Reducing Scottish greenhouse gas emissions

Annexe

AUDIT SCOTLAND

Prepared for the Auditor General for Scotland
December 2011

Auditor General for Scotland

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Introduction

1. This annexe supports the Audit Scotland report *Reducing Scottish greenhouse gas emissions*, and is structured in five parts:
   - background (paragraphs 2 to 8)
   - progress in reducing emissions (paragraphs 9 to 11)
   - plans for further emissions reductions (paragraph 12)
   - the cost of planned emissions reductions (paragraphs 13 to 14)
   - managing emissions reductions (paragraphs 15 to 18).

Background

See paragraphs 1 - 15 of the report

2. Greenhouse gas emissions are reported as the balance of emissions from sources of greenhouse gases, less greenhouse gases that are absorbed by carbon 'sinks'. The main 'sink' processes are the absorption of carbon dioxide by oceans and photosynthesis by plants.

3. Different greenhouse gases vary in their effectiveness at warming the atmosphere (Exhibit 1, overleaf). This variation is measured in terms of gases' global warming potential (GWP) relative to the effect of carbon dioxide (CO_2). Carbon dioxide is the most common greenhouse gas and accounted for 77 per cent of Scottish emissions in 2009. It has a lower GWP than other greenhouse gases but due to its abundance, it is the most significant.[1,2]

4. There are numerous uncertainties with reported levels of emissions.[3] Reported emission levels are estimated not by directly measuring them but by calculating them from the quantities of fossil fuels used and from other relevant processes relating to industry and agriculture - but there are gaps in the data on use of fuel use, and the emissions behaviour of soils is still poorly understood.

5. Emissions for many sources are estimated - sometimes using basic assumptions - for the devolved administrations in Scotland, Wales and Northern Ireland, only after UK-wide data have been finalised. Overall, the data for the devolved administrations are less certain than for the UK as a whole.

6. Current assessment methods in the UK follow international guidance and reporting requirements - but these do not cater for greenhouse gas emissions from international aviation and shipping. Aviation emissions are relatively well known but estimates of shipping emissions suffer from a lack of data on fuel use.

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1 *The Science Behind Climate Change* (online guide), Met Office, www.metoffice.gov.uk/climate-change/guide/what-is-it/why

2 *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: report to the Department for Energy and Climate Change, the Scottish Government, the Welsh Government and the Northern Ireland Department of Environment*, AEA Technology plc, September 2011.

3 *UK Greenhouse Gas Emissions: Measurement and Reporting*, National Audit Office, March 2008.

Exhibit 1

Scottish greenhouse gas emissions in 2009

Carbon dioxide has the lowest global warming potential but is the most common greenhouse gas.

Formula	Name	GWP	$MtCO_2e$	Per cent	Main source
CO_2	Carbon dioxide	1	39.31	77.2	Burning fossil fuels (eg coal and oil).
CH_4	Methane	21	5.68	11.1	Landfill and agricultural activity.
N_2O	Nitrous oxide	310	4.96	9.7	Agricultural soils.
HFCs	Hydrofluorocarbons	140-11,700	0.90	1.8	Refrigeration and insulating foam.
PFCs	Perfluorocarbons	6,500-9,200	0.05	0.1	By-product of aluminium smelting, and a replacement for chlorofluorocarbons in the manufacture of semiconductors.
SF_6	Sulphur hexafluoride	23,900	0.05	0.09	Used in heavy industry to insulate high-voltage equipment and to assist in the manufacturing of cable-cooling systems.
Total	**Total**		**50.95**	**100.0**	

Note: GWP = Global Warming Potential. $MtCO_2e$ = millions of tonnes of carbon dioxide equivalent.

Sources: AEA Technology plc, Scottish Environment Protection Agency, Scottish Government

7. As the science of assessing emissions develops, retrospective adjustments are constantly made to emission data for previous years, including the baseline from which subsequent changes are measured.

