WRITTEN SUBMISSION FROM ROYAL SOCIETY OF EDINBURGH

Summary
The Royal Society of Edinburgh welcomes the series of well-conceived and appropriate processes proposed in the Climate Change (Scotland) Bill. However, there are several approaches embedded in the Bill that the Society believes seriously undermine its potential to achieve its objectives and which the Scottish Parliament's Transport, Infrastructure and Climate Change Committee is encouraged to consider for amendment.

- The endpoint target of an 80% reduction by 2050 is an irrelevance unless there are appropriate intervening milestones. The key target must be to minimise the aggregate emissions between now and 2050; to minimise the area under the emissions curve.

- The Bill implicitly assumes, as do many other approaches to this issue, that early emissions reductions will be small and later ones large. We believe that it would be more appropriate to reverse these relationships by targeting early, strong reductions that start as early as possible.

- We strongly advocate that an interim strategy target should be defined for 2020. It should be a challenging target that encourages early action, and one that, because of its imminence, perennially impinges on Government perspectives no matter which party is in power.

- Periods of recession tend to produce a reduction in emissions, which could create an unjustified sense of optimism about the ease with which targets could be achieved without the need for challenging emissions reduction strategies, only to find that emissions rise dramatically as we climb out of recession. It is important therefore that strategies are put in place now to ensure that re-establishment of growth does not create a strong increase in emissions.

- We are strongly of the view that short-term targets set by Government, should be based on the definition of a longer term trajectory. This should be done by an independent body that is advisory to Government that is able to draw upon the best available scientific and technical capabilities in climate science, energy technology, economics, business and social science. There is a place for a Scottish body since it may be the case that the appropriate policy in Scotland will need to vary from the more general policy across the UK.

- The effectiveness of an emissions reduction regime that depends on achieving frequent, clearly-defined targets will depend fundamentally on the rapid availability of accurate estimates of net emissions. In practise Scottish data typically arrives twenty months after the year in question. Unless this can be improved, annual setting of targets will be flawed and the assessment of the trajectory of change will be uncertain. We suggest that an independent monitoring and audit function should be set up that is robust and rigorous, and which will not only need to call on routine measurements but also on experimentally and computationally verified estimates.

- The purpose of the Bill is to establish the legal framework within which Scotland can take the path of reduction in its greenhouse gas emissions. This framework alone will not achieve that end. It must be clearly associated with powerful and credible strategies that stimulate change, and with the political leadership needed to persuade citizens of the need for action. We advocate the approach taken in the Nature Conservation (Scotland) Act 2004, in which a specific duty is placed on Scottish Ministers to designate a strategy for the conservation of biodiversity. We suggest that the Bill should place an analogous duty on Ministers to create a strategy designed to achieve the targets as set out in the Bill.

- It is important that a suitable array of Action Plans is developed by the Scottish Government on a sector-by-sector basis for strategy implementation and that this is done in an integrated fashion to ensure convergence of purpose.

- There are early gains to be made in reducing emissions and it would be sensible and natural to pick off the "low hanging fruit" first. There should be increased focus on those immediate and cost-effective ways of reducing emissions, such as energy efficiency. Major energy efficiency measures for buildings must be the major priority if we are to maximise our chances of reducing carbon emissions rapidly.

- As the trends of climate change and its actual and imminent impacts become clearer, the imperative to move towards a low carbon economy is becoming stronger. It is recognised that those countries able to develop and implement low carbon technologies and limit the use of carbon-derived energy will be well positioned economically to exploit a developing global trend. The Scottish Government should consider developing an overarching low carbon strategy that also includes demand reduction.

1. The Royal Society of Edinburgh (RSE), Scotland's National Academy, considers the Climate Change (Scotland) Bill to be of the utmost importance in creating the framework for efforts to reduce Scotland's greenhouse gas emissions and achieve the targets agreed by the Scottish Parliament. Through the unrivalled technical expertise of its multi-disciplinary fellowship, the RSE has already provided input into the Scottish Government's proposals for a Scottish Climate Change Bill, the precursor to the current Bill, and to the initial outline of Scotland's climate change adaptation framework.

