# Imagineering 2050 emission-lite Scotland

## Peter Jones

The essays in this volume are not forecasts. Forecasting is a truly hazardous art. Libraries are littered with books that got it wrong, and thinly populated with volumes that got it right. Rather, these essays are an exercise in imagineering, a word coined in 1940s America and defined as "the fine art of deciding how we go from here".

No single contribution should be taken as plotting the "right" path by which Scotland can reach the target of cutting greenhouse emissions by 80 per cent by 2050. That is not the purpose. The object, instead, is to set out various scenarios from different perspectives – environmental, business, economic, consumer, academic – for what might be done over the next four decades. No attempt has been made to produce a consensus view for there is a risk that such a consensus might crowd out alternative viewpoints and suppress radically different strategies when they, indeed, might have the right perspective. The history of science teaches us that the accidental discovery, the flash of insight, and the "wrong" approach are almost as important in advancing scientific knowledge as planned and programmed research.

Understanding this is particularly important when the world's population and its governments are confronting the problem of climate change. This is unlike any other problem humanity has encountered. Mitigating and reversing the processes which are helping to cause climate change requires stopping, or at least greatly reducing, something which, ever since the Industrial Revolution, has been assumed to be a pathway to greater human prosperity and happiness – the burning of the fossil fuels of oil, coal, and gas.

Achieving that requires radical and perhaps painful actions. It requires re-thinking industrial processes, how all of us go about our daily lives, and how we make social and political decisions. And it demands unprecedented global as well as national and individual action.

This introductory essay does not attempt to draw definitive conclusions. Its purpose is to gather together the common and conflicting threads, the agreements and antagonisms, and the different dimensions to the debate to present an overview which sets out some of the challenges we face and the choices we will have to make if we are to reach the 2050 goal. So first of all …

**What is the scale of the task?**

The aim is to reduce Scotland's greenhouse gas (GHG) emissions by 80 per cent of their 1990 levels by 2050. In 1990, Scotland is estimated to have produced 64.4 million tonnes (mt) of carbon dioxide equivalent (CO2e).[1] So in round terms, Scotland has to get that down by 51.5mt to 12.9mt. Most, but not all of this, is carbon dioxide (CO2), accounting for 50mt or 77.6 per cent of the total. The remainder mainly comprises methane (8.2mt, 12.7 per cent) and nitrous oxide (6.2mt, 9.6 per cent).

Scotland seems to be making good progress towards reducing these greenhouse gas emissions. By 2005, total greenhouse gas emissions were down to 54.6mt, a reduction of 15.4 per cent. It puts Scotland 54th in a world league table – between Hungary and Columbia - of greenhouse emissions by 206 countries.[2] Carbon dioxide emissions were reduced to 43.8mt (down by 12.4 per cent) methane emissions cut to 5.1mt (a cut of 37.8 per cent) and nitrous oxide emissions had fallen to 4.9mt (down by 21 per cent). Only another 42mt to go then.

How did this reduction come about? The carbon dioxide reduction mainly occurred because of changes in the economy – the disappearance of steel-making, for example – and, since these are net emissions, an increase in afforestation helped the consumption of carbon. Closure of deep mines reduced methane emissions and landfill rubbish tips also produced less methane. Changes in agriculture meant there was less nitrous oxide from fertilizers.[3]

Throughout this period, the Scottish economy grew by about 33 per cent. So one lesson is that it is clearly possible to have both economic growth and to cut greenhouse gas emissions. However, a second lesson is that some of the events which have led to these cuts were painful – the closure of deep mining and of the Ravenscraig steelworks, for example. Knowing this, we can also understand that the emission cuts were accidental or unintended consequences of economic change.

That means that emissions can also accidentally rise again. Indeed, there was a 5.4 per cent rise in emissions in 2006, mainly due to a switch to coal-fuelled electricity generation caused by a rise in gas prices.[4] This tells us that the price of the energy we consume matters a lot more than its emissions output.

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[1] Scottish Government. *Key Scottish Environment Statistics 2008.* Edinburgh. August 2008. Page 12. Available at: http://www.scotland.gov.uk/Publications/2008/08/19084547/44

[2] See http://en.wikipedia.org/wiki/List_of_countries_by_carbon_dioxide_emissions

[3] Scottish Government. *Second Annual Report on Scotland's Climate Change Programme (April 2007-March 2008)* Edinburgh May 2008. Page 3. Available at: http://www.scotland.gov.uk/Publications/2008/05/20102350/0

[4] . Scottish Government. *Scotland faces emissions challenge* Press Notice September 18, 2008

In an individual basis, the task looks even more onerous. In 2005, each Scot produced about 10.7 tonnes of CO2e. That ranks us about 50th in the world league table of greenhouse gas emissions per capita, alongside Japan (also an advanced industrial nation) and Myanmar (where there is large-scale destruction of forests). To meet the 2050 target, that will have to come down to about 2.6 tonnes of CO2e, of which about 2 tonnes will be carbon dioxide. That assumes a Scottish population of 5.1 million; if the population is bigger than that, the per capita consumption will have to be lower.

