Stu's Notes #13

Stu's Notes provide selected passages from books that are of interest to Stu. They are primarily direct quotes, though some longer passages are summarized. They do not generally provide a thorough synopsis of the book. Rather, they capture individual facts or opinions of interest, which may or may not be reflective of the overall text.

Title: **Heat: How to Stop the Planet from Burning**

Author: George Monbiot

Publisher: Doubleday Canada

Published: 2006

Stu's Notes: 2006 November 26

Summary: *Chapters 1 through 3 make the case for dealing with climate change: 90% per capita greenhouse gas reduction by 2030. Chapters 4 through 10 explore good and bad ideas for saving energy and producing clean energy. Topics include: homes, electricity generation, surface transportation, air transportation, shopping, concrete, and carbon offsets.*

Highlights:

90% per capita greenhouse gas reductions by 2030 [p.15-16]

Passivhaus [p.68]

Carbon capture and storage [p.84-89]

DC power transmission, including its potential to overcome the intermittency problem of renewables [p.104-117]

Sensors or timers on appliances, to run at off-peak times [p.116 & 130]

Combined heat and power [p.131-132]

Cars running on leased, interchangeable batteries [p.165]

Jet air travel needs to be virtually eliminated: use airships? [p.170-188]

Buying food remotely, from warehouses [p.191-196]

5% to 10% of our carbon dioxide comes from cement [p.198-199]

Ineffectiveness of some or all carbon offset schemes [p.211-212]

Foreword to the Canadian Edition

Emission statistics for different nations are from "International Energy Annual 2003", Energy Information Administration, 2005. [p.ix]

"You think of yourselves as a liberal and enlightened people, and my experience seems to confirm that. But you could scarcely do more to destroy the biosphere if you tried." [p.ix]

Canada needs to cut emissions by 94%, by 2030. [p.x]

Introduction: The Failure of Good Intentions

"If in the year 2030, carbon dioxide concentrations in the atmosphere remain as high as they are today, the likely result is two degrees centigrade of warming (above pre-industrial levels). Two degrees is the point beyond which certain major ecosystems begin collapsing. Having, until then, absorbed carbon dioxide, they begin to release it. Beyond this point, in other words, climate change is out of our hands: it will accelerate without our help. The only means, Forrest argues, by which we can ensure that there is a high chance that the temperature does not rise to this point is for the rich nations to cut their greenhouse gas emissions by 90 per cent by 2030. This is the task whose feasibility *Heat* attempts to demonstrate." [p.xvii-xviii]

"Whether or not we enjoy the soft life (and I suspect that some of those who advocate its dissolution would be among the first to perish in the wilderness), it is politically necessary to discover the means of sustaining it. This book seeks to devise the least painful means of achieving a 90 per cent cut in carbon emissions. It attempts to reconcile our demand for comfort, prosperity and peace with the restraint required to prevent us from destroying the comfort, prosperity and peace of other people." [p.xviii]

1: A Faustian Pact

"In the Antarctic, scientists watched stupefied in 2002 as the Larsen B ice shelf collapsed into the sea."

> **Footnote 36:** "The collapse is described by the scientists who saw it in an article by John Vidal, 'Antarctica Sends 500 Million Billion Tonne Warning of the Effects of Global Warming', Guardian, 20 March 2006." [p.5]
>
> Note: correction posted with the above article at www.guardian.co.uk indicates that the correct amount is 500 billion tonnes.

Discussion of methane (the West Siberian bog) and thermohaline circulation. [p.11]

Monbiot's Rationale for a 90% Per Capita GHG Reduction by 2030

"We have a short period – a very short period – in which to prevent the planet from starting to shake us off. Our aim must be to stop global average temperatures from rising to more than 2° above pre-industrial levels, which means more than 1.4° above the current point. Two degrees, because it has been widely recognized by climate scientists as the critical threshold, has sometimes been characterized as a 'safe' level of warming. As I hope this account has shown, it is merely less dangerous than what lies beyond. [p.15]

"Two degrees, because it has been widely recognized by climate scientists as the critical threshold, has sometimes been characterized as a 'safe' level of warming. As I hope this account has shown, it is merely less dangerous than what lies beyond. A conference of scientists convened by the UK's Met Office warned that at less than 1° above pre-industrial levels, crop yields begin to decline in continental interiors, droughts spread in the Sahel region of Africa, water quality falls and coral reefs start to die. At 1.5° or less, an extra 400 million people are exposed to water stress and another 5 million to hunger, 18 per cent of the world's species will be lost and the 'onset of complete melting of Greenland ice' is triggered. There are, I am afraid, some effects of climate change which cannot be avoided.

