Carbon Commentary Newsletter #2

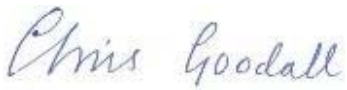
A critical appraisal of issues in the move to a low-carbon economy

Monday 1 October 2007

The second edition of Carbon Commentary assesses some of the main issues to arise over the past two weeks in the climate change field. It looks at questions as diverse as UK consumer behaviour, the prototype Ceres Power domestic CHP boiler and climate modification by geo-engineering. Please pass this newsletter on to anyone you think will be interested. All the material is copyright Chris Goodall, but may be freely quoted provided the source is acknowledged.

At present, this newsletter is free. Anyone wishing to sign up for future editions should simply send an empty email to subscribe@carboncommentary.com.

As always, any comments will be most gratefully received.



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Chris Goodall's book *How to Live a Low-Carbon Life* won the 2007 Clarion prize for non-fiction on 28 September.

Articles in this edition

Consumer segmentation: Research from the Henley Centre and Marks and Spencer

Many companies selling to UK families have a strong sense that consumer demands are shifting rapidly. M&S recently talked to Carbon Commentary about its perceptions of changes in attitudes and behaviour. This article compares its results with those of a survey by the Henley Centre in summer 2007.

During the last year or so, the percentage of 'green zealots' in M&S research has risen from 3-4% to nearer 8%. Henley also sees a figure of 8% for the two greenest groups 'principled pioneers' and 'vocal activists'. A further 31% (Henley Centre) or 30-35% (M&S) are actively concerned and want to adjust their behaviour. There has also been a big growth in this group in the last year.

In both surveys another third are aware of environmental and ethical issues, but are unlikely to take active steps unless pushed. A final quarter or so don't care very much. M&S says that they are 'struggling'. Henley calls them 'disengaged'.

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Consumers do not generally see climate change as the most important environmental and ethical issue

M&S's strikingly ambitious Plan A has five sets of targets. Only one of these relates to climate change. M&S emphasises the hierarchy of consumer concerns that drove it towards the wide spectrum of targets in the 100-point Plan.

1. **Food and Health:** consumers want food to be made from high quality ingredients, with no additives and minimum amounts of salts, saturated fats and other undesirable ingredients.
2. **Ethical sourcing:** M&S customers generally want to buy goods that are made and sold under what might be called 'FairTrade' conditions. Suppliers are paid properly, workers are not exploited and environmental damage is minimised.
3. **Better recycling, less packaging**
4. **Climate change**

M&S commented that Food and Health was 'way out on its own' as an issue, but other concerns have been creeping up to match it. Respondents to its surveys are now much better informed about environmental issues but 'there's still an awful lot of confusion'.

M&S customer segmentation work throws up 4 groups:

- **A:** Green zealots: people who will actively seek out the most ethically and environmentally responsible products. Climate change is particularly important issue to these people.
- **B:** Those interested and concerned, but often uncertain how to shop to achieve their ethical objectives.
- **C:** Aware of the problem, not certain that their actions can have much effect or that they need to shop differently.
- **D:** Struggling, do not give high priority to issues covered in Plan A.

The company gives some approximate figures for the numbers in each group compared to the numbers of three years ago.

Marks and Spencer consumer segmentation

Group	Now	3 years ago
A	5-10%	3-4%
B	30-35%	about 15%
C	30-35%	about 50-60%
D	25-30%	25-30%

The key change in the last few years has been the move from group C to group B. The A family has grown substantially but still remains a small percentage. The strugglers have largely remained in the same group. To put it in simple terms, the mainstream M&S customer has shifted from a C to a B. This makes Plan A seem entirely logical, though I think the company may actually be moving somewhat faster than its customers. Plan A almost seems to suggest that M&S thinks that its core shoppers are just about to shift to Group A.

M&S's numbers have great similarity to those produced by the Henley Centre in mid-summer.

Henley Centre consumer segmentation

Group	Percentage	Closest M&S group	M&S percentage
Principled Pioneers	4%	A	8%
Vocal Activists	4%	A	
Positive Choosers	31%	B	30-35%
Conveniently Conscious	35%	C	30-35%
Disengaged Onlookers	26%	D	25-30%

Henley makes the point that consumers in group A will already be choosing their goods and services with care. Group B will tend to make the same purchase decisions, though they may be less vocal about their preferences. Group C will not take active measures themselves, but Henley says that they will not object if companies selling to them 'edit out' products that do not meet reasonable ethical or environmental standards. This is consistent with M&S's view that its customers wanted the chain to take positive actions to improve the environmental attributes of the products its

stores sold, even at a small increment in the price.

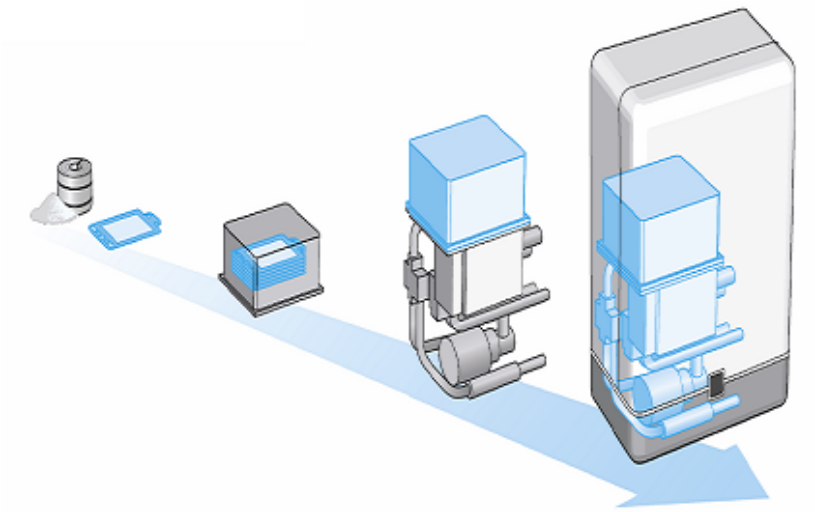
Perhaps the two main features of these research findings are:

- Trusted brands do have some freedom to take less environmentally acceptable goods and services off the shelf. Three quarters of the population accept that issues such as climate change should affect what is selected by retailers for sale.
- The zealots are growing in number, but don't yet form a mass market for most products and services. Products like British Gas's Zero Carbon tariff (covered in Carbon Commentary Newsletter #1) will be taken up by this group, but will struggle to penetrate beyond this demographic.

Separately, Henley comments that the most concerned consumers do not strongly congregate in a particular age group, social class or region of the country. This finding is entirely consistent with other surveys. Boden mums in Surrey may not be any more likely to search out ethical brands than middle-aged male teachers in Gateshead. This makes ethical marketing more difficult because target audiences do not correspond well to well-understood existing demographic segments. It will be interesting to research what TV the zealots watch and which web sites attract their regular attention. My guess is that these consumers are disportionately members of ethical pressure groups such as WWF and Greenpeace. The Friends of the Earth mailing list is going to get more valuable.

Domestic Combined Heat and Power

Ceres Power, a £150m AIM-listed company, recently demonstrated its new Combined Heat and Power product. This power plant is targeted at ordinary domestic homes. Combining an efficient central heating boiler with a fuel cell that converts gas to electricity, the new product has excited the City. Ceres is extremely optimistic about sales of the device, based on the cash and carbon dioxide savings it says can be achieved.



