



Carbon Commentary Newsletter #6

A critical appraisal of issues in the move to a low-carbon economy

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This fortnight's Carbon Commentary has articles on the surprising changes in the IPCC's views since the last synthesis report in 2001, the content of Gordon Brown's first speech on climate change, community-owned wind farms, the new Amazon e-reader, Heathrow expansion plans, and the financial impact of higher standards for the construction of new homes.

As ever, comments are very welcome.

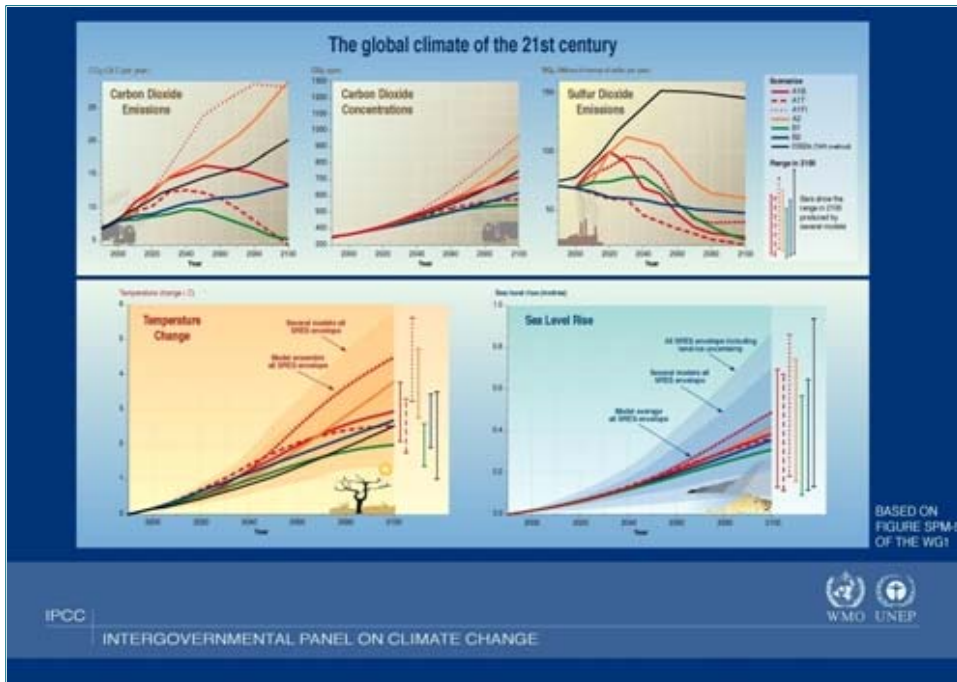
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Chris Goodall's book [How to Live a Low-Carbon Life](#) won the September 2007 Clarion prize for non-fiction.

The 2007 IPCC synthesis report



The IPCC released a 23-page report summarising the work of the fourth phase. Newspaper headlines suggested the document was more apocalyptic than the third summary of 2001. The reality is more complex.



Click on the image to enlarge.

Since 2001 huge numbers of scientific papers have been published on climate change. Major research efforts have been devoted to understanding the process by which increasing greenhouse gas (GHG) volumes will affect the world climate. But a careful comparison of the 2001 and 2007 synthesis reports does not immediately show substantial increases in the degree to which climate scientists feel confident about their predictions and their understanding of climate systems. For example, the width of the range of predictions of temperature rise has increased. Scientists acknowledge greater uncertainty about the impact of the sliding ice on sea level rise than they did in 2001.

The increased uncertainty does not extend to all aspects of the report. The 2007 authors say that they are more confident about climate changes at the regional level. In other words, they feel that they understand better how temperature and rainfall changes are going to affect various different parts of the world. Nevertheless, the degree of confidence in the main predictions appears to be no greater than six years ago.

What is going on? There are several possible hypotheses. First, as the IPCC process has become better known, it may be individual scientists have argued for greater caution in forecasts. Perhaps the process has become more political, with scientists from countries lagging in the response to climate change more likely to restrain the language of their colleagues. The IPCC report writing process is collegial, and individual scientists can alter the tone of what is written.

The last few days have not seen any evidence of merit to this first hypothesis. A small number of scientists have voiced concern that the report is not hard-hitting enough. But I believe that the same phenomenon occurred in 2001. I see no evidence of any systematic change.

A second hypothesis is that the participating scientists are now even more clearly aware of the complexities of climate than they were in 2001. Refinements to climate models may be showing greater unpredictability. This hypothesis is consistent with the language of the 2007 document, particularly on temperature rise and sea level increases.

What are the main changes between 2001 and 2007?

Temperature change up to now

In 2001, the IPCC reported its estimate that global temperature had increased by 0.6 degrees in the period 1901 to 2000. The updated figure for the hundred years to 2005 is 0.74 degrees, a substantially larger number. Both reports say that the increases have been highest in the high northern latitudes and greater over land than ocean.

Temperature changes in the future

The third assessment report (TAR) suggested that the range of temperature increase to 2100 is between 1.4 and 5.8 degrees. The second report from a few years earlier had said 1.0 to 3.5. The rise between the two older reports was due to an IPCC expectation that sulphur dioxide emissions would be lower in the future than it had previously expected. (All other things being equal SO₂ emissions tend to decrease temperatures.)

By the time of the 2007 report, the IPCC had widened the range of the forecast for the end of the century to 1.1 to 6.4 degrees, suggesting a fall in scientists' confidence in their ability to predict the future. The 2007 document says

that the 'uncertainties and upper ranges for temperature' arise because the IPCC models suggest 'stronger climate-carbon cycle feedbacks'.

