with a 2050 target for a 90% reduction on 1990 levels.

The new legislation should also allow for target dates to be set for net-zero emissions, on a CO₂-only and/or all-greenhouse gas basis.

- **Date for net-zero CO₂ emissions.** Should a net-zero CO₂ target date not be legislated initially, it would be appropriate for the new Bill to allow for such a date to be set subsequently, whether for 2050 or a later date.
- **Date for net-zero greenhouse gas emissions.** We currently do not have a sufficient understanding of how a net-zero target for all greenhouse gases could be met in Scotland. We therefore recommend that such a target is not set now. However, it would be appropriate for the new Bill to allow for such a target date – likely to be after 2050 – to be set in legislation in future, once such an evidence base exists.

⁴⁸ The existing annual targets imply a reduction in Scottish emissions of 64% by 2030 against 1990 levels on a net basis, with the annual target for 2032 being a reduction of 66% on a net basis.

⁴⁹ Our scenarios assess the feasible and cost-effective paths for emissions reduction on a sector by sector basis. Some sectors have paths for emissions with front-ended emissions reduction (e.g. the power sector), whilst others are more back-ended due to the need to build markets, reduce costs and develop infrastructure (e.g. heat and transport). When combining these, the rate of emissions reduction across the economy turns out to be similar to a straight-line reduction.

4. Form of targets

Percentage reduction or absolute (megatonne) targets

The Committee's assessment is that setting targets on different bases, such as the percentage reduction and absolute (megatonne) targets in the existing Act, is unsatisfactory and that one or other basis should be chosen that applies to all targets.

Given that percentage reduction targets will generally be less sensitive to changes in the greenhouse gas emissions inventory, ***we recommend that the 2050 target, all interim targets and the annual targets are all specified as percentage reductions on baseline (i.e.1990) emissions levels.***

Should there be changes in the scientific evidence such that the level of climate change consistent with the legislated percentage reduction targets comes to be sufficiently different from the current understanding, this could constitute a significant change in circumstances and warrant a review of the target levels.

Cumulative emissions

The level of global temperature change is closely linked to the cumulative total of emissions over time of CO₂, and some other long-lived greenhouse gases (such as nitrous oxide and some F-gases). This relationship highlights the need to bring emissions of these gases to near zero, but our assessment is that legislating a long-term cumulative emissions budget would not help significantly to drive the necessary decarbonisation and would be difficult to keep aligned with other emissions reduction targets:

- Peak global temperature rise depends primarily on cumulative emissions of CO₂ and other very long-lived greenhouse gases (e.g. nitrous oxide and some F-gases). Temperature limits will therefore only be met if emissions of these gases reach net zero. Other, shorter-lived gases (e.g. methane) drive temperature by their rate of emission. The lower the emission rates, the greater the available cumulative budget for the very long-lived gases.
- Cumulative greenhouse gas budgets over long periods of time (e.g. from now to 2050) are unlikely to be an effective tool to drive the near-term policy action required for decarbonisation. Rather, policy can address the rate of emissions reduction over the next decade or so, and create options to meet longer-term goals. Therefore, targets for emissions in specific years – informed by consideration of cumulative emissions budgets – are more likely to drive the concrete actions required.
- It is important that the set of legislated targets remain aligned with each other, so as to avoid the situation that has occurred under the existing Act, in which different targets have diverged, even though they were aligned initially. Given our conclusion that percentage reduction targets are preferable to absolute (i.e. megatonne) targets in providing a stable basis to drive decarbonisation, the scope for an additional cumulative emissions budget – which would naturally be set in megatonnes – is therefore limited.

Our assessment is therefore that a long-term cumulative emissions budget is less practical as a policy tool to drive the necessary reductions in emissions than targets for specific years.

However, the Committee will continue to use the principle that cumulative emissions are important as an input to our advice on the level of Scottish targets.

Again, should there be changes in the scientific evidence such that Scottish emissions are considerably higher than previously thought and that the legislated percentage reduction targets are insufficiently ambitious, this could constitute a significant change in circumstances and warrant a review of the target levels.

We address the existing role of the cumulative emissions budget in requiring shortfall against the targets to be made up with outperformance of subsequent targets in section 6.