What answers do our contributors have to the question …

**How will change come about?**

There is general agreement that while governments can set targets for reducing greenhouse gas emissions and create mechanisms for achieving those targets, they will be ineffective unless their citizens accept the need to move in this direction and adapt their behaviour accordingly. Ian Marchant says that the world will change "because of changes in attitude and behaviour and the human capacity for ingenuity and survival." Martyn Evans adds that "consumers and citizens [are] the only effective solution to the challenges and not the problem". But …

**What will drive this change?**

***Fuel prices***. The writers are generally agreed that the rise in oil prices seen in 2008, peaking at $147 a barrel, with consequent price rises in gas and oil, are but harbingers of further price rises to come. Simon Pepper contends: "Energy prices provided the explosive charge behind a transforming surge in policy, rising to $200 per barrel (after some ups and downs) – often more than a $10 rise in a single day." Michael Northcott is more apocalyptic: "The price of oil rose from $300 to $900 a barrel between 2012 and 2025 and for most people driving and flying became too expensive."

I would caution against pinning too much belief in ever-escalating oil prices, at least in the short-term. When prices rise, demand falls, a phenomenon seen in the USA this year when demand for gasoline fell to 2002 consumption levels. That was outstripped by the rise in consumption in non-OECD countries, the biggest consumers being China and India where fuel prices are subsidized. Globally, subsidies amount to about $300 billion, the bulk of them being paid in China and India.[5] Such subsidies are unsustainable at high prices, meaning that consumers currently benefitting from them will surely feel our pain sooner or later and cut their consumption accordingly.

[5] United Nations Environment Programme. *Cutting Fossil Fuel Subsidies Can Cut Greenhouse Gas Emissions Says UN Environment Report* Press Release, 26 August 2008. Available at: http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=543&ArticleID=5902

Nevertheless, even on some conservative oil price forecasts of $50-80 a barrel[6], much higher oil prices than we have been used to are evidently here to stay, though whether they are quite the high-pressure driver suggested is debatable. Nevertheless, the other side of the price coin is …

***Cost savings***. The Youth Parliament point out that when there is much greater public realisation that money can be saved by being more efficient with energy, adoption of measures which cut emissions will become more widespread and second-nature. "Provision and fitting of insulation for elderly peoples' homes and mass production of reduced cost energy-saving light bulbs brought this way of life straight to the public …" and " …the push for all new homes to be built with energy efficiency in mind …" will, the Youth Parliament thinks, do much to educate the public towards a low-carbon economy. Besides these domestic pressures, there is the wider strategic question of …

***Security of supply***. Ian Marchant, accepting that fuel prices will rise, contends that there will be increasing dislike of reliance on distant sources of supply in faraway, unstable countries and that there may even be regional wars over scarce resources. This, he says, "brought home the reality that energy security delivered by more local, sustainable resources was an important part of national security." Some of this is already happening: rumours of any new tensions in the Middle East prompt spikes in oil prices and Russia seems to have begun using its large gas exports as a lever to attain political objectives, notably to mute western European responses to the conflict in Georgia. But as well as man-made difficulties, nature is also causing …

***Weather catastrophes***. The rain which has drenched and locally flooded much of Britian in 2008, hurricane Katrina which swamped New Orleans in 2007, the droughts afflicting Australia and much of Africa, are all pointers to climate change which has already begun with dreadful consequences. Most of the writers believe that much worse is to come.

Geoffrey Boulton believes that accelerated flow in glacier ice streams in the polar regions will cause sea levels to rise much fast than predicted, at about 2cm a year by 2012. "The imminent threat to vast areas of highly populated lowlands became very clear, with the potential demise of the Netherlands, Bangla Desh, Kuwait, and flooding of large areas of the US Gulf of Mexico, Florida and east coasts of Myanmar, Thailand and NE China, etc. Large parts of south-eastern England, and in Scotland, the Forth, Clyde, Moray and Solway lowlands were clearly at risk."

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[6] Thorsten Fischer. *Crude Oil: when will the bubble burst?* March 2008. Royal Bank of Scotland Group Economics. Available at: http://www.rbs.com/economic03.asp?id=ECONOMIC/WORLD_ECONOMY

Simon Pepper is no less pessimistic. Contending that an increase in average global temperatures of 2°C will occur by 2050, when many climate scientists believe that a tipping point of irreversible climate change will occur, he says: "Storm, flood and drought set off the deadly dominoes of hunger, migration and political unrest throughout the developing world. Europe and the US, and prosperous enclaves in other countries world-wide, began to bar the fortress gates, fearing the hordes."

Campbell Gemmell thinks this may occur earlier. "I think it was one of the sequence of devastating heat waves in the US North-east and across north-west and central Europe that finally did it, coming on top of the dramatic coastal damage in the 20s after the final decline of the Greenland Ice Sheet triggered the collapse of what was left of the West Antarctic Ice Sheet. That extra 3 metres sea-level rise did the trick."

It is always possible that these things won't happen. But the increasing flurries of straws in the wind, such as the north-west and north-east passages around the extremities of the Arctic Ocean becoming navigable in 2008, strongly suggest that they cannot be ruled out either. One missing element from these scenarios is that if they occur, even only to milder degrees, then additional costs will be imposed on the insurance industry, to the point that some companies may be bankrupted and lots of properties may become uninsurable, something which will surely impact on public thinking, as will …

***Population growth***. Even if individuals' demands for energy, transport, food and shelter were to remain constant at 2008 levels, world demand for all these things will continue to increase because of population growth. In 2008 the world population reached 6.7 billion, a two-and-a-half fold increase since 1950, and the proportion living in urban areas grew to 50 per cent.[7]

The writers' projections for the world population in 2050 range from 8 billion (Pepper) to 10 billion (Gemmell), a 20-50 per cent increase. Even though much of this increase will occur in countries which have low per capita greenhouse gas emissions, it still implies a worsening climate change problem. It also implies an extra demand on the earth's resources, whether these be oil, steel, or rice. Consequent price rises are liable to send a strong message to all people that the world is facing serious problems requiring urgent action. In Scotland, which has a relatively high per capita carbon output, government objectives of population growth, if achieved, mean that the 80 per cent reduction goal will become more difficult to achieve.