8. Uncertainties associated with greenhouse gases other than carbon dioxide can be significant, particularly concerning emissions from agriculture and related land use. For example, the uncertainty level is plus or minus 12 per cent for Scottish emissions of carbon dioxide in 2009, but plus or minus 290 per cent for nitrous oxide.[4], For any given year, considerable uncertainties surround the emissions estimates for a pollutant, but trends over time are likely to be much more reliable.[5]

[4] *Greenhouse Gas Inventories for England, Scotland, Wales and Northern Ireland: report to the Department for Energy and Climate Change, the Scottish Government, the Welsh Government and the Northern Ireland Department of Environment*, AEA Technology plc, September 2011.

[5] *Scottish Greenhouse Gas Emissions 2009,* Scottish Government, September 2011.

Progress in reducing Scottish emissions

See paragraphs 16 - 18 of the report

9. After adjustment for trading in the European Union Emissions Trading Scheme (EU ETS), Scottish emissions reduced from 71.8 $MtCO_2e$ (millions of tonnes of carbon dioxide equivalent)in 1990 to 52.0 $MtCO_2e$ in 2009, a reduction of 28 per cent (Exhibit 2).[6, 7] Between 1990 and 2009, emissions decreased from every major source except transport, for which emissions increased by 3.7 per cent overall. In 2009, 62 per cent of all emissions resulted from the generation and supply of energy or from transport.[8]

Exhibit 2

Sources of Scottish emissions in 1990 and 2009

Emissions from transport rose by 3.7 per cent overall between 1990 and 2009.

	1990		2009		Change: 1990-2009	
	$MtCO_2e$	Per cent	$MtCO_2e$	Per cent	Per cent	Direction
Energy supply	22.24	31.0	18.21	35.7	(18.1)	↓
Transport - total	13.09	18.3	13.57	26.6	3.7	↑
• road and rail	10.56	14.7	10.74	21.1	1.7	↑
• international aviation & shipping	2.53	3.5	2.83	5.6	11.9	↑
Agriculture and related land use	14.51	20.2	10.63	20.9	(26.7)	↓
Housing	8.15	11.4	7.34	14.4	(9.9)	↓
Business and industrial processes	12.34	17.2	6.76	13.3	(45.2)	↓
Waste management	6.48	9.0	2.07	4.1	(68.1)	↓
Development	1.79	2.5	1.55	3.0	(13.4)	↓
Public sector	1.33	1.9	0.79	1.6	(40.6)	↓
Forestry	(8.27)	(11.5)	(9.97)	(19.6)	20.6	↑
Total - before EU ETS adjustment	**71.66**	**100**	**50.95**	**100**	**(28.9)**	
Total - after EU ETS adjustment	**71.75**		**51.98**		**(27.6)**	

Note: Forestry is a net sink for emissions, so its emissions values are negative. See paragraph 10 of this annexe for information on the EU ETS.

Source: Scottish Government

6 *Scottish Greenhouse Gas Emissions 2009*, Scottish Government, September 2011.

7 Before adjustment for the EU ETS, emissions reduced from 71.7 $MtCO_2e$ in 1990 to 51.0 $MtCO_2e$ in 2009, a reduction of 29 per cent.

8 *Scottish Greenhouse Gas Emissions 2009,* Scottish Government, September 2011.

10. The EU ETS is one of the key policies introduced by the EU to help meet its target of reducing greenhouse gas emissions by eight per cent below 1990 levels. A Europe-wide, cap and trade scheme, it started in 2005 and is the first of its kind.[9] The effect of the EU ETS is that major producers of emissions in EU nations have a financial incentive to reduce them (Exhibit 3).

Exhibit 3

The European Union Emissions Trading Scheme

The EU ETS covers electricity generation and the main energy-intensive industries.

- Each EU member state (the UK is the relevant state for Scotland) must develop a National Allocation Plan (NAP) which is approved by the European Commission. The NAP sets an overall cap on the total emissions allowed from all the installations covered by the system. This is converted into allowances - one allowance equals one tonne of carbon dioxide - which are then distributed by EU member states to installations covered by the system.
- At the end of each year, installations are required to surrender allowances to account for their actual emissions. They may use all or part of their allocation. Installations can emit more than their allocation by buying allowances from the market. Similarly, an installation that emits less than its allocation can sell its surplus allowances. The environmental outcome is not affected because the total amount of allocated allowances is fixed.
- The EU ETS covers electricity generation and the main energy-intensive industries – power stations, refineries and offshore, iron and steel, cement and lime, paper, food and drink, glass, ceramics, engineering and the manufacture of vehicles. Combined, these account for around 48 per cent of UK emissions of carbon dioxide.