Global context

2. Human intervention in the natural systems of the Earth, including our impact on the climate system, has created massive problems for the sustainability of many aspects of human activity. Correcting such damaging impacts presents unprecedented political challenges because of the need for a global response. Although there is much uncertainty about the precise magnitude of future climate change, the direction of change is well established and the recent rate of change has been faster than scientifically anticipated. However, notwithstanding much debate and many good intentions, the rate of emissions of greenhouse gases from human sources has almost doubled since the year 2000, worse than the most pessimistic scenario of the Inter-Governmental Panel on Climate Change (IPCC). This makes it almost certain that the CO_2 equivalent greenhouse gas concentration in the atmosphere will rise above the 450ppm level regarded as a threshold for "dangerous climate change".

Why should Scotland act?

3. The first reason is ethical. Although we recognise that greenhouse gas emissions directly produced in Scotland are a relatively small part of the total, our consumerist lifestyle means that we are responsible for a much greater share of global emissions. Because we import many of our manufactured goods rather than creating our own, we effectively export our emissions to others. Even without this however,, we emit far larger quantities of carbon in comparison with the inhabitants of, say, Botswana, where the immediate impacts of climate change will be much greater. The fact that Scotland's direct emissions are a small part of the global total is beside the point. The ethical imperative is for the burden of change to be borne according to the extent that we individually pollute the global atmospheric resource. It is the per capita consumption of that resource, measured by the impact of emissions on the atmosphere, that is the central ethical issue.

4. Secondly, self interest demands that we should want to see direct, local, damaging impacts minimised. To do this requires concerted global action and the prospects for this will be maximised when all states agree to act on the imperative. We make a contribution towards this trend by creating the legal and policy framework represented by this Bill, by associated policies and through leading by example.

5. Thirdly, as global trends move towards reducing environmental impacts of economic activity, and developing carbon-neutral systems of energy generation and use, there will be an economic, and possibly an international legal imperative for us to change. The relevant part of the science base in Scotland is very strong by international standards, renewable resources of wind and wave are plentiful and there still remains considerable investment potential in the financial services sector of the Scottish economy. If properly encouraged, there is great potential for Scotland to be a leader in developing and exploiting processes that will be the bedrock of a lower carbon, greener economy. At a time when there is a significant downturn in the economy there are both environmental and economic benefits to be gained from shifting patterns of consumption and changes in lifestyle.

Major issues for the current Bill

6. The RSE very much welcomes the seriousness with which the Scottish Government takes this issue and its commitment to ambitious and challenging targets for reducing greenhouse gas emissions by 80% by 2050 compared with emissions in 1990. Most of the processes proposed in the Bill seem to us to be highly appropriate and well-conceived. *However, there are several approaches embedded in the Bill that the Society believes seriously undermine its potential to achieve its objectives and which the Scottish Parliament's Transport, Infrastructure and Climate Change Committee is encouraged to consider for amendment.* Rather therefore than responding to all the individual questions posed in the call for evidence, we have concentrated on the clauses in the Bill that we strongly advocate should be amended. We also comment on a number of omissions from the Bill that we regard as lost opportunities.

"The area under the curve"

7. The endpoint target of an 80% reduction by 2050 is an irrelevance unless there are appropriate intervening milestones. The key target must be to minimise the aggregate emissions between now and 2050; in other words, to minimise the area under the emissions curve. We therefore approve of the approach taken by the Bill, particularly for the period 2020-2050, which specifically requires emissions reduction of at least three percent per year compared to the target of the previous year. *However, we suggest that the real political decision which the Committee would wish to consider is whether such targets could be introduced earlier e.g. from 2011, to put Scotland on the pathway to achieving its emissions reduction targets and reducing its aggregate emissions.*

8. With this in mind the Committee may find it useful to examine the illustrative scenarios which we have compiled in an appendix. From this the Committee will note that neither scenario 1 nor scenario 2 delivers the 80% emissions reduction target in 2050 (which is 14.02 Mt CO_2e based on the current 1990 baseline - 2006 Emissions Inventory). In other words, even if Scotland achieved 3% per year reduction in greenhouse gas emissions from 2010 the 80% reduction target would not be achieved by 2050. They also show the aggregate emissions for different reduction trajectory scenarios.