"Two degrees is important because it is the point at which some of the larger human impacts and the critical positive feedbacks are expected to begin. If we do not greatly reduce our emissions, temperatures are likely to reach that point in about 2030.

"My correspondent Colin Forrest, who is not a professional climate scientist but appears to have done his homework, argues his case as follows. Researchers at the Potsdam Institute for Climate Impact in German have estimated that holding global temperatures to below 2° means stabilizing concentrations of greenhouse gases in the atmosphere at or below the *equivalent* of 440 parts of carbon dioxide per million. While the carbon dioxide concentration currently stands at 380 parts, the other greenhouse gases raise this to an equivalent of 440 or 450. In other words, if everything else were equal, greenhouse gas concentrations in 2030 would need to be roughly the same as they are today.

"Unfortunately, everything else is not equal. By 2030, according to a paper published by scientists at the Met Office, the total capacity of the biosphere to absorb carbon will have reduced from the current 4 billion tonnes a year to 2.7 billion. To maintain equilibrium at that point, in other words, the world's population can emit no more than 2.7 billion tonnes of carbon a year in 2030. As we currently produce around 7 billion, this implies a global reduction of 60 per cent. In 2030, the world's people are likely to number around 8.2 billion. By dividing the total carbon sink (2.7 billion tonnes) by the number of people, we find that to achieve stabilization the weight of carbon emissions per person should be no greater than 0.33 tonnes. If this problem is to be handled fairly, everyone should have the same entitlement to release carbon, at a rate no greater than 0.33 tonnes per year.

"In the rich countries, this means an average cut by 2030 of around 90 per cent. The United Kingdom, for example, currently releases 2.6 tonnes per capita, so would need to reduce its emissions by 87 per cent. Germany requires a cut of 88 per cent, France of 83 per cent, the United States, Canada and Australia 94 per cent." [p.15-16]

Footnote 114: see pages 191-199 (actually pages 177-185, Chapter 18) of http://www.defra.gov.uk/environment/climatechange/internat/pdf/avoid-dangercc.pdf, which says:

“Below a 1°C increase the risks are generally low but in some cases not insignificant, particularly for highly vulnerable ecosystems and/or species. Above a 1°C increase risks increase significantly, often rapidly for vulnerable ecosystems and species. In the 1–2°C increase range risks across the board increase significantly, and at a regional level are often substantial. Above 2°C the risks increase very substantially, involving potentially large numbers of extinctions or even ecosystem collapses, major increases in hunger and water shortage risks as well as socio-economic damages, particularly in developing countries.”

Chapters 11, 28 and 36 of this document are also useful.

Footnote 115: see page 11 (actually page 1) of http://www.wbgu.de/wbgu_sn2003_engl.pdf, which says:

“The key goal of the UNFCCC is to stabilize greenhouse gas concentrations at a level that would prevent dangerous anthropogenic interference with the climate system. Article 2 of the Convention defines this in specific terms: Ecosystems are to be able to adapt naturally to climate change, food production is not to be threatened and economic development is to be able to proceed in a sustainable manner. The Council has examined each of these three criteria with regard to the threshold from which climate impacts would no longer be tolerable. The present state of science does not yet make it possible to derive these ‘guard rails’ stringently and quantitatively from the climate impacts that must be prevented. The WBGU was thus limited to providing a qualitative assessment, based on its own expertise and on commissioned external reports and study of the literature.