[7] Population Reference Bureau. Available at: http://www.prb.org/Publications/Datasheets/2008/2008wpds.aspx

**Brakes on change.**

All forces which demand change have opposing forces. So it is with climate change. What forces are there which resist change?

***Denial.*** A good many people do not accept that human activity is causing climate change. Pepper refers to an Ipsos Mori opinion poll, reported in the *Observer* newspaper in June 2008. It found that the British public have mixed and contrary views about climate change: 45 per cent believed it was the most serious threat facing the world today but only 9 per cent thought it would impact on them personally. The *Observer* reported that although 2,500 scientists for the UN Intergovernmental Panel on Climate Change (IPCC), found a 90 per cent chance that humans were the main cause of climate change, this poll found that 56% of Britons thought that the scientific jury was still out on the cause.[8] As Richard Wakeford observes: "It's been surprising how many natural disasters on the scale of the flooding of New Orleans have still left people in denial about the need for action."

It may be, however, that pollsters and social scientists have not yet found an accurate gauge of public opinion on climate change. A Globescan survey for the BBC World Service in September 2007 (perhaps when hurricane Katrina was fresher in the memory), found that across 21 countries, an average of 79 per cent of respondents (70 per cent in Britain) agreed that "human activity, including industry and transportation, is a significant cause of climate change". And perhaps the reason for apparently contradictory public attitudes lies in …

***The China evasion***: Pepper coins this term to characterize an attitude which recognizes that climate change is a big problem but whatever one person does in response is bound to be wiped out many times over by the huge and increasing greenhouse gas emissions of China. The point is made by Nick Hanley who says that even if Scotland achieves its 80 per cent target by 2050, this will make a "vanishingly small" contribution to reducing global emissions. "Currently, Scotland's emissions account for 0.15 per cent of global greenhouse gas emissions, and this fraction will fall as emissions from countries such as China and India rise," he notes. The Ipsos Mori survey found that 33 per cent of those polled thought they had no influence at all on work to combat climate change. This attitude helps to contribute to …

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[8] Juliette Jowitt. Poll*: Most Britons doubt cause of climate change*. The Observer, June 22, 2008. Available at: http://www.guardian.co.uk/environment/2008/jun/22/climatechange.carbonemissions and Phil Downing and Joe Ballantyne. *Tipping point or turning point: social marketing and climate change.* Ipsos Mori, June 2008. Available at: http://www.ipsos-mori.com/reportsandpublications/socialresearch.ashx

***Green conflicts***: Jan Bebbington says: "We had the technology to produce energy from wind but were witnessing high levels of resistance from many communities to have wind clusters or wind farms sited near to them." Developing renewable wind energy tends to put two green objectives in conflict with each other – the beauty of an unspoiled landscape versus wind turbines despoiling the landscape. The same conflict is apparent in opposition to the upgrading of the Beauly-Denny high voltage transmission line, necessary if Scotland is to harvest Highland wind. Whether this same conflict in the debate about nuclear energy develops in the same direction seems more debatable. Patrick Harvie thinks that just as 'peak oil' (when the production of oil goes into terminal decline) will be reached within the next decade, so too, if the world rushes into expanding nuclear energy production, will peak uranium occur in the 2020s. Yet some environmentalists have begun to see the fact that nuclear power produces very little greenhouse gas emissions as more important than the fact that it produces radioactive waste with long-term storage problems.[9] Only one writer breaks the consensus that Scotland will remain anti-nuclear. Evans suggests that the final push to meet the 2050 target will come in the 2040s when a decision will be made, using technology which has solved many current problems, "to deliver a new generation of nuclear power plants." Regardless of whether such attitude changes occur, there remains the problem of …

***The planning system***: The business contributors are unanimous in identifying barriers in planning – the system by which companies and householders get permission to build large and small renewable energy projects – as slowing down the shift towards renewables. David Watt talks of backlogs of queues of people trying to get permission for micro-renewable schemes as does Marchant. Iain McMillan says: "We will need to realize a streamlined planning system that delivers the necessary low carbon generation capacity in a timely manner." One report says that wind farm developers have to wait on average for 33 months for government decisions on big wind farms, and small developers have to wait 20 months on average for decisions from councils.[10] Hydro schemes face similar delays. If this gets resolved, there is still a question of …

***Price***: Although rising energy prices are a driver towards lowering greenhouse gas emissions, price differentials between different technologies involved in generating electricity work against renewable generation. One study, for example, by the Royal Academy of Engineering, estimates the costs of electricity generated by conventional means at 2.2-3.2 pence per kilowatt hour (p/kWh) against 3.7p/kWh for onshore wind and more than 6p/kWh for biomass, offshore wind, wave, and tidal power.[11]

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[9] See, for example, George Monbiot. The stakes could not be higher, everything hinges on stopping coal. The Guardian. August 5, 2008 Available at: http://www.guardian.co.uk/commentisfree/2008/aug/05/kingsnorthclimatecamp.climatechange