This comment from the IPCC is the most important remark in its 2007 work. The organisation is saying that the changes induced by global warming, in terms of temperature, rainfall, and wind, are tending to interact with sources and sinks of atmospheric CO₂. For example, lower rainfall in the Amazon basin might be reducing the CO₂ takeup of the forest. Or increasing ocean water temperatures may be reducing the ability of the seas to absorb CO₂.

The 2001 report makes no mention of any link between carbon cycle changes and global temperatures. The 2007 document reflects the growing unease that land and ocean CO₂ sinks are already beginning to lose their effectiveness. To repeat, this is the most important implication of the 2007 document.

The 2007 report should have also perhaps have noted another reason for concern. The IPCC temperature estimates are based on six scenarios for the future growth of emissions. The scenarios with the highest emissions growth are, of course, those with the highest expected temperature rise. Since 2001, the rate of emissions growth has been much faster than the policy-makers and scientists expected under any of the six scenarios. If this continues, the most likely expected atmospheric concentration of CO₂ will be at the top end of the range, implying that the temperature rise will be nearer 6.4 degrees than 1.1 degrees.

To summarise, the IPCC's range of possible temperature increase has widened and shifted slightly upwards. Within this range, the rapid growth of world emissions will mean that the likely eventual outcome is towards the higher end of the range of possible temperature rises.

For the next two decades, the mid-point estimate of temperature rise is approximately the same in both reports. Temperatures are forecast to rise by about 0.2 degrees per decade.

Sea level rises

In 2001, global mean sea level was projected to rise between 9cm and 88cm between the years 1990 and 2100. The melting of the Greenland ice cap was forecast to contribute 'a few cm' to sea level during the 21st century.

In 2007, the scientists appear to have reduced the range of possible sea level rises, and its midpoint. The IPCC quotes a spread of 18cm to 59cm. It therefore looks as though scientists are more confident that they can forecast the rate of thermal expansion (the dominant cause of sea level rise thus far) and speed of Greenland and other ice melt.

This would not be an entirely correct impression. The IPCC report explicitly excludes the impact of sea levels on changes in the rate of flow of ice into the sea. (A discussion of this phenomenon as it applies to [Greenland ice is contained in Carbon Commentary issue 1.](#))

The IPCC says the following in 2007:

There is better understanding than in the TAR that the risk of additional contributions to sea level rise from both the Greenland and possibly Antarctic ice sheets may be larger than projected by ice sheet models and could occur on century time scales.

The IPCC goes on to say that it does not therefore provide a 'best estimate' or 'upper bound' to sea level rise because of the lack of knowledge of what determines the rate of Greenland ice flow. As with future temperature rises, the UN body has indicated that as it improves modelling in one area, other uncertainties develop.

Precipitation

By contrast, the IPCC now appears more confident about rainfall level changes. In 2001, it said that 'Globally averaged annual precipitation is projected to increase during the 21st century' and indicated also that this increase will be accompanied by larger year-to-year variations.

Australia, Central America, and southern Africa were expected to show consistent decreases in winter rainfall.

By 2007, the IPCC is saying that it has more confidence in projections than in the TAR. In its precise language, it now says that it is very likely that precipitation will increase in high latitudes, whereas in 2001 this was just 'likely'. There is also a very likely increase in heavy precipitation events. This is one of the few instances where the IPCC has felt able to express substantially more confidence in its forecast than in 2001.

Ocean Acidification

In 2001, the synthesis report did not mention this effect of global warming. It is now perceived as a serious problem. Higher acidity will destroy corals, with the consequent effect on local ecosystems. A large percentage of the world's population has a diet that includes fish species that live and feed in the protected waters of coral reefs. Higher acidity will also inhibit the formation of calcium carbonate shells on marine creatures. These shells sequester carbon by falling to the bottom of the ocean when the organism dies. So higher acidity means that oceans will become less

effective carbon sinks.

Species extinction

The latest report expresses 'medium confidence that approximately 20-30% of species assessed so far are likely to be at risk of extinction' with more than 1.5 to 2.5 degrees of warming. With more than 3.5 degrees of temperature change, the IPCC's model projections indicate a possible figure of 40-70%. The 2001 report mentions species extinction, but does not provide percentage estimates for varying temperature rises.

Summary conclusions

In the wake of the 2007 report, many commentators have fastened on the use of the words 'abrupt' and 'irreversible' to refer to possible catastrophic impacts of global warming

It may be interesting to note how the 2007 report varies from its predecessor in its use of language. Here is what was said in 2001:

Greenhouse gas forcing in the 21st century could set in motion large-scale, high impact, non-linear and potentially *abrupt* changes in physical and biological systems over the coming decades and millennia, with a wide range of associated likelihoods.

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Some of the projected [...] changes [...] could be *irreversible*, but there is an incomplete understanding of some of the underlying processes.

(The use of italics is mine.) The 2007 document says:

Anthropogenic warming could lead to some impacts that are *abrupt* or *irreversible*, depending upon the rate and magnitude of the climate change.

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Climate change is likely to lead to some *irreversible* impacts.

The 2007 report is slightly less tentative, particularly with regard to irreversibility, but the attention paid to the two words by the press and television may simply reflect the greater simplicity of the language in 2007 rather than any underlying change in the scientific assessment.

Six years of further study of climate change appears to have increased our knowledge of the 'known knowns' but decreased our comprehension of the 'known unknowns' and made us far more aware of the possibility of significant 'unknown unknowns'.

Heathrow expansion



The government announced that it was minded to allow Heathrow to expand. A new runway and sixth terminal will increase capacity from 480,000 to 702,000 flights. The government's consultation documents – totalling hundreds of pages – did not provide an estimate of the impact on CO2 emissions. In this article, we offer a tentative figure of about 16m tonnes as the potential maximum impact of the proposed expansion. After multiplying by 2.7 to account

for the other pollutants created by aviation, the increase takes the total UK emissions from aviation up to 144m tonnes of CO2 equivalent.

