PART 1 - THE EMPTY SHELL OF UK CLIMATE POLICY
FAILING TO PLAN – OR PLANNING TO FAIL?

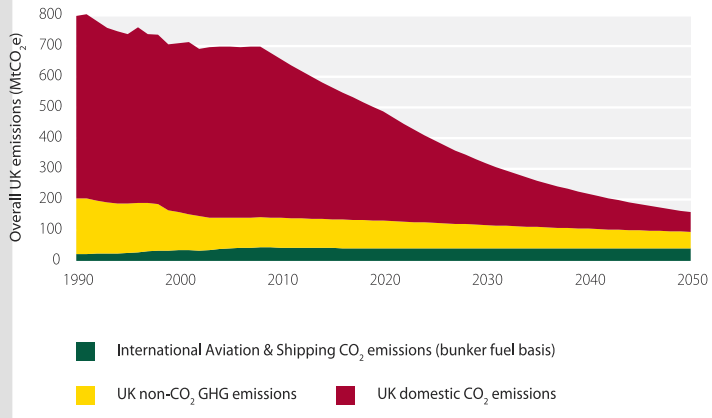
If we are to achieve anything like a sustainable level of greenhouse gas emissions spread equitably around the world, UK emissions probably have to be cut by around 80%-90% from 1990 levels. The Stern review cites sustainable global emissions of around 20GT/yr of CO_2(e), which if spread equitably across 11 billion people gives 1.8t CO_2(e) per capita[1].

The UK deserves credit for taking a leading position on climate change – with a legally binding commitment to reduce its GHG emissions to 20% of 1990 levels by 2050, which would get us close to our sustainable national emissions. Sadly, though, current policies and actions almost guarantee that this vitally important target will be missed. Here's one reason why.

Achieving 80% reduction must take into account that some sectors will be unable to achieve anything like this. Agriculture, and specifically livestock emissions, are difficult to control though of course the emissions (and jobs) can be exported – but that's another matter. Shipping is also a major problem. Aviation, though, is the biggest challenge. The industry faces huge growth in demand, the capital equipment is exceedingly long lived and design cycles long, so reductions will be slow to implement (*Planes being bought today will still be flying in 2050*). In Jan 2009 the government set an goal for aviation emissions in 2050 to be no higher than in 2005, at 37.5 million tonnes of CO_2/yr. If this is achieved, and non CO_2 emissions are reduced by 70%, then according the Committee on Climate Change (CCC) **the rest of the economy would have to cut CO_2 emissions[2] by 90%** from 1990 levels to meet the 80% economy wide target. This would require emissions of CO_2 to reduce from 590 million tonnes a year in 1990 to 59 million tonnes a year by 2050.

We designed a scenario to show how the 80% target could be achieved across all sectors including aviation with very limited offset credit purchase. Specifically, we showed that if aviation emissions in 2050 were broadly equal to 2005 levels, if shipping followed the same pattern and if non-CO_2 emissions were reduced by 70% relative to 1990, then a 90% cut in CO_2 emissions from other sectors would achieve an 80% economy-wide cut (Figure 1.4).

Figure 1.4 Indicative path to the UK target of an 80% reduction in GHG emissions in 2050



Source: CCC (2008), Figure 2.28.

FIGURE 1 - EXTRACT FROM CCC REPORT ON AVIATION

[1] UK GHG emissions in 1990 were about 766 million tonnes CO2(e). The UK population in 2050 is expected to be 78 million. 1.8 tonnes per person reflects a national emission limit of 140 million tonnes CO2(e), or 18% of 1990 emissions.

[2] Note the difference between CO_2 emissions and CO_2(e) or CO_2 equivalent emissions.

There is one critically important caveat in the CCC Aviation report. It is that their analysis does not include the non-CO_2 emissions from air travel, **though the report stresses that these should be taken into account**. A widely used estimate is that the non-CO_2 contribution to global warming is approximately equal to the CO_2 component. Adding this emissions source to the 1990 figures would push up the baseline against which the reduction targets will be measured, so increasing the amount of emissions allowed in 2050[3]. On the other hand if aviation emissions in 2050 have not declined, the additional 37.5 Mt has to be accommodated in 2050 in full – reducing the emissions from the rest of the economy even further.

