

WHEN TO SET A NET-ZERO GREENHOUSE GAS EMISSIONS TARGET YEAR:

Information and Analysis to support discussion of the Climate Change (Emissions Reduction Targets)(Scotland) Bill

May 2018



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WHEN TO SET A NET-ZERO GREENHOUSE GAS EMISSIONS TARGET YEAR

Introduction

On 23 May 2018 the Scottish Ministers introduced the Climate Change (Emissions Reduction Targets) (Scotland) Bill 2018 (the Bill) to the Scottish Parliament.

The Bill sets out the most ambitious, legally binding, domestic emissions reduction targets of any country in the world. It also reflects the Government's aspiration to achieve net-zero emissions as soon as possible. The targets in the Bill are:

- 56% emissions reduction by 2020
- 66% emissions reduction by 2030
- 78% emissions reduction by 2040
- 90% emissions reduction by 2050

This Bill puts into law the Scottish Government's intent to deliver our fair share of the global emissions reduction necessary to limit temperature rises to 1.5°C. It demonstrates our commitment to global leadership in tackling climate change.

In preparing the Bill, Ministers have considered the most ambitious domestic target for 2050 that can credibly be set at the present time. The independent, expert advice received from the UK Committee on Climate Change (CCC) is that, at the present time, a 90% target is at the limit of feasibility. The Bill ensures that Ministers will regularly review the earliest date that a net-zero target can be set, that these reviews will be informed by advice from the CCC that will be publicly available, and allows for the earliest achievable date to be set in legislation.

This paper summarises the information and analysis considered by Ministers in determining both the 90% target and the aspiration of net-zero and is presented to the Parliament to help inform its own consideration of these issues. It assesses Scotland's targets and ambition against those of other leading nations and considers the implications, both domestic and international, of Scotland setting a net-zero emissions date in legislation at this point.

Putting a net-zero target year into legislation just now, before a credible pathway for achieving it through domestic effort can be shown, would require Scotland to compromise its existing framework in one or all of the following ways:

- by paying other countries to reduce emissions on our behalf through the purchase of international carbon credits, instead of focussing purely on domestic effort
- by removing some sectors from the target
- by making legally binding commitments that are dependent on as yet undeveloped technological advancement and cannot be properly scrutinised
- by taking steps that would have a substantial detrimental impact on people's wellbeing and the economic growth of Scotland

Section 1: The importance of achieving net-zero emissions as soon as possible

The United Nations (UN) describes climate change as “one of the major challenges of our time”. The evidence is clear that climate change presents significant risks to the continued wellbeing of Scotland's people, communities, and environment, unless urgent and sustained action is taken.

Climate change is causing changes to atmospheric and ocean temperatures, sea levels, ocean acidity, water cycles, and other earth systems. These physical impacts in turn cause human impacts through multiple channels such as crop yields, storm damages, flood and drought impacts, health impacts and reduced productivity.

Several studies have sought to weigh up the damage that will occur if climate change continues at current pace against the cost of action to prevent further change and the cost of adapting to a changing climate. This is complicated by the fact that the costs and benefits are experienced differently by different populations across the world and different generations over time.

The long-term, cumulative, nature of the impacts of climate change means that it is future generations that will be most affected. Geographically, it is developing countries that are most vulnerable, because they already operate at elevated temperatures, their economic structures are more exposed to the external environment, and poorer populations generally have lower adaptive capacity. Analysis from the World Bank Group indicates that, without further action, climate change could push an additional 100 million people into poverty by 2030.

The overwhelming moral, scientific and economic case for increased action led to the 2015 UN Framework Convention on Climate Change Paris Agreement. The Agreement aims to strengthen the global response to climate change by holding the increase in global average temperatures to well below 2°C above pre-industrial levels and to pursue efforts to limit this further to 1.5°C. The Agreement states that, in order to achieve this, global emissions must peak 'as soon as possible' and decline so as to reach a net-zero level in the second half of this century. Ahead of the Paris talks, the First Minister called for a 'bold and ambitious deal', and subsequently confirmed Scotland's backing for the historic agreement.