“With regard to ecosystems, the effects of climate changes are already apparent today. The threshold from which damage to the global natural heritage is no longer acceptable cannot be determined precisely. However, the WBGU estimates it to be in the range of 2°C global warming relative to pre-industrial values. For worldwide food security, too, the threshold appears to be in this range, as above this global warming level worldwide climate-related losses in agricultural production must be expected, as well as a steep rise in the number of people threatened by water scarcity. Concerning health impacts, no tolerance threshold can currently be appraised due to poor data availability and a lack of mature methodologies. However, it can be assumed that for some regions the effects of climate change would already lead to intolerable impacts at 2°C mean global warming. Moreover, climate change has the potential to trigger singular, catastrophic changes in the Earth System, such as a shift in worldwide ocean circulation, the melting of major ice sheets (West Antarctic, Greenland) or the sudden release of huge methane reserves. Quantitative assessments of the threshold values for these effects are beset with great uncertainty.

> "**The WBGU's recommendation: A maximum of 2°C warming is acceptable**
>
> "The WBGU reaffirms its conviction that in order to avert dangerous climatic changes, it is essential to comply with a 'climate guard rail' defined by a maximum warming of 2°C relative to pre-industrial values. As the global mean temperature has already risen by 0.6°C since the onset of industrialization, only a further warming by 1.4°C is tolerable. A global mean long-term warming rate of at most 0.2°C per decade should not be exceeded.
>
> "This climate window should be agreed as a global objective within the context of the UNFCCC process. The European Union should seek to adopt a leading role on this matter."
>
> **Footnote 122:** provides a link to the referenced work of Colin Forrest, which underlies this analysis. However, the link is not current, and I have been unable to find the work posted elsewhere.

"Because the carbon released now stays in the atmosphere for some 200 years, and causes climate change many years into the future, there is perhaps a 30 per cent chance that we have already blown it. We might already be committed to 2°." [p.17]

2: The Denial Industry

"As people in the rich countries – even the professional classes – begin to wake up to what the science is saying, climate-change denial will look as stupid as Holocaust denial, or the insistence that AIDS can be cured with beetroot. But our response will be to demand that the government acts, while hoping that it doesn't. We will wish our governments to pretend to act. We get the moral satisfaction of saying what we know to be right, without the discomfort of doing it. My fear is that the political parties in most rich nations have already recognized this. They know that we want tough targets, but that we also want those targets to be missed. They know that we will grumble about their failure to curb climate change, but that we will not take to the streets. They know that nobody has ever rioted for austerity." [p.41-42]

3: A Ration of Freedom

"One of the arguments made by those who claim that we should take no action is that if the same amount of money were spent on relieving hunger, or supplying clean water, or preventing AIDS or tuberculosis or malaria, it would save more lives. This approach tends to overlook the fact that climate change is likely to cause more hunger, more water stress and more communicable diseases, thereby raising the cost of addressing them. But this is not the principal argument against it. Behind this case is an unfathomable assumption: that money spent on preventing climate change is money not spent on foreign aid. In other words, it supposes that the climate-change budget is in direct competition with the rich countries' foreign aid budgets, rather than with any other kind of spending." [p.53-54]

"It is a choice between state spending on climate change or state spending on coal, oil, roads, farm subsidies, environmental destruction and unprovoked wars. We would do well to ask why governments seem to find it so easy to raise the money required to wreck the biosphere, and so difficult to raise the money required to save it." [p.56]

"If we in the rich nations do not act to prevent it, we are likely, over that period, to have more money in our pockets than if we do. We could spend that money on – well, on what exactly? More cars, more flights, more Barbie dolls, more tiger prawns? More roads, more farm subsidies, more wars? In either case it is hard to see how these delights will compensate for the damage to our lives that climate change will cause." [p.57-58]

4: Our Leaky Homes

The Khazzoom-Brookes Postulate: that increasing energy efficiency reduces the cost of making things, and so more things are made, and total energy demand actually increases. [p.61]

The *passivhaus* has no active heating or cooling system, though it does have a low-energy heat exchanger that transfers 80% of the heat from the air being expelled to the air being drawn in. [p.68]

"Soon after Angela Merkel became Chancellor of Germany in November 2005, she announced that her government would be spending the equivalent of £1 billion a year to ensure that 5 percent of the homes built before 1978 were refurbished to meet high energy efficiency standards: within twenty years every house in the country will be airtight and well-insulated." [p.73]

"A fridge or freezer which uses vacuum-insulated panels to stay cold burns about 12 percent of the energy of the average model used today, but simply cannot be found for sale through the usual channels in the United Kingdom. Because electricity remains so cheap, and the incentives to conserve it are so slight, the great potential of new technology is mostly being squandered." [p.75]