9. The Bill implicitly assumes, as do many other approaches to this issue, that early emissions reductions will be small and later ones large. We believe that it would be more appropriate to reverse these assumptions by targeting early, strong reductions that start as early as possible. Not only will the area under the curve be minimised if early reductions are substantial, but we believe that there is "low hanging fruit" to be taken provided that robust policies are introduced to encourage it (see also paragraph 21). We suspect that in practise, it will be most difficult to wring out the late stage reductions in emissions that bring us to the 80% target. We suspect that an S-shape curve of emissions reduction is most likely. The first part, of slow change, represents the time taken for policy instruments to come on-stream. The second part, of the fastest rate of emissions reduction, as one where we pick the "low hanging fruit", with the final stage being one of relatively slow rate of reduction.

Major milestones

10. If Scotland is to develop the early trajectory of emissions reduction for which we argue, and even if it is to achieve its 2050 target, it is important that targets are set in such a way as to encourage early reductions. The Society is sceptical that the interim statutory milestone of 2030 is early enough. It does not convey the necessary urgency, nor give the issue sufficient prominence in a political environment that is not short of distracting issues. *We strongly advocate that an interim strategy target should be defined for 2020. It should be a challenging target that encourages early action, and one that, because of its imminence, perennially impinges on Government perspectives no matter which party is in power.*

11. The challenging target is not the interim target per se but the three percent or more per year emissions reduction from 2020 to 2050. A recent paper[1] examined the impact of government emissions reduction programmes and it noted that no advanced economy has achieved more than a one percent year-on-year emissions reduction except as a consequence of economic recession. The current recession, of unpredictable length and depth, may well lead to such a reduction. It could create an unjustified sense of optimism about the ease with which targets could be achieved without the need for challenging emissions reduction strategies, only to find that emissions rise dramatically as we climb out of recession. *It is important therefore that strategies are put in place now to ensure that re-establishment of growth does not create a strong increase in emissions.* Further comments about linking recession to emissions reduction are found in paragraph 25.

Setting targets

12. The approach to target-setting in the Bill could prove to be flawed. The Bill proposes that Scottish Ministers can modify annual targets for Scottish emissions from 2010 to 2050. The risk is that this will focus debate on what short term targets should be, and not whether Scotland is achieving its long term objectives. The temptation for Government will be to set targets that can be met, and met without strong reactions from one special interest group or another that will perennially argue for a relaxation of targets. It could obscure the much more taxing imperative to meet long-term targets, and the concomitant pressures that will stimulate technological responses.

13. Although Government and Parliament are crucial parts of the process of achieving carbon targets through their design of legal and administrative frameworks and providing leadership, the license for Ministers to modify annual targets could become a highly party political matter rather than being determined by technical imperatives. It is crucial that policy is determined with reference to the technical nature of targets rather than to political considerations. As far as possible climate change issues should be considered apolitical given the seriousness of possible impacts. Ultimately, all of us, as citizens, rather than simply governments will be held accountable.

14. *We are strongly of the view that short-term targets set by Government, should be based on the definition of a longer term trajectory. This should be done by an independent body that is advisory to Government, that is able to draw upon the best available scientific and technical capabilities with a range of expertise in climate science, energy technology, economics, business and social science. It would require carbon economics expertise as carbon markets develop and become increasingly important.* There are number of models that would permit disinterested external advice to mesh with the ultimate responsibility of Government and Parliament. For example, such an advisory body could propose, and Parliament could debate adoption of, say, a 5-10 year trajectory so that progress could be monitored by Government, Parliament and citizens. Ideally, the failure in any one year to hit the desired trajectory should not be regarded as a failure by Government, but as an index of the efforts that would need to be made to get back on track, for ultimately, the challenge is not merely for Government, but for the whole of society.