The Ceres fuel cell (on the left) is incorporated into an ordinary domestic condensing boiler (on the right)

Ceres promises reductions in utility bills of £300 a year and 2.5 tonnes savings in carbon dioxide for the typical UK house. Our short report shows why we think that these savings are unlikely even in the most appropriate UK installation. In fact, the emissions reductions are likely to be minimal and the reductions in the electricity bill will not easily justify the approximately £1,000 extra cost of the CHP cell.

Micro CHP is a difficult proposition. Other companies have found that it is hard to make substantial savings in domestic installations. CHP is not well suited to rapidly fluctuating and unpredictable demand for electricity and hot water.

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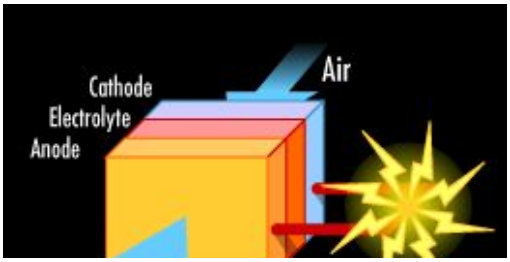
What is micro CHP?



The logic behind CHP is that almost all electricity generation methods involve gross inefficiency. A large coal-fired generating station might only convert 35% of the energy in the fuel into electricity. The rest is lost as heat. An average of 7% of all electricity is then lost in the transmission networks, emitted as heat or electromagnetic radiation. A combined heat and power plant captures the lost heat and uses it to

warm buildings or heat water. Big CHP plants exist in the UK, and in much greater numbers in northern Europe. Micro CHP devices are attempts to replicate these plants at the scale of a single household. The core financial proposition is that the householder generates valuable electricity using inexpensive gas.

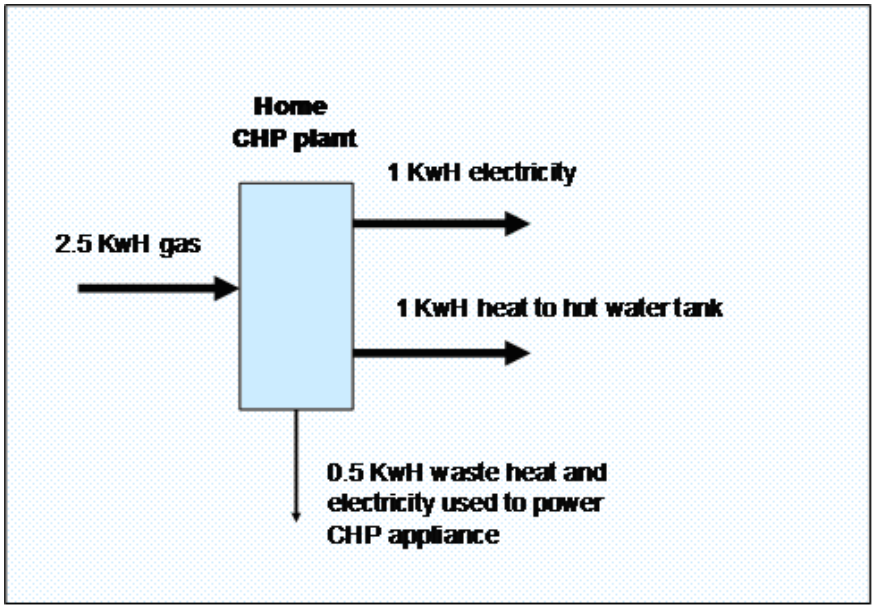
Why is it difficult to make CHP work, either in terms of reduced emissions or lower bills?
Home electricity demand fluctuates every second. All small generation technologies find it difficult to adjust to this. Unless surplus power can be sold to the electricity networks, CHP devices lose money from using gas to make electricity with no value. In the UK, unlike Germany and other countries, the money paid for feeding electricity into the grid is negligible. There is very little prospect of so-called 'feed-in' tariffs improving in the UK. Secondly, the household has to have a use for the heat that is produced as a by-product of generation. In most micro-CHP, the heat is dumped into the hot water tank, which may or may not need it. Thirdly, most CHP devices, including Ceres, are slightly less efficient (converting fuel into useful outputs) than a new condensing boiler. There just isn't much of a gain from installing a tiny CHP plant.

Past experience
Field trials of other micro CHP devices have proved inconclusive. In some cases, fuel bills went up as a result of installing the technology. In the large majority of cases, the savings in carbon emissions were low. Ceres claims its new technology, which is based on a relatively new type of fuel cell, is much better. I accept that its fuel cells may be excellent at delivering efficient generation of electricity, but I think that in domestic homes the savings are likely to be as disappointing as previous technologies.

The *ideal* Ceres CHP installation
The new Ceres CHP power plant delivers between 300w and 1 kW of electric power, responding to the level of electricity demand in the household. 300 W is equivalent to a two large TVs operating simultaneously. 1 kW is a typical power use for an electric heater.

To have maximum value to the householder, the electricity demand of the home should be a constant 1 kW. This would enable the CHP plant to deliver a high and consistent efficiency and maximise the savings.

When it was generating 1 kW of electricity, the CHP plant would also be delivering approximately 1 kW of heat to the hot water tank. About 0.4 kW would be wasted, partly in the form of unused heat and partly in electricity used to drive the CHP plant itself.



- The input cost of 2.5 kWh gas is about 6.25p.
- The hourly output of the CHP appliance (1 kWh electricity and 1 kWh heat to the water tank) would cost about 13.8p.
- So the hourly saving would be about 7.45p. Grossed up, this is £653 a year.
- The saving in CO2 is about 1.3 tonnes a year.

These are the absolute maximum savings attainable with this boiler. To get these savings the CHP plant needs to be working at 100%, or exactly 1 kW all the time. This means the house has to have an absolutely constant electricity demand. This is, of course, an unreasonable assumption; typical domestic demand fluctuates every second and falls to very low levels at night and when the house is empty. If the CHP plant is working flat out it will deliver 8,760 kWh

a year, or over two and a half times the UK average for a domestic property. A large house might well have aggregate demand this high, but not consistently. Secondly, the house also has to need about 8.760 kWh of heating for the hot water tank. This is a very high level for a UK property and unlikely to be used except in houses with a large number of occupants.

What about the benefits of installing the CHP cell in the typical UK property?
The typical UK house is thought to take about 3,300 kWh of electricity a year, far lower than the level discussed in the preceding paragraphs. (This conventional assumption is used in all advertising and in product comparisons. It is out-of-date and 3,700 would be a better figure.) If this demand was exactly constant, it would mean that the CHP plant would need to deliver 377 watts of electricity all the time, and provide a similar amount of hot water heat. I calculate that the annual savings from using the Ceres CHP plant, above and beyond those installing a good condensing boiler are still quite large, though not as great as if the CHP cell worked constantly at 1 kW.