[10] Rob Edwards. Wind farms in Scotland face prolonged delays. Sunday Herald. 20 January 2008. Available at: http://www.robedwards.com/2008/01/wind-farms-in-s.html

[11] Royal Academy of Engineering. *The Costs of Generating Electricity*. London 2004. Available at: http://www.raeng.org.uk/policy/reports/electricityreports.htm

To make renewables economic, the British government introduced the renewable obligation scheme which exacts a levy on conventional generation to distribute as a subsidy to renewable suppliers. This levy, about £10 on the average domestic bill in 2008 is expected to rise to £20 by 2015.[12] So far this does not seem to have caused much public disquiet. But above that is the prospect of carbon pricing and taxation, which would impinge much more widely, covering, for example, transport and vehicle fuel prices. Nick Hanley argues that establishing a price on pollution is essential to enable market mechanisms for reducing greenhouse gas emissions to function. "However," he notes, "as evidenced by recent political responses to the fuel duty escalator in a world of rising oil prices, carbon taxes would be a very hard sell." A rudimentary carbon taxation scheme does exist – the European Union's Emissions Trading Scheme. However imperfect, it has established the principle that emitting greenhouse gases carries a cost.

Hanley adds an extremely important point: "Moreover, the Scottish government's ability to enforce its own carbon tax is very limited." This, I suspect will become an important political debate in the years ahead – which jurisdiction should have the legal competence to enforce rules on emissions and to impose penalties for breaching them: the EU, the UK, Scotland, or perhaps some as yet uninvented world or supranational body. And if Scotland, whether devolved or independent, chooses to set higher targets than those laid out in international agreements, can those targets be legally enforced?

Nevertheless, it still remains to be seen how much cost society is willing to bear, both in monetary and judicial terms.

**What may tip the balance towards action on climate change?**

The writers seem generally confident that a combination of human actions (mainly rising energy prices) and natural action (climatic cataclysms) will do the trick. The price imperative, reckons Sue Roaf, will turn energy inefficient buildings into "an investment nightmare in the tumultuous markets created by soaring energy prices."

Marchant expects that the climate imperative will make green conflicts over the visual impact of wind turbines disappear: "The professionalised environmentalists played an increasingly leading role as they realised that climate change threatened everything – and the arguments of some of their own, to oppose all wind farms as 'blots on the landscape' for example, became untenable."

[12] Ofgem. *Household Energy Bills Explained.* Factsheet 66. Available at: http://www.ofgem.gov.uk/Pages/MoreInformation.aspx?docid=73&refer=Media/FactSheets

Political leadership is also important, he thinks: "Positive action came when leading politicians put forward a compelling message that economic prosperity depended on environmental stewardship." And he considers, perhaps more in hope than expectation that rational fact-based debate will triumph over opinion and "ill-informed shouting matches."

**What tools are needed to build an emission-lite Scotland?**

Top of the list, and referred to by several writers but most explicitly by Hanley, is …

***Carbon pricing*.** The production of carbon dioxide is what economists call an 'externality'. Externalities can be positive, but in the case of greenhouse gases, they are negative or are an 'external cost'. This means that it is something which results from a purchase or a process undertaken by one group of people and which has an effect on other people whose choices or interests were not taken into account. Thus the external cost of buying a tankful of petrol and using it is pollution which causes fumes in the locality of the petrol-user and adds to global pollution levels. A conceptually simple way of dealing with this is to make the petrol-user pay the cost by putting a price on the pollution and incorporating that into the price of petrol. This should deter people from using petrol and, in theory at least, the money raised from those who continue using petrol can be spent to reduce the effects on other people.

The production of carbon is now recognized as having a major external cost and one of the principal conclusions of the Treasury's review of the economics of climate change under Sir Nicholas Stern was that "establishing a carbon price, through tax, trading or regulation, is an essential foundation for climate change policy".[13] In ideal world, as Hanley says, there would be a global price on carbon. That seems a long way off, but in the meantime there is the EU Emissions Trading Scheme which does put a price on carbon, and within which any Scottish climate change strategy has to fit. It is much criticized for prices which are too low. Some countries – Denmark, Norway, the Netherlands, Finland, Sweden – have, since the 1990s, introduced national carbon taxes, but the effects have been mixed.[14]

Hanley contends that the Scottish government could use its limited powers and leverage to argue that the EU scheme should be extended to cover emitting sectors not presently covered, to allow land managers to act as suppliers of carbon credits (controversial with environmentalists), and for a reduction in the supply of permits.

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[13] HM Treasury. *The Stern Review: The Economics of Climate Change Policy*. London 2006. Page xviii. Available at: http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm

[14] A useful summary of the taxes and their effects has been prepared by the US Environmental Protection Agency and is available at: http://yosemite.epa.gov/EE/Epalib/incent.nsf/c484aff385a753cd85256c2c0057ce35/0483a144da8fa434852564f7004f3e68

He also reckons that prices need to be set for other negative externalities such as methane and nitrous oxides, congestion, and the effect of wind farms and transmission lines on landscape and wildlife.

But, instead of just taxing externalities, should we be prepared to think rather more radically? There may be a case for an …

***Ecological tax base***. Bebbington raises this idea tantalisingly briefly, suggesting that we might move towards this in 2017. Our current taxation system is geared towards the taxation of wealth and the rewards – income, profits – of creating it. An ecological tax system would abandon such taxes, and shift towards taxing activities which detract from the ecology of the planet, such as the extraction of hydrocarbons and the burning of them. Activities which are ecologically neutral, such as the planting, harvesting and burning of biocrops would attract no tax. Activities which are ecologically positive, such as the planting or enhancement of native vegetation, might enjoy a subsidy. Such a tax system would ramp up the costs of ecologically harmful activities, especially those emitting greenhouse gases, quite sharply and focus attention and resources on eliminating such activities. That appears to be the outcome expected by Bebbington.