[1] Kerr, A.; Serendipity is not a strategy: the impact of national climate programmes on greenhouse-gas emissions, *Area* Vol.39 No.4 pp 418-430, Royal Geographical Society (with the Institute of British Geographers) 2007

15. There is a place for a Scottish body since it may well be that the appropriate policy in Scotland will need to vary in detail from the more general policy across the UK. It would be important however that such a body is formally linked to the UK Committee on Climate Change. There are arguments for and against the different models that have been put forward for Scotland – and in some cases Ministers will already receive advice from existing public bodies. For example, SNH already advises on the impact on wildlife, SEPA advises on flooding etc. However, there is a case for advice that genuinely emanates from an entirely independent source.

Monitoring progress: priorities and institutions

16. The effectiveness of an emissions reduction regime that depends on achieving frequent, clearly-defined targets will depend fundamentally on the rapid availability of accurate estimates of net emissions. International requirements are that emissions data is delivered fifteen months after the end of the year in question. Disaggregated data for Scotland is likely to follow after this international data since it draws on UK-wide data sets. In practise Scottish data typically arrives twenty months after the year in question. Unless this can be improved, annual setting of targets will be flawed and the assessment of the trajectory of change will be uncertain. *We suggest that an independent monitoring and audit function should be set up that is robust and rigorous, and which will not only need to call on routine measurements but also on experimentally and computationally verified estimates, for example of the rate of forest sequestration of carbon, that will require input from basic research located in the universities and research institutes.* The University of Edinburgh is a core partner in taking forward ICOS, a new European Research Infrastructure programme for quantifying and understanding the greenhouse balance of the European continent and adjacent regions.

17. In its response to the Scottish Parliament's Economy, Energy and Tourism Committee Inquiry into Energy, the RSE strongly advocated the creation of an independent, authoritative audit body responsible for collecting and publishing reliable statistics. We also suggested that the two audit functions, of energy and emissions, should be well integrated, preferably by the same independent body. It is important that we agree about the facts and then debate what should be done, rather than arguing about the facts.

18. *There is much to be said for smoothing the assessment of emissions trends by making running mean estimates of emissions rather than using the last year's data as the gauge of progress.* Our principal concern should be to see trends rather than be over-influenced by strong annual fluctuations likely to be produced by unusually cold or warm winters or by generation reduction from aging nuclear stations that are compensated for by increased generation from coal–fired stations that cause increases in carbon emissions in that year. A 3-year running mean might be most appropriate, which also argues for the timely release of emissions data.

Linking the Bill to emissions reduction strategies

19. The purpose of the Bill is to establish the legal framework within which Scotland can take the path of reduction in its greenhouse gas emissions. This framework alone will not achieve that end. It must be clearly associated with powerful and credible strategies that stimulate change, and with the political leadership needed to persuade citizens of the need for action. It is crucial therefore, in parallel with the legal framework, that a strategy, grounded in the practical realities and able to stimulate achievement of targets is forthcoming. A framework without an accompanying strategy would be futile. *We advocate the approach taken in the Nature Conservation (Scotland) Act 2004, in which a specific duty is placed on Scottish Ministers to designate a strategy for the conservation of biodiversity. We suggest that the Bill should place an analogous duty on Ministers to create a strategy designed to achieve the targets as set out in the Bill.* We suggest below, issues that could be the basis of such a strategy.

A duty on Ministers to create an emissions reduction strategy

20. It is important to consider as context for the Bill, some of the strategic issues and opportunities for emissions reduction, which are also relevant to the case we present above for sharper, earlier reductions and earlier, statutory milestones. Scottish emission targets cannot be viewed in isolation. A strategy for emissions targets must be intimately related at least to an energy strategy that is realistic about the market impacts of policy and its socio-economic consequence. Whilst we recognise the Scottish Government has been actively taking forward an adaptation framework in addition to the current Bill, mitigation and adaptation aspects need to be better integrated. The Bill is strong on appropriate mitigation measures, but weak on adaptation and societal engagement at the individual and community levels.