Source: Department for Energy and Climate Change

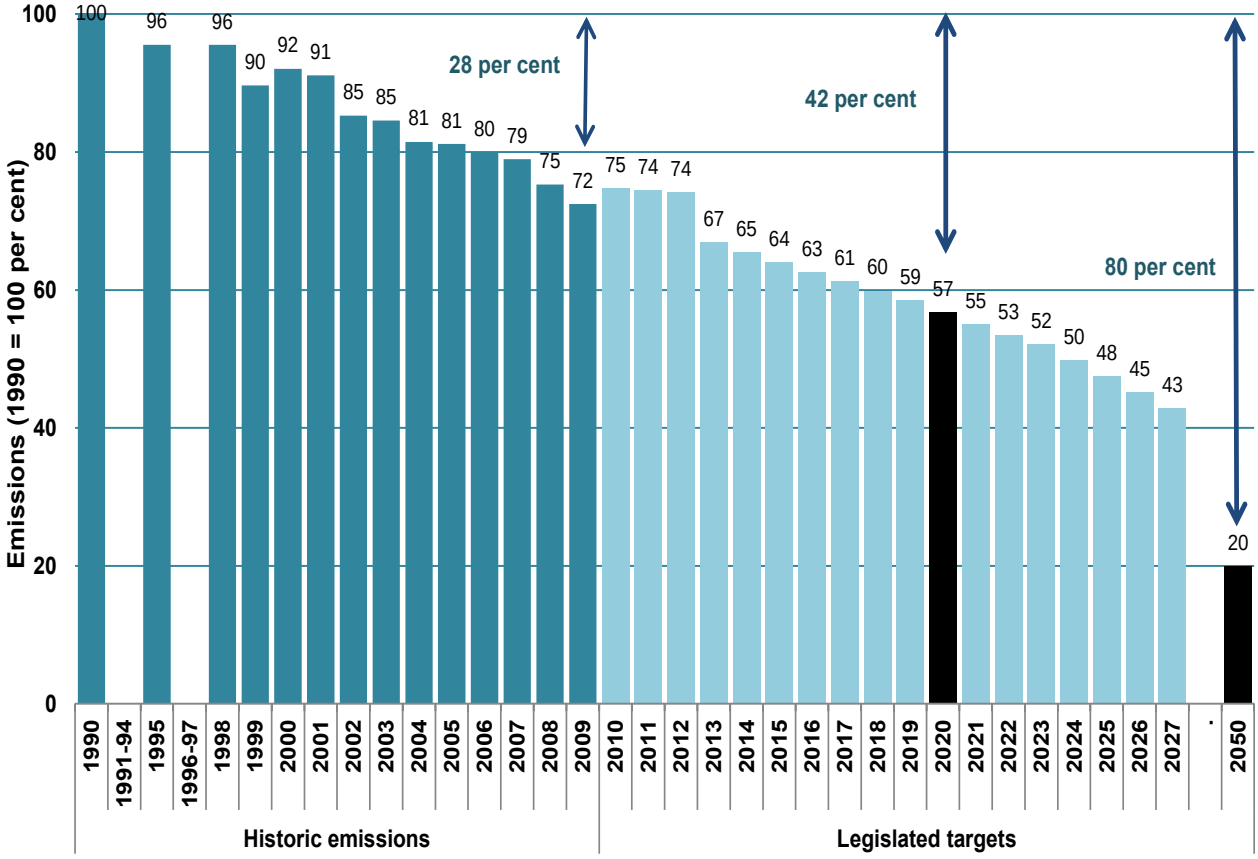
9 *How Does the EU ETS Work* (online guide), Department for Energy and Climate Change, www.decc.gov.uk/en/content/cms/emissions/eu_ets/eu_ets.aspx

11. Scottish targets require total emissions at the end of 2020 to be at least 42 per cent lower than in 1990 (Exhibit 4). Emissions should reduce from their 2009 level of 52.0 $MtCO_2e$ to no more than 40.7 $MtCO_2e$ by the end of 2020, representing a reduction of 22 per cent from 2009 levels.