A variation, which is my own suggestion, and which is equally radical would be to abolish all existing consumption taxes – VAT, fuel duties, air passenger duty – and replace them with a greenhouse gas tax, or GGT. The rationale behind this goes back to the over-riding priority identified by the contributors – to change attitudes and behaviours. The best way of doing that is to exact a tax at the point of consumption which would be levied according to the amount of greenhouse gas emissions caused by the creation of the product or service. Hydrocarbon fuels would attract a high level of tax, renewable electricity for the powering of electric vehicles a low level. Mangos air-freighted from Africa would be highly taxed, strawberries from Tayside lowly taxed; concrete buildings would carry a high tax tariff, wooden buildings a low tariff, and so on. Exceptions might have to be made on health grounds for special duties on tobacco and alcohol (both relatively carbon neutral products) but otherwise, and provided the levels of GGT were transparently identified (much as VAT is now) such a tax could have radical effects. Admittedly, identifying the carbon content of each item might be excessively bureaucratic and prone to fraud but in my view, no suggestion should be summarily rejected at this stage.

This last point raises the question of the degree of required …

***Regulation***. Hanley counsels against over regulation, arguing that if government sets too many sub-targets within the overall 80 per cent reduction target, flexibility will be lost. For example, he criticizes the Scottish government for setting the sub-target of generating 50 per cent of Scotland's electricity requirements from renewables. The evidence is, he says, that this is an expensive way of reducing carbon emissions.

He argues: “Much better for the Scottish government to set the overall target, establish a menu of economic incentives which encourages this to be achieved, and then let firms and households decide on their own best response.”

The other contributors generally agree. Skea envisages that a future government might impose obligations on energy suppliers that entailed them having compulsory access powers to install insulation, solar thermal heating and triple-glazing. Civil disobedience and communities barricading themselves against police and utility workers could well be the outcome, he imagines.

One interesting exception to the light regulation rule is proposed by McMillan. He suggests that a relatively fast way to reduce greenhouse gas emissions is to make a distinction between the upstream (generation) and downstream (consumption) parts of electricity production and use. The responsibility for emissions could be limited to generation and industrial sites, while households would only be able to use electricity and not oil, gas, or coal. Household action on climate change would then be limited to energy efficiency, he suggests.

This idea focuses attention on an area where there are sharp divisions between the contributors. This is whether the best way to reduce emissions is by ..

***Government action or market mechanisms***. A distinctly sceptical tone when assessing governments’ willingness to take the hard decisions needed to mitigate climate change pervades many contributions. Harvie, perhaps unsurprisingly, is scathing about ministers proclaiming their climate change credentials while approving greenhouse gas-multiplying motorway and airport runway projects. Less predictably, Marchant is dismissive of political leaders announcing grand targets which are way beyond their time of office. One exception is Skea’s imagining of a key turning point – a European Commission decision about 2020 to take court action against all member states failure to meeting undertakings on the deployment of renewable energy.

Perhaps such action is easier when the decision-makers are appointed, not elected, a point made, rather worryingly, by Pepper: “The democratic excess of denial and delay was inviting catastrophe. China’s command regime – ever the contrast – moved swiftly ahead with dramatic energy efficiency targets …” Gemmell, thankfully, sees a quite different scenario: “The democratisation of the biggest country on earth … brought the largest, smartest and most active population to bear on the scale of innovation that Seattle and southern California had shown at the end of the 20$^{th}$ century, but 50 to 100-fold …”

Equally extreme views are expressed about market mechanisms. Watt, for example, expects many to be surprised that “the private sector led the charge to cut greenhouse gases and did not have to be penalised through taxation or legislated into action. The dual factors of market forces and business opportunities were the biggest drivers …”

Against that, several, citing the Stern review, insist that climate change is the greatest market failure the world has seen. Evans posits further failures, imagining that a 'CarbCard' scheme to permit carbon trading by individuals may balloon then burst: "The 'CarbCard Bubble' as it came to be known, collapsed in acrimony within five years of its launch in 2025, accusations of fraud, scamming, manipulation, freeloading, speculation, and elitism all taking their toll."

And yet the broad picture which emerges from the contributions is that governments, people, companies, social groups all have a job to do in much the same way as they do now. Watt, despite his espousal of the free market, expresses it well: "We have achieved our targets … due to government taking key structural and organizational culture moves; business being creative, inventive and innovative; and finally individuals reacting positively …" Watt also believes that we need a …

***Streamlined planning system***. He reckons this will come in the next decade when there will be "a national planning agency to replace what had previously been known as the planning service" and the government will give it a "clear focus on bringing Scotland up to world class in terms of getting projects approved and completed quickly and efficiently". Marchant also sees a planning system which "helped rather than hindered"
But some writers also think we need a …

***Participative public and political decision-making system***. Bebbington introduces the idea of advances in 'social technologies' encompassing the rules used to make decisions, models of thinking in government, approaches towards taxation, and how individuals and groups interact with each other. Wider groups of people, she suggests, will become involved in longer and more extensive discussions. One such method could be the creation of a virtual parliament accessible to all which, she believes will lead to political leaders becoming "respected and trusted" and "our democracy [becoming] more democratic". She contends this will be important in facilitating individual and, more importantly, collective behaviour change, especially in a huge array of social experiments aimed at achieving low-carbon living.