Energy strategy

21. There are early gains to be made in reducing emissions and it would be sensible and natural to pick off the "low hanging fruit" first. There should be increased focus on those immediate and cost-effective ways of reducing emissions, such as energy efficiency and demand reduction. Major energy efficiency measures for buildings must be the major priority if we are to maximise our chances of reducing carbon emissions rapidly. There are multiple government-led energy efficiency schemes and measures, with low take-up, being managed by a range of organisations, which are in need of better coordination. Behavioural change is inextricably tied up with energy efficiency, to ensure for example that 'savings' in one area do not lead to increased consumption in another. Promotional campaigns are however unlikely to achieve rapid, significant changes in habitual patterns of domestic consumption. (This is evident from long experience of public investment in health promotion, which has failed to tackle increasing obesity amongst other health problems.) In order to improve their effectiveness, promotional campaigns should be focussed on single issues, they should avoid trying to convey too many messages at once and should be linked to regulations that limit energy-wasteful designs, technologies and building practices. The success of the Scottish Parliament's bold decision to ban smoking in public buildings shows that well-considered, decisive action coupled with political leadership on a major issue of public concern can be highly effective.

22. Given the current focus on the development of low carbon technologies across the energy spectrum, in Scotland and elsewhere, we reaffirm the recommendation from the RSE's Report into *Energy Issues for Scotland* that due to the lack of robust procedures for assessing energy technologies and a lack of objectivity in assessments that are undertaken that a common methodology should be developed to assess the relative merits of energy technologies; this should include full lifetime costs and a full carbon audit.

Public engagement

23. There is every likelihood that strategies to achieve tight emissions targets such as that suggested above could arouse considerable popular antagonism, with the potential to split any political consensus on emissions or undermine Government policies. *Success will only come about if there is a greater awareness of the threats posed by climate change and a willingness, both individually and collectively, to engage in appropriate measures to address those threats.* Central and local government are crucial in providing leadership and setting the terms of that engagement, but non-governmental and voluntary bodies will need to energise civic society and promote individual and collective responsibility (for example, the Royal Society of Edinburgh is shortly to launch a major inquiry on adapting to climate change, which will contain a major public engagement element). The target of a low carbon economy by mid century will not be achieved without radical and costly changes in our use of energy and patterns of consumption. Strategies and policies to promote this paradigm shift are notably absent from the Bill.

A decisive initiative for the low carbon economy

24. As the trends of climate change and its actual and imminent impacts become clearer, the imperative to move towards a low carbon economy is becoming stronger. It is recognised that those countries able to develop and implement low carbon technologies and limit the use of carbon-derived energy will be well positioned economically to exploit a developing global trend. *The new US administration has announced policies that reflect a decisive shift in this direction, with the intention to capture a powerful economic and technological position. The Scottish Government should consider a similar approach, by going beyond its encouragement of low carbon renewable energy technologies to develop an overarching low carbon strategy that also includes demand reduction.*

25. Given the precarious nature of the current economic climate, new employment opportunities could also be created and maintained by the shift to a lower carbon economy. The public sector should position itself to take a clear and crucial leadership role and identify areas where investment could pay dividends particularly in terms of emissions reductions and energy savings in the near term as well as creating employment opportunities. We applaud the Scottish Government for its efforts in the renewable energy domain and this effort should be replicated in other areas where Scotland can command competitive advantage.

A cross-cutting strategy

26. Climate change represents a hugely complex cross-cutting issue over many areas of government and society. The practical immediate consequences are the intertwined issues of climate, energy, food, and the challenge of sustainable economic and social development. However, the administrative boundaries by which government manages its business can result in a lack of policy connectivity and policy contradiction. Moreover, many government decisions have emissions implications (e.g. abolishing bridge tolls) and as such, decision-makers need to be acutely aware that a decision in one area may have a contradictory and unintended consequence for mitigation and adaptation to climate change. *It is important therefore that a suitable array of Action Plans is developed by the Scottish Government on a sector-by-sector basis for strategy implementation and that this is done in an integrated fashion to ensure convergence of purpose.*