"In Japan and Australia by contrast, the government finds the most efficient model and insists that by a certain date all others must match it. The House of Lords alleges that because of the timidity of our rules, Europe is now becoming 'a dumping-ground for less efficient goods'." [p.76]

Consumption declines if we know how much we're consuming (smart metering, etc.). [p.76-77]

"In other words, there are limits to energy efficiency, even within a cap and rationing system. The Environmental Change Institute's figures suggest that the maximum reduction of energy use in housing by 2030 is likely to be a little over 30 per cent: around one third of my target. What this means is that most of the cut will have to be made by changing the sources of the energy our buildings use: in other words by producing fuel and electricity whose carbon content is as low as possible. This task, which is much harder than many people – especially the advocates of renewable energy – have led us to believe, is the subject of the next three chapters." [p.78]

5: Keeping the Lights On

Carbon capture and storage starts on p.84.

"If burying carbon is to be used as a means of tackling climate change, it cannot also be used as a means of recovering oil." as this would lead to more oil being used in vehicles, where carbon capture is not feasible. [p.87]

"… the International Energy Agency (IEA) believes that 'Large-scale carbon capture and storages is probably ten years off, with real potential as an emission mitigation tool from 2030 in developed countries.' At first sight, in other words, it appears to be too far away to make a major contribution to meeting our target. But as I will show at the end of this chapter, estimates like the IEA's could be unduly pessimistic. I have come to believe that this technology, alongside others which have been judged 'too far away', can, with sufficient political commitment, be widely deployed long before 2030. The difficulties I have encountered while investigating the other technologies have persuaded me that carbon capture and storage – while it cannot provide the whole answer – can be and must be one of the means we use to make low-carbon electricity." [p.89]

"Despite all the uncertainties I have encountered, I think I have grounds for making my decision. Because of the industry's record of corner-cutting, because of its association with the proliferation of weapons of mass destruction and because of the unresolved questions about waste disposal and the energy balance, I will provisionally place nuclear power second from last in my list of preferences, just above generation using coal from open-cast mines. And I will propose carbon capture and storage as a partial solution to the problem. The current state of the technology and the replacement rate of power stations suggest that, with sufficient political will, gas-fired power stations fitted with carbon capture equipment could provide roughly 50 per cent of our grid-based electricity by 2030. A greater contribution than this, however, is unlikely, so to reach my target I will have to look elsewhere. The obvious alternative is renewable energy. But how much of our electricity can it supply, and at what cost?" [p.99]

6: How Much Energy Can Renewables Supply?

Huge potential for wind turbines. Make off-shore turbines larger than today (10 MW instead of existing max. 3 MW. On-shore turbine is already at practical maximum of 2 MW because, "… there are no lorries big enough to carry longer blades." [p.103]

Stu's question: Are there no other means of transporting larger blades (e.g., helicopter)?

> **Footnote 10:** see http://www.worldbank.org/html/fpd/em/transmission/technology_abb.pdf.

A wider range of more remote generating sites becomes feasible if you switch to DC power, which has lower resistance over longer distances (e.g., 650 km at present, and that range is falling rapidly). "There is no inherent limit on the length of a DC cable. Already there is a line in the Democratic Republic of Congo that is 1,700 kilometres long." [p.104]

“What this means is that you can draw your electricity from a far greater area than before. High voltage DC, which can be run along the sea bed, opens up any patch of sea shallower than 50 metres to wind turbines, and pretty well all the continental shelf to wave power devices, which (because they float) can be anchored at great depths. Since wind speeds rise by around one metre per second with every 100 kilometres from the shore, this means that the cost of renewable power could actually fall with distance from the coast.” [p.104-105]

“But it’s not just new wind and wave power that the long lines could exploit. At the moment there is an inverse relationship between the availability of solar power and human habitation. It is most concentrated and most reliable in deserts. For years, rogue environmentalists have been pointing out that solar electricity generated in the Sahara could supply all of Europe, the Gobi could power China, and the Chihuahuan, Sonoran, Atacama and Great Victoria deserts could electrify their entire continents. These people have been dismissed as nutters. The development of cheap DC cables suggests that they might one day be proved right.” [p.105]