Evans also sees potential for the same sort of development, but coming through the internet and vast increases in computing power. The internet, he suggests, will result in a shift in popular culture from consuming to participation which will democratize innovative science. Collaboration amongst large groups of people – inventors, university academics, bankers – may, he thinks produce dramatic innovations such as light-weight and high-power batteries.

Politicians, however, may need pressure applied on them through …

***Legislative Obligations***. Wakeford points out that politicians can pass laws to, say, require double-glazing, but the policy can have little effect if people leave the windows open.

Marchant suggests that it may be time to close the politicians' windows: "Legislation which made politicians more accountable before each election for their actions in climate change and energy also concentrated the political mind wonderfully."

If all, or even just some of the above, happens …

**What will Scotland look like?**

The short, and not very helpful, answer is that in some ways, Scotland may be very different and in other ways it may change very little. In approaching this part of this essay, I decided to present it according to a rule of thumb I adopted after reading a number of reports on climate change including the Stern review. This is that the most rapid progress towards reducing greenhouse gas emissions will occur where the necessary measures are cheapest and produce most economic benefit. One report I found very helpful was prepared by McKinsey & Co, a consulting firm, on greenhouse gas emissions in America.[15] While the Scottish economy is different, it is also an advanced economy which means the McKinsey conclusions are still relevant.
The report researched the economics of greenhouse gas emissions across the whole range of economic activities and found that costs and benefits cutting emissions varied enormously. It concluded that there were five clusters of activities with potential for greenhouse gas abatement. Ranked in order from lowest to highest average cost of abatement, the five clusters were:

1. Improving the energy efficiency of buildings and appliances.
2. Encouraging higher energy efficiency in vehicles while reducing the carbon intensity of transportation fuels.
3. Pursuing a range of targeted measures across energy-intensive portions of the industrial sector.
4. Expanding and enhancing carbon sinks.
5. Reducing the carbon intensity of electric power production.

The finding is a bit of a surprise, for the current environmental debate in Scotland is dominated by discussion of how to increase the output of electricity from renewable sources such as wind and hydro power. Yet, according to the McKinsey findings, this is the most expensive course of action. Given that energy prices have risen sharply in 2007-08, and that renewable energy is expensive to produce (indeed, it requires a subsidy) relative to conventional generation, it seems reasonable to think that the attention of individuals, companies, and other organizations is now much more sharply focused on reducing energy use. This fits with the McKinsey cost rankings given above. So, let's begin with …

[15] McKinsey & Co. *Reducing Greenhouse Gas Emissions: How Much at What Cost?* December 2007 Available at: http://www.mckinsey.com/clientservice/ccsi/greenhousegas.asp

***Buildings and appliances*.** The most extraordinary insight into buildings and their energy efficiency is offered by Roaf who says that much commercial property has been built with features more intended for the profit of third parties than the convenience of owners and users. "For instance," she says, "the lighting profession had developed standards that required excessive lighting." But, she argues, by making use of solar power and other technologies, it is possible to construct buildings that run on tiny amounts of energy with 90 per cent less emissions than at present. High energy prices and climatic stress should push construction decisively in this direction by the 2020s. "Even in rainy Scotland, the myth was proved very wrong that there is not enough sun in northerly latitudes to make solar energy worth the investment," she says.

On domestic residential buildings, there is a striking unanimity of opinion on the way to move towards low-carbon energy efficiency. Marchant argues that energy firms will no longer just produce energy, but will have to become energy service companies – selling the means to use energy well in addition to producing it. Smart meters (which tell a consumer the cost of energy used, potentially for individual rooms and devices) may become mandatory and household microgeneration will proliferate. Skea, along with others, foresees energy companies working in partnership with local authorities and other organizations to equip houses with energy-saving materials and help people save money. He offers the intriguing thought: "Eventually, profligate energy use was stigmatized in the way that tobacco use and drink driving had been in the past."

Skea also believes that electrical appliances will also become much more efficient, that their stand-by mode when they consumer power while "off" will disappear, and that advances in digital and communication technology will dramatically reduce the amounts of power used in communication.

All this sounds exciting. But as Hanley warns, greater energy efficiency does not necessarily lead to less energy use because of what is called the "rebound" effect.[16] In simple terms, where an individual, business, or company uses low amounts of energy because it is too costly, greater energy efficiency may reduce their energy bills and so enable them to use more energy. Moving on to …

***Transport***. Most of the contributors agree that the age of the fossil-fuelled vehicle is now coming to an end. There will be a conversion to fuel-efficient vehicles perhaps accompanied by a rise in the use of bio-fuels (debateable given that recent increased bio-fuel cropping appears to have contributed to food shortages) ending in a shift to electric vehicles (depending on advances in battery technology). Marchant offers the enticing prospect of petrol-head adoration of BBC TV's *Top Gear* being replaced by electro-brain adulation of *Top Volt*. But there is a division of opinion regarding the end result. Some think car use will be limited to sharing via car clubs (Bebbington, Pepper), others that electric car ownership will still be widespread (Skea, Evans).