[Another piece in this newsletter discusses Gordon Brown's statement in the same week that total UK emissions from all sources may need to fall to no more 155m tonnes by 2050.](#)

The disjunction between government policies on aviation and climate change is startling.

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The aviation industry is making improvements in the fuel consumption of its aircraft. Air traffic control changes are also slightly reducing unnecessary mileage. These two improvements are not happening fast enough to hold down CO2 output. BAA, the operator of the largest UK airports, admits that 'aviation is growing at a faster rate than technology can reduce emissions'.

Between 1990 and 2005, CO2 output from EU aviation approximately doubled. There is no sign that the rate of increase is declining. The latest figures from the European Environment Agency showed greenhouse gas emissions from air travel up 7.2% in 2005.

Heathrow is the busiest airport in Europe. It uses about 20 million litres of fuel a day. For comparison, motor fuel consumption (petrol + diesel) for the whole of the UK is about 125 million litres a day.

The government now plans to allow a new runway at the airport. This 2,200m strip will run east-west, just south of the M4 motorway. It will be accompanied by a sixth terminal building. These changes are intended to allow the number of aircraft movements to rise from 480,000 to just over 700,000 flights a year. The size of the typical aircraft is also expected to rise so the number of passengers passing through the airport is forecast to go up from 67 million to 128 million.

Number of aircraft movements	Up 46%
Number of passengers handled	Up 91%

Transport Secretary Ruth Kelly said that the new runway is desirable. She said that 'if nothing changes, Heathrow's status as a world-class airport will be gradually eroded – jobs will be lost and the economy will suffer.'

The thrust of the government's opinion is that London's status as an international business centre will be reduced if its airports fall behind others in Europe. Heathrow is crowded and operates almost at maximum capacity.

The airport owner, Ferrovial, has a slightly different slant on the reasons for expansion. According to a Reuters news report, Ferrovial believes new infrastructure will 'bring economic benefits through tourism, job creation and businesses relocating to be near Heathrow'. These may be good commercial arguments, but they are not the same as Ruth Kelly's insistence that Heathrow expansion was critical for the future of the UK.

What will the impact will the new runway have on CO2 emissions?

The new runway and terminal will allow more aircraft to take off and land. Estimating the eventual impact on emissions is difficult:

- the extra flights may or may not be larger airplanes than at present
- travel distances could be longer or shorter
- the new flights could reduce the rate of growth at other airports
- aero engine efficiency gains will continue (for new aircraft)
- small air traffic routing improvements are possible.

I have therefore assembled three estimates of the CO2 increase arising from Heathrow expansion:

1. Heathrow has a 22% share of all UK flight movements. I estimate the effect of expansion by assuming that the average extra flight uses the same amount of fuel as the average UK flight today. This is a conservative, or low, estimate because Heathrow flights tend to use big aircraft travelling much longer distances than other airports. This is therefore towards the bottom end of the range of potential impacts. I estimate that this option raises UK CO2 emissions by 3.8m tonnes.
2. Heathrow has a 29% share of all passenger movements by air from UK airports. If it moves from 69m passengers to its new capacity of 128m passengers, and these extra travellers are typical of the UK as a whole, the extra emissions will be about 9.3m tonnes.
3. Heathrow's fuel use today is about half of the total UK aircraft consumption. (This is not incompatible with Heathrow having only 29% of passenger movements – the flights are longer and in bigger aircraft.) If the

average Heathrow flight remains as long as it is today and with the same sized aircraft, then if the new capacity is fully used it will increase emissions by about 16m tonnes of CO₂.

Today's UK CO ₂ emissions from air travel	37.4m tonnes
CO ₂ increase if extra flights use small amounts of fuel	3.8m tonnes (option 1 above)
CO ₂ increase if extra flights are similar to current Heathrow number of passengers per flight	9.3m tonnes (option 2 above)
CO ₂ increase if new capacity is used in the same way (average distances, average plane sizes) as at present	16.0m tonnes (option 3 above)

If option 3 is right, then UK emissions from aviation will rise by almost 50% from today's levels. This is a pessimistic assumption:

- It assumes that the new capacity is used to fly big aircraft long distances (Heathrow's current pattern).
- It assumes that no diversion takes place from other airports and it allows for no increase in engine efficiency.
- But it is also easy to imagine circumstances in which the high figure is not far from the truth. The market for long distance travel is increasing fast. More and more people want to visit far-flung places. Aircraft size is getting bigger. The underlying rate of growth in travel is high, so there may be little effect on the business of other airports as a result of the Heathrow expansion.

Air travel in the UK is rising about 5% a year. Let's assume that the Heathrow expansion takes 10 years to happen. The new capacity can just handle the expected rise in passenger kilometres of travel. If Heathrow were the only airport to expand (which it will not be), then the total impact of the new capacity may well be close to the 16m tonnes figure.

Does this matter?

At the moment, CO₂ emissions from aviation are about 6% of the UK total. There is scientific dispute about how the other pollutants created by aircraft in flight should be treated. The IPCC suggests that the CO₂ figure should be multiplied by 2.7 to capture the effect of nitrous oxide and other emissions. If we used this figure, current emissions would be about 16% of the UK's total.

At the moment, international aviation is not included in the emissions 'inventories' of Kyoto countries because of the difficulties of allocating the CO₂ between states. There is little doubt that the new round of climate change negotiations will bring air travel into any future agreement.

