What should Scotland do about climate change?

Nick Hanley
Professor of Environmental Economics
University of Stirling

With contributions by
Professor Pete Smith (Aberdeen) and Simon Hart(UPM-Tilhill)

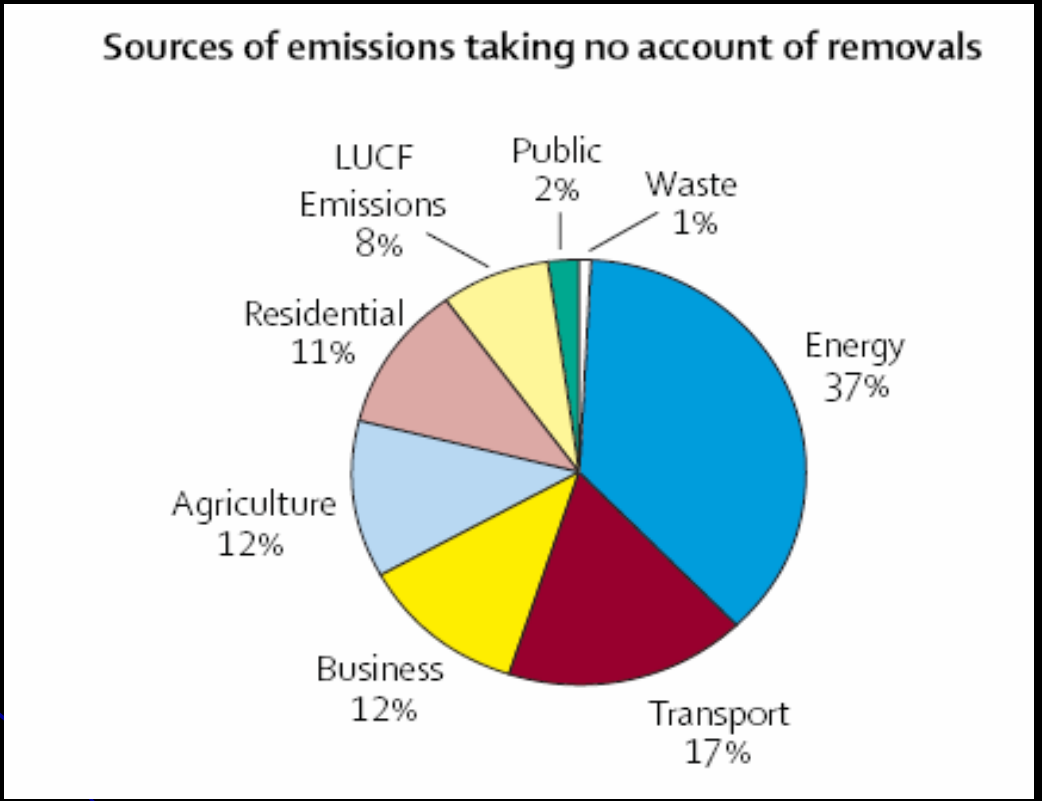
- What this is not about: whether human-induced climate change is happening. We take as given the existence of targets (Kyoto, “Scottish Share”) for reducing Green House Gases (GHGs)

outline

- What are the main *sources* of GHGs in Scotland, and what are the *trends*?
- Cost-effective emissions control
  - *Principles*
  - *By sector* for Scotland
- Mitigation versus *adaptation* – what makes more sense?
- Conclusions – what should our climate policy be?