The intermittency problem means you need spare generation capacity from conventional sources. Or harness private standby generators at peak times. Or intermittent sources that are spaced very far apart, so that their intermittencies are not correlated. Or a massive energy storage system (e.g., pumping water from a low reservoir to a high one). Or have appliances (e.g., refrigerators) that automatically switch themselves off at peak times. He ultimately guesstimates that renewables can supply 50% of Britain’s electricity needs. [p.107-117]

“In other words, if my guesses are correct, all our electricity could be produced by two kinds of low-carbon generators: power stations burning gas whose exhausts are stripped of carbon dioxide, and renewable power plants, stationed either on our own soil or hundreds of kilometres away, and connected to the grid by means of long-distance cables. An electricity system running entirely on these two kinds of power (and conventional generators fired up to meet shortfalls in supply) would produce no more than 15 per cent of the carbon emissions currently released by our electricity suppliers. In combination with the efficiencies I discussed in Chapter 4, this would achieve an overall reduction of almost 90 per cent. But I am sorry to say that, ambitious as this proposal is, it solves only part of the problem.” [p.117]

This is because it doesn’t solve the problem of providing heat. Growing biofuels is limited by available land & water, and would drive up the price of food for poor people. Solar heating has limited potential in Britain, “… as the capital costs of installing the system are high, and the sun here is weak.” [p.117-121]

Ground source heat pumps have modest potential, but biogas (landfill methane) has essentially none. Considering all renewable sources for heat, “… I have located only 46.5 per cent of the 1.2 exajoules of heat I was seeking.” [p.121-123]

It is subsequently noted [p.141] that “Around half of our grid-based electricity could be supplied, as I suggested in Chapter 6, by means of a few very large power stations burning methane – either in the form of natural gas or the effluvium from underground coal gasification – and burying the carbon dioxide they produce. The other half, if my meta-guess is correct, could be provided by offshore wind and wave machines.”

7: The Energy Internet

Proposes a system of micro-generation, based in homes and businesses. This involves scrapping the national electric grid.

One source could be solar photovoltaic. But northern countries don't get that much sun. And peak energy demand tends to be at night, in winter. We could put timers on our clothes washers and dishwashers to run at off-peak times, when the sun is out.

"Here are two facts you seldom see on the same page. Solar photovoltaic cells pay for themselves after 25 to 35 years. Solar photovoltaic cells have a life expectancy of 25 to 30 years. At the moment you cannot make your money back. This relationship will soon start to improve, however." [p.130]

Prospects are worse for micro wind power. It doesn't work well if the wind is weak, gusty, or turbulent; which tends to be the case in urban areas. Other than rural areas, they might work on high-rise buildings. [p.130-131]

A more promising option is 'domestic combined heat and power'. "When I report that our power stations have an average efficiency of 38.5 per cent, I mean that the majority of the energy they produce escapes in the form of heat. Using government figures, the energy campaigner Chris Dunham has shown that our demand for heat is roughly equal to the heat wasted by our thermal power stations. The micro generation enthusiasts hope to turn two problems into one solution." [p.131-132]

"The idea, at its simplest, is that instead of using a boiler to produce only hot water and heating for your home, you use a tiny power station to produce heat and electricity at the same time." [p.132]

But the system is not particularly effective in reducing greenhouse gases, unless it could be switched away from natural gas to another fuel, but there are no obvious candidates. [p.133-134]

Voices some hope for hydrogen, by creating hydrogen from natural gas and capturing the carbon. Various challenges, including creation of a hydrogen distribution network (unless the hydrogen was manufactured locally). [p.134-139]

8: A New Transport System

"The production of carbon dioxide by land transport should be easier to solve than the other problems this book addresses. Everyone can see how inefficient the transport system is: thousands of people, one to each overpowered car, heading in the same direction every day then heading back again. The technologies and economic policies required to address it have been available for decades. Far from costing more money, a rational, efficient system, producing 10 per cent current emissions or less, would save us billions. But the real problem is neither technological nor economic. It is political, or more precisely, psychological." [p.142]

Carbon dioxide emissions (kg) for a trip from London to Manchester: car 36.6, train 5.2, bus 4.3. [p.147] (the straight-line distance is approx. 300km)

City buses should have dedicated lanes, leading to coach terminals at the motorway. Dedicated lanes on the motorways. Lower emissions & more frequent service than trains. [p.148-150]