- £249 in reduced electricity charges, net of a smaller increase in gas bills
- 0.55 tonnes of CO2

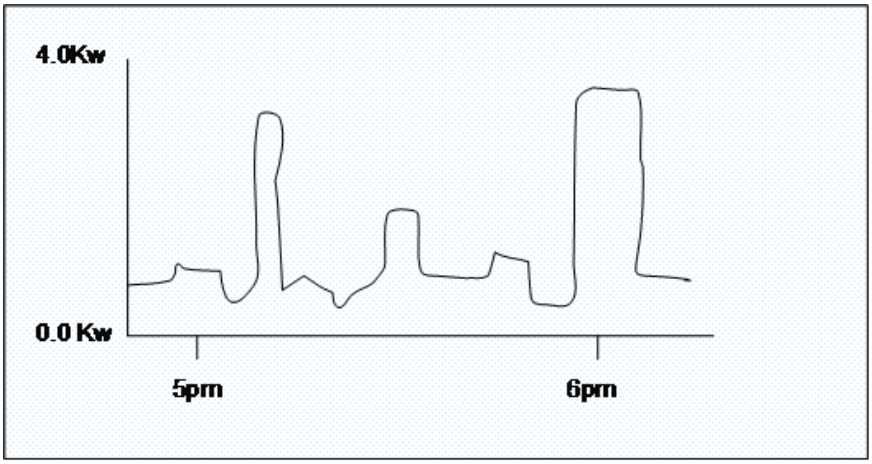
These figures are much lower than those provided by Ceres, which suggests figures of £300 and 2.5 tonnes of CO2 for a typical installation. I want to stress that the savings that I estimate also assume absolutely constant electricity demand and a perfect match between the amount of heat provided and household needs for hot water. Of course, real households have rapidly and erratically varying electricity needs and more consistent, but still highly unpredictable, hot water needs.

The other reasons why the Ceres forecasts of carbon and cash savings are unlikely to be met
I have suggested so far that the maximum saving from using the CHP stack would be achieved in a very big house with stable electricity demand and very high water needs. In the average UK house, needing 3,300 kWh of electricity a year, stable electricity demand and full use of the hot water heat, the CHP plant would save some carbon dioxide and a reasonable fraction of the home energy bill, though not as much as Ceres suggests.

Now I want to go to show that the rapidly varying electricity demand in an ordinary household, combined with the likely pattern of hot water need, will mean that a Ceres CHP plant will not save the householder significant sums of money or avoid much carbon emission.

There are six principal reasons for my scepticism:

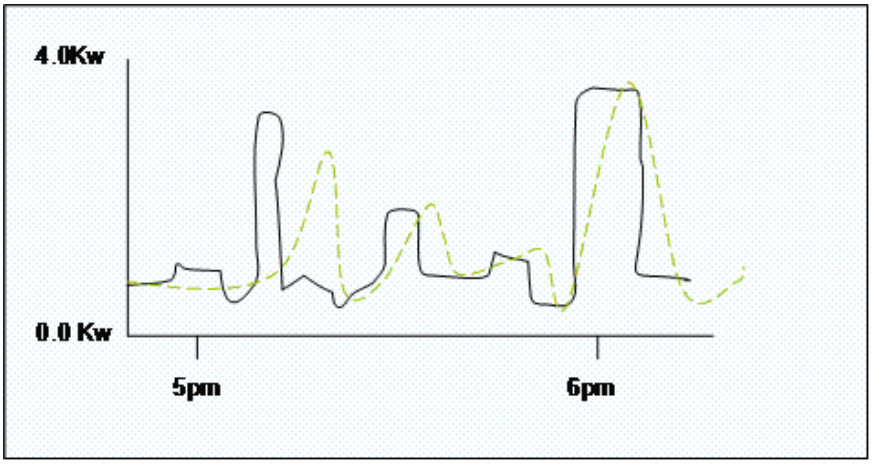
1. **The Ceres CHP plant does not react instantaneously to changes in electricity demand.** According to a company spokesperson, the stack may take over 5 minutes to adjust its output to the level of demand in the house. This is an extremely important failing. The chart below shows how demand in a typical house might vary over the course of an hour.



The swings in demand are sharp. The ‘baseload’ of the typical house might be 150-200 W or so, depending on the number of appliances on standby and other factors. When major appliances are switched on, the amount of electricity taken by a house will instantaneously rise to 3 kW or more. A kettle, for example, uses 3 kW, and is on for about 3 minutes. A dishwasher has quite low demand for part of its cycle, but uses large amounts of electricity when it is heating water. Refrigerators are using electricity some of the time, but not at other points. To give the most obvious example, if the Ceres CHP plant adjusts its output with a lag of five minutes, it will completely fail to meet any of the extra demand ever created by a kettle or a toaster. These two devices alone might be as much as 7% of electricity demand in some houses.

The output pattern of a CHP stack based on a fuel cell is likely to look very roughly like the dotted green line in the drawing below. The stack is often supplying power when it is not needed, but at other times is failing to

meet the household's demand.



This reduces the household's savings in electricity consumption, perhaps significantly. (Please note: the relatively small Ceres plant can only ever produce 1 kW, so not only would the output lag demand, but it will not meet the peaks.)

2. **The Ceres power-generating stack will generally not generate electricity at a level below 300 W.** In many houses, but not all, the baseload electricity demand is well below this minimum level. The Ceres machine can either be programmed to turn itself off when demand is lower than 300 W, or it can simply 'spill' the excess production back into the electricity network (for which the householder will generally not get paid). When I questioned Ceres about this, I was told that in most households, for most of the time, background demand is 300 watts or more. Ceres has done substantial work on the profile of household demand, so I defer to their findings. Nevertheless, it is worth pointing out that a household taking 300 watts all the time uses over 2,600 kWh a year on baseload alone, out of a total electricity use of 3,300 or 3,700 kWh.

   In my view it is inherently unlikely that baseload demand is such a very high fraction of total demand. (People often mention the high 'standby' demand of consumer electronics when discussing baseload, but total use from this source is very unlikely to exceed 50 W in the average house, or perhaps 60 W in houses with a Sky box. The underlying point is this – a household that is careful and economical with its electricity is unlikely to have a base demand as much as 300 watts. For households, buying a Ceres CHP plant means that a lot of electricity is going to be lost to the outside network or the Ceres machine will simply not be working most of the time.