Sources and trends

Scottish Emissions of Greenhouse Gases in 2003



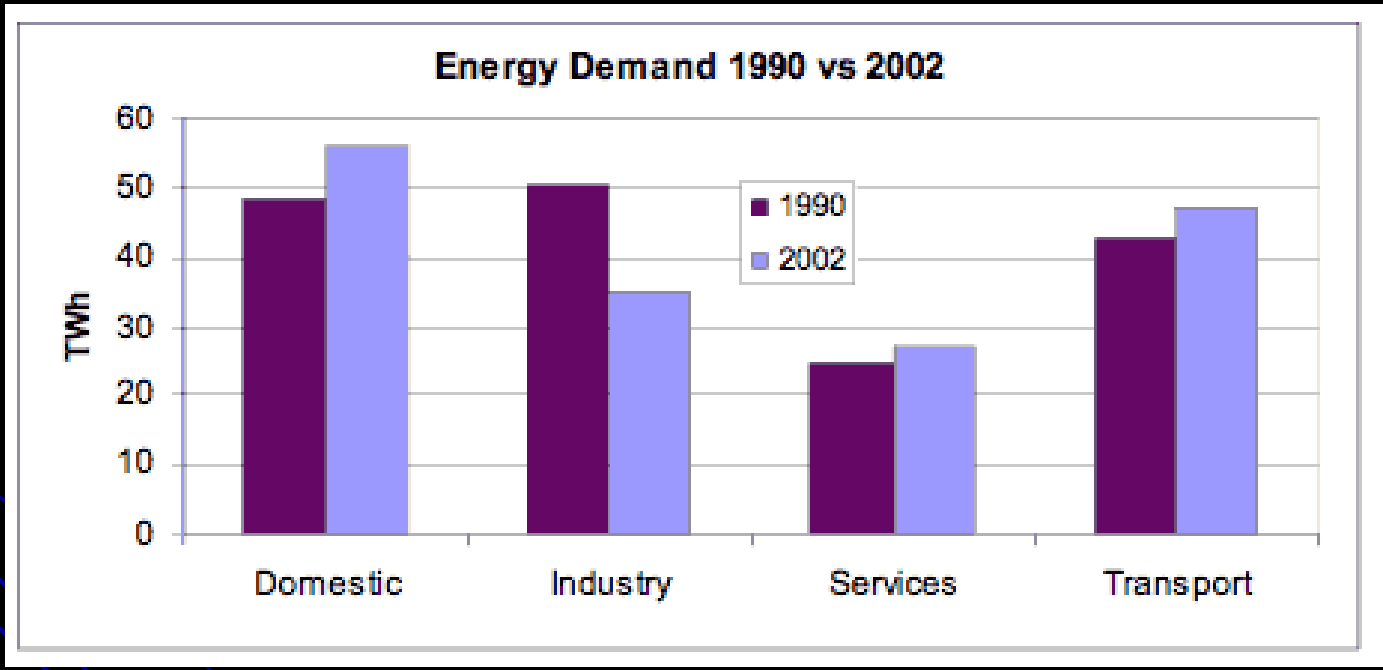
- Overall, Scotland's net greenhouse emissions (ie emissions minus removals) fell by 14% between 1990 and 2003 (from 17.3 to 14.9 MtC).
- Some sectors have falling emissions (eg business and industrial processes)
- But some are rising eg transport, energy supply

targets

- Kyoto target: UK to cut by 12.5% over 1990 levels by 2008-2012. Scottish share is 1.7 MtC/yr cut by 2010
- Scottish Exec. has added a further 1 MtC to this target
- UK energy white paper: 60% target cut by 2050

- These are tough targets, especially as the “do nothing” baseline would be rising emissions

And energy demand is rising..



Cost-effective control: principles

- Baumol and Oates least-cost tax theorem: equalise "marginal abatement costs" across sources. MAC are the costs firms and households face in reducing carbon emissions
- Economic theory tells we can achieve this least-cost outcomes with a **pollution tax** or a **tradeable pollution permits** system

A complication: Climate change is a stock pollution control problem – damage depends on stock of GHGs, not on current period emissions; although costs of control depend on current period emissions cuts.

Cutting emissions – “mitigation”

- Investing in energy-saving technology (firms or households)
- Switching to lower C-content fuels for production, heating and transportation
- Reducing output
- For farmers, reducing their stocking levels to reduce methane emissions
- For airlines or bus operators, replacing their fleet with more fuel-efficient planes or buses.