Exhibit 4

Scottish emissions targets

There is little difference between the rate at which emissions have reduced over the past two decades and the rate at which they must fall to meet the 2020 target.



Note: Data are not available for emissions in 1991-94 or in 1996-97. Targets for 2020 and 2050 are fixed by the *Climate Change (Scotland) Act 2009*. Targets for other years are agreed by the Scottish Parliament through secondary legislation.

Source: Audit Scotland

Plans for further emissions reductions

See paragraphs 19 - 37 of the report

12. The Scottish Government's plans for reducing greenhouse gas emissions are drawn together in its *Report on Polices and Proposals*, which was published in March 2011 (Exhibit 5).[10]

Exhibit 5

Key documents relating to reducing emissions

The *Report on Policies and Proposals* relates to numerous other key documents.

Year	Month	Key document
2005	December	• Choosing Our Future: Scotland's sustainable development strategy
2006	October	• The Scottish Forest Strategy
	December	• Scotland's National Transport Strategy
2009	November	• Climate Change Act 2008 (the UK Act)
	June	• Securing our Future: A Carbon Emissions Reduction Target Strategy for Scotland • Climate Change Delivery Plan • Recipe for Success: Scotland's First National Food and Drink Strategy
	August	• Climate Change (Scotland) Act 2009
	September	• Carbon Assessment of the 2010/11 Draft Budget
2010	June	• Zero Waste Plan
	October	• Conserve and Save: the Energy Efficiency Action Plan for Scotland
	November	• Low Carbon Economic Strategy • Draft Electricity Generation Policy Statement • Carbon Assessment of the 2011/12 Draft Budget
	December	• Low Carbon Scotland: Public Engagement Strategy
2011	March	• Low Carbon Scotland: Meeting the Emissions Reduction targets 2010-2022: the Report on Policies and Proposals
	March	• Scotland's First Land Use Strategy
	July	• Routemap for Renewable Energy in Scotland
	September	• The Government Economic Strategy
	September	• Carbon Assessment of the 2012/13 Draft Budget

Note: This is a sample of the many documents produced by the Scottish Government.

Source: Audit Scotland

[10] *Low Carbon Scotland: meeting the emissions reduction targets 2010-2022: the report on policies and proposals*, Scottish Government, March 2011.

The cost of planned emissions reductions

Paragraphs 38 - 48 of the report

13. Where major programmes and projects are involved, HM Treasury's *Green Book* recommends the use of a discount rate of 3.5 per cent to calculate the value of future cashflows in money at today's value (current prices).[11] When this rate is applied to the Scottish Government's data, the estimated total cost of implementing all its 17 existing policies and 18 proposed new policies is between £9.60 and £10.68 billion from 2011-2020 (Exhibit 6). However, estimates of the total cost could vary significantly according to the discount rate that is applied.

Exhibit 6

Effect of different discount rates on estimated total costs of reducing emissions

A higher discount rate reduces the cost. We have calculated costs using a rate of 3.5 per cent.

		Estimated cost at current prices (£ billion)				
Discount rate		1.0 per cent	3.5 per cent	5.0 per cent	10.0 per cent	12.5 per cent
Existing policies	Maximum	5.86	5.32	5.04	4.29	3.99
	Minimum	4.92	4.48	4.25	3.63	3.38
Proposed new policies	Maximum	5.99	5.36	5.03	4.13	3.77
	Minimum	5.73	5.12	4.8	3.94	3.6
All policies	Maximum	11.85	10.68	10.07	8.42	7.76
	Minimum	10.65	9.6	9.05	3.94	6.98

Note: The data exclude costs for energy production and supply, and three policies that Scottish Government did not cost. See Appendix 3 of the report for a list of all existing and proposed new policies.