The estimate from option 3 adds almost 50% to the UK's aviation emissions. The increment pushes the aviation figure close to the level suggested by [the government's 80% reduction target discussed in this issue of Carbon Commentary](#). (Please note that because the 80% figure is calculated as a reduction from the higher 1990 emissions figure, it is not the same as an 80% reduction from today's levels.)

Heathrow expansion could mean that almost all the UK's total emissions allowance in 2050 is absorbed by aviation. Option 3 calculations suggest that after applying the 2.7 multiplier UK aviation will be up to 144m tonnes of CO₂ equivalent. This is just below the figure of 155m tonnes voiced by Gordon Brown as a potential target for the UK in 2050.

Perhaps this is too gloomy a prediction. Engines are getting better and UK airlines will have replaced all their aircraft by 2050. But the scope for improvement is not infinite and continuing growth in plane size will outweigh much of this benefit. Increased prosperity will also create more demand for long-distance travel. The unfortunate truth is that aviation growth and limits on overall UK emissions are extremely difficult to reconcile.

The UK is in a particularly exposed position. In the rest of the EU, emissions from aviation are a much lower percentage of the total. Estimates from the European Environment Agency suggest a figure of something over 3% (not 2% as Ryanair recently reported in a results presentation), so the need to constrain aviation growth is much less pressing elsewhere. If UK plc really is financially dependent on international air travel, then we are in a mess.

Gordon Brown's first speech on climate change

The environmental community tends to think that Gordon Brown doesn't understand the complexity and size of the climate challenge. His first speech on the subject



gave more detail than expected and reassured some that the prime minister does recognise the severity of the challenge. He moved towards an 80% reduction in GHGs by 2050, but even under optimistic assumptions his plans will not result in emissions reductions on the scale required. All his proposals were pain-free. He does not yet believe that the electorate is ready to face the real challenges of emissions reduction.

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Gordon Brown's speech consisted of a long list of measures his government would back. The proposals ranged from tighter car emissions rules to providing free light bulbs. Some items on the shopping list aim at reducing demand growth, others at reducing the carbon content of the energy used in the UK. There was no figure for the total savings expected.



Total emissions from the UK

The prime minister indicated that the government would ask the new Climate Change Committee (CCC) to approve a target of reducing emissions by 80% by 2050. The speech wasn't entirely clear what this means. It means a reduction to about 154m tonnes, down from 770m in 1990, not from today's figure of about 658m tonnes. So the actual percentage cut from the current figure is 76-77%. When the leaders of other countries talk about 80% cuts, they generally seem to mean from today's levels but the UK uses the higher 1990 figure because it makes the emissions target easier to achieve.

The world has settled on a view that climate change is manageable if temperature increases are kept below 2 degrees. In order to do this, the consensus opinion – by no means universally shared – is that the concentrations of GHGs must not stabilise at more than 500 parts per million CO2 equivalent (ppm CO2e).

The Stern review – mentioned approvingly in the speech – suggested the 2 degree and 500 ppm CO2e ambitions need global emissions to average no more than 21bn tonnes of CO2 a year during the 21st century. The UK's 2050 target of 154m tonnes in 2050 will absorb over 0.7% of this total, roughly equivalent to the country's expected share of the world population total.

But Stern does not rest there. He looks for emissions in 2050 and beyond to average less than a quarter of this. In the year or so since Stern was published, scientific opinion has substantially hardened. However much we may welcome Gordon Brown's stronger words on climate change, his speech nowhere recognised the increasingly alarming scientific analysis nor the need for the UK to contemplate reductions down 40m tonnes or so, the level corresponding to a fair share of the global total in the second half of the century. This is no more than about 6% of today's emissions totals.

Nor did the prime minister accurately report the conclusions of last week's IPCC synthesis report. The IPCC did not suggest that business as usual would result in temperature increases of 'up to 4 degrees centigrade' and a sea level rise of 'up to 60cm'. In fact, the IPCC suggests an upper bound of 6.4 degrees. It also says explicitly for the first time that its top figure of 59cm for sea level rise excludes the impact of substantial changes in ice flow patterns. This exclusion is simply because the IPCC is not yet adequately able to model these effects, not that they are not already occurring in Greenland and elsewhere.

Demand reduction

The speech envisaged these principal measures:

- all new homes to be zero carbon by 2016
- loft and cavity wall insulation for 5m homes
- discounted energy efficient appliances
- smart meters
- a 'green homes' service
- carbon trading for middle-sized companies
- banning plastic bags.

All new homes to be zero carbon by 2016

In this context I believe that 'zero carbon' means no net use of carbon-based fuels for heating, lighting and electric appliances. The problems with this target were laid out in [Carbon Commentary's article on the Bladon eco-homes](#). The best UK new builds are still very substantial users of fossil fuels. German Passiv Haus construction techniques may allow the achievement of the zero target, when combined with on-site generation of electricity. But 2016 is only eight years away. The UK construction industry has recently begun to accept the need for better insulation of new homes, and its commitment is only half-hearted. Dragging this most Medieval of industries into the 21st century will be challenging.

Loft and cavity wall insulation

Almost all houses now have loft insulation, though most do not have enough. But despite the active subsidy programme, the government has only succeeded in persuading 2m out of the 11m households with cavity walls in 2002 to insulate the cavities. About 9m houses remain with open cavities, out of the UK's stock of about 25m homes. (By the way, a large percentage of these houses will be still standing in 2050.) The government now promises that 5m homes will get cavity wall or better loft insulation by 2010, paid for by the utility companies.

This is a remarkably inadequate commitment. Home heating represents about 10% of UK emissions. Better domestic insulation has a far greater economic return than any other approach to emissions reduction. It is simply impossible to understand why the government's approach is so limited and hesitant.