Can also invest in “sinks”

- On farmland, eg by re-creating wetlands
- By increasing forest cover

- Big problems with monitoring/measuring changes in carbon sinks from such actions

Main aspects of current UK policy

- **EU Emissions Trading Scheme** (some sectors only; 12,000 sources)
  - Two phases: 2005-2007; 2008-2012
  - Trading between and within countries
  - Permits initially allocated for free under National Allocation Plans
  - Many broking firms have now emerged
  - Prices plummeted in mid 2006 due to over-supply announcement
  - Now around £14/tonne CO_2
  - Joint trading with Kyoto “flexible mechanisms” CDM and JI

Policy (cont.)

- **Climate Change Levy**
- **Energy Efficiency Grants**
- **Renewables Obligation Scheme**
- Others

New analysis for Scotland

- Compare “marginal” abatement costs across important emissions sectors
- Lots of information gaps
- We only have point estimates (mostly) not MAC functions
- Little information on how these will shift over time
- But still gives interesting insights
- Sectors: industry, renewable energy, household energy use, agriculture, forestry.

Industry: 12% of total emissions

- Assume cost-minimising behaviour by firms in relevant sectors
- Implies adjust emissions to point where MAC=permit price
- Means we can use the EU ETS price as a point estimate of average MAC
- Currently £14/tonne CO2

- Actually, more sectors than just “industry” are covered by emissions trading:

EU ETS Sectors in Scotland

Aerospace	1
Brewing	1
Ceramics	4
Chemicals	12
Dairies	1
FDT	1
Food & Drink	1
Offshore	6
Other Oil & Gas	8
Power Stations	13
Pulp & Paper	4
Refineries	2
Services	30
Spirits	2
Wood Board	2
Total Phase 1	88