Source: Audit Scotland

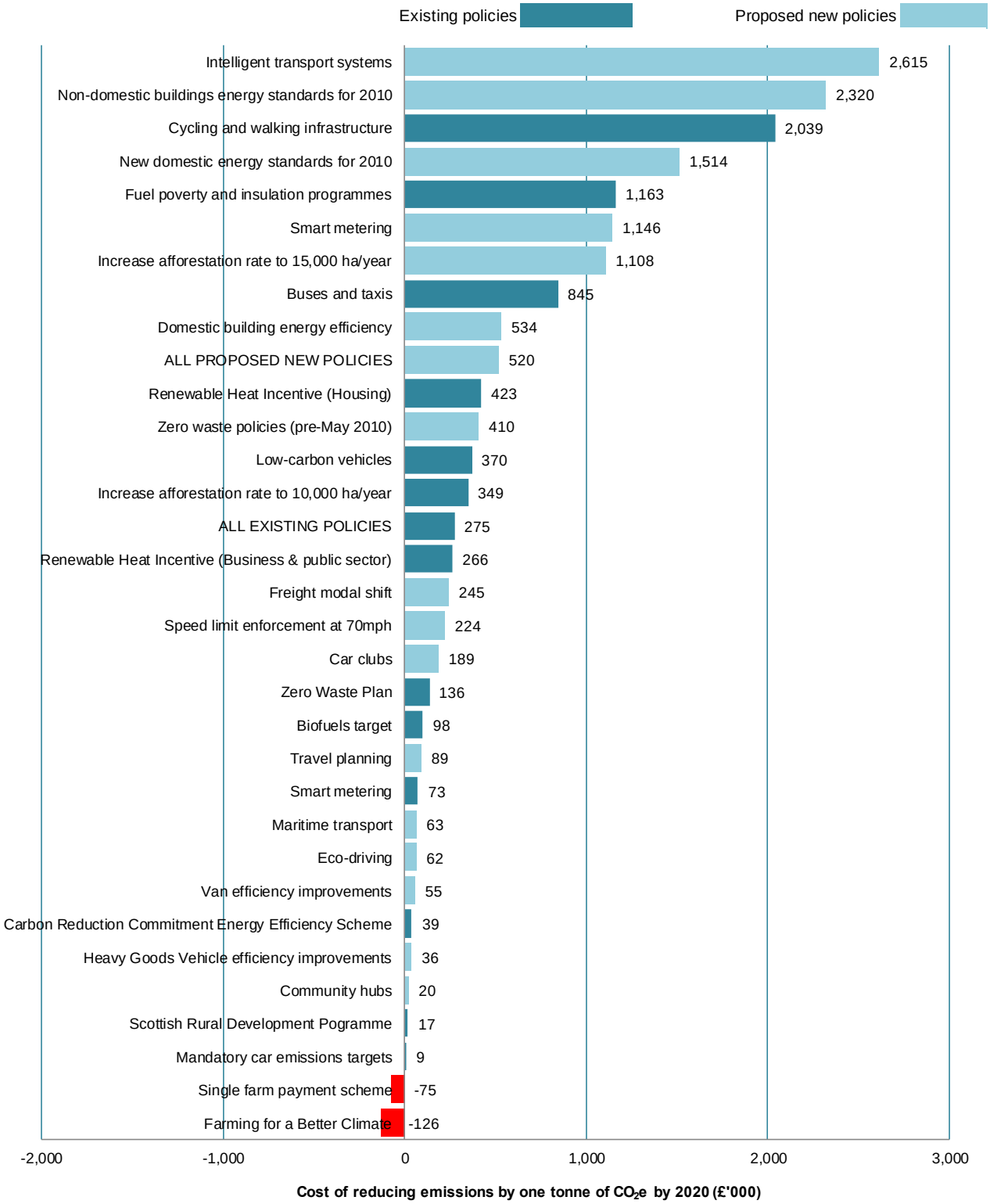
14. There is wide variation in the cost effectiveness of the existing policies and proposed new policies, in terms of the likely cost of reducing emissions (Exhibits 7 and 8). These exhibits exclude costs for energy production and supply, and three policies that Scottish Government did not cost.

[11] *The Green Book*, HM Treasury, www.hm-treasury.gov.uk/data_greenbook_index.htm

Exhibit 7

The cost-effectiveness, at current prices, of different policies to reduce emissions by 2020

The cost of reducing emissions by a tonne of carbon dioxide equivalent varies widely.



Note: This chart uses the maximum values in Exhibit 8.

Source: Audit Scotland

Exhibit 8

The cost-effectiveness, at current prices, of different policies to reduce emissions by 2020

The cost of reducing emissions by a tonne of carbon dioxide equivalent varies widely.