The importance of large scale policy integration

27. Whilst the Bill should focus on matters that the Scottish Government can control and lead on, it important that it ensures optimal linkages with policies and processes outwith Scotland. In terms of emissions, energy systems and cost, it is important to recognise that the linkages into the UK energy transmission system and the European market can be used to optimise efficiency. In principle, the most efficient low carbon system of energy transmission and supply for Scotland would be an integrated European system that was able to take generation from anywhere in Europe so as to optimise on low emissions, low cost and high security. An a priori concept of energy self-sufficiency with a failure to utilise efficiencies of scale could be damaging to the Scottish energy system, to its achievement of emissions targets and to its economy*. It is vital therefore that UK and European level cooperation is exploited as part of the policy for emissions and energy security.*

Maximising the impact of Scotland's carbon sinks

28. The search for international agreement on greenhouse gas reduction will inevitably not only consider sources but also sinks, so that a national net budget is recognised and audited. Without it, there will be no incentive to preserve the planet's great forest and peatland sinks for carbon. The woodland resource in Scotland will have a clear role in off-setting the country's carbon emissions. The contribution that tree planting can make to removing CO_2 from the atmosphere is becoming increasingly clear. In 2005 the land use, land use change and forestry sector provided a net sink for greenhouse gases equivalent to 8% of Scotland's total emissions. Within this overall figure, forest plantations, together with land converted to grassland, provided a sink equivalent to 20% of Scotland's total emissions[2]. There are also clear benefits for climate change moderation by increasing the use of wood and wood products as biofuels if they substitute for fossil fuels; and in the use of timber in construction as a substitute for more carbon intensive materials, such as steel and concrete.

29. Although there is considerable potential to increase the sequestration of carbon by forest planting, the rate of new planting has dropped to between 4,000 and 6,500 ha per year, at least partly as a result of rising land prices and uncertainty over CAP reform. The Scottish Government's Forestry Strategy sets a target for increasing the woodland cover of Scotland from 17 per cent to 25 per cent by the second half of this century, justified by the contribution that forests can make to carbon management and the mitigation of climate change if sited on suitable soils. This reflects a shift in priority over the last 30 years from the creation of a strategic timber reserve through environmental and amenity priorities to one of combating climate change. In its Report on the *Future of Scotland's Hills and Islands* the RSE Committee of Inquiry supported the increase in woodland cover but saw no possibility of achieving it unless measures were introduced to attract land out of other uses. It is not clear where this land will be found without impacting on either agricultural production or on biodiversity and landscape conservation. Without an effective framework for making decisions to resolve conflict, and identifying where there is potential synergy of use, important decisions will be delayed, or reached on an *ad hoc* basis.

30. The Bill proposes mechanisms to increase the rate of planting with the proposals for long-term leasing of cutting rights in forests currently managed by the Forestry Commission to private interests. This has provoked debate about the adequacy of the economic instruments to incentivise private interests to increase forestry planting without detriment to the sustained management of Scotland's forests and the other benefits they provide.

In conclusion

31. The Framework proposed by the Bill presents Scotland with a real opportunity to make significant contributions to a vital global challenge and build upon the expertise it already has in a number of fields, such as in energy, particularly in relation to carbon capture and storage and renewables, whilst also reaping tangible benefits. There is also an opportunity to promote the excellence and technical expertise available in Scotland by establishing an independent group which can play a crucial role in setting the trajectory of targets for Scotland as we have suggested. To realise such opportunities it is critical that the Scottish Government adopts both a leadership role and an over-arching strategy, and that it acts as an enabler for more localised and individual actions. Timescale is a major factor and government will clearly need to stress the urgency of the situation with early statements of intent.