Section 2: International comparisons

Scottish Ministers want to deepen Scotland's contribution to global action on climate change. Adopting new, more stretching targets puts Scotland amongst a select number of countries who have committed to translating the Paris Agreement into domestic law. In addition, certain features of the the Bill set Scotland apart as having one of the toughest legislative frameworks anywhere in the world. Following passage of the Bill:

- Scotland will have the most ambitious target in legislation for 2050 that will be **based on domestic effort alone**
- Scotland will continue to be the only country with **annual targets in legislation**
- Scotland will have the **most ambitious interim targets for 2020, 2030 and 2040 in legislation**
- Scotland will continue to be the only country that includes **a fair share of all international aviation and shipping in its targets**
- Scotland's targets will continue to cover **all greenhouse gases – including those generated by land use changes**

Comparisons between different countries' legal frameworks are not straightforward. France, UK, EU, Sweden, Norway and Finland each have domestic legislation for reducing emissions by between 75 and 100%. Sweden's legislation is considered by some as being the most ambitious – with a net-zero target for 2045 – however, it reserves the right to make up a significant share (15%) of this reduction through payments to other countries. **Scotland's proposed 90% reductions will come from domestic effort alone.**

There are other jurisdictions, such as California and New York State, who also have ambitious legislation relating to emissions reduction and others who are actively considering net-zero targets. Iceland, for example, has made a political commitment to net-zero but not yet indicated how they intend to achieve it or indicated a plan to legislate for it. A commitment to legislate for a net-zero target has been made in New Zealand, though decisions about which sectors of the economy will be included and whether or not all effort will be domestic have yet to be made.

The Scottish Government is closely monitoring international developments and is committed to international co-operation. For example, in the past year the First Minister signed a letter of co-operation with Governor Jerry Brown of California and spoke at a number of events both in Scotland and overseas, including at the Arctic Circle Assembly in Iceland and COP23 in Germany.¹ In addition, Scottish Government support for climate outreach programmes has increased, such as with support for the UNFCCC Gender Action Plan and the Women's Delegate Fund.

There has also been support for Under2 Coalition projects, like the Future Fund, to help developing countries engage with the global climate agenda and a policy initiative to develop better understanding around the role out of electric vehicles. This builds on the work of previous years, contributing to strengthening Scotland's status as a world leader on climate change, and sets the scene for developing Scotland's message on climate action, spreading it further and more visibly across the world.

¹ COP23 was the 2017 UN Climate Change Conference, incorporating the 23rd Conference of the Parties of the UN Framework Convention on Climate Change (UNFCCC)

Section 3: Independent, expert advice

The Climate Change (Scotland) Act 2009 established the principles of an evidence-based approach to setting targets. In particular, it gave a statutory role to an independent body – the UK Committee on Climate Change (CCC) – to provide regular expert advice to the Scottish Ministers. Committee members are experts in the fields of climate change, science, economics, behavioral science and business and have a statutory duty to act impartially and objectively.

The Scottish Government sought, and received in March 2017, advice from the CCC in preparation of the Bill. The advice is available at:

<https://www.theccc.org.uk/publication/advice-on-the-new-scottish-climate-change-bill/>

The key recommendation from the CCC was that Scotland should either “keep the target for a reduction in greenhouse gas emissions of at least 80% by 2050 with subsequent reviews to increase ambition” or “set a ‘stretch’ target for a reduction in greenhouse gas emissions of 90% by 2050”. The CCC advised that “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.”

Excerpts from the UK Committee on Climate Change's advice

“Scotland's existing 2050 target is for a reduction in greenhouse gas 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.”

“A 90% reduction in greenhouse gas emissions would be more consistent with the temperature limits set out in the Paris Agreement.”

“A reduction in GHG [Greenhouse Gas] emissions of 90% would require strong progress in every sector and is at the limit of the pathways currently identified to reduce Scottish emissions. 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”.

Section 4: The scale of the challenge

Transformational changes and extremely ambitious policy choices will be needed to achieve a 90% target by 2050.