5. Near-term emissions targets

Alongside interim targets for 2020 and 2030, other near-term targets should keep open action that goes beyond an 80% reduction in greenhouse gas emissions by 2050. This means near-term targets consistent with our High Ambition scenario for Scotland, which is also the basis for the annual targets under the existing Act. These could be either multi-year (e.g. 5-year) carbon budgets or annual targets:

- **Annual targets**, as exist under the existing Scottish framework, are more vulnerable to year-to-year fluctuations in emissions but ensure robust, regular scrutiny of policy and progress. Should annual targets again be adopted, it is likely some targets for some years will be missed due to external factors, even if underlying policy action is on track to the decadal targets.
- **Multi-year (e.g. 5-year) carbon budgets** are used under the UK Climate Change Act. As they cover multiple years, year-to-year fluctuations in emissions from factors outside the control of policy (e.g. winter temperatures, which affect heating demand) are smoothed to some extent. This provides a more reliable indicator of underlying progress and need not result in a loss of annual scrutiny. For multi-year targets to balance smoothing fluctuations with the ability to adjust as more information becomes available they should be neither too short (e.g. not less than 3 years), nor too long (e.g. not more than 7 years).

Annual targets are widely accepted by stakeholders in Scotland and we operate under the assumption that the Bill will provide for the continuation of this approach. Should a multi-year approach be adopted it should include a mechanism for annual assessments (e.g. through annual reports by the Committee to the Scottish Parliament).

The recommended levels of near-term targets to 2032 are set out in Table 4.1. These are presented as annual targets, as exist under the current legislative framework in Scotland, but on a percentage reduction basis (as recommended in section 3).

We recommend that these are legislated as percentage reductions with one decimal place (e.g. 66.0% for 2030). Should a decision to adopt multi-year carbon budgets be taken, these annual targets could be averaged as required (e.g. a 5-year budget for 2023-27 would require emissions for those years to be 61.0% below 1990 emissions on average).

Table 4.1. Recommended near-term emissions targets on an annual basis (2019-2032)

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Percentage reduction on baseline emissions	55.0	56.0	57.0	58.0	59.0	60.0	61.0	62.0	63.0	64.0	65.0	66.0	67.2	68.4

Notes: The specified numbers are the percentage reductions on baseline emissions, which is calculated from 1990 emissions for all greenhouse gases except for HFCs, for which the earliest available data (1995) are used. Target levels after 2030 are on a linear path to a 90% reduction, and fall at a slightly faster rate than the reductions up to 2030.

6. Making up for underperformance against targets

Under the existing Scottish framework, the cumulative emissions budget plays two roles: as well as providing a link between the underlying science and allowed emissions (see section 4), it also requires underperformance against annual targets to be made up with outperformance of targets in subsequent years. In practice, the large changes to the inventory meant that the size of the cumulative under-performance was too large to be made up subsequently.

Other mechanisms can be designed to require underperformance against annual targets to be made up in subsequent years. If such a mechanism is sought to require the Scottish Government to outperform future annual targets to compensate for earlier underperformance, we recommend:

- The mechanism should track cumulative under-performance against annual targets and require subsequent outperformance within a set period (e.g. 5 years).
- This would only operate if there has been cumulative under-performance to date. If targets to date have been out-performed, subsequent under-performance should not be allowed – any reduction in future effort would not be appropriate given the stretching nature of long-term emissions targets.
- The cumulative underperformance against annual targets could be accounted for either in absolute terms (i.e. MtCO₂e) or on a percentage basis (i.e. as a % of 1990 emissions).

Annex 1: Sectoral scenarios for Scottish emissions

In 2020 our Central and High Ambition scenarios give similar levels of reduction compared to 1990: 55% and 56% respectively. By 2030 these diverge to 62% and 66% due to the different roll-out of technologies. The CCC scenarios for Scotland to 2030 and then 2050 require deep reductions in most sectors.

Although these scenarios are not prescriptive, any scenarios to meet annual emissions targets on a gross or net basis will involve a significant expansion of renewable energy in Scotland: in the power sector, in heat and, via electrification, in transport. Scotland would need to deliver above the UK average in these areas. For example, the scenarios could require Scotland to achieve double the share of heat pumps in homes than for the UK, and be a significant exporter of renewable power to the rest of the UK. Energy efficiency also has an important role: both the carbon and energy intensity of the Scottish economy will have to significantly improve.

The more stretching the target for 2050, the less room there is to leave residual emissions across the economy and therefore the less freedom there is to balance greater effort in one area with less in another.