Working through the implications for CO_2 emissions is complex, but the overall effect is clear – CO_2 emissions have to be reduced by much more than the CCC estimate of 90% to make room for this extra portion of aviation emissions. My best estimate is that we need to achieve somewhere around 29 million tonnes of CO_2 emissions per year - 30Mt below the estimate if we ignore non CO_2 aviation emissions.

Current CO_2 (2010) emissions were 496 million tonnes for a population of 61 million – or 8.1 tonnes of CO_2 per person. The Office for National Statistics projects a population of 78 million by 2050. Allocation of the 29 million tonnes of CO_2 between the projected population gives a ration by 2050 of under 0.37 tonnes of CO_2 per person per year across the entire economy except for aviation emissions. This means we need to achieve 95% reduction of CO_2 emissions compared to 2010 in order to meet the GHG commitments.

Now let us consider our building stock. The UK has around 26 million households. Most of our homes were built before energy security and climate change were understood, and when energy was cheap. As a result our housing stock is hopelessly inefficient. Our office blocks, warehouses, shops and other buildings are no better. As we now move into the 21st century we are beginning to realize that 'something needs to be done about them'.

Electricity in homes for lighting and appliances is relatively easy to deal with – modern lighting is hugely more efficient than it was in 1990, and we can anticipate further improvements by 2050. Lights are easily changed. Likewise, appliances get better each year and are frequently replaced. Thus, so long as we substantially decarbonise electricity, emissions from domestic lighting and appliances can meet the targets set.

Much more complex, though, is heating. In 1990 emissions from domestic combustion (mostly heating and some cooking) were 77.8 million tonnes of CO_2[4]. Reducing this by 95% effectively rules out natural gas as a source of heat for our housing stock. That leaves electricity.

IMPLICATIONS OF HEATING WITHOUT NATURAL GAS.

We cannot simply swap from gas to electric heating. In 2010 we used 440TWh[5] of heat from fossil fuels other than electricity to heat our houses. Assume we heat for about 6 months of the

[3] Adding 37.5 million tonnes non-CO_2 emissions from aviation to the accounts increases the baseline GHG emissions in 1990 by 37.5Mt, and also increases the allowance in 2050 - by 20% of 37.5 or 7.5 Mt a year. However because these 37.5 Mt of emissions will continue through 2050, the emissions from sectors other than aviation must be reduced by an extra 30 Mt (37.5-7.5).

[4] http://www.decc.gov.uk/en/content/cms/statistics/climate_stats/gg_emissions/uk_emissions/uk_emissions.aspx

[5] http://www.decc.gov.uk/assets/decc/11/stats/publications/dukes/5959-dukes-2012-annex-a.pdf . 2010 data show domestic energy consumption for all fuels except electricity and bio-energy of 37.7 million tonnes of oil equivalent – at 42GJ/TOE.

year, and for 12 hours a day, that means we have to have about 200GW of electricity generating capacity to provide our heating. Allow for the fact that on a cold day we need much more than the average, and 300GW of capacity looks like a good first guess at what's needed to heat our homes. Now consider that the TOTAL UK generating capacity in 2010 was about 90GW.

Of course we could use heat pumps. A heat pump is a device that works like a fridge in reverse, and extracts energy from the air to provide heat. Heat pumps use electricity, but can deliver 2-4 units of heat for every unit of electricity used (*this number is called the Coefficient of Performance or COP*) provided they are installed in well designed systems. In reality there are limitations on the efficiency of heat pumps on cold days that mean they are not as efficient as they could be – but let us assume an average COP of 3. Heating every home with a heat pump would reduce power demands from 300GW to about 100GW – which is still more than total UK generating capacity. However it gets worse – because population is projected to expand by 2050 to 78 million people. This will add another 7 million households – almost 30% - but for the sake of this analysis let's pretend that all these will be hyper efficient houses that use no heating. Clearly this is unrealistic, but it does make the 300GW figure for heating needs look conservative.

All this new capacity would have to be provided with carbon free generation. Solar simply couldn't deliver because we need the heat in the winter. If we did this with wind it would need 100,000 3MW turbines[6] plus an awful lot of batteries. If we did it with nuclear it would need around 100 new nuclear power stations – around one every four months between 2015 and 2050! Bear in mind that we have to do this as well as phase out all our existing coal and gas fired power stations – so if we went 100% nuclear we would need to build a new power station every two months! This is clearly impossible. Thus the only way to have affordable heating and hot water in a fully electric house is to reduce massively the amount of energy consumed and to provide the heat needed with a much reduced electricity demand.