At present, it is estimated that Scotland emits around 55 million tonnes of carbon dioxide equivalent (MtCO₂e, or megatonnes) to the atmosphere each year. Around 7 megatonnes are absorbed back out of the atmosphere by the natural forestry sink, so Scotland's net emissions are currently estimated to be around 48 megatonnes per year. Global emissions are around 49,000 megatonnes per year, meaning Scotland's emissions are approximately 0.1% of the global total.

Scotland's targets are set as percentage reductions from the 1990 baseline, which the most recent estimates suggest was around 77 megatonnes per year. A 90% reduction target currently means that net Scottish emissions will be around 8 megatonnes by 2050. However, frequent technical revisions to the data means that this may change (see box).

Frequent changes to estimates of emissions

The science of how greenhouse gas emissions are measured is continuously evolving. This results in the estimates of Scottish emissions, for both the present day and all previous years including the baseline year, changing frequently. The changes are overseen by a UK-level steering committee, in line with UN guidelines.

Past data have been revised in every set of Scottish emissions estimates published to date. One of the most significant changes that has occurred so far is an upwards revision of around 3 megatonnes per year to estimates of forestry emissions. In other words, 3 megatonnes of emissions were added to Scotland's inventory to reflect a better understanding of the science, but without any actual change in emissions taking place.

Very large data revisions can affect the appropriateness of emissions reduction targets: targets can become either harder or easier to meet. Implementation of the UN guidelines on wetland emissions is expected to mean a large revision to the data. It is likely to mean that the estimate of past Scottish emissions levels will increase far more significantly than any changes seen to date. In this event, a 90% target by 2050, and the proposed interim and annual targets between now and then, would become substantially more challenging and achieving it will require additional technological developments and social and economic changes.

In the CCC's scenario for Scotland achieving a 90% reduction by 2050, based on current estimates, about 17 megatonnes would continue to be emitted, with around 9 megatonnes being removed from the atmosphere by forestry and substantial deployment of new negative emissions technologies, namely bioenergy with carbon capture and storage. Of the 17 megatonnes still being emitted, over a third would come from the agriculture sector, with the only other substantial contributions being from industry, aviation and maritime transport. All other sectors, such as surface transport, energy supply, waste, and buildings, would be either fully, or near-fully decarbonised.

The changes needed to deliver a 90% reduction will take place in every home and community across Scotland. In many cases this will have a positive impact, benefiting health, creating new economic opportunities, producing cost savings, supporting new industries and providing international opportunities for Scottish businesses.

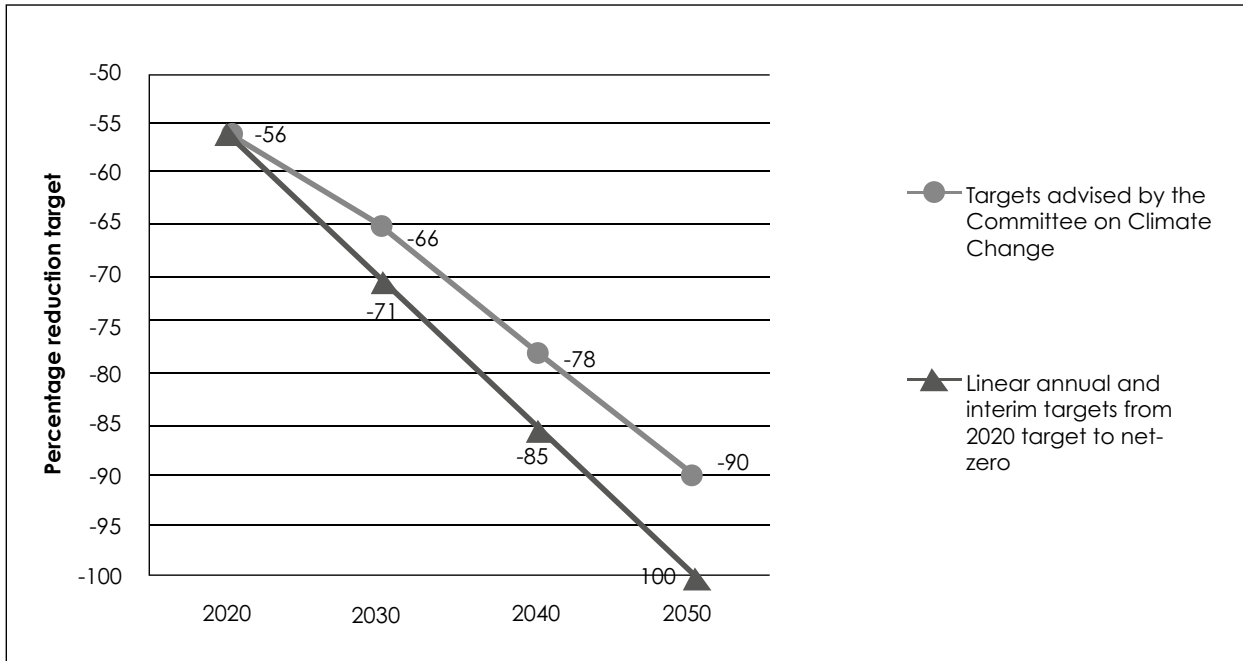
The way in which people heat their homes, for example, will be very different by 2050. The technology is currently being piloted so it is not possible to be sure at this time exactly which technology will prove to be the most effective. It is important that a decision on the best technology is not made prematurely, which could result in sub-optimal technology being installed in people's homes. In addition, changes in areas such as home energy must ensure there are no negative consequences in other priority policy areas such as tackling fuel poverty.