For those homes without wall cavities (about 5m out of 25m) insulation is more challenging. But new technologies are arriving that allow cheaper external cladding for solid wall homes. There is no mention of this in the Prime Minister's speech.

Discounted or free lighting and electric appliances

Incandescent light bulbs are likely to disappear from shops within about 3 years. (The progenitors of this change have yet to explain to observers how UK householders are going to be able to replace kitchen and bathroom halogen bulbs.) The prime minister simply 'announced' a continuation of existing plans. The offer of discounted energy-efficient electric appliances was left unspecified. What the prime minister did not say was that the growth in typical television screen size will probably wipe out any savings in domestic electricity consumption from subsidising new appliances. He made no reference to the increase in home energy consumption resulting from the addition of more and more electrical devices across the house.

Unfortunately, this was a problem throughout the speech. The idea that British people might have to give something up if we are to achieve climate change targets is still an unspoken taboo. A grown-up political system would have started to discuss how to restrain the purchase of new energy-using appliances, but British politicians are reluctant to discuss demand limitation, whether it be for air travel, motor cars or consumer electronics. There was, for example, not a single mention of public transport in the speech. Getting people out of cars and into efficient and comfortable buses is simply not something that Labour is prepared to discuss.

Smart meters

The prime minister mentioned 'smart meters'. The primary purpose of such meters in other parts of the world is to give incentives to users not to consume electricity when demand is high. Turn your air conditioner on at 3pm in the afternoon and the price of electricity might be five times what it is at 3am at night. Typically, there was no mention of this in the speech. Mr Brown concentrated on selling smart meters as a way of providing more accurate bills to customers. He avoided even hinting that some electricity prices might rise to choke off demand.

A 'green homes' service

This proposal caught the attention of newspapers. It will offer advice on energy efficiency, particularly in poorer areas. The record of government energy advice centres does not inspire confidence that this idea will do more than scratch the surface of the problems of poor domestic insulation standards and the unstoppable proliferation of electrical appliances.

Carbon trading for medium-sized enterprises and sites

The prime minister talked about 'carbon trading' for smaller businesses than those covered by the EU ETS. He was referring to a scheme in gestation since 2006, now called the Carbon Reduction Commitment. The design of this scheme is not yet fully worked out, and it looks extremely complex to administer. It also seems to offer limited incentives to reduce emissions, largely because the participants capture only a small fraction of the value of energy reductions. It is therefore not really a conventional emissions trading scheme. Like many other subjects in the speech, the scheme has been widely discussed elsewhere though some observers may have gained the impression it was a new initiative.

Banning plastic bags

This was a real howler. The prime minister said that plastic bags create methane gas in landfill. Of course, they do not. They stay there for millions of years. When we are all long gone, the Tesco label will still be visible.

Demand reduction in summary

The only new plan was the Green Homes service. The rest of the schemes are already part of government policy. The prime minister did not touch on any sensitive topics, such as reducing home electricity use, or using higher utility prices to help restrain demand.

Low-carbon technologies

There was a mixture of new ideas and schemes that have already been well aired:

- nuclear
- carbon capture and storage
- 20% renewable energy commitment
- encouragement of offshore wind and the Severn barrage
- reducing obstacles to onshore wind, using more biomass and energy from waste
- the Energy Technologies Institute
- car emissions reductions.

Nuclear

Although the consultation on nuclear has now ended, the prime minister hardly mentioned this source of electricity. Nevertheless his few words left no-one in any doubt that the government will support new applications for atomic power stations.

Carbon capture

Government ministers have been giving speeches about the carbon capture competition for months. Mr Darling talked about it in the Pre-Budget Review. But Gordon Brown's speech did not hesitate to bring it forward as a completely new idea. 'I can announce today that we are launching a competition to build [...] one of the [...] first commercial CCS [...] projects'.

He also mentioned the agreement between China and the UK to work together on Near Zero Emission Coal. He said it was the first of its kind. It was not. Australia and China signed a similar deal in September.

Gordon Brown also floated the idea that CCS might be made mandatory in new power plants in the UK. This depends, he said, on whether it was 'commercially viable'. Of course, if CCS is indeed commercially viable then it wouldn't have to be made mandatory. In other words, this is a completely toothless commitment and provides exactly the unclear signal on clean energy technologies that government says it wants to avoid.

20% renewable commitment

In recent days persistent press reports indicated that the government might be backing away from the EU plan to insist on 20% renewables in the energy mix. These appear to have been slightly misleading. The prime minister now says that he supports the 20% target, as long as it is applied across the EU. Individual countries may not have to achieve this level, provided other countries do better than 20%. The UK only generates 2% of its total energy needs (electricity plus gas) from renewables, a low figure compared to most European countries.

So the government will be arguing that it should not be asked to get the country up to the 20% average. The rest of the EU will be deeply unimpressed; the UK has by far the best renewable resources in Europe and it is completely unclear why it should remain a laggard.

Encouragement of offshore wind and the barrage

To a government that faces fierce opposition to every initiative to increase renewable electricity generation, offshore wind is looking increasingly attractive. The opponents of giant schemes like the London Array are much less organised and effective than the people mobilised against onshore wind or the Severn barrage. The main opposition to offshore wind seems to come from inside central government in the form of the Ministry of Defence, worried about its radar signals.

With the current level of financial support from the ROC system, offshore wind now looks reasonably cost competitive. I sense we will see many more schemes for large arrays of three hundred or more turbines coming forward.

Reducing obstacles to other renewables

The prime minister wants more onshore wind, more 'energy from waste', more burning of biomass and more microgeneration.