urce: SEPA

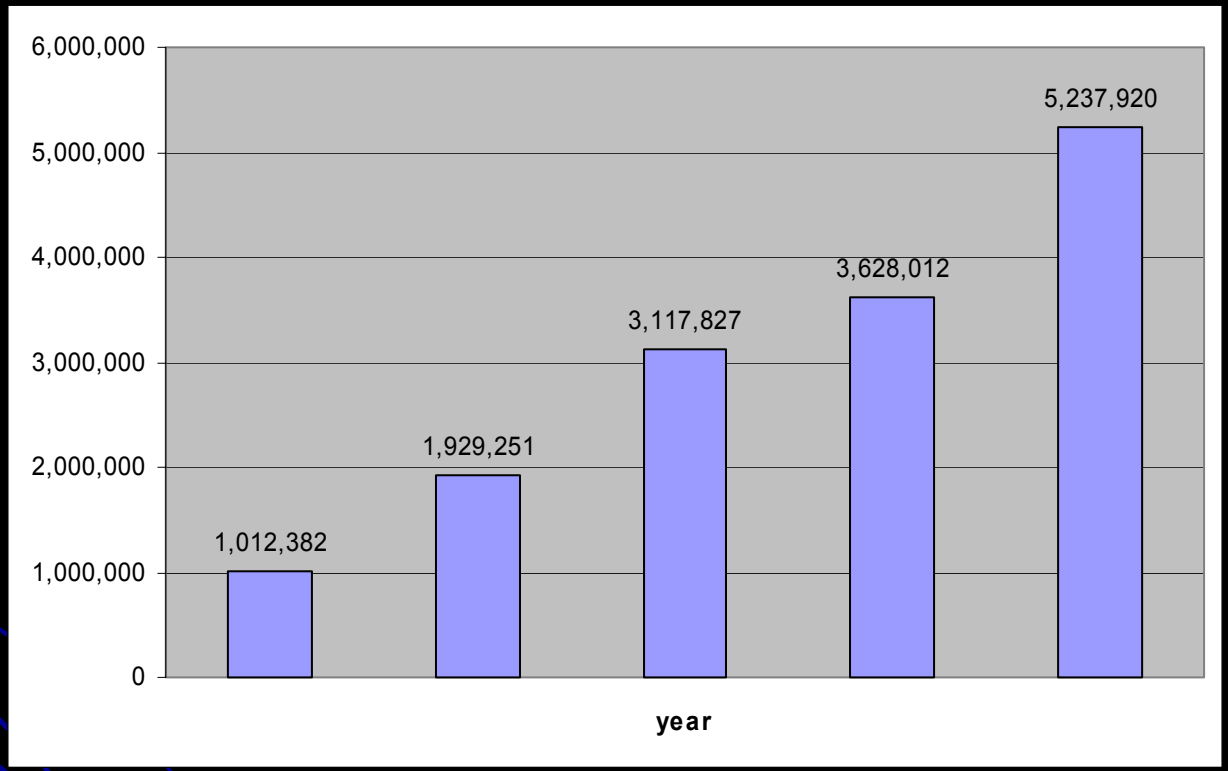
Energy supply: 37% of current emissions

- Main focus of government is on switching from fossil fuel electricity to renewables
- Incentivise private sector via Renewables Obligation
- Means price consumers pay rises to cover “additional costs” of incremental renewable supplies
- Renewable producers earn ROCs which are valuable (£50/MWhr)

Criticisms of the ROS

- Recent Ofgem report criticises the scheme as being “needlessly expensive” to consumers, and for “over-compensating” producers.
- Ofgem estimated the cost of the RO system at £32 bn over the lifetime of the scheme.
- But has resulted in very fast growth in renewables capacity. In 2005, the amount of electricity generated in Scotland by renewable sources equated to 18.2% of the electricity consumed in Scotland, compared with 14.3% in 2000.
- Growth in on-shore wind power has been substantial in recent years.

Expansion of renewable capacity in Scotland under the Renewables Order, 2002/3 – 2006/7



- But what is the cost per tonne of CO2 displaced from the generating mix?
- Cost estimates based on incremental generation costs according to investment type and displaced fuel
- Note that these are *under* estimates of the cost per tonne of CO2 reduced since they explain the loss in consumers surplus to households due to higher electricity prices ➔ real costs are much higher

Table 4: Costs of reducing one additional tonne of CO_2 by displacing fossil fuel generation with new renewables.

ROC, LEC and ETS included	*Onshore Wind*		*Offshore Wind*	
	Coal	Gas	Coal	Gas
Cost of switching 1 MWh	-36	-24	-28	-16
Cost of reducing 1 tonne of CO_2	-32	-8	-25	-5
Only ETS included	*Onshore Wind*		*Offshore Wind*	
	Coal	Gas	Coal	Gas
Cost of switching 1 MWh	18	29	46	57
Cost of reducing 1 tonne of CO_2	16	10	41	20
Only ROC and LEC included	*Onshore Wind*		*Offshore Wind*	
	Coal	Gas	Coal	Gas
Cost of switching 1 MWh	-27	-21	-19	-13
Cost of reducing 1 tonne of CO_2	-24	-7	-17	-4
Excluding all Gvmt intervention	*Onshore Wind*		*Offshore Wind*	
	Coal	Gas	Coal	Gas
Cost of switching 1 MWh	27	32	55	61
Cost of reducing 1 tonne of CO_2	24	11	49	21

Forestry and land use change: *net sink, increasingly so.*

- Can change area under forestry as a way of locking up more CO2 during the lifetime of the forest
- Cost per tonne CO2 depends on (i) land value and land type (not on bogs!) (ii) yield class of trees (iii) planting costs.
- A market already exists in “forests for sequestration”: current prices around £750-£1500/ha (supply and demand of course)
- Key question: what is the supply price of additional hectares of woodland for C sequestration?

xample calculations for costs of C sequestration by new woodland planting in Scotland.