The CCC have said:

"we need that steer [on low carbon heat] in the first half of the 2020s — by 2025, and the earlier the better. However, that decision cannot be made now. There has to be a learning phase where things are demonstrated in a way that enables us to understand them better and understand more about their costs."

Section 5: The implications of setting a net-zero target date of 2050 now

Going beyond the advised target of 90% by 2050 at this time would imply also going beyond the advised target levels for 2030, 2040, and all the annual targets from 2021 onwards. The chart below shows the targets both advised by the CCC and included in the Bill introduced by Government, alongside a straight-line trajectory from the 2020 target to a net-zero target in 2050 (it should be noted that a curved line, with more or less effort in earlier years, could also lead to net-zero by 2050).



To commit to targets beyond the limit of technical feasibility would, as previously noted, mean:

- paying other countries to reduce emissions on our behalf, instead of focussing purely on domestic effort
- removing some sectors from the target
- making legally binding commitments that are dependent on as yet undeveloped technological advancement and cannot be properly scrutinised
- taking steps that would have a substantial detrimental impact on people's wellbeing and the economic growth of Scotland

Pay other countries to act on our behalf or remove some sectors from the target

Scotland's progress in reducing emissions to date has been entirely based on domestic action to reduce emissions at source, in Scotland. The alternative is to pay for other countries to take action on Scotland's behalf through the purchase of international carbon offset credits.

International credits are generated through mechanisms set up under the UNFCCC Kyoto Protocol and this Parliament's 2009 Act places tight statutory limits on the extent that they can be used to meet targets in Scotland. The Bill strengthens those limits further. The Bill means that credits cannot be used to meet targets at all, unless Ministers bring forward secondary legislation which the Parliament then approves, to allow a maximum of 20% of the year on year change to be accounted for by credit purchase. Based on current information, that limit means that less than 0.2 megatonnes per year can be accounted for in this way for any year from 2020 to 2050.

One approach to achieving a net-zero target by 2050, and the higher annual and interim targets from 2020 onwards that would imply, would be to revisit this approach and follow the example of countries such as Sweden. Sweden's legislation allows for up to 15% of the overall target to be made up through credits. If Scotland followed this approach, come the 2040s more than 50 times the limit proposed in the Bill could be accounted for through credits.

The estimated cost of using credits to make up the gap between what is technically feasible domestically here in Scotland and a net-zero target in 2050 would be around £15 billion over the period to 2050². This expenditure would need to be found from other areas within current and future Scottish Government budgets and would have little or no economic benefits to Scotland.

A further change that could be made to increase the feasibility of achieving a net-zero target by 2050 before a credible pathway can be demonstrated would be to remove some sectors from the target. Scotland is unique in including a fair share of the emissions from all of its international aviation and shipping in the scope of targets, so removing this would increase consistency with other leading countries. Some European countries also do not include sectors covered by the EU-Emissions Trading Scheme in their domestic targets.