He hints that the government is considering how to incentivise communities to accept wind turbines. The language is opaque: 'I want to explore how local communities can themselves benefit from the economic opportunities they [wind farms] create'. This is unclear, but may be a precursor to offering support for community ownership of wind farms. (This edition of Carbon Commentary contains an article on the Fenland community owned scheme.) Onshore wind farms are now so profitable that allowing the locals to invest in them is a very good way of encouraging acceptance.

He says he wants more 'energy from waste'. This may mean more encouragement of incineration with waste capture. As techniques for pyrolysis (heating in the absence of oxygen) evolve, we may see an increasing numbers of plants that generate electricity from consuming municipal waste. This is a good alternative to landfill provided worries over dioxin emissions can be calmed.

Energy Technologies Institute

This body has already been announced and will carry out research into low-carbon technologies, particularly those in which the UK has a natural advantage, such as wind, wave, and tidal stream.

Car emissions standards

The prime minister acknowledges the role of the EU in getting a target of 130g of CO₂ per km by 2012 close to final agreement. He wants to increase the EU standard to 100 g/km by 2025. This is approximately the level achieved by the best small cars in the market today – it is perfectly feasible for the average car by 2025. In fact, it is quite undemanding. A more revolutionary approach would have been to try to replace the internal combustion engine (about 30% efficient) entirely by electricity (100% efficient if generated from home renewables) by 2025.

How far will the government have got by 2025 if cars are typically generating 100g/km? This is about 40% better than the average today, but the number of cars on the road will increase substantially. The net effect will be small.

Summary on low-carbon technologies

Mr Brown did not mention aviation, except in the context of the ETS. At current rates of growth, aviation will use up the UK's entire CO₂ allowance by 2050. No government that plans to expand runway capacity can be truly serious about encouraging low-carbon technologies.

He also devotes only a sentence or two to low-carbon heating sources for the home. After aviation and car travel, this is the single most important source of emissions over which the consumer has direct control. Progress on this is slow, even though the example of biomass-fuelled district heating schemes in the Nordic countries shows that substantial progress can be made.

Nor is there any comment on decarbonising food production and distribution. Recognition of the importance of the food supply chain in GHG emissions is rising, but the UK government is still lethargic in its response.

Summary of the speech

The prime minister sees the scale of the challenge. But nowhere in government is there even an outline plan for how the UK economy gets from 658 tonnes (and rising) to 154 tonnes within the lifetime of the next generation of power stations. As with most government speeches, a long list of measures seems to be a substitute for the hard thought necessary to decide how really to cut emissions.

Community-owned wind farms



In Denmark and Germany, large numbers of individuals own shares in local wind farms. If the government encouraged this in the UK, a large part of the local opposition would disappear. Onshore wind farms in windy locations are good investments which could form an effective part of many people's pension plans.

One of the few co-operatively owned wind farms in the country has almost finished raising its funds. Investors have put up £3m to buy two existing turbines in the Fens. Locally owned wind farms should be encouraged as a cost effective means of cutting emissions.

About 100,000 people in Denmark own shares in wind farms. Although most of the newest developments have been financed in conventional ways, the early growth of wind power was largely driven by cooperatives. Individuals bought their stake and receive income from their investment. The arc of 20 wind turbines that sits outside Copenhagen harbour is a good example: 8,000 investors own 50% of the venture with a local utility owning the rest.

The Danish example has been copied by a small number of wind farms in the UK. Two years ago, Westmill Wind Farm in Oxfordshire raised £5m to build a wind farm on a hilltop site in the west of the county. After the money was raised, Siemens, the equipment supplier, told the co-operative that it no longer had any turbines for sale, having committed all its output to the US market. Negotiations eventually resolved the issue and the wind farm is now being constructed. It has 2,400 shareholders, most of whom live within a 30-mile radius. Shareholders typically invested £2,000 each. Additional finance was provided by the Co-operative Bank.

In recent months another co-operatively owned wind farm has been raising cash. The closing date for the share offer is 30 November, but the business looks as though it has got the cash commitments that it needs. The Fenland Green Power Co-operative has the rights to buy two 2MW turbines that have already been constructed near Deeping St

Nicholas in Lincolnshire. The rest of the wind farm is owned by EDF and these two turbines were promised to local investors as part of the package that got the planning permissions several years ago.

The economics of the venture make investment reasonably attractive to local investors:

- The risk is negligible. The turbines are already working, and have produced almost as much power as predicted before they were constructed. Modern turbines are extremely reliable and should need very little unplanned maintenance for the 25 years of their life.
- The two turbines should produce about 11,200MWh a year in total. If the energy were sold by an independent entity on the spot market, the current value of this would be about £500,000 a year. The Renewable Energy Certificates (ROCs) that the co-operative is entitled to will also be worth about £500,000, making a total of about £1m of revenue.
- Probably to assist with debt financing, the venture has gone a different route and has sold the ROCs and the power to EDF. Its actual revenue is likely to be about £750,000.
- Operating costs are low and the cash flow before interest is likely to be about £500,000 a year. About £200,000 is kept as a sinking fund to repay the investors at the end of 25 years.
- The total cost of the project is about £4.4m, of which £3m is being raised in equity. With the leverage from the bank loan, the cash return to investors will be over 10% within a few years.
- Shareholder investments will benefit from 20% EIS relief, raising the prospective return to investors to more than 15% per annum over the life of the project.
- The principal uncertainty is the price that is obtained for the power when the initial contract with EDF has finished in some years time.
- For an investment that has a highly predictable and secure cash flow, the returns to individual investors seem attractive and better, for example, than typical corporate bond issues.
- The return on the Fenland investment is likely to be slightly better than the UK average. The percentage of peak output achieved by the turbines has been about 32% compared to the UK average of around 28%. (A turbine has a maximum power, reached when the wind is high, but not so high that the turbine is closed down. 28% is the typical yearly output compared to the figure that would be reached if the turbine was operating at full power all the time.)