[16] For a useful account, see http://www.carboncommentary.com/2007/11/11/51

One consequence of this, points out Hanley however, will be a rise in the consumption of electricity though whether this outweighs reductions through efficiency gains elsewhere cannot be determined. Public transport and high-speed trains will become much more important, but again there is a division over whether air travel will survive. Northcott suggests the exciting concept of solar-powered airships using "spray-on solar cells that were used to coat the helium-filled airships."

But the most dramatic vision is set out by George Hazel. We will be able to route plan journeys according to their monetary and carbon costs, he believes, using a personal mobility planner. It, when we input our start and end points, will tell us all the possible permutations of how to make that journey. Mobility, far from being restricted by fuel and carbon costs, will be enhanced and people will be able to make their own decisions on how to minimise the carbon output of travel rather than having such decisions taken for them. There also appears to be an equally optimistic view of the prospects for …

***Industry.*** While there is a sense in some contributions that industry will need pushing by government action and subsidies towards reducing their energy demands and carbon output, it is striking that the business contributors speak of a strong will to head in these directions anyway. Watt says that rising costs will force companies to cut their energy and carbon tax bills, but McMillan says it will go beyond mere cost-cutting to new business models: "Efficient and effective carbon management within the business and also down supply chains will reduce costs and wasted energy and so become the new token of a successful business." New low-carbon technologies, particularly when there is a global price for carbon, will lead, for example, to low-carbon steel production. New markets for such technologies will open up and could be worth $1 trillion within five years of a global deal limiting greenhouse gas emissions. McMillan points towards industrial systems where energy through the industrial process is recycled so none is wasted and the development of a 'green collar' skills sector driven by rising demand for specialist environmental skills.

Watt, in common with some environmentalist contributors, sees a shift to different working patterns towards home and remote working by company employees: "Big offices began to shrink and local became good." Skea lauds the luxury of being able to work at home or at the community tele-hub. Watt agrees with McMillan that there will be new business opportunities and contends that Scotland could "lead in Europe, if not the world, in developing the ideas and technology to make carbon efficient energy production turn from dream into reality".

Hanley says that government can assist with this, not by trying to pick technology winners, but by incentivising research and development and the uptake of new technologies. The general point is that provided government gets the tax framework right, there are big opportunities for business and economic growth while reducing business carbon footprints. Big though these opportunities are, even bigger ones may await the …

***The countryside and carbon sinks***. No-one has any doubt that the countryside and agricultural production will change dramatically, but there the unanimity ends. A dilemma, Wakeford delicately suggests, is faced by livestock farming because of rising costs of grain feed and methane emissions from animals. Northcott contends livestock numbers will be substantially reduced (helping to cut emissions) but dairying, because of the discovery of feeds that reduce methane emission and transport costs rendering milk imports uneconomic, will become highly profitable. Sporting estates will have to get rid of deer, he suggests, because the weight of deer turns soils from carbon sinks into carbon emitters. Estates, he reckons, will benefit from carbon credits by replanting indigenous forests, a vision shared by Watt and Evans. Wakeford cautions that the EU Common Agricultural Policy, which Evans thinks will be abolished, perversely discourages upland tree planting. Pepper also believes that any tree planting resulting from carbon off-setting (planting a tree to compensate for carbon produced, say, by a plane journey) will be short-lived as legislators realise that such trades create a moral hazard (people come to believe there is no environmental harm caused by air travel so long as lots of trees are planted). Skea thinks new crops (Evans suggests Tayside vineyards) will become viable. Northcott sees transnational imports of food disappearing as African and Asian countries turn away from imports to self-sufficiency, a trend that will manifest itself in Scotland by cities and towns becoming surrounded by wide greenbelts of allotments "where urban dwellers grow much of their own food, keep chickens and pigs in free-range common areas, and camp out on long summer evenings." Gemmell bets that the proportion of the workforce involved in food production will rise from 1.5 per cent to nearly 40 per cent. Farmers, he thinks, will become carbon stewards. Most writers think that these changes, plus a drive for community-based renewable energy sources, will make for growth in rural businesses and communities which, reckons Evans, will also benefit from new leisure pursuits such as electro-cycling and from expanded timber production. The new opportunities, avers Pepper, will make rural Scotland more densely populated than at any time in the last 5000 years. But, whether living in town or on a farm, people will still need …

**Energy.** No-one has any doubt that electricity generation from renewable sources will expand, but there is uncertainty about what form it will take. There does not appear to be, as Gemmell remarks, a magic bullet solution. This is entirely understandable, as in 2008, the only commercially proven technologies are onshore wind (albeit with subsidy) and hydro, for which there is only scope for minor expansion. Offshore wind, wave, tidal, and the non-renewable but low-emission carbon capture and storage technologies in 2008 are all still at development stage and some way short of being proven to be viable. Bebbington fears we may back some 'loser' technologies – the unintended adverse consequences of biofuels being an early example. Skea sees carbon capture and storage eventually gaining market credibility until 2030 but never meeting "purist" demands for zero-carbon output. Pepper thinks it will be the mid-2020s before renewables make a serious impact.

Boulton fears that the engineering problems of carbon capture may prove too intractable and that the strategy of relying on this and other renewables is high risk. Yet the task is urgent. McMillan emphasises that over the next 20 years most of Britain's energy system needs to be replaced at an estimated cost of £100 billion.