Discount rate = 3.5 per cent		Emissions reduction	Cost (£ million)		Cost effectiveness (£ per tCO_2e)	
	Policy	($MtCO_2e$)	Min	Max	Min	Max
Transport						
Mandatory car emissions targets	Existing	2.927	26	26	9	9
Biofuels target	Existing	2.398	235	235	98	98
Buses and taxis	Proposed	1.351	1,141	1,141	845	845
Travel planning	Proposed	1.002	89	89	89	89
Heavy Goods Vehicle efficiency improvements	Proposed	0.978	35	35	36	36
Freight modal shift	Proposed	0.526	129	129	245	245
Cycling and walking infrastructure	Proposed	0.495	1,010	1,010	2,039	2,039
Eco-driving	Proposed	0.418	26	26	62	62
Community hubs	Proposed	0.400	8	8	20	20
Low-carbon vehicles	Proposed	0.284	105	105	370	370
Maritime transport	Proposed	0.275	17	17	63	63
Car clubs	Proposed	0.215	41	41	189	189
Speed limit enforcement at 70mph	Proposed	0.169	38	38	224	224
Van efficiency improvements	Proposed	0.101	6	6	55	55
Intelligent transport systems	Proposed	0.076	199	199	2,615	2,615
Total for costed policies	**Existing**	5.325	261	261	49	49
	Proposed	6.290	2,844	2,844	452	452
	Total	11.615	3,105	3,105	267	267
Business and the public sector						
Renewable heat incentive	Existing	3.306	387	878	117	266
Carbon Reduction Commitment Energy Efficiency Scheme	Existing	0.745	29	29	39	39
Smart metering	Existing	0.324	23	23	73	73
Non-domestic buildings energy standards for 2010	Existing	0.227	527	527	2,320	2,320
Total for costed policies	**Existing**	4.602	967	1,457	210	317
	Proposed					
	Total	4.602	967	1,457	210	317
Housing						
Domestic building energy efficiency	Existing	1.635	873	873	534	534
Renewable Heat Incentive	Existing	1.179	224	499	190	423
New domestic energy standards for 2010	Existing	0.640	969	969	1,514	1,514
Smart meters	Existing	0.433	417	496	963	1,146
Fuel poverty and insulation programmes	Proposed	1.717	1,998	1,998	1,163	1,163
Total for costed policies	**Existing**	3.887	2,483	2,837	639	730
	Proposed	1.717	1,998	1,998	1,163	1,163
	Total	5.604	4,480	4,835	799	863
Agriculture and related land use						
Farming for a Better Climate	Existing	2.295	(290)	(290)	(126)	(126)
Scottish Rural Development Programme	Existing	0.109	2	2	17	17
Single farm payment scheme	Proposed	1.620	(121)	(121)	(75)	(75)
Total for costed policies	**Existing**	2.404	(288)	(288)	(120)	(120)
	Proposed	1.620	(121)	(121)	(75)	(75)
	Total	4.024	(409)	(409)	(102)	(102)
Waste						
Zero waste policies (pre-May 2010)	Existing	1.661	681	681	410	410
Zero Waste Plan	Existing	0.766	(132)	104	(173)	136
Total for costed policies	**Existing**	2.427	549	785	226	323
	Proposed					
	Total	2.427	549	785	226	323
Forestry						
Increase afforestation rate to 10,000 hectares per year	Existing	1.074	375	375	349	349
Increase afforestation rate to 15,000 hectares per year	Proposed	0.482	534	534	1,108	1,108
Total for costed policies	**Existing**	1.074	375	375	349	349
	Proposed	0.482	534	534	1,108	1,108
	Total	1.556	909	909	584	584
Overall						
Total for costed policies	**Existing**	19.719	4,346	5,428	220	275
	Proposed	10.109	5,255	5,255	520	520
	Total	29.828	9,601	10,683	322	358

Source: Audit Scotland

Managing emissions reductions

See paragraph 53 of the report

15. The Scottish Government's Emissions Reduction Board has identified five risks to the delivery of emissions reductions (Exhibit 9).

Exhibit 9

The Emissions Reduction Programme Board's risk register

The five risks are the responsibility of the Director-General, Enterprise and Environment.