The Scottish Government does not consider the use of credits or the removal of sectors to achieve a net-zero target to be either credible or to be the best use of resources at this time and believes Scotland should continue to set world-leading targets based on domestic action.

Making legally binding commitments that are dependent on as yet undeveloped technological advancement and cannot be properly scrutinised

As mentioned above, the CCC's advice that Scotland could potentially achieve a 90% target by 2050 is based on a modelled scenario that includes substantial deployment of new negative emissions technologies such as carbon capture and storage, or bioenergy with carbon capture and storage.

Carbon capture and storage is a process whereby the CO₂ produced by combustion of fossil fuels and industrial processes is captured and transported offshore for safe and permanent storage in depleted oil and gas fields or deep saline aquifers. By using carbon capture and storage, energy can be generated and other products such as plastics, cement and steel can be produced using fossil fuels with minimal greenhouse gases being emitted to the atmosphere.

Bioenergy with carbon capture and storage goes further as energy is produced while greenhouse gases are actively removed from the atmosphere. Biomass, such as maize or rapeseed, is grown as an input to the combustion process. While growing, the biomass absorbs CO₂ from the atmosphere. The emissions from combustion are then captured and stored.

To achieve a 90% emissions reduction target by 2050 Scotland will need commercial-scale deployment of carbon capture and storage to begin in the 2030s. To achieve net-zero emissions by 2050, the scale of carbon capture and storage, with or without bioenergy, would need to be far greater and begin much sooner.

Studies indicate that the cost of industrial carbon capture and storage could be up to £330 per ton of CO₂ captured, depending on which industry and process it is being applied to. As the volume of emissions captured increases, more expensive processes need to be deployed, with removing the remaining emissions becoming more technically challenging. The cost of capturing emissions at the scale of those associated with refining and petrochemical activity at Grangemouth, for example, could be £230 million per annum or more³. These cost estimates exclude transportation and monitoring, which will be significant. The capital cost of building a 1 GW (similar in scale to Peterhead) gas fired carbon capture and storage power station could be up to £2.7 billion.

Taking steps that would have a substantial detrimental impact on people's wellbeing and the economic growth of Scotland

Tackling climate change and reducing emissions requires adaptation by industry to a low or zero carbon future. The CCC's advice on a 90% target suggests that the sectors of the Scottish economy where any substantial emissions are likely to remain in 2050, after achieving a 90% reduction in emissions, would be agriculture, aviation and maritime transport, and industry. Of these, emissions from agriculture will be the largest.

2 Using UK Government estimates of long-term carbon valuations. Discounted to 2018 prices the cost of the cumulative shortfall ranges is estimated at £6 billion

3 Based on emission data from SEPA, cost per tonne from a CONCAWE review (<https://www.concawe.eu/wp-content/uploads/2017/01/cr202-ccs-2011-04593-01-e.pdf>), OFX exchange rate data (April 2018) and adjusted to 2017 prices using ONS quarterly national accounts.

Agriculture

It is not possible to produce food without generating greenhouse gas emissions.

There are various steps underway to reduce emissions through altering farming practices and these are supported through schemes such as the Knowledge Transfer and Innovation Fund, the Farm Advisory Service, and Greening payments. In addition, research into the role of genetics and feed additives in reducing emissions from livestock, the role large-scale slurry fed anaerobic digesters, and methods for the use and storage of manures and slurries is all underway.

Requiring reductions in emissions from farming beyond what can be achieved through efficiency and technology would mean reducing the amount of food produced in Scotland.

In particular, committing to substantial further reductions in agricultural emissions would imply livestock farming, for both meat and dairy production, becoming unviable in Scotland.

This would have serious implications for Scotland's food and drink industry, reducing or even eradicating exports of Scotch Beef and Lamb. Without accompanying policies to force radical changes to the diets of individuals and households in Scotland, to reduce or eradicate the consumption of meat and dairy in Scotland, the result would be near total reliance on imports for these products. While this may mean a reduction in emissions in Scotland, it could result in increased emissions elsewhere, particularly given that other countries may not have efficient farming practices in place and the goods would all require to be transported.