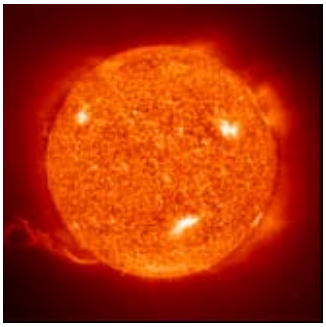
3. **And, perhaps more importantly, the Ceres power plant cannot generate more than 1 kW.** Most domestic households will frequently exceed this level during the average day. Any domestic appliance that heats water (kettle, dishwasher, tumble dryer, washing machine) uses two or three kilowatts for a substantial part of their operating cycle. At those times, the Ceres CHP will be able to fulfil only a small fraction of total electricity demand. Similarly, any machine with a large motor (a vacuum cleaner) or heating elements (toasters) will generally use much more than 1 kW. The Ceres unit will be unable to cope with these peaks. I don't have accurate figures but I suspect that electricity consumed in a typical house at times when total demand is over 1 kW may be as much as 30% of total usage. This demand is completely unmet by the Ceres device.
4. **The CHP plant responds to electricity demand; the useful heat produced goes to the hot water tank.** On days when not much electricity is produced, not enough heat will get to the hot water tank. Households use hot water primarily for washing. This does need does not fluctuate much each day. But electricity use varies greatly. It varies by time of year (winter higher than summer), it varies by the day of the week and by the hour of the day. At times, the heat produced when the CHP plant is generating electricity will not be enough to cover the hot water needs of the house. When I asked about this point, Ceres responded by saying that the central boiler will make up any deficiency. And indeed it can in most circumstances. But imagine the following scenario: water is taken from the tank at 10.30pm for showers. From that point on, electricity generation is very limited, largely because the house is on baseload use, probably less than 300 watts. The CHP plant may not be operating at all until the household gets up again in the morning. Therefore the central heating boiler will heat the water instead of the CHP device, so that the tank is ready for any morning draw of water. This is fine, but then the CHP plant is needed to generate electricity during the day. If the water is already hot, there will be nowhere for the heat to go and it will have to be dumped, or the CHP plant turned off. Once again, this will reduce the cash and carbon savings of the device.
5. **An analogous position arises when the house needs a lot of electricity and little hot water.** Imagine a big house with only two people in it who only take brief showers. Electricity demand is high, but hot water need is low. In these circumstances, the CHP plant will have to dump the heat or turn itself off. Savings will be

small.

6. **When the household is not present, the CHP machine will have to be turned off, or waste all its heat.** A house has continuing demand for electricity when unoccupied (perhaps when the household is taking a holiday) but not for hot water. The continuing demand may be lower than the 300-watt minimum, in which case the CHP plant may be off anyway, but it will still be wasting heat.

Our conclusions
The Ceres plant is an extraordinarily impressive piece of technology. It has solved major problems in applying fuel cell technology to small-scale installations and at low cost. Unfortunately, I think that the household savings are unlikely to be anywhere near as large as the company hopes. This will severely restrict potential demand.

Geo-engineering



Some scientists think that the world's halting attempts to reduce carbon emissions are bound to fail. So they have proposed various schemes for counteracting the global warming impact of fossil fuels. The Gaia scientist James Lovelock proposed an unusual and untested idea in a recent paper. He suggested that we install millions of pipes to bring nutrient-rich water to the surface to feed carbon sequestering organisms. Other scientists are working on schemes as diverse as mirrors that reflect part of the sun's energy, increased aerosol pollution to stop sunlight getting to the earth, and improving plankton growth by adding iron to the oceans.

All these schemes are 'offsets'; they seek to counter-balance the impact of human activities with schemes to reduce CO2 elsewhere. The technology optimists believe that one or more of these techniques can completely counteract human effects. The cost often seems very reasonable – in the billions rather than the trillions – and the technological challenges seem not insuperable. The pessimists say these schemes will have huge unintended effects, possibly worse than climate change itself, and that toying with 'geo-engineering' projects, as they are called, simply delays the day that the world starts to realise it must cut fossil fuel use. Geo-engineering deals with the symptoms, not the causes, of global warming. And none of the proposed schemes deal with the adverse effects of higher CO2 concentrations, such as increased ocean acidity.

This article argues that all the major geo-engineering proposals have substantial pitfalls, but that it makes clear sense to increase the research funding into these schemes. The opponents and proponents of geo-engineering have got locked into an almost theological debate as to the ethics of climate modification but this argument should be secondary to the need to have well-defined back-up plans in the event of increasingly rapid deterioration of the global climate.

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Geo-engineering
The idea of geo-engineering has a long history. John von Neumann thought that climate modification could be used to ensure drought in the Soviet Union during the Cold War. Von Neumann later foresaw 'forms of climatic warfare as yet unimagined'. More peaceful schemes for climate modification in the 1960s included spreading heat-absorbing soot across the Arctic ice in order to encourage melting and eventually increase temperatures across northern Canada and Siberia. In the 1970s the US military made a failed attempt to increase rainfall over the Ho Chi Minh trail to impede movement by North Vietnamese forces.

By the 1970s scientists were already beginning to propose schemes for future emergency remediation of the atmosphere to counter rapid increases in temperature or other effects of global warming. Contrary to many people's impressions, scientific papers on the dangers of fossil fuel burning began to be written as long ago as the late 1950s.

The main ideas for geo-engineering to counter global warming have evolved gradually, usually over a period of decades. They can be divided into two main categories: improving ocean take-up of carbon and reflecting more of the sun's energy.

- Ocean seeding of iron to increase plankton growth and sequester carbon.
- The Lovelock scheme is a variant of this.
- Mirrors in the upper atmosphere to reduce the amount of the sun's energy reaching the earth.
- Increasing the reflective aerosol content of the upper atmosphere, also to reflect more sunlight.

Seeding the oceans with iron

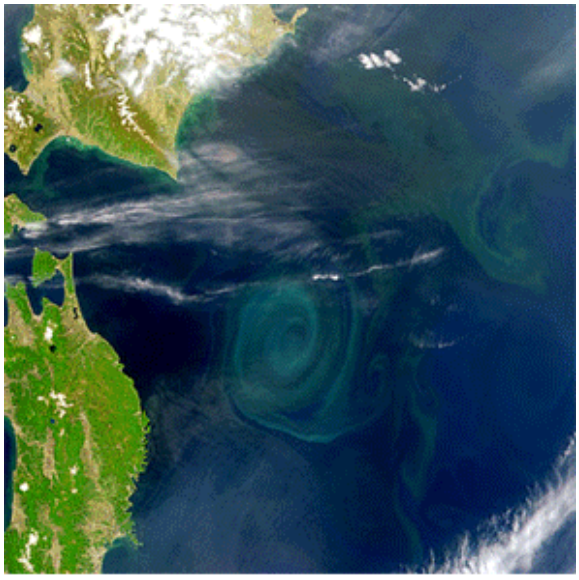
In some parts of the world the growth of ocean plankton is impeded by a lack of iron in the water. The advocates of ocean seeding say that seeding the ocean with more iron will enhance the growth rate of micro-organisms. Many experiments have confirmed that this is the case. This growth absorbs carbon. Approximately half of all photosynthesis on the planet is carried out by plankton, so this form of carbon capture is potentially extremely useful. It is also true that in many parts of the world's ocean plankton volumes appear to have fallen substantially, partly as a result of the warming of the oceans. So improved iron availability in the water may restore some part of the missing plankton. Increased plankton availability may also improve the volume of fish and birds up the food chain.

This much is largely agreed; the arguments come over whether the plankton stores carbon for a significant period of time.

The proponents of ocean seeding of nutrients say that when the organisms die they will sink to the ocean bottom and the carbon in their cells will be stored for centuries. The sceptics respond by expressing doubts as to whether the plankton sink, or simply rot near the surface; or, if they do sink, whether the carbon will be stored on the sea floor. So far, the evidence supports the sceptics.

This hasn't stopped attempts to use carbon sequestration by plankton as a commercial opportunity. Planktos, a US company, is just about to start an experiment by tipping one hundred tonnes of powdered iron into the Pacific, not far from the Galapagos Islands. The company sees the project as an attempt to understand whether seeding the ocean with iron can sequester carbon for long periods. Success would enable the company to start selling commercial offsets. Its critics say the experiments are just another form of pollution.