Local ownership and the impact on public opinion

Some of the antagonism to wind farms arises from the perception that they are owned by large remote companies with no interest in the area. A large part of the opposition can be defused if the local community is offered a chance to participate in the financial success of the venture. Boyndie Wind Farm in Aberdeenshire, Scotland is also partly owned by co-operative investors as a result of a deal with the local community when the farm was constructed.

Most surveys show that about 80% of the population favours wind farms. A figure of about 60% or slightly more would be happy to have turbines within view. This second figure means that a substantial fraction of the affected population is likely to oppose wind farm plans. If neighbourhood opinion-formers had a financial stake in a successful wind turbine, their opposition might be more muted.

The Westmill wind farm in Oxfordshire faced serious local opposition during the ten years or so it took to get through the planning process. As the first wind farm in the UK designed from inception as a local co-operative, Westmill was blazing a trail, and most local residents probably did not understand that it might eventually be possible to buy a share in the venture. Once the Westmill model (pushed by an organisation called Energy4All) is well understood around the country, it should help wind farm proposals through the planning process.

Government, companies, and co-operative wind farms

In his November speech on climate change (see [this edition of Carbon Commentary](#)), Gordon Brown talked about onshore wind farms. He seemed to suggest that the government would be sympathetic to any schemes that improved the local acceptability of turbines. Perhaps he was hinting that the government would do more to assist co-operatively owned wind projects.

BT has announced it will attempt to set up 120 wind turbines on its properties around the country (see [Carbon Commentary Newsletter #4](#)). Its chances of getting these ambitious plans approved would be significantly enhanced if it brought in local investors at each of its sites. It might even be able to reduce the overall cost of capital for its wind plans by using equity money from private individuals, who might be willing to invest with expected rates of return no greater than the cost of bank debt.

The cost per tonne of carbon dioxide saved is low for commercial wind farms. I calculate that the Fenland wind turbines will typically save a tonne of CO₂ per £36 invested. This cost is higher than the £8 that climate care might charge, but far below the price needed to subsidise small-scale home renewables. In windy areas, large commercial wind turbines, funded by the local community, are the most effective means of cutting carbon emissions.

Eco housebuilding



After decades of foot-dragging, the UK construction industry has begun to see the importance of good insulation and higher environmental performance. Large housebuilders are beginning voluntarily to build their major developments to a better standard than required by building regulations.

Housebuilders also see the increasing commitment by government to increasing the mandatory standards for home insulation and other environmental characteristics. By 2016, all new homes will have to be 'zero carbon'.

A report just released by estate agents Knight Frank examines whether buyers are prepared to pay the cost of the eco-improvements. The answer seems to be a cautious 'yes'.

Government is rapidly increasing the pressure on housebuilders. For decades we have seen the construction industry fiercely resist increases in the minimum standards for new homes. Small changes in the building regulations were fought over for years. Government generally caved in. On one extraordinary occasion some years ago, the current building minister, Yvette Cooper, agreed to water down an improvement in insulation standards, claiming the change was 'gold plating'. The standards would still have left the UK well behind the performance of almost every other country in northern Europe. About a quarter of all the UK's emissions come from the energy consumption in domestic homes, so comprehensive action is well overdue

Central government now appears to understand the lamentable UK record in building new homes to a reasonable standard. The new 'Code for Sustainable Homes' sharply ratchets up insulation standards in the period to 2016. Developers are supposed to get to Level 3 of this code by 2010 and Level 4 by 2013. Energy use at Level 3 must be 25% below current standards, rising to 44% for Level 4.

These targets are relatively simple to achieve. Berkeley Homes has already committed to get to Level 3 on all developments beginning in 2008, several years in advance of the requirement. Getting to levels beyond 4 may be much more difficult. Level 6 requires the home to have no net use of energy at all. All fuels taken from the electricity or gas grids must be balanced by on-site or near on-site generation.

Knight Frank's report provides the following illustrative figures for the incremental cost of achieving the various levels. (For the purpose of comparison, the average price at which UK houses are currently selling is about £185,000 - source Nationwide)

Extra cost per unit

	Housing	Low-rise flats	High-rise flats
Level 3	£5,000	£3,500	£6,500
Level 4	£15,000	£8,500	£17,000
Level 5	£26,000	£34,000	£36,000
Level 6	Unknown	Unknown	Unknown

The estate agent does not cost Level 6, saying it is unclear how housebuilders are going to achieve the target.

In a previous edition of the newsletter, we looked at a row of eco-homes under construction in the Oxfordshire village of Bladon. The developer gave us an estimate that the additional cost was about £40,000 per unit. The houses would achieve the top end of Level 4. The figures in the table above should probably therefore be seen as costs only achievable when the industry has acquired substantial experience and skills at delivering the new standards.

The numbers show that Level 4 will add a significant but probably manageable amount to the costs of construction, even though for high-rise flats the costs will be surprisingly high. Getting to Level 5 for flats will be much more expensive. (I believe that flats will be more expensive than houses because it will be more difficult to use microgeneration to achieve emissions reductions.)

The extra costs imposed by the new regulations could either be paid for by increasing prices, lower developer margins, or lower land values. Buyers should, at least in theory, be prepared to pay a small premium above what they could afford for a less-well-insulated home because their yearly outgoings will be lower. Level 4 homes may reduce fuel bills by perhaps £250 a year. It is probably not worth paying more than about £8,000 for this benefit. The remainder of the cost will probably be absorbed in lower land prices.

What are the attitudes of buyers?