Risk	Likelihood	Impact	Score	Controls
1. External factors beyond Scottish Government control (eg fluctuations in the economy, weather) lead to increased emissions, thereby making statutory annual targets more difficult to achieve.	4	5	20	• Improve access to data/indicators on likely impact on emissions of external factors. • Integrate the low carbon economy into the Government Economic Strategy and economic recovery plan. • Identify additional proposals and policies to compensate for potential shortfall in targets. • Use and promote use of levers within Scottish Government control to demonstrate best efforts on progress towards targets.
2. Ministerial policy and/or spending decisions lead to increased emissions, or lack of action to reduce emissions in line with statutory targets.	4	5	20	• Monitor decision-making process through carbon scorecards. • Introduce a carbon assessment tool. • Maintain a collective approach to decision-making on issues that have significant impact on emissions. • Ensure that advice includes assessment on potential impact on delivery of annual targets. • Provide Ministers with widest possible range of policy choices to compensate for decisions that increase emissions.
3. Public and business behaviour does not transform at the speed or extent required to meet statutory targets.	4	5	20	• To be confirmed in due course.
4. Actions by other government/institutions (EU, UK etc) are inconsistent with Scottish statutory targets.	3	5	15	• Maintain close relationships with the European Commission, Department for Enterprise and Climate Change, other government departments and other EU Member States. • Make a case for the transition to a low carbon economy (and higher targets) on international and UK stage. • Maintain/increase pressure on the UK Government and EU. • Provide Ministers with widest possible range of policy choices to compensate for decisions that increase emissions.
5. The internal governance and monitoring system fails to support the mainstreaming of climate change, leading to a lack of action to meet statutory targets.	3	5	15	• Operation of the Emissions Reduction Programme Board, with a tight and focused agenda. • A robust approach to planning and monitoring action to deliver targets. • Integrate a climate change and low carbon perspective into corporate, strategic and portfolio business programmes. • Strong analytical support for policy development.

Source: Scottish Government

16. The Scottish Government is developing a set of spreadsheet-based scorecards to monitor and manage emissions reductions (Exhibit 10). These aim to provide more up-to-date performance information on progress towards emissions reductions, than the annual emissions data allow. There is a scorecard for each major source of emissions (eg energy, transport, housing, etc).

Exhibit 10

The Scottish Government's scorecards for managing emissions reductions

The table below illustrates the approach using examples from energy and transport.

Feature	Energy	Transport
Targets	• A 12 per cent reduction in total final energy consumption by 2020.	• Increase low-carbon travel in Scotland.
Milestones	• Every home with gas central heating to have a highly efficient boiler with appropriate controls.	• An electric vehicle charging infrastructure in place in Scottish cities by 2020.
Policies	• The Energy Assistance Package.	• Increase the availability of electric vehicle infrastructure.
Actions	• Improve insulation levels and energy efficiency in homes of fuel-poor households in Scotland through the four-stage Energy Assistance Package.	• Central Scotland is one of five projects in the UK-wide *Plugged-in Places Programme*, which provides match funding for up to half the cost of installing publicly available electric vehicle charging points.
Achievements	• The number of households moved on a social tariff for energy.	• The number of vehicle charging points created.
Progress	• Red, amber, green rating.	• Red, amber, green rating.
Activity indicators	• Domestic electricity consumption.	• The number of vehicle kilometres travelled by all vehicle types on all roads.
Efficiency indicators	• The percentage of properties with inefficient boilers over 10 years old.	• The proportion of new vehicles that are alternatively fuelled**.**
Drivers and pressures	• The unit cost of electricity for domestic properties	• The cost of petrol and diesel fuels for transport.

Note: The exhibit is not a comprehensive description of the energy or transport scorecards.

Source: Scottish Government

17. Each scorecard is the responsibility of a Scottish Government director. Reporting of progress against the scorecards is a standing item at meetings of the Emissions Reduction Programme Board. It is not possible to measure and attribute reductions to specific policies, so proxy indicators which track activity likely to bring about reductions in emissions are used, eg the numbers of cars on the road, or sales of petrol. Some datasets in the scorecards are only updated annually, making more frequent reporting problematic.

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