Dear Convener,

Climate Change (Emissions Reduction Targets) (Scotland) Bill – Financial Memorandum

Thank you for your letter of 1 November requesting further information on aspects of the Climate Change (Emissions Reduction Targets) (Scotland) Bill. Our response to each question raised is set out in the Annex to this letter.

Yours sincerely

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ANNEX

In evidence to the Committee, you said:
We came up with that £13bn figure by running TIMES under the assumptions of the CCP for the 80% end target for 2050. We then ran the figures again using the 90% target. We took the system costs from both and subtracted one from the other to find the difference, which was £13bn. That is above and beyond the cost that would happen anyway through society continuing to function. It is the additional cost of moving from a target of 80% to one of 90%.

However, it is not clear from the evidence given, nor from your subsequent response, whether the same assumptions and inputs used to develop the final CCP were also used when you ran the figures again using the 90% target. I would be grateful if you could provide the Committee with detail of the constraints placed on the TIMES model for the run based on a 90% target scenario

The starting point for both runs was the Climate Change Plan (CCP) final model run\(^1\), with updated assumptions on land use, land-use change and forestry (LULUCF) emissions to reflect emerging findings from new sectoral models currently being developed by the Centre for Hydrology and Ecology. These take into account the expected impact of a fundamental change in the scope of future inventories resulting from adoption of the Wetlands Supplement guidance published by the IPCC. Whilst the underpinning scientific research continues, the Centre for Ecology and Hydrology currently estimate that these changes, which include incorporating new emission factors and categories of peatland condition is likely to substantially increase emissions from LULUCF in Scotland. By increasing overall emissions, and the scale of abatement required, these revisions also increase the cost of meeting both a 90% and 80% reduction in emissions.

TIMES was not able to find a pathway to a 90% target with the constraints of the Climate Change Plan included. In order for the model to find a solution to achieve a 90% target it was necessary to alter the constraints of the mode. The constraints altered were chosen on the basis that they would allow for a 90% target to be met and a cost to be produced, as required for the Financial Memorandum. They do not represent a change in Scottish Government policy, or a revision to the Climate Change Plan. The changes to the model were:

- We allowed the model to draw on carbon capture and storage technologies post- 2025 (relative to post-2035 in the Climate Change Plan),
- We allowed the model to deploy bioenergy with carbon capture and storage (a negative emission technology),
- The lower output bound for refineries was revised downwards in the period to 2050 to allow for potentially greater decarbonisation in industry by 2050,
- We modified the constraint on exports and imports of electricity to ensure that the system maintained sufficient capacity to continue exporting to the rest of the UK.

In order that the cost differential between the 80% target and a 90% target could be provided in the most objective way, the 80% and 90% runs were conducted using the same set of assumptions and constraints, i.e. the relaxed constraints above that allowed for a 90% target to be met by TIMES. For this reason, the cost of meeting the 80% target given here is not the same as the cost of delivering the Climate Change Plan.

The Committee requests details of the figure for 80% (which was subtracted) and the figure for 90%, which were used in this calculation to arrive at £13bn.

Achieving an 80% target under the relaxed constraints necessary to achieve a 90% target, is estimated to cost £47 billion (relative to a baseline of no-action) whilst achieving a 90% target would

result in additional costs of £13 billion. The £47 billion figure is higher than that previously calculated due to additional emissions in the LULUCF sector. It is not the cost of delivering the Climate Change Plan, because different constraints were also included in the model.

In your letter, you also said: Adjusting for inflation and removing the impact of discounting, the estimated cost of moving to a 90% target is approximately £59bn. The Committee seeks details of the two figures used to arrive at this figure.

The £13 billion estimate is in 2017 prices, discounted using the social discount rate. Presenting cost information in this manner is best practice when considering costs and benefits which incur in the future, and is the approach adopted in prominent international studies\(^2\) and consistent with HM Treasury Green Book guidance on appraising long term costs.

By allowing the impact of expected inflation in both runs, such that costs in 2050 would be equal to costs in 2017 plus the cumulative expected impact of inflation between 2017 and 2050, the cost of moving to a 90% target is estimated to be approximately £25bn.

Discounting is a technique used to compare costs and benefits occurring over different periods of time on a consistent basis, providing an estimate in present value terms. It reflects two components: firstly 'time preference', the concept that people value goods and services in the current time period over future time periods; and secondly, 'the wealth effect', where income grows over time, and future consumption will increase, so the value of each individual pound will be lower than it is today.

It is worth noting that removing the impact of discounting is not best practice and contrary to the approach taken in many international studies, particularly given the modelling approach makes decisions based on the concept. However I understand that the Committee wants this information following discussion on 19 June and exchange of letters on 26 June and 27 July so am happy to provide it: removing the impact of discounting, as well as allowing the impact of inflation, the estimated cost of moving to a 90% target is approximately £59bn.

Can you confirm whether the TIMES model has removed discounting and adjusted for inflation in order to arrive at the £13 billion?