The dangers from the project are probably quite limited. The increase in oceanic iron will be measured in parts per trillion or less than the impact of Chinese sandstorms on the iron content in the western parts of the Pacific. This year's experiments by Planktos will probably show significant plankton growth, but are unlikely even to begin to convince the sceptics that the carbon taken up will be stored productively. But if it were to work, it would surely be quite inexpensive per tonne of carbon sequestered.



Plankton blooms off the coast

The Lovelock scheme

James Lovelock – along with Chris Rapley of the Science Musuem – proposes that the world considers placing millions of vertical pipes several hundred metres long in the world's seas and oceans. Cold water would come to the surface as a result of a one-way valve and the upward and downward moving of the pipe. Cold water from the deep contains more nutrients and the scheme is intended to encourage the growth of tiny sea creatures such as salps. These organisms excrete carbon-rich waste, which then falls to the ocean floor. As with the iron dust idea, the increased growth of sea-level organisms helps to capture carbon. Once again, the key question is how long the carbon is held for before returning to the atmosphere.

The scientists behind the proposal think that the pipes may also have the effect of increasing algae growth. This will add to the ocean's output of dimethyl sulphide, a chemical known to stimulate cloud formation, possibly helping to block sunlight from reaching the earth.

Lovelock and Rapley don't propose this scheme because it is the best way of dealing with climate change. They seem to be advancing the idea in despair at the slow pace of political endeavours to check emissions growth. By coincidence, their scheme is in the early stages of commercial development by Atmocean, a US company based in

New Mexico. As with Planktos, the immediate commercial applications of this technology seem non-existent. Their entrepreneurial drive must be based on a view that the carbon market will eventually reward businesses like these two for sequestering CO2. It has to be said that this is a brave gamble.

Mirrors in the atmosphere
The global warming impact of increased atmospheric CO2 can be counterbalanced by decreasing the amount of solar energy reaching the earth's surface. Instead the light energy could be reflected. The percentage of the sun's energy that needs to be reflected is quite small; perhaps one or two per cent.

This could be done by placing billions of small mirrors in the high portions of the atmosphere reducing the amount of light energy getting to the earth's surface. Despite this idea resurfacing regularly at scientific conferences, there appears to be no large-scale research trial planned.

Sulphate or other aerosols in the high atmosphere
Fine dusts thrown into the atmosphere reduce the strength of the sun's rays reaching the earth. We know this works because of the measurable impact of large volcanic eruptions that have spewed small particles into the air. The explosion of Mount Pinatubo in 1991 chilled the world by about 0.5 degrees the following year. Sulphates can be used as a countervailing pollutant to CO2.

Edward Teller, the main proponent of the US 'Star Wars' missile defence programme, wrote an article in 1997 suggesting that blasting enough reflective dust to chill the atmosphere would only cost a billion dollars a year.

This idea received powerful support over the last year from Nobel scientist Paul Crutzen who advocated further research into sending light-reflecting particles such as sulphates to the edges of the atmosphere. He and others have stressed that they view such schemes as last resorts but that the world needs to research these ideas further because of the possibility of extremely rapid warming at some stage in the future.

It does seem clear that we need to research this idea, however unattractive it seems. Blocking a portion of the sun's rays does not reduce the CO2 in the atmosphere so problems such the increasing acidification of the oceans will continue. The eruption of Mount Pinatubo did cool the world, but it also significantly changed rainfall patterns, causing drought in some areas.

In 1971 British meteorologist Hubert Lamb said that before we engaged in geo-engineering it would be 'an essential precaution to wait until a scientific system for forecasting the behavior of the natural climate…has been devised and operated successfully for, perhaps, a hundred years'. He was right, but we probably don't have the luxury of waiting.

The eco-homes at Bladon, near Oxford

New UK housing has insulation standards that do not come close to matching the best northern European levels. Individual homeowners and ethical investors have built single 'eco-homes' but a small new development in Bladon, Oxfordshire is among the first to be speculatively built by a mainstream housebuilder.

The new houses are not 'zero-carbon' and do not use the Passiv Haus technologies pioneered for low-emissions housing in Germany. But they are a substantial improvement on most mass-produced homes. Will they make the builder more money? No, says the company, but the experience it has gained will enable it to build eco-homes at a more competitive price in the future. These nine houses each cost over £40,000 more than their draughty Persimmon equivalents. The builder expects the price premium to be slightly less.

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At the edge of the Blenheim estate, nine new houses are almost completed. Clad in stone to fit in with the style of local buildings, these eco-homes are now being actively marketed by Kingerlee, a family-owned building company in Oxford. The homes are terraced two- and three-bedroom houses, typically 1,200 square feet, or about 50% larger than today's average new build property. (A smallish detached house might be about 2,000 sq ft.)

The site is a difficult one and access has not been easy. But Bladon is an attractive place to live and there would have been substantial competition for the land. The decision to risk building really well-insulated and robustly constructed housing was a brave one when demand was unknown.

The homes have six major improvements intended to guarantee better insulation and lowered utility bills:

- The walls are constructed from Ziegel blocks rather than the brick, air cavity and aircrete blocks construction

typical of UK homes. Ziegel blocks are made from clay with insulation being provided by the air passages inside the block. The blocks glue together, and there is no mortar course. This means much lower heat loss.

- The second major insulation improvement is in the loft, with Pavatex wood-based insulation boards and Warmcel, an insulator made from recycled newspapers.
- Ground floor thermal insulation is provided by 150mm of urethane.
- Far more focus on air tightness than most new builds
- Solar thermal panels for hot water
- Argon-filled double glazing

In addition, the ground floor has a wood-burning stove that is big enough to provide most of the heat needed on a cold day. Other house features will reduce water consumption and low-energy lightbulb fittings are standard.

The best measure of a house's likely energy consumption is its SAP rating. The Bladon houses average 86 (out of a maximum 100) compared to 75 or so for a conventional home built properly to today's building regulations. This may seem a relatively small improvement, but the builder thinks that the house will probably consume about 40% less gas than the average new build of the same size.

The company gave me some figures for construction costs. It estimates that the total bill, including all preparatory fees such as architects' bills, comes to about £170 per square foot, about 25% more than would be expected for an ordinary set of houses. Typically, therefore, the construction costs of the houses will be something over £200,000, perhaps £45,000 more than a standard unit.

Kingerlee says it expects this 25% premium to fall to about 15% or less. This is the first time construction sub-contractors have worked on properties of this type, and trades such as bricklayers had charged a substantial premium, even though laying Ziegel blocks is no more difficult than the UK's standard aircrete ('breeze blocks').

The houses are priced at about £400,000 each. According to the company, the premium over conventional homes of otherwise the same quality will be less than the £45,000 necessary to cover the incremental building cost. More optimistically, it thinks the lessons and experience gained in Bladon will enable future developments to cost less than the potential price premium it can attain.

It is important to note that the price premium will not be driven by a rational assessment of the capitalised value of the house's lower utility bill. If the Bladon houses consume 40% less gas, 10% less electricity and 15% less water than a comparable dwelling, the saving will be perhaps £500-600 a year. At today's mortgage rates, it certainly doesn't make sense to pay much more than £10,000 for this benefit.