Faster roads carry fewer people, because you need more space between the vehicles. "… the capacity of the M25 moves from 15,000 – 20,000 in cars to 260,000 in coaches." [p.150]

Buses need "… good leg room, seat quality, work stations, food, drinks and media stations … In other words these vehicles can be an elite form of road travel … Coaches, in principle, are another form of stretch-limousine." [p.151]

This coach concept "… does not solve all our transport problems. As a means of addressing climate change, it would work only with the help of two other policies: the capping and rationing of the carbon we use, and the capping and rationing of the road space we use. … Reaping the carbon benefits of Storkey's proposal means giving buses and coaches some of the lanes that cars now use, rather than building new lanes to accommodate them." [p.153]

"Confronted with the twin disasters of climate change and an impending oil peak, it is hard to see how anyone could justify the assertion that the need to drive a car which can accelerate from 0 to 60 miles an hour in 4.5 seconds (the Audi S4 for example) overrides the Ethiopians' need to avoid recurrent famines, or the whole world's need to avoid the economic catastrophe we'll suffer if petroleum peaks too soon. The speed and acceleration of our cars is a form of profligacy at which all future generations will goggle." [p.154-155]

"In 1991, the Rocky Mountain Institute in the United States published a design for a 'Hypercar' which, it claimed, could save at least 70 – 80 percent of the fuel other models used. The Institute's critical innovations involved massive reductions in the vehicle's weight and drag. It proposed that the steel body should be replaced with carbon fibre composites, Kevlar or fibreglass and that the underside of the car be made as smooth as its roof. Then, like the Toyota Prius, it would use a 'hybrid-electric drive' (powered by a combination of liquid fuel and an electric motor) which could turn the energy now lost when the car brakes into electricity.

"Fifteen years later, though the Institute's design seems to be viable, safe and cheap, and some of its features have been incorporated into real models like the Prius, nothing resembling the whole package has been launched as a mass-market car on either side of the Atlantic." [p.156]

People like the idea of biofuels, but there are two problems. One is the finite amount of land and water. Poor people would be pushed into starvation. "The market responds to money, not need. People who own cars – by definition – have more money than people at risk of starvation: their demand is 'effective', while the groans of the starving are not. In a contest between cars and people, the cars would win." [p.159]

And forests around the world would be cut down to create new plantations to grow the biofuels. [p.159-160]

Hydrogen may be feasible, if the price comes down enough. There's the chicken-and-egg problem of getting refuelling infrastructure. Car hydrogen tank would need to be ten times the size of a gasoline tank, or extremely high pressure. [p.161-164]

"Alternatively, there might be a means of overcoming the main drawback of the electric vehicle. Electric cars already exist, and some new models are as fast as any vehicle needs to be. But its range is limited by the capacity of the battery: the best ones run out after 100 – 300 miles and take hours to recharge. The energy expert Dave Andrews suggests a simple solution: the cars should use batteries provided by a network of filling stations. As the battery runs down, you pull into a station, pay a fee and swap it for another one. The stations could charge their batteries from electricity provided by offshore wind farms when the wind is blowing strongly and demand is low. This means that the carbon costs would be roughly zero, surplus wind power would not be wasted and the financial costs would remain small, as the power is bought when it is cheap. This looks like a far simpler and less costly means of reducing the carbon content of transport fuel than a hydrogen network. Given that the alternatives are so much easier to develop, our government's obsession with hydrogen cars seems incomprehensible." [p.165]

"In her excellent book Car Sick, the transport analyst Lynn Sloman, drawing on surveys conducted in Australia, three English towns and a rural area in mid-Wales, derives what she calls 'the 40:40:20 rule'. Irrespective of location, some 40 per cent of current car journeys could already be made by bicycle, on foot or by public transport. Another 40 per cent could be made by other means if public transport or cycling facilities were improved. Roughly 20 per cent of car journeys cannot be swapped." [p.166]

Discusses TravelSmart-style directed marketing, minimum bus service requirements, more flexible bus systems (e.g., shared taxi service), good intermodal connections, walking school buses, car-free shopping (see Chapter 9), telecommuting, carpooling (including with connections made on the Internet). [p.166-169]