Insulation is part of the story, but alone it isn't enough. A substantial proportion of our heat is also lost through air leakage, and making existing homes airtight is difficult. Then, once the home is airtight, air circulation and fresh air becomes a problem. This more or less mandates the choice of mechanical ventilation with heat recovery – which in turn pushes the heating system to be driven by air source heat pumps. Delivering all of this means that homes need a major and expensive overhaul – it can't simply be done by piecemeal fitting. A recent refurbishment of a 4 bedroom Victorian semi-detached house in Oxford to near zero carbon standards cost around £60,000 over and above

Heating homes using a heat pump coupled with heat recovery and an airtight envelope can result in exceptionally low electricity consumption. In a recently refurbished Victorian semi-detached four bedroom house in Oxford the walls were reduced to a U value of 0.15 (EST costs are based on achieving around 0.35 – i.e. losing twice as much heat), the windows were designed to achieve a U value of 0.7 (typical double glazing achieves only 2.8), and the house was made functionally airtight with mechanical ventilation to allow for heat recovery. In addition waste heat is being recovered from warm waste water. The net cost of this was approximately £60,000 – being the difference between the cost of the work done and the cost if the house was only refurbished to comply with Building Regulations (www.myretrofit.blogspot.com). Most current houses, of course, do not comply with current Building regulations, so the actual cost of refurbishment would be higher than that stated.

[6] Assuming a 33% utilization factor

the cost of meeting current building regulations. Even a significantly more modest attempt at efficiency and conversion to electric heating will be costly. The EST reports[7] the cost of the three simplest and most significant interventions for a typical house as being:

	Low estimate	High estimate
Loft Insulation (270mm)	£200	£700
Solid Wall insulation[8]	£5,500	£13,000
Double Glazing	£3,300	£6,500
TOTAL	**£9,000**	**£20,200**

Note though that these figures do not include any change in heating system from wet to electric, or any heat recovery or significant airtightness improvements. The true cost of delivering these changes at scale is likely to be perhaps £15,000-£30,000 per existing dwelling – giving a range of investment of £400-£800 Billion to be invested between now and 2050. Assume it takes 2-3 years to put the policies and mechanisms in place, and we then have 35 years to deliver – we need to plan to invest £10-£20 Billion per year every year from 2015 to 2050.

Barring some new technology that could deliver a radically new solution (and there may just be one!), it is clear that both a major new power station construction programme and a massive energy efficiency drive are needed. However the current faltering moves at energy efficiency, such as the New Green Deal, will probably add to the overall cost of emissions reduction, not reduce them. The reason is as follows.

Achieving the deep efficiency gains we need means we need much more insulation than is specified in today's building regulations, substantial improvements in airtightness, a probable shift to heat recovery in mechanically ventilated systems, and complete scrapping of the existing heating systems. Whilst small amounts of insulation and airtightness improvement can be cost effective in today's market, these deep changes are far from cost effective. This is particularly true when the basis for cost is gas prices rather than renewable electricity prices. The result will be that households will approach the problem of energy reduction in a piecemeal fashion. It is almost certain that work that they do will therefore need to be re-done. The result will be that the cost is much higher than it would be if the work was done in one pass to a standard appropriate for the end result.

It seems clear that UK government policy on climate change is hollow. There are no moves afoot to build power stations or new generating capacity on the scale needed; there is no discussion about the consequences of dismantling the natural gas grid, and there is no inkling of a policy on energy efficiency that comes close to addressing the scale of the problem. The only measures we do have in place look set to achieve modest gains at the expense of increased overall cost. This is somewhat tragic given that we have almost three million people unemployed and an economy desperately in need of stimulus to get it going again. The opportunity exists to tackle all these three problems simultaneously – but nothing is happening.

Oh! – and we haven't even started to think about heating industrial and commercial property, or the consequences of electrifying our cars.

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[7] http://www.energysavingtrust.org.uk/Using-this-site/Our-calculations

[8] Cavity wall insulation is ignored in this assessment as it makes savings that are insufficient to achieve anything close to the requirements – all houses will have to have additional insulation.