Kingerlee thought that the buyers would be 'silver-haired'. The purchasers would be buying the house because it was extremely well-constructed with low maintenance costs and reduced utility bills. The good energy rating would make it easy to sell in the future. Kingerlee mentioned that the new Home Information Packs would give housebuyers written evidence of the energy efficiency of these homes.

These houses are strikingly attractive buildings and they are amongst the most energy-efficient homes built speculatively by a builder in the UK. Other developments, such as BedZed (Zero Emission Development) in SW London and the Ecos buildings in the south-west of England were not constructed with profit-maximising risk capital. Nevertheless, Kingerlee admits that the buildings do not come close to having a zero-carbon footprint. If it takes a 25% cost increment to make the progress we see at Bladon it may take another 25% to get to zero carbon. The government's generous plan to reduce stamp duty on new homes with no emissions looks like an offer that few will take up.

Straws in the wind: The Lib Dems' climate change paper

Both the Conservative and Lib Dem parties have produced position papers on climate change in the last few weeks. The Conservative document is over 500 pages long but contains very few specific proposals. To be harsh, it is little more than a prolonged agonising over whether the climate change problem can be addressed using conventional free-market mechanisms. The Lib Dem paper is a tenth of the length but does contain the outlines of a coherent set of policies.

This article analyses the Lib Dem proposals. It shows that the Lib Dems are prepared to use the price mechanism to choke off increasing demand for aviation. The party also contemplates extending the Emissions Trading Scheme beyond the 50% of the economy currently covered. On the other hand, it makes completely clear that it has no intention of raising the prices of energy and fuels to domestic consumers.

Although the party presents itself as the only UK political institution ready to grasp the need for an economy-wide carbon price that will bring down emissions by 30% in 2020, the detailed proposals are far less radical. In the material that follows, I try to tabulate the Lib Dem ideas, focusing on whether they use price, regulatory fiat or pious hope as the proposed means of emissions reductions. As in the Conservative paper, estimates of the costs and benefits of their policies are almost completely absent from the Lib Dem paper. It is a shocking commentary on British politics that no major party is prepared to quantify exactly how it proposes to shift taxes towards polluting activities and away from other sources.

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Aviation

Price mechanism	Regulatory or quantity limit	Exhortation, pious hope, warm words
Full inclusion in ETS, including pollutants other than CO2	No 'major' expansion of runways	The usual stuff about 'high-speed rail'
Fuel tax		
VAT on European flights		
Also air passenger duty of £10		

The Lib Dems' green credentials are at their clearest with aviation. The party seems to think it can get away with proposing serious restrictions on air travel. The party's environment spokesman, Chris Huhne, used to talk of allowing the aviation industry to grow at about 2.5% a year, but this figure has been dropped. The language in the policy paper is now much tougher.

The paper makes no acknowledgement of the severe legal difficulties in getting taxation applied to international air travel. The UK is hemmed in by hundreds of multilateral treaties that explicitly disallow taxation of cross-border air travel. VAT on national flights is easier and seems now to be the policy of all parties.

The Lib Dems also offer a quantitative constraint. At some points in the document they say their policy is 'no' expansion of runways. At others, it is 'no major' expansion. But they do seem to be completely committed to blocking new runways at the London airports.

Plans for high-speed rail links are given the conventional praise. There is no detail or explanation.

Cars

Price mechanism	Regulatory or quantity limit	Exhortation, pious hope, warm words
Widening the range of Vehicle Excise Duties (VED) depending on CO2 emissions of cars	Support for increase in mimimum biofuels content of motor fuels	Better public transport
Fuel tax escalator	Proposals for very severe limits on new car emissions	'Zero emissions' cars by mid-century

The banded VED is a potentially useful policy instrument in that it penalises cars pro-rata to their emissions. So far, it does not appear to have much effect on purchase decisions, but the evidence from other countries is that relatively small increases at the top end may now reduce demand for big-engined cars.

The Lib Dems support increasing petrol prices using a tax escalator tied to GNP growth. No doubt aware of the political sensitivity of the issue, they allow an escape, saying that the duty would not be increased at times of 'spikes in the oil price'.

The party wants to increase the biofuels obligation on petrol and diesel suppliers. (This proposal faced some opposition at the party conference.) Biofuels are a disaster in the making and we can expect the Lib Dems' enthusiasm to wane quietly over the next few years. In their case, it is particularly incompatible with their emphasis on using wood and other biomass for power generation. The world cannot feed an extra 3bn with its existing agricultural land if large acreages are handed for biofuels and for growing willow for power stations.

The party looks for impressively strict limits on new car emissions. The EU's wounding battle with German car makers

is forgotten as they advocate average fuel economy of less than 100g of CO2 per kilometre, or less than a Prius today. Their target is perfectly possible, but only with a rapid move to electric cars, lighter vehicles and smaller engines.

Importantly, there are very few words devoted to getting people to drive less. The Lib Dems like technology, not behavioural change.

Home heating

Price mechanism	Regulatory or quantity limit	Exhortation, pious hope, warm words
	New homes to meet the best European Passiv Haus style standards within a fewyears	A raft of measures to improve the insulation standards of existing houses
	Curious proposal to force electricity and gas retailers to sell less eachyear	

Home heating emissions are usually underestimated as a factor in the UK carbon footprint. The average house emits about 3 tonnes of CO2 a year from central heating boilers. (The Lib Dems actually exaggerate the figure, saying that heating is 90% of all domestic emissions; the figure is really about two thirds.)

Insulation standards that are lamentably poor by north European standards are partly responsible for the high fuel bills of the less well-off. The quickest and most efficient way of improving insulation on existing houses would be to double the price of domestic gas. This would produce the surge in do it yourself home insulation that the Lib Dems are looking for. But it would exacerbate the dire problem of fuel poverty in large sections of the community and cause deterioration in winter health, particularly among the elderly. (The UK has higher differences between winter and summer mortality than in much colder countries in Scandinavia.)

So the Lib Dems promise far more emphasis on cheap home insulation programmes rather than using a price signal. The language is not persuasive. For the majority of people in the community, gas bills are simply not high enough to make it worthwhile redoing the loft insulation to modern standards, blasting fluff into cavity walls, or even taking simple measures such as removing the letter flap in the front door. The Lib Dems use warm words but a truly radical programme would be one in which better insulation standards were forced on householders.

The Lib Dems also propose the most extraordinary idea. They suggest that they would oblige energy retailers to reduce the amount of electricity and gas that they sold every year. This is a half-thought-through wheeze that will be quietly dropped.

Food

Price mechanism	Regulatory or quantity limit	Exhortation, pious hope, warm words
		More R+D on diets that stop cows belching methane
		Defra to provide advice on GHG reduction on farms
		Support for anaerobic digesters for farm slurries

It is impressive to see the attention paid to agriculture. The greenhouse gases from the food supply chain may be over 15% of the UK total. Politicians and policy makers have usually ignored this source of emissions. But although the policy document devotes several pages to agriculture, it does not come up with specific and credible programmes.