Central scenario

The Central scenario is broadly consistent with meeting the current 80% reduction target in 2050, taking account of uncertainty in projections (we estimate a reduction of 79%). This scenario includes:

- Falls in **power** sector emissions from 2014 of 84% by 2050, with the emissions intensity of Scottish electricity generation cut to less than 20 gCO₂/kWh in 2030 and to 10 g/kWh in 2050, compared to a 2014 level above 200 gCO₂/kWh. Much of the reduction results from the closure of the coal power station at Longannet in 2016. Continued expansion of renewable generation ensures that Scotland remains a net exporter of low-carbon power during a period when existing nuclear power stations are expected to close. Storage, demand-side response and interconnection play an important role in balancing the low-carbon system and maintaining security of supply.
- Falls in **buildings** emissions from 2014 of 75% by 2050. This includes low-carbon heat in about 57% of homes by 2050, supplemented by significant roll-out of about 3.7 TWh of heat networks, primarily in public and commercial buildings. Around 3 million more homes are properly insulated by 2050.
- Falls in **surface transport** emissions from 2014 of about 80% by 2050. Vehicle efficiency improves throughout the period to 2030 and the gap between test cycles and real-world performance is reduced. By 2030, 60% of new car and van sales are ultra-low emission (e.g. electric) vehicles, on track to close to 100% of sales in 2035. 30% of the car and van stock is ultra-low emissions by 2030, rising to close to around 93% by 2050. Further abatement is delivered from biofuels, a shift towards public and active transport (i.e. walking and cycling) and more efficient freight operations. Our scenarios reflect a detailed assessment of travel patterns specific to Scotland. The scenarios also include improved efficiency in aviation and shipping.

- Falls in **industry** emissions from 2014 of 45% by 2050. Various opportunities to improve energy efficiency are taken up, including waste-heat recovery and material efficiency. There is a switch away from fossil fuels to bioenergy and some electrification for space and process heating. A Scottish carbon capture and storage cluster is developed to reduce emissions from large point sources.
- **Bioenergy with carbon capture and storage (BECCS)** start under our scenarios in 2035. By 2050 it could provide up to 4.4 MtCO₂e of emission removals. If this bioenergy were not used with CCS for carbon removal, it could be used in alternative ways that would displace fossil fuels, although providing a lesser contribution to overall emissions reductions.
- Falls in **agriculture** emissions from 2014 of about 25% and a decrease in the size of the **land-use sink** of about 80% by 2050. The rate of new tree planting falls from current target levels to 7,600 hectares per year by 2030 and remains at that level in 2050. Various measures are implemented to reduce emissions in agriculture, requiring stronger levers than the current voluntary approach including: on-farm efficiency measures, improved management of crops and soils and improved animal health.
- Further abatement is delivered from **waste disposal** and **F-gases** (combined falls of just under 70% from 2014). These could largely be delivered through effective implementation of the existing waste policy plans and the new EU F-gas regulation.

High Ambition scenario

The High Ambition scenario could deliver a 90% reduction by 2050. This scenario has very similar abatement opportunities to the Central scenario for power, waste and F-gases, agriculture, aviation and shipping and emission removals from BECCS. However, for surface transport, buildings, industry and forestry it is more stretching. Greater reductions in the period to 2030 should help to prepare for this greater challenge. The key differences between the Central and High Ambition scenarios are:

- Falls in **buildings** emissions from 2014 of 95% by 2050. This includes low-carbon heat in 64% of homes in 2050, supplemented by greater roll-out of heat networks (5.4 TWh), primarily in public and commercial buildings.
- Falls in **industry** emissions from 2014 of 60% by 2050. This includes greater abatement from bioenergy as fuels in chemicals sector and CCS in refineries. We assume some initial deployment of CCS by 2030, and that by 2050 application and geographical barriers have been overcome (either through low-cost transport or use of captured carbon) meaning that CCS is applied to all iron & steel, chemicals, cement and refineries, plus larger CHP units in the food & drink and paper & pulp sectors. This provides 1.5 MtCO₂e of further abatement beyond our 'Central' scenario, where CCS wasn't deployed as widely by 2050.
- Falls in **surface transport** emissions from 2014 of over 90% by 2050. Vehicle efficiency still improves throughout the period to 2030 and the gap between test-cycle and real-world performance is reduced. By 2030 65% of new cars and vans sold are ultra-low emission (e.g. electric) vehicles, with 31% of the stock being ultra-low emissions. By 2050 this rises to 100% of the stock.
- Falls in **agriculture** emissions from 2014 of nearly 30% and a decrease in the size of the **land-use sink** of 20% by 2050. The rate of new tree planting increases to 16,000 hectares per year by 2050.



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