The £13bn figure has been discounted and adjusted for inflation, i.e. it is in constant 2017 prices.

During consideration of the draft CCP, the Committee became aware that not all sectors had been modelled within TIMES and that transport, agriculture, land use and waste had all been modelled externally before the results were added into the TIMES runs. In order to better understand how this impacts on the costs which TIMES predicts, the Committee requests clarification as to how each sector was considered and modelled when running the TIMES model for the 90% target. This should include information about whether modelling done externally to TIMES for non-energy sectors was updated from modelling done for the 80% target under the current CCP.

The assumptions and model inputs (including non-energy emission projections) used in TIMES are identical in the 80% and 90% scenarios, with the exception of the overall emission constraint across both runs. This was intentionally done, to ensure that the cost differential between an 80% and a 90% scenario only arose as a result of moving to a tighter emission pathway.

As discussed in the Technical annex to the Climate Change Plan, TIMES is an energy system model of the Scottish economy but incorporates non-energy sectors’ emission projections. The same non-energy emission projections were used in the Climate Change Bill runs up to 2032, but were then extended and built on out to 2050. The exception to this is LULUCF, where we updated emissions to

\(^2\) For examples, see https://www.nature.com/articles/s41586-018-0071-9 and http://www.legislation.gov.uk/ukia/2016/177/pdfs/ukia_20160177_en.pdf
reflect emerging findings from sectoral models, to ensure we were using the most up-to-date information.

In your letter of 27 July 2018, you provided further details of where the additional costs might lie in moving from 80% to 90%. The largest cost category is an additional £10bn on investment costs, which describes broadly where investment will be required in the energy and transport sectors. The Committee requests details of:

- Why investment is only highlighted for these sectors?

Cost figures within TIMES represent the cost of meeting final energy demands (such as hot water, transport or appliances) over the period to 2050 across the demand-driven sectors (electricity, industry, transport, residential, services and parts of agriculture), and therefore costs in all of these are reflected in the £13 billion figure.

The increase in investment costs by 2050 is the result of a number of broad changes. Firstly, there is greater investment in renewable energy for electricity generation and in the upgrading and processing of the additional volumes of bioenergy that are either imported or domestically produced. Secondly, there are also higher investment costs as a result of further electrification of the residential, services and transport sectors, with expenditure in the transport sector also increasing due to additional spending on hydrogen technologies.

- How has the TIMES model developed cost pathways for sectors modelled outwith TIMES (Land use, agriculture, waste and Transport)?

The transport sector is constrained by an emission envelope and fuel shares sourced from sector-specific modelling in the period up to 2032. After 2032, the emission envelopes and fuel shares for the transport sector are entirely determined by the TIMES model.

As sector emission pathways in non-energy sectors (LULUCF, waste and most of agriculture) have not been modified between the 80% and 90% targets, there are no additional costs borne out by these in the £13 billion figure.

- What investment is envisaged in sectors other than energy, and does this form part of the £10 billion?
- If not part of the £10 billion, how much additional cost does it represent?

The answers to these questions are covered above.

Previously, in its report on the draft CCP, the Committee suggested that the final CCP should include more detail on the estimated costs of each of the policies and proposals, including the estimated costs to the public and business sectors. The Committee understands that the TIMES model cannot provide this information, however it is asking the SG to move beyond a high level assessment and provide the Committee detail of:

- An assessment of the potential costs to the public or other sectors of meeting a 90% target.

As set out in my letter of 27 July 2018, where the costs fall will be determined by the future design of policies and proposals that will deliver emissions reductions in order to achieve the targets. There are many ways in which costs can be distributed. For example, currently the cost of supporting renewable technologies in the electricity system is not entirely borne by the consumers in the geographical area in which a generating station is located, but are instead paid for by domestic and non-domestic electricity consumers across the integrated GB wholesale market. Alternatively, the Renewable Heat Incentive, a scheme for promoting the uptake of alternative heating technologies such as Biomass Boilers and Heat Pumps, is paid for through general taxation.

The future distribution of costs will also depend on a number of factors outside Scotland’s influence. As international efforts to decarbonise intensify, global bioenergy demand could increase resulting in higher costs and lower availability of Scottish imports of bioenergy inputs. Furthermore, international
and European action will also substantially influence the development of technology costs and how are they borne, via global investments and the potential development of global carbon markets.

As such, it is not possible to provide an assessment of the potential costs to the public or other sectors of a meeting a 90% target beyond the estimates given in the financial memorandum.

- **Whether it plans to set out estimated costs (or a range of costs) to the public and other sectors in the next draft CCP, as previously recommended by the Committee?**

I note the Committee’s recommendation that future draft Climate Change Plans should provide estimated costs to the public and other sectors, and can assure the Committee that this recommendation will be given serious consideration ahead of Ministers making decisions about future Climate Change Plans.