Tonnes CO_2	*Examples*	*Planting cost/ha*	*Land cost £*	*Total cost£/TCO_2*
600	Oak, uplands	2500	1000	5.83
800	Scots pine, upland, 2 rotations	2500	1000	4.38
600	Scots pine, upland, 2 rotations	2500	1500	6.67
300	Sitka spruce with thinning, lowland	2500	2000	15.00
400	Birch, upland,	2500	2000	11.25
600	Birch, upland,	2500	2000	7.50
600	Birch, upland,	2500	3000	9.17
600	Oak, lowland	2500	5000	12.50
800	Oak, lowland	2500	5000	9.38

But a lot of issues:

- Additionality? Verification? Measurement?
- Monitoring over lifetime of contract?
- Converting carbon sequestered per year into carbon price.
- Price of carbon versus price of other forest joint products (eg recreation, biodiversity)

Domestic energy use: 11% of emissions

- Rising energy demand in household sector
- Much policy (advice, grants) directed at getting households to invest in loft insulation, cavity wall insulation etc
- Households seem to pass up investments which would generate positive NPV in terms of energy saving
- Oxera: all household investments considered had net present benefit, not cost

- So why? Oxera study found that lack of information, transactions costs and upfront costs were much more important than lifetime energy savings
- But within range considered, net costs of reducing CO2 emissions through this route seem to be **negative.**

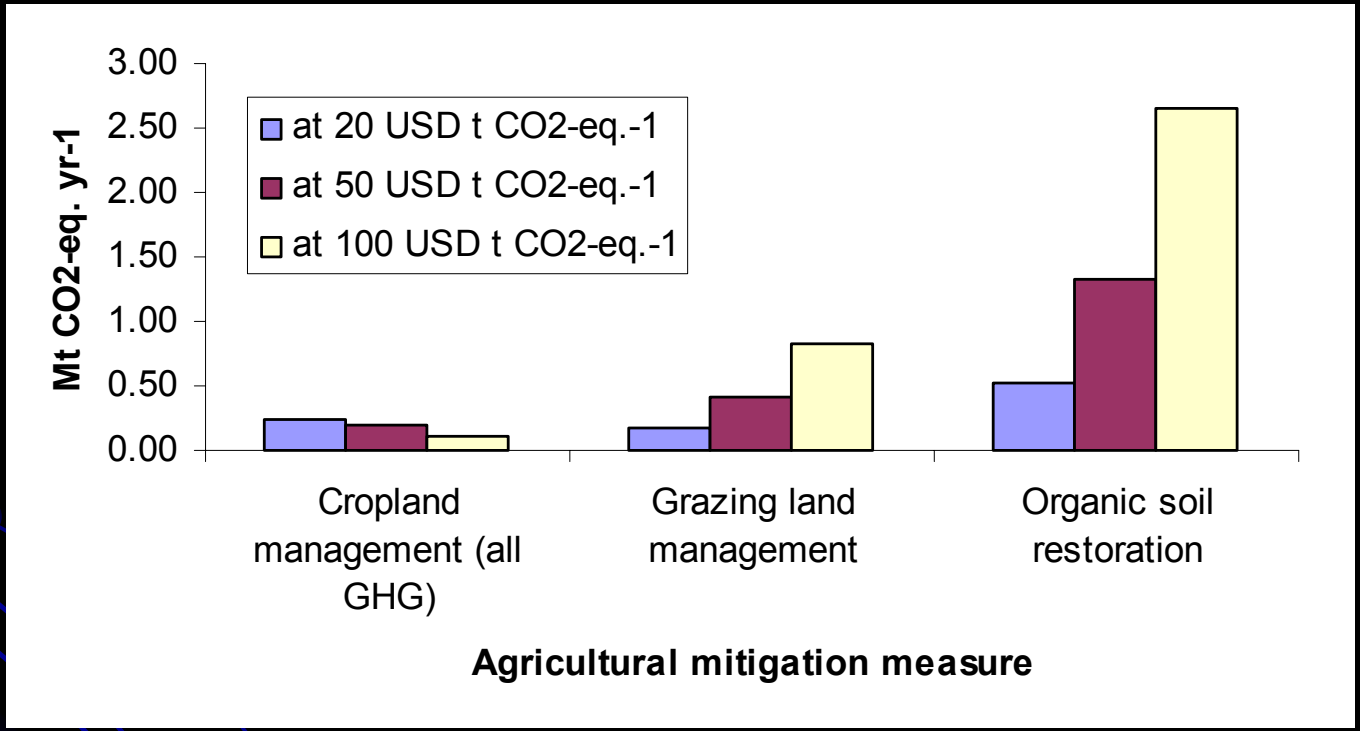
Agriculture: 12% of emissions (carbon-equivalent)