So it is, but the rewards are potentially high as well. Watt sees big opportunities for large and small companies to make and install domestic wind turbines, heat pumps etc., and that Scottish innovation, manufacturing and innovation could make Scotland a world leader in making "carbon efficient energy production turn from dream to reality". Fuel cell development should, he thinks, enable the storage of intermittent power from renewables, making them a more reliable part of the energy mix. Allowing the household and community micro-generation that many contributors see as important to flourish will require, notes Wakeford and Marchant, a new local energy grid. Meantime, the National Grid, contends Boulton, will become part of a European energy grid to maximize supplies of energy from low-carbon sources and, says Northcott, to allow Europe to tap into power supplies from Concentrated Solar Power arrays in northern Africa.

I have not attempted to list all the technologies that the contributors think will or may be available between now and 2050. Nor have I delved into the possible new political parties and religions that might be the side-effects of Climate change. And I have resisted cataloguing all the fascinating business opportunities that the writers have cooked up. They are, of course all here, so do go and enjoy them before I return with some concluding thoughts.

**Concluding Thoughts.**

A myriad of ideas, a few really big ones amongst plethora of smaller but equally important ones, have emerged from the splendidly fertile imaginations of the contributors. As Jeremy Peat says, this volume is a treasure trove. There are also some profoundly big themes which emerge about the nature of society in 2050 Scotland. I want to conclude by picking out three, the last one of which is somewhat sobering.

**A carbon economising Scotland.**

If Scotland is to get really serious about combating climate change, it is clear that carbon dioxide does not just have to be taken out of the atmosphere; it has to become a central part of our economy and everyday life. McMillan expresses this in most detail, suggesting that by 2050, everyone will have a personal annual carbon allowance of 2 tonnes of CO2. This entails entirely new education programmes aimed at ensuring every school-leaver is carbon literate, for just as we now compare prices of goods in shops and things like mobile phone tariffs, so we will have to be able to compare the embedded carbon contents of goods.

As we now look at foodstuffs to check their E-numbers and their calorie count, so we may also be checking carbon content. Indeed, by then, consumers will be demanding low-carbon energy-efficient products routinely. It also means that new professional skills such as carbon accountancy and de-carbonising designers/engineers will be in big demand by companies whose success will be measured by how low they can get their greenhouse emissions. McMillan also thinks that these carbon allowances will be tradeable, so people whose lifestyles produce more carbon output will be able to buy unused allowance portions from people whose activities produce very little. This particular aspect may trouble environmentalists, but it will be a feature of a carbon-orientated economy because of the second big theme …

**Empowered Scots**.

A strong element appearing in most of the papers is that individuals will have much more power over the choices they make in their lives than is the case now. This is already happening through the spread of mobile phones and the internet. And as computing power increases (doubling every two years, according to Moore's Law, with no sign of a limit being reached) so the power of the individual as a consumer making decisions over what to buy and use will also increase. The most graphic example given here is Hazel's vision of how we will be arranging transport. But advanced computing power will transform virtually everything. In only a few years, it has become possible to do all your shopping sitting at home. Now imagine doing, say, the weekly food shopping not just at one online store, but several, comparing all the prices and their embedded carbon content, checking whether items are in stock, and placing orders for, say, half a dozen stores to deliver a total of 50 items to you. All these processes could be carried out in seconds and probably from a device which is mobile phone, film and TV player, radio, music player, etc., which can fit in your hand and be used at the top of mountain if you so wish. It will also give citizens enormous power in the political process. Imagine knowing that an important decision is to be taken by politicians and being able to use your hand-held device to tell them you want them to vote for or against the item. The possibilities are limitless - people will become seriously empowered consumers and citizens. The trick will be making them want to use that power to arrest climate change, because by 2050, we may be living in a …

**A hotter Scotland and nastier world**

The impression may have been given in mine and some other contributions that in 2050 we may all be running around doing things differently, but Scotland itself will be much the same, perhaps a bit milder in winter and wetter in summer. That looks unlikely. As the Stern Review said bluntly: "The scientific evidence is now overwhelming: climate change presents very serious global risks, and it demands an urgent global response." Some of the prospects presented here are truly frightening.

Boulton's belief is that rising sea levels, caused by melting polar ice, will have flooded lots of low-lying Scotland, including, thinks Bebbington, the home links of golf at St Andrews. Gemmell considers that people, especially the old and very young, may be living in community domes for protection from floods and heatwaves.

Beyond Scotland, but affecting us nonetheless, desertification of large areas of the world, even in Europe, will see millions of climate change refugees on the march. Many nof these displaced people, perhaps 500,000 will end up in Scotland. In such a changed world Hanley and others make the strong point that adapting to this change – re-thinking flood management and housing strategies, for example - may well become just as important a strategy as trying to prevent further change.

The prospect of climate change rolling on may also raise a cry of "why bother?" giving succour to the climate change deniers, many of whom may regard any such change as part of a natural cycle rather than anything to do with human activities. Those of us who think we should bother need to have our answers ready.

To my mind, one is that there may well be a natural course of events occurring, but the physics of how adding carbon dioxide, methane, etc to the atmosphere raises temperature is well known and not disputed. So why on earth should we carry on making a bad thing worse?

A second is that although what we do now and in the next couple of decades may not do much to alter trends in the next 50 years, such efforts can have an effect in the next 50 to 100 years and beyond.

A third is that we all want our children, and our children's children to live in a better world and 50 to 100 years time is when many of them will be in the prime of their lives. We have been profligate with the earth's resources, but there is no need for us to make our children's lives worse by carrying on wasting the earth's riches and contributing to turning it into an unpleasant and largely uninhabitable oven. Our children may have much better things to do with what's left of our planet's resources. We need to clear up our mess for their sake.

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