During August and September 2007, Knight Frank asked homeowners about their attitudes to 'eco' features. Perhaps the most interesting comparison was the difference in the number of people who had seen 'environmentally friendly features' as important when buying their current property (43%) compared to the 79% who say it is important for a future purchase. In other aspects, householders aspirations for a future house were similar to their objectives when buying the house they live in now.

Respondents were also asked about their underlying attitudes to sustainable homes. Younger people were likely to associate eco-homes with other desirable attributes such 'modern design' features. Over 75% of people under 40 linked good environmental features with 'value for money'. One developer of eco-friendly homes (R.gen) provided data to Knight Frank showing that only 20% of its buyers were over 35, but this may be more to do with R.gen's portfolio of smaller flats and city-centre developments.

Some outstanding modern houses with good insulation and other eco-features can achieve 20% premiums to houses of similar size and location. But Knight Frank's research showed a generally more limited willingness to pay extra for eco-homes. 41% said they would be prepared to pay no more, and only 10% could envisage paying 6-10% more. Given that most buyers are extremely financially stretched at current UK house prices, this may be no surprise.

Percentage of home-buyers willing to pay a premium for eco-homes

Premium	Buyers willing to pay
None	41%
1-2%	32%
3-5%	17%
6-10%	10%

But asked in a slightly different way, over 80% of respondents were prepared to pay a premium for lower running costs.

Kindle: Amazon's electronic book reader

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amazonkindle

Amazon's new e-reader has been widely discussed this week. Most of the comments have been unflattering. Critics have gasped at the high price (\$400) and commented unfavourably on the slightly dated appearance of the device. Others asked why Amazon thought it could charge for newspapers and blogs that are available free via a computer.

This isn't the first attempt to market an e-reader. Other pocket readers, such as Sony's, have failed to make much impression. Will Amazon overcome the early objections and turn Kindle into something worth buying? I think the answer is probably yes, and the impact on CO2 emissions might be more than trivial. Paper and card manufacture is responsible for about 4% of UK emissions. (Much of the UK's paper is made abroad, so doesn't show up fully in national accounts.) Getting rid of paper use is a worthwhile carbon-saving aim.

* * *

Electronic readers have been available for ten years or more. Early PDAs could download books via a computer. The reading experience was poor and nobody succeeded in getting customers to pay for the book. Sony's reader was better in that it used 'e-ink', which can be read in bright light.

Amazon's Kindle brings some substantial further advantages over the first generation of e-readers:

- It downloads books through a mobile phone connection. Download speeds are high and the book will be available a minute or so after ordering. (The device only works on a US EVDO network.)
- A large percentage of current bestsellers is available for sale, along with newspapers, journals, and blogs. All the perishable material is downloaded in the background if the user has paid a subscription.
- The user has free access to dictionary definitions, Wikipedia, and can search and bookmark all the texts on the machine.
- The e-reader will need charging every couple of days, a process which takes about two hours.
- Word or PDF documents can be mailed to the device and shown on its screen.
- It is the size of a large-ish paperback and weighs about 300g.

The press decided that that this was Amazon's attempt to launch the equivalent of the iPhone. But the Kindle has a mediocre design and makes little attempt to market itself as as a high-status accessory. Critics could not see why anybody would pay \$400 to carry books around that might be bought for \$5 in an airport book store. On a more positive note, the reviewers admired the quality of the screen and the legibility of the text.

It is easy to dismiss the Kindle but eventually electronic readers will take over a substantial fraction of our paper-based reading. Early successful use will come in some obvious markets:

- Any text material that is regularly updated, such as technical manuals or computer programming guides.
- Books, such as legal textbooks, which would benefit from easy search, cross-referencing, and comparison.
- Material of very high urgency, such as financial news.

High-income professional users will probably form the early market, rather than the general fiction reader identified in Amazon's publicity. Many of these people may well have broadband modems for their laptops already, but the easy legibility of texts may be of advantage. Imagine a lawyer going into court. She might email much of the background material for the case on to the e-reader for rapid searching. The main legal textbooks and manuals of

precedents would also be available on her reader. A good always-on e-book device would be of substantial advantage.

Or what about a university academic needing to get access to scores of different sources? Amazon's searching technology allows easy reading of paragraphs from several books on the topic of interest. In this respect, the Kindle is a real advance over conventional computers.

Does paper matter?

The manufacture of paper is a substantial contributor to national emissions. The UK uses about 13m tonnes of paper and card a year (about 200kg per person). About two thirds of this (8m tonnes) is newsprint and papers for writing and printing, including books. About half of this paper is imported and half is made in the UK.

Very approximately, a kilo of virgin paper produces 3kg of CO₂ in its manufacture. Recycling saves about half of this. An increased fraction of the UK's paper and newspaper is now recycled; the current figure is about two thirds. The declining amount of paper manufacture in the UK means that increasing amounts of the paper to be recycled is sent abroad for processing. All-in-all, the total net carbon dioxide cost of paper used in the UK is probably about 30m tonnes, much of which will be incurred abroad.

For reading matter such as newspapers, the principal CO₂ cost lies in the manufacture of the paper. One close analysis of the carbon impact of direct marketing similarly puts the paper at over 90% of the total. Books will be somewhat different: one study showed that a 500g book had a CO₂ cost of over 3kg, double the impact of the paper alone. At current ETS prices, the cost of this CO₂ is about 5p, which probably would add about 5% to the manufacturing cost of a typical substantial paperback.

Transferring a quarter of our total reading of books, papers, marketing fliers, manuals, and office documents to an e-book reader might save approximately 7m tonnes of emissions, or about 1% of the UK total. The Kindle deserves a chance.

Companies mentioned in this newsletter: BAA, Ferrovial, Ryanair, Siemens, Co-operative Bank, EDF, BT, Knight Frank, Berkeley Homes, R.gen, Amazon, Sony.

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