Transport

There is no doubt that by 2050 our transport system will have been transformed, and not just in how vehicles are powered. Our ambition to remove the need for petrol or diesel powered vehicles by 2032 is the first step in achieving the almost complete decarbonisation of road transport by 2050. For cars and light vans, there is a clear technology pathway to decarbonisation by 2050 – through battery electric vehicles and hydrogen fuelled vehicles. With zero-emissions at the tail pipe and a strong tie in to renewable electricity generation, switching to these vehicles will play a major role in reducing emissions. We are putting steps in place now to achieve that ambition, including having one of the most comprehensive charging networks in Europe, soon to be reinforced by the Electric A9, financially supporting the take up of ultra-low emissions vehicles, increasing support for active travel and encouraging the use of low carbon means of travel where possible – including exploring increased use of rail freight.

Internationally, the decarbonisation of road transport is gathering pace, and according to Bloomberg, a number of international forecasts of electric vehicle uptake have doubled in recent years. Evidence also indicates the pace of technology development is increasing, with forecasts indicating that plug-in electric vehicles could be price comparable to combustion engines by 2025.

The Scottish Government's ambitions for Ultra Low Emission Vehicles are in step with these trends. Around a quarter of road transport emissions come from vehicles other than cars and vans. This includes heavy commercial vehicles, buses, and motor cycles. The technology to decarbonise heavier vehicles is less advanced and it is more difficult to predict the pace or direction of innovation. The necessary technological advancements will require concerted action by the international community and vehicle suppliers to drive innovation and bring down costs. With 50% of miles driven in Scotland being in rural areas, a move to zero emission vehicles before the cost of technology has come down could raise the costs of goods and services, and would hit those in rural areas hardest.

In the CCC's scenario for 90% emissions reduction by 2050, the only transport emissions remaining will be from aviation and shipping.

It is not currently possible to plan for deep reductions in aviation emissions while also protecting Scotland's international connectivity and the services to our rural and island communities. This is because of the lack of certainty about the potential for zero emission aircraft.

For ferries, the actions we are already taking to reduce emissions are around alternative fuels and better operating efficiencies. We are committed to developing the ferries of the future as technology develops. We are currently building vessels which are hybrid electric or Liquefied natural gas (LNG), which reduces emissions using up to date technology, and we are encouraging better operating efficiencies. Ferries have a lifetime of around thirty years, so to achieve zero emissions by 2050 we would have to start replacing the

current fleet now. But the technology does not currently exist to do this in an effective, cost efficient way that would not compromise vital lifeline services, with the impact on island communities that would result.

Industry

In addition to power generation and oil refining, processes that build ships, or that manufacture products such as cement, pharmaceuticals, paper and pulp, textiles, glass, ceramics, iron, steel and renewables, all emit greenhouse gases. Food and drink production, including whisky distillation, is also responsible for carbon emissions. The manufacturing sector accounts for 7% of total employment, is responsible for 52% of Scotland's exports and 55% of business expenditure on research and development.

Many opportunities exist to reduce emissions from industrial processes and the Scottish Government is actively working with industry to identify and act on those opportunities. Support to decarbonise the fuel and heat required by industry is provided through a variety of means including the Low Carbon Infrastructure Investment Programme, the Scottish Manufacturing Advisory Service (managed by Scottish Enterprise and Highlands and Islands Enterprise), Resource Efficient Scotland (managed through Zero Waste Scotland), and Sector Plans and Sustainable Growth Agreements (being developed by Scottish Environment Protection Agency (SEPA)).

Through Zero Waste Scotland and with the help of EU funding, the Scottish Government plans to provide £18 million to support manufacturing businesses to unlock their circular economy potential, including grants of between £20,000 and £1 million to small and medium-sized enterprises (SMEs) through the Circular Economy Investment Fund. Over the next year, support will also be offered through the £8.9 million Lightweight Manufacturing Centre to help manufacturing businesses use new lightweight materials which reduce energy use. This is the first step towards the development of the National Manufacturing Institute which aims to put Scotland at the forefront of advanced manufacturing technologies, research and development, and skills.