- In 2003 in the EU, emissions from agriculture account for about 10% of total emissions, whilst direct emissions from agriculture were 12% of total emissions in Scotland (excluding removals).
- Main emissions are CH4, N20 and CO2, from livestock and arable and pasture land management

- Options for mitigation:
  - *reduce emissions*, for example by improving nutrient management
  - *enhance removals*, for example by restoring wetlands or by reducing heather moorland burning
  - *displacing emissions*, for example by growing bio-fuels which replace fossil-fuel derived fuels for heating or transport

- Recent IPCC report investigates potential for mitigation of GHGs via changes in agricultural practices
- Calculate “technically feasible” range of mitigation, and also economically feasible range for range of shadow prices for carbon
- Rose et al (2007), in a review of a large number of assessment models, conclude that *agriculture can be a cost-effective source of mitigation*, and thus a significant contributor to a cost-effective programme.
- For Scotland, no primary estimates of Marginal Abatement Costs, but can use EU/US figures in conjunction with technical possibilities.

Mitigation potential of cropland management, grazing land management and restoration of cultivated organic soils in Scotland by 2030 at different carbon prices.



Transport: 17% of emission, rising

- Policy in place at present: fuel duty; emissions standards for new vehicles; public transport subsidies; variable vehicle licensing tax. Biofuel Directive.
- Options (for Scotland): road pricing, increased investment in public transport, investments in biofuel production as substitute fuel source. No figures available on the costs per tonne of CO2 displaced.
- For UK, wider set of options including aviation taxes and the return of the fuel duty escalator??
- But again, no figures that I can find on costs per tonne of CO2 displaced.

Summarising the options

Sector	**Costs per tonne CO_2 eq.**	**Comments**
Industry	£14	Current EU ETS price.
Housing	*negative*	Based on UK wide data
Transport	Not known	No Scottish research available
Renewables	£11 - £49	Depends on whether on- or off-shore wind and whether replaces coal or gas
Agriculture	£10	Can deliver up to 1 Mt/yr., but based on US/EU data
Forestry	£4-£12	Assumes additionality

finally

- What makes sense for a small country? Spending on mitigation, or spending on **adaptation**?
- Adaptation = invest now to reduce expected damage costs
- Mitigation produces very small benefits for Scotland, yet all the costs fall on us (although some of these “costs” are actually benefits)
- But adaptation produces benefits which occur only to us, in terms of avoided damages. Eg investments in flood control

- Climate change could actually produce some benefits to Scotland anyway, in terms of tourism and increased crop growth
- But politically we don't have much choice over whether to mitigate or not; so we should try and *ensure that our mitigation actions are cost-effective*; and we should try to achieve *a correct balance between mitigation and adaptation*.

- Not much evidence of this happening as far as one can judge!

- Thanks for listening
- N.D.Hanley@stir.ac.uk
- www.economics.stir.ac.uk