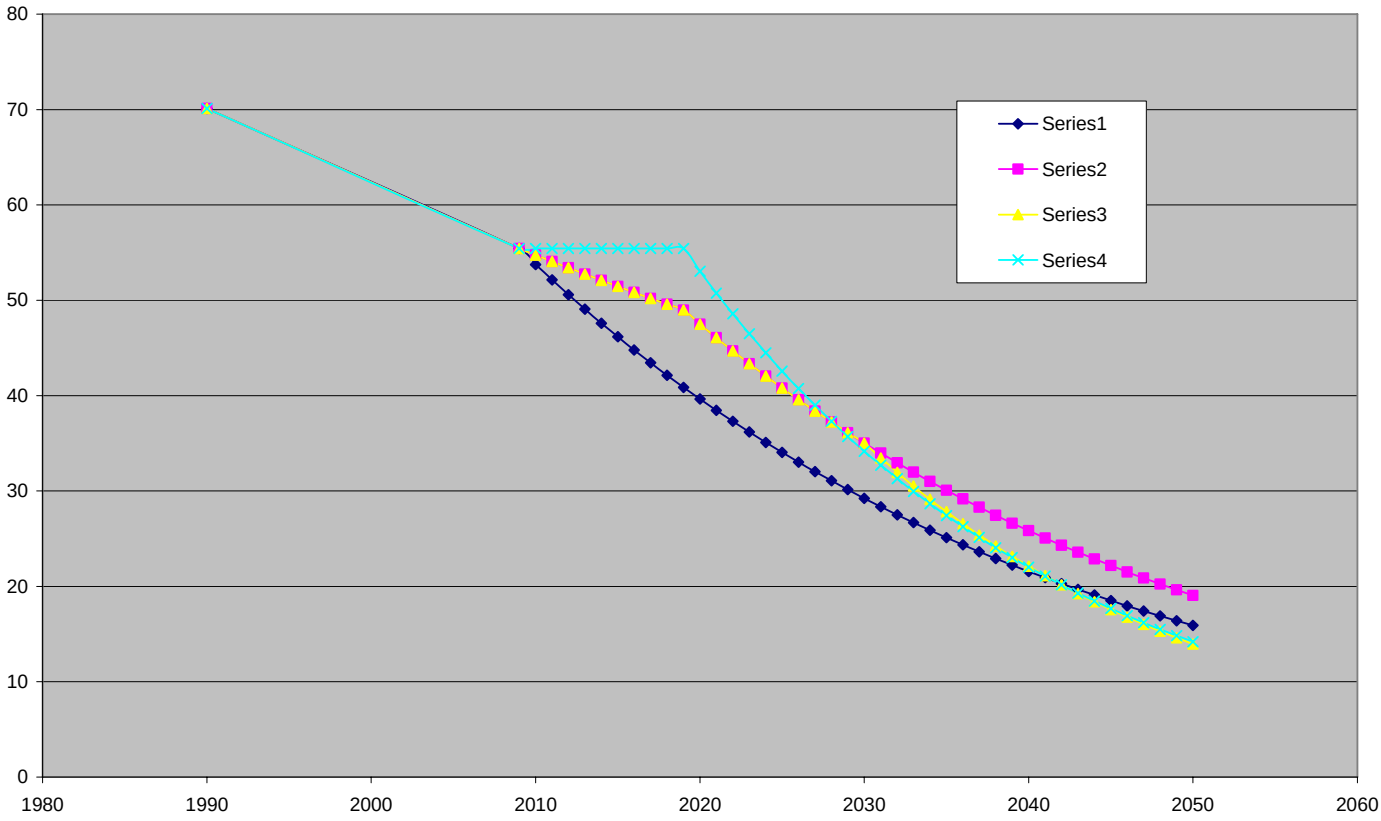
[2] Greenhouse gas emissions from land use, land use change and forestry, SPICe briefing, 1 July 2008

Additional Information and References

In responding to this consultation the Society would like to draw attention to the following Royal Society of Edinburgh responses which are of relevance to this subject:

- The Royal Society of Edinburgh's Inquiry into *Energy Issues for Scotland* (June 2006)
- The Royal Society of Edinburgh's submission to the Scottish Government, *Proposals for a Scottish Climate Change Bill* (April 2008)
- The Royal Society of Edinburgh's submission to the Scottish Parliament's Economy, Energy and Tourism Committee, *Determining and delivering Scotland's energy future* (August 2008)
- The Royal Society of Edinburgh's Inquiry into the *Future of Scotland's Hills and Islands* (September 2008)
- The Royal Society of Edinburgh's submission to DIUS, *A Vision for Science and Society* (October 2008)
- The Royal Society of Edinburgh's submission to the Scottish Government, *Adapting Our Ways: Managing Scotland's Climate Risk* (October 2008)
- The Royal Society of Edinburgh's submission to the Scottish Government, *Framework for the Development and Deployment of Renewables in Scotland* (December 2008)