Business and commerce

Price mechanism	Regulatory or quantity limit	Exhortation, pious hope, warm words

Widen the scope of the ETS to include more organisations		Decentralised space heating to be encouraged
Increase the reach of the new energy reduction commitment on smaller organisations		More 'smart metering'
Make all the allowances under the energy reduction commitment subject to auction		Lots of support for improving heat generation, but few specific proposals

The principal proposals for reducing energy demand in business are designed to put a high and stable carbon price on business activities. Detail is sketchy, perhaps because companies might otherwise publicly attack the proposals. But business should be in doubt that the Lib Dems want to see much higher energy costs in business. Energy efficiency will be fostered by putting almost all the business sector inside the cap and trade scheme. They also strongly support auctioning rather than the unforgivable present policy of donating permits to existing polluters.

Electricity generation

Price mechanism	Regulatory or quantity limit	Exhortation, pious hope, warm words
'Feed-in' tariffs for micro generators	National Grid will be obliged to fire up low-carbon generators first (!)	Swing to 'decentralised generation'
	No nukes	Sponsor a carbon capture and storage project
		Examine the way the planning process works
		Target of 30% renewables by 2020
		More emphasis on using biomass for generating electricity

Like the Conservatives, the Lib Dems think that high 'feed-in' tariffs for microgeneration are a good idea. (A 'feed-in' tariff is a special payment to small generators for the miniscule amounts of energy that they produce.) The Conservatives pick 45p per kilowatt hour, the Lib Dems appear to favour 40p.) Feed-in tariffs are a popular idea. Pundits speak glowingly of the influence of high tariffs on the growth of solar roofs in Germany and elsewhere. Nobody mentions the cost. Paying a householder 45p per kilowatt hour implies an electricity price of over ten times the current wholesale value of electricity. It seems a good idea, but would inevitably raise the price of electricity. Per tonne of carbon saved, high feed-in tariffs are absurdly expensive. The romanticisation of microgeneration should stop. There are good arguments for sustained support but a 40-45p tariff will provide the householder with a real post-tax return of almost 10% in the sunniest parts of the country. Feed-in tariffs at this level are a waste of money.

The Lib Dems start another strange hare running. The paper advances the idea that the National Grid should put power stations into service in the order of their carbon intensity. When demand is low, the Grid will call upon the lowest carbon generators. As demand rises, the climate criminals will be gradually turned on until the worst coal generators are at full steam. A quick study of the operation of the UK electricity market should have shown the Lib Dems that this proposal would involve tearing up the entire market apparatus of the purchase and sale of power in the UK. It seems to be news to the Lib Dems that we have a free market in electricity generation. Power users contract with power producers. The role of the National Grid is not to determine which power station is operating, but to balance the system so that exactly enough power is being generated to meet the minute-to-minute changes in demand.

The Conservatives equivocate over nuclear power but look as they will eventually support Labour plans to allow it; the Lib Dems are against. (This proposal was argued over at the party conference, but the policy was carried.)

Both the Tories and the Lib Dems argue in favour of sponsoring a carbon capture project at a power station. They both then support non-intervention, expecting that a full carbon price will make it economic for power generators to

install capture equipment. This is largely the same policy as that of the current government.

The paper is silent on the unavoidable conflict between the need to centralise the planning approval process and the Lib Dem policy of generally encouraging more local control. If the UK is to use its super-abundant resources of wind and tidal energy, planning decisions need to be taken out of local hands. Quite understandably, the Lib Dem paper makes no mention of this, nor of the importance of building the high voltage transmission line from Scotland that is vital to increasing the number of wind farms in the windy north.

Other measures

Price mechanism	Regulatory or quantity limit	Exhortation, pious hope, warm words
'Carbon tax'	Widening the scope of the ETS to cover all fuels in the economy	

The proposal for a 'carbon tax' in addition to the quantity limits imposed by the ETS is a striking, but very unclear, part of the proposals. There are no figures and very few details. It almost seems as though the idea was inserted in the document at the last minute, perhaps because of the widening view among academic economists that it is better to tax than cap.

There are also references to widening the scope of the ETS to include motor fuels at their point of production. In effect this brings the whole of the transport sector within the Emissions Trading Scheme. As in so many other areas, details are sparse and confused.

What is not here:

- No measures to decrease home electricity consumption. Very little on proposals to use labelling to improve efficiency.
- No support for local or community-based initiatives to curb energy use.
- Nothing significant on slowing travel growth. Very little on reducing private travel in favour of the use of public transport.
- As with the Conservatives, warm words for 'Personal Carbon Allowances' but no substantial support.

Tesco vs. Wal-Mart vs. carbon emissions

The rivalry between Tesco and Wal-Mart is well known. Tesco's imminent entry to the US heartland of the world's largest retailer may have created an extra edge to the battle. And, unsurprisingly, the two giants are squaring up over carbon issues as well as over such things as employee conditions and global sourcing policies.

Tesco said earlier this year that it would eventually put carbon labels on all its 70,000 food lines. It has been trying to find way of doing this using Life Cycle Analysis, putting a greenhouse gas cost on every element of a product's move from farm to plate. This was always a hugely over-ambitious project and recent weeks have seen the company drift back from its early optimism. Now Wal-Mart has come up with a similarly impossible dream – to use the Carbon Disclosure Project (CDP) to assess and manage the energy footprint of its suppliers. These big retailers know that they have to be seen to be doing something about greenhouse gases, so they have both launched incomplete schemes that will achieve little.

* * *

Wal-Mart will use the CDP to collect emissions data on all its suppliers.

On Monday 24 September, Wal-Mart participated in the annual presentation of the CDP in New York. On behalf of many of the world's major investment funds, CDP collects data on emissions from thousands of companies around the world. The funds backing this project manage about half the world's invested assets, so CDP has increasing clout.

For years Wal-Mart refused to participate in the CDP data collection process. The carbon footprint of the retailer is enormous, and it probably didn't want the numbers to be widely known. But the company's conversion to carbon reduction in the last two years has been rapid and genuine. It has committed to power all its stores with 100% renewable energy, a plan far in advance of Tesco or even Marks and Spencer.

Now Wal-Mart is not only taking an active role in the CDP, it has also publicly decided to ask all its 60,000 suppliers to do the same. As we so often hear, measuring carbon output is the first step in the process of reduction.

Wal-Mart's language is very different to the UK retailers. It consistently refers to the cost benefits of cutting the use of fossil fuels. Tesco might talk about responsibility to the widest group of outside stakeholders but Wal-Mart emphasises the role that energy use reduction can play in reducing supplier costs, and hence prices in the stores. John Fleming, the Wal-Mart executive presenting at the CDP conference, made clear that he didn't expect the prices of any of its goods to rise as a result of the move to lower emissions manufacturing and distribution. Tesco has said similar things, but with far less conviction in its corporate voice.

How big are the footprints of the largest retailers?

Wal-Mart's CDP report shows emissions of about 20m tonnes of CO2, equivalent to about 3% of the UK's total. Tesco reports a figure of 4m tonnes, of which about 2.3m is in the UK. These figures exclude the CO2 output of suppliers and the energy cost of the products when used or consumed. About half of the UK figure is electricity, and another quarter the emissions of the particularly nasty greenhouse gases used in almost all store refrigeration.