In evidence received by the Committee, it has been presented that the cost of acting will be less than the cost of failing to act. The Committee has also been told that action sooner, rather than later, will be less burdensome. In evidence to the Committee, Jim Skea of the IPCC and Andy Kerr of ClimateXChange both spoke of the co-benefits to be derived from action to mitigate climate change. The Committee requests details of the social and economic cost-benefits and risk analysis for which the SG has undertaken in relation to a move from an 80% target to a 90% or 100% target, and how benefit and cost savings are impacted by the rate at which action is taken. If this work has not been undertaken, the Committee seeks clarification as to why and recommends the SG carry out this work in order to provide the findings to the Committee. The Committee also seeks this information in relation to analysis of the difference in cost of achieving a limit of global temperature rises of 1.5 degrees and 2 degrees.

ClimateXChange, on behalf of the Scottish Government, commissioned a Rapid Evidence Assessment (RES)\(^3\) and synthesis of key global assessments of the costs and benefits of climate change action. A key message of this review was that estimates of climate impacts are inherently uncertain, such that climate policy needs to be assessed in terms of risk management, rather than straightforward cost-benefit analysis.

To estimate damage costs, the authors drew on the Intergovernmental Panel on Climate Change (IPCC) fifth assessment report (AR5)\(^4\), and specifically on 14 studies that assumed warming in the range 2.5-3°C by the end of the century. The studies estimated a mean damage cost as percentage of GDP of 2.2% with a median of 1.5%. The IPCC study assumed that GDP will grow over the course of the century, meaning that climate damages, while large in absolute terms, appear modest in comparison with GDP. Emerging literature is beginning to challenge this view. A study that assumed climate change can reduce GDP growth rates, rather than just incurring instantaneous damages, estimated a median damage cost of about 9% of GDP in 2050\(^5\).

Studies in IPCC (2014)\(^6\), consistent with a 50% change of limiting warming to below 2°C, estimated median global abatement costs at 3.4% of GDP by 2050.

While the balance of evidence suggests that the mid-point estimates of abatement cost may be higher than mid-point damage estimates, it is reasonable to conclude that there is a considerable risk of much higher-than-expected damages, which would justify the cost of ambitious climate action. This is in line with the conclusion arising from climate risk literature, suggesting that reducing the risk

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of exceeding tipping points\textsuperscript{7} is a key reason to aim for strong abatement targets globally. Tipping points become much more likely at higher levels of warming but cannot be ruled out at low-to-moderate warming levels. Such tipping points include ice sheets on Greenland and West Antarctica, for example, as well as dieback of the Amazon rainforest.

On the potential wider benefits of climate policy, the Scottish Government published three independent evidence reviews of the potential wider impacts of climate change mitigation options, focussing on Agriculture, Forestry, Waste and related Land Use\textsuperscript{8}; the Built Environment\textsuperscript{9}; and Transport\textsuperscript{10}. The reviews were published alongside the draft Climate Change Plan and highlighted the potential for positive social, economic and environmental impacts to result from climate action.

The Scottish Government has also published research commissioned from EY on the challenges and opportunities associated with transitioning to a low carbon economy\textsuperscript{11}.

The Scottish Government has also commissioned the University of Strathclyde, via ClimateXChange, to link UK versions of an economic model that they have to TIMES. This piece of work, to be completed over the next twelve months, will allow further analysis of the wider economic impacts of TIMES scenarios.

Finally, advice that the Cabinet Secretary for Environment, Climate Change and Land Reform has commissioned from the UK Committee on Climate Change (CCC), following the IPCC Special Report, specifically requests that evidence should be given on how reductions in line with the CCC’s recommendations might be delivered in key sectors of the economy, and the expected costs and benefits across the spectrum of scenarios, in comparison to the costs and benefits of meeting the current targets.

The Committee considers that there is a difference between the actions which would be taken as a result of progress and technological advances, and actions which are proposed to be taken specifically to meet the objectives of the Bill and future CCPs. The Committee requests detail of the SG’s assessment of what will occur anyway and what action will arise specifically as a result of the Bill and future CCPs.

The actions necessary to meet the targets will be set out in future Climate Change Plans.

\textsuperscript{7} TEEB (2009) (\url{http://www.teebweb.org/media/2009/09/TEEB-Climate-Issues-Update.pdf}) notes that a tipping point is a threshold of irreversibility, beyond which the ecosystem ceases to function. They note that we have reached this point with coral reefs, whereby gradual reduction in future greenhouse gas emissions will not stop their imminent loss. At the tipping point, decisions should no longer be based around marginal costs and benefits, but should capture the ethical and other consequences of losing the ecosystem.

\textsuperscript{8} \url{https://beta.gov.scot/publications/evidence-review-potential-wider-impacts-climate-change-mitigation-options-agriculture/}


\textsuperscript{11} \url{https://www2.gov.scot/Topics/Environment/climatechange/meetingemissionstargets/climate-change-plan/transitioning-to-a-low-carbon-economy}