Appendix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Series1
Series2
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Series4

Year	Target in CC Bill	Scottish emissions Mt CO2e Scenario1	Scenario2	Scenario3	Scenario 4	
		3% from now; meets 50% 2030 target; doesn't meet 80% 2050 target	**1.23% to 2020; 3% from 2020, meets 2030 target but not 2050 target**	**1.23% to 2020; 3% per year from 2020; and 4.5% from 2030 - hits both 2030 and 2050 targets**	**% required to hit 2030/2050 targets if no reduction to 2020: 4.3% per year**	
1990		70.12	70.12	70.12	70.12	
2009	Assume in line with the rate of reduction between 1990 and 2006	55.42	55.42	55.42	55.42	
2010		53.7574	54.738334	54.738334	55.42	
2011		52.144678	54.06505249	54.06505249	55.42	
2012		50.58033766	53.40005235	53.40005235	55.42	
2013		49.06292753	52.7432317	52.7432317	55.42	
2014		47.5910397	52.09448995	52.09448995	55.42	
2015		46.16330851	51.45372773	51.45372773	55.42	
2016		44.77840926	50.82084687	50.82084687	55.42	
2017		43.43505698	50.19575046	50.19575046	55.42	
2018		42.13200527	49.57834273	49.57834273	55.42	
2019		40.86804511	48.96852911	48.96852911	55.42	**% change to hit targets if no reduction to 2020**
2020	at least 3% per year	39.64200376	47.49947324	47.49947324	53.03694	**4.30%**
2021		38.45274365	46.07448904	46.07448904	50.75635158	
2022		37.29916134	44.69225437	44.69225437	48.57382846	
2023		36.1801865	43.35148674	43.35148674	46.48515384	
2024		35.0947809	42.05094214	42.05094214	44.48629222	
2025		34.04193747	40.78941387	40.78941387	42.57338166	
2026		33.02067935	39.56573146	39.56573146	40.74272625	
2027		32.03005897	38.37875951	38.37875951	38.99078902	
2028		31.0691572	37.22739673	37.22739673	37.31418509	

2029		30.13708249	36.11057483	36.11057483	35.70967513
2030	50% below 1990 - 35.05	29.23297001	35.02725758	35.02725758	34.1741591
2031		28.35598091	33.97643985	33.45103099	32.70467026
2032		27.50530148	32.95714666	31.9457346	31.29836944
2033		26.68014244	31.96843226	30.50817654	29.95253955
2034		25.87973817	31.00937929	29.13530859	28.66458035
2035		25.10334602	30.07909791	27.82421971	27.4320034
2036		24.35024564	29.17672497	26.57212982	26.25242725
2037		23.61973827	28.30142323	25.37638398	25.12357288
2038		22.91114612	27.45238053	24.2344467	24.04325924
2039		22.22381174	26.62880911	23.1438966	23.0093991
2040		21.55709739	25.82994484	22.10242125	22.01999494
2041		20.91038446	25.05504649	21.1078123	21.07313515
2042		20.28307293	24.3033951	20.15796074	20.16699034
2043		19.67458074	23.57429325	19.25085251	19.29980976
2044		19.08434332	22.86706445	18.38456415	18.46991794
2045		18.51181302	22.18105252	17.55725876	17.67571147
2046		17.95645863	21.51562094	16.76718211	16.91565587
2047		17.41776487	20.87015231	16.01265892	16.18828267
2048		16.89523193	20.24404774	15.29208927	15.49218652
2049		16.38837497	19.63672631	14.60394525	14.8260225
2050	80% below 1990 - 14.02	15.89672372	19.04762452	13.94676771	14.18850353
Aggragate emissions		1333.339266	1540.920939	1471.620977	1527.260514
Difference in Aggragate emissions			207.5816727	138.281711	193.9212481

Sources: TECHNICAL NOTE: Climate Change (Scotland) Bill: Greenhouse gas Emissions, Annual Redcutions and Targets