To achieve a 90% target by 2050 all organisations with the ability to improve efficiency and implement decarbonisation measures will have already done so and carbon capture and storage will have been successfully integrated into processes where possible.

The ability to further improve efficiency and implement additional decarbonisation measures will be different from industry to industry and between large and small enterprises whose capacity to make and invest in the necessary improvements will vary. Going beyond a 90% target significantly increases the risks that smaller or medium sized enterprises will be unable to make changes required of them. It also increases the risk that businesses will relocate operations to other countries with less ambitious climate change targets. As a result, global emissions would not be reduced, and may even be increased, in addition to Scotland's economy being harmed.

Businesses currently considered by the EU to be at risk of relocating, such as the manufacturing of chemicals, employ over 91,000 workers in Scotland, have an annual turnover of around £19 billion, and account for over 45% of all Scottish international exports⁴.

The steel sector directly employs some 1,800 people in Scotland and provides materials for building and maintaining transport infrastructure, hospitals, schools and other public buildings, as well as the renewables sector.

The impact on jobs would likely be felt most strongly in particular regions. For example, there would likely be impacts on the chemical industries around Falkirk, aerospace around Prestwick, textiles in the Borders, whisky in rural areas and aluminium production in Lochaber. Communities reliant on employment at energy intensive gas plants or oil terminals in locations such as St Fergus or Shetland could be impacted. Likewise, supply chain clusters such as the oil and gas sector in Aberdeen and Aberdeenshire, would be adversely affected.

The Scottish economy has much to gain from being in the vanguard of the transition to a low carbon economy. Stretching but technically feasible targets will help drive new industries and services with the potential to create jobs and wealth across Scotland and new export and investment opportunities. But going beyond that could jeopardise the business confidence and investment necessary for that transition to take place and our ambition to create sustainable and inclusive economic growth.

⁴ Scottish Government analysis using the EU Carbon Leakage List and data from the Scottish Annual Business Statistics 2015 and Export Statistics Scotland 2016.

Conclusion

Strong progress has been made in recent years, reducing Scottish emissions by 49% from the 1990 baseline. In the EU-15, only Sweden and Finland have done better. This has been achieved while both growing the economy and improving the wellbeing of people in Scotland and the Government is determined to continue this ambitious, balanced approach.

The Bill sets a target of 90% emissions reduction by 2050 based solely on domestic activity. The UK Committee on Climate Change describe this as a “stretch target” that “is at the limit of the pathways currently identified to reduce Scottish emissions”. Combined with highly ambitious interim and annual targets, which apply to all sectors of the economy, the Bill as introduced would secure for Scotland the most ambitious and stringent climate legislation of any country in the world.

The moral, scientific and economic case for achieving net-zero emissions is clear and the Bill requires Ministers to regularly seek advice on the earliest achievable date for that target. The advice will be publically available. As soon as a target date can be credibly and responsibly put in legislation, that will be done.

References and sources of further information

Section 1

UN webpages on climate change, including the Paris Agreement: <http://www.un.org/en/sections/issues-depth/climate-change/>

Intergovernmental Panel on Climate Change's 5th Assessment Report on climate science: <https://www.ipcc.ch/report/ar5/>

World Meteorological Organisation Statement on the State of the Global Climate in 2017: https://library.wmo.int/opac/doc_num.php?explnum_id=4453

ClimateXChange landscape review of international assessments of the economic impacts of climate change (November 2017): https://www.climateexchange.org.uk/media/2962/international_assessments_of_the_economic_impacts_of_climate_change.pdf

World Bank Group Climate Change Action Plan 2016 - 2020: <https://openknowledge.worldbank.org/bitstream/handle/10986/24451/K8860.pdf?sequence=2&isAllowed=y>

Section 2

Three ClimateXChange reports on international comparisons, published November 2017, January 2018 and May 2018, can be found on their publications website. <https://www.climateexchange.org.uk/research/publications-library/>