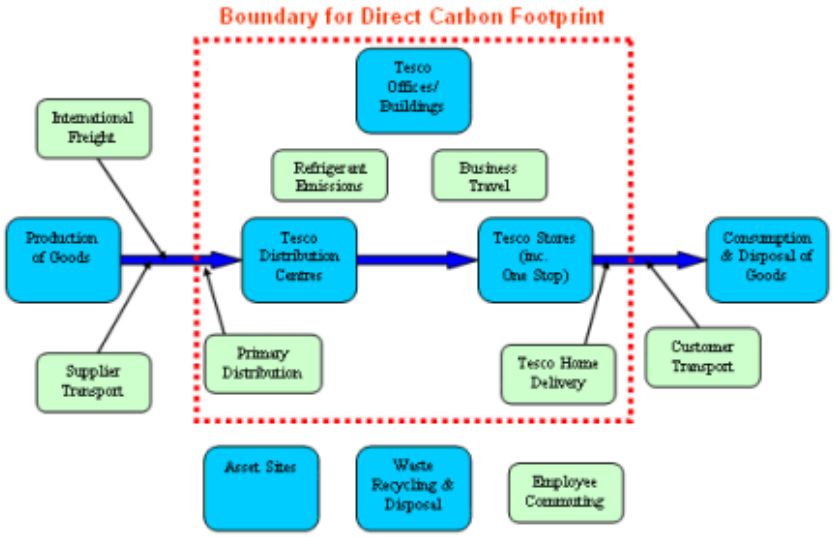
M&S does more detailed work on the supply chain. It estimates that its total CO2 output from retail operations and distribution fleet is about 0.6m tonnes. The figure it offers for suppliers is 3m tonnes, or five times as much. If the ratio was the same at Tesco UK, the activities of the company could account for over 10m tonnes of CO2 equivalents, or almost 2% of the UK total. Wal-Mart worldwide would be 100m, or almost one sixth of the total emissions of the UK. Wal-Mart matters, and it makes no attempt to hide this.

The efforts to manage down the total size of the footprint

Until recently, Wal-Mart and Tesco have focused on two areas – packaging and company-wide energy use:

- Packaging: Wal-Mart has said will reduce packaging use by 5% by 2013. Tesco has a much more ambitious target of 25% buy 2011.
- Energy use: Wal-Mart has set itself a challenge of being entirely powered by renewable electricity. Tesco says it will cut energy use by 50% between 2000 and 2010 (and is well on the way to achieving this).

Tesco's boundary for the calculation of its own footprint



Source: Tesco.com

There have also been competing initiatives on low energy light bulbs (Tesco: 10m in 2007; Wal-Mart: 100m this year) and on using micro-generation at new stores (little more than a token in either case).

The real battle between the two companies is over the carbon footprint of the products that they sell. If Marks and Spencer's numbers are right, this is unsurprising: the Tesco plan is to label all 70,000 foods sold in shops with a carbon label. Despite the obvious complexity and difficulty of this assignment, Tesco announced its commitment in January 2007. It asked Oxford's Environmental Change Institute (ECI) to work on a couple of projects to begin the marathon scheme of getting a carbon figure on every packet. A figure of £5m was thrown around as the budget for carbon label work, but this number is no longer mentioned by Tesco or the ECI. By the end of May, ECI team leader Brenda Boardman confessed to finding carbon labelling 'difficult' and Tesco called it 'problematic'.

And problematic it is. The food supply chain is complex and the carbon input to foodstuffs is immensely difficult to

calculate. Importantly, it isn't just CO2 – emissions of nitrous oxide, methane and the fluorinated refrigerant gases all need to be calculated. There is no consensus anywhere in the world on any single issue in the assessment of the carbon footprint of food. It will be decades before any shared understanding emerges and is widely agreed around the world.

Why did such a well-managed company as Tesco dive head first into the empty swimming pool of carbon labelling? The most plausible suggestion is that it had already stamped its authority on nutrition labelling and fought off regulatory challenge over 'traffic light' signs on products. One Tesco spokesperson said to me that the successfully rejected 'red, yellow, green' label would have put people off buying the worst products. She was apparently unconscious that is precisely what the Food Standards Agency had intended. Similarly, Tesco's pre-emptive plans for carbon labelling might have forestalled commercially dangerous labels imposed by other agencies. Now carbon labelling is just one of the potential projects at Tesco's new Sustainable Consumption Institute at Manchester University. The projects at Oxford have finished with a whimper. Tesco still says it will get some labels on its products, but the timescale has drifted far from the ambitious aims of early 2007.

Unsurprisingly, given the debacle over labels in the UK, Wal-Mart has gone a different route. But we will probably see the same unhappy result.

Wal-Mart has teamed up with the UK-based Carbon Disclosure Project not to calculate the footprints of each *product*, but to measure the energy use of each *supplier*. This is, at least in theory, a much simpler task. Wal-Mart may have almost as many suppliers (60,000) as Tesco has UK food products (70,000) but merely reading the electricity and gas meters at 60,000 factories is a minute fraction of the effort that would have gone into carbon labelling.

This is what John Fleming of Wal-Mart said at the CDP conference:

> Using CDP's carbon reporting expertise and our own experience with supply chain efficiency…we are working together…to measure our global supply chain footprint and to encourage our suppliers to reduce greenhouse gas emissions

What is wrong with this apparently innocuous scheme?

- The CDP is not set up to be much more than a repository of data. Many of the submissions that it accepts from companies are incomplete, but all the data it receives seems to be published. The CDP is an extremely important initiative, but the Project does not have the skills to use the returns from 60,000 companies in a meaningful way. As Tesco is finding, carbon footprinting is a complicated task that needs to be done by specialists. CDP is no substitute.
- Wal-Mart is probably the biggest single customer for a large percentage of its 60,000 suppliers, but neither it nor the CDP is able to tell how much of the carbon footprint of suppliers should be allocated to the goods supplied and sold to Wal-Mart. A growing company selling an increasing fraction of its goods outside Wal-Mart might have increasing emissions. How will Wal-Mart deal with this? It certainly won't look good to competition authorities if Asda, for example, puts pressure on suppliers to reduce emissions just because they are selling more to Tesco.
- Wal-Mart said that it would work initially with companies in seven sectors, including soft drinks and DVDs to identify the full carbon footprint. But in most of these categories the main carbon impact is probably further up the supply chain, in the suppliers of Wal-Mart's suppliers. For example, the manufacture of slab aluminium and then its conversion into cans may well use far more energy than the mixing of the sweet syrup that is the main manufacturing function of a cola company. To be an interesting measurement, all the energy inputs across the whole supply chain will need to be measured. Do this, and Wal-Mart will end up with the same problem as Tesco – an unmanageably complex analytical task even for two of the most competent companies in the world.
- The CDP focuses very largely on carbon dioxide. But CO2 is often not the dominant greenhouse gas in food production. Nitrous oxide and methane on farms are just as important. Measuring these gases, even if Wal-Mart wanted to, is an order of magnitude more difficult than CO2. Some of the same problems also apply to refrigerant gases.

It is very good news that Wal-Mart has decided that there is business logic in reducing the energy use of its suppliers. But, despite its significant strengths, CDP is not a credible partner. The complexity of the methodological issues faced in carbon footprinting means that the partnership is likely to fail. And failure means a further delay in getting greenhouse gases out of the food supply chain.

Companies mentioned in this newsletter: Tesco, Wal-Mart, Marks & Spencer, Ceres Power.