London School of Economics analysis of climate change laws of the world: <http://www.lse.ac.uk/GranthamInstitute/climate-change-laws-of-the-world/>

7th National Communications from parties to the UN Framework Convention on Climate Change: <https://unfccc.int/process/transparency-and-reporting/reporting-and-review-under-the-convention/national-communications-and-biennial-reports-annex-i-parties/submitted-national-communications-from-annex-i-parties>

EU webpages on climate change policy: https://ec.europa.eu/clima/policies/strategies_en

Nordic Council of Ministers report on Nordic action on climate change: <https://norden.diva-portal.org/smash/get/diva2:1148260/FULLTEXT01.pdf>

Finnish Government report on medium-term Climate Change Policy Plan for 2030: http://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/80769/YMre_21en_2017.pdf

California State Government webpages on climate action: <http://climatechange.ca.gov/>

Section 3

The Climate Change (Scotland) Act 2009: <http://www.legislation.gov.uk/asp/2009/12/introduction>

The Scottish Government's Climate Change Plan - the Third Report on Proposals and Policies, 2018 - 2032: <http://www.gov.scot/Publications/2018/02/8867>

Committee on Climate Change website: <https://www.theccc.org.uk/>

Committee on Climate Change's initial advice (March 2017) on the Bill:

<https://www.theccc.org.uk/publication/advice-on-the-new-scottish-climate-change-bill/>

Committee on Climate Change's updated advice (December 2017) on the Bill:

<https://www.theccc.org.uk/publication/letter-lord-deben-roseanna-cunningham-msp-advising-scottish-climate-target-framework/>

Most recent Official Statistics on Scottish greenhouse gas emissions (for 2015):

<http://www.gov.scot/Publications/2017/06/9986>

Archive of previous Official Statistics on Scottish greenhouse gas emissions:

<http://www.gov.scot/Topics/Statistics/Browse/Environment/Publications>

Code of Practice governing Official Statistics:

<https://www.statisticsauthority.gov.uk/code-of-practice/>

Intergovernmental Panel on Climate Change guidelines on accounting for emissions from wetlands (2013), which is to be implemented in the UK inventory over the coming years:

<https://www.ipcc-nggip.iges.or.jp/public/wetlands/>

Section 4

National Physical Laboratory report on Understanding the UK Greenhouse Gas Inventory: An assessment of how the UK inventory is calculated and the implications of uncertainty 2017:

<https://www.theccc.org.uk/wp-content/uploads/2017/06/Understanding-the-UK-Greenhouse-Gas-Inventory.pdf>

Most recent Official Statistics on Scottish greenhouse gas emissions (for 2015):

<http://www.gov.scot/Publications/2017/06/9986>

Intergovernmental Panel on Climate Change's Summary for Policymakers, Mitigation of Climate Change 2014:

http://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_summary-for-policymakers.pdf

Committee on Climate Change's independent assessment of the UK's Clean Growth Strategy, 2018:

<https://www.theccc.org.uk/wp-content/uploads/2018/01/CCC-Independent-Assessment-of-UKs-Clean-Growth-Strategy-2018.pdf>

Committee on Climate Change's report on the next steps for UK heat policy, 2016:

<https://www.theccc.org.uk/wp-content/uploads/2016/10/Next-steps-for-UK-heat-policy-Committee-on-Climate-Change-October-2016.pdf>

Official Report of the Scottish Parliament Environment, Climate Change and Land Reform Committee 27 March 2018:

<http://www.parliament.scot/parliamentarybusiness/report.aspx?r=11449&mode=pdf>

Section 5

UN Framework Convention on Climate Change webpages on the Kyoto Protocol: <https://unfccc.int/process/the-kyoto-protocol>

Farm Advisory Service: <https://www.fas.scot/topic/climate-change/>

Farming for a Better Climate <https://www.farmingforabetterclimate.org/>

EU webpages on carbon leakage: https://ec.europa.eu/clima/policies/ets/allowances/leakage_en

UK Government high-level review (2013) on Carbon Capture and Storage costs for UK industry: <https://www.gov.uk/government/publications/carbon-capture-and-storage-ccs-costs-for-uk-industry-high-level-review>

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