"It is not hard to see how a universal switch to hypercar technologies or electric vehicles and a return to lower speeds and lower standards of performance, accompanied by car sharing, tele-commuting, a car-free shopping scheme, better public transport and better facilities for cyclists and walkers, could cut emissions by more than 90 per cent across the journeys that Storkey's system could not replace. But the problem is political, not practical. We need governments to start deciding how best to run a transport system, rather than how best to accommodate the private car. That means confronting a lobby which appears to become more confident by the year, as the libertarian politics encouraged by driving make any limitations on drivers harder to achieve. The longer governments prevaricate, the less plausible substantial change becomes; the problem which in other respects is the easiest in this book to fix is in danger of becoming insoluble." [p.169]

9: Love Miles

'Eco-vacations' ignore the environmental cost of getting there. [p.170-172]

“There are two reasons why flying dwarfs any other impact a single person can exert. The first is the distance it permits us to cover. According to the Royal Commission on Environmental Pollution, the carbon emissions per passenger mile ‘for a fully loaded cruising airliner are comparable to a passenger car carrying three or four people’.” [p.173]

“On a return flight from London to New York, every passenger produces roughly 1.2 tonnes of carbon dioxide: the very quantity we will each be entitled to emit *in a year* once a 90 per cent cut in emissions has been made.

“The second reason is that the climate impact of aeroplanes is not confined to the carbon they produce. … The overall impact, according to the Intergovernmental Panel on Climate Change, is a warming effect 2.7 times that of the carbon dioxide alone. This is mostly the result of the mixing of hot wet air from the jet engine exhaust with the cold air in the upper troposphere, where most large planes fly. As the moisture condenses it can form condensation trails which in turn appear to give rise to cirrus clouds – those high wispy formations of ice crystals sometimes known as ‘horsetails’. While they reflect some of the sun’s heat back into the space, they also trap heat in the atmosphere, especially at night. … While the different warming effects are not directly comparable, because carbon dioxide stays in the atmosphere for much longer than condensation trails or cirrus clouds, if we were to multiply the carbon emissions produced on that round-trip to New York by 2.7, we would, of course, exceed our annual allowance on that journey by the same factor.” [p.173]

“Unless something is done to stop this growth, aviation will overwhelm all the cuts we manage to make elsewhere.” [p.174]

“You might wonder how the British government reconciles this projection with its commitment to cut carbon emissions by 60 per cent by 2050. The answer is that it doesn’t have to. As the Department for Transport cheerfully admits, ‘International flights from the UK do not currently count in the national inventories of greenhouse gas emissions as there is no international agreement yet on ways of allocating such emissions.’

“This is a remarkable evasion. It is true that there is ‘no international agreement yet’. But a child could see that you simply divide the emissions by half. The country from which passengers depart or in which they arrive accepts 50 per cent of the responsibility.” [p.174-175]

“The one certain means of preventing the growth in flights is the one thing the British government refuses to do: limit the capacity of our airports.” [p.176]

“As far as aircraft engines are concerned, ‘breakthrough technologies’ appear to be a long way off.” [p.178]

“The only technology which does offer a major improvement in fuel efficiency, creates fewer condensation trails (because it is used at lower altitudes) and is known to work is one plucked not from the future but the past: the propeller plane.” [p.179]

Carbon dioxide emissions (kg) for a trip from London to Manchester (updated to include planes): plane 63.9, car 36.6, train 5.2, and bus 4.3. [p.180] (the straight-line distance is approx. 300km)

Alternative fuels (to kerosene) are problematic. Biodiesel does poorly at low temperatures. Ethanol is insufficiently dense and, in aeroplanes, extremely dangerous. Hydrogen could be burned in combustion engines (not fuel cells), but it contains four times less energy by volume than kerosene, and produces 2.6 times as much water vapour as a plane running on kerosene. [p.180-182]

"And that, I am afraid, is it. As the Intergovernmental Panel on Climate Change discovered, 'there would not appear to be any practical alternatives to kerosene-based fuels for commercial jet aircraft for the next several decades.'" [p.182]

We could switch to high-speed trains. They're not as fast as planes, but you travel directly from one city centre to another and have shorter check-in times, so they can compete (on travel time) for many routes. High capital cost. [p.182-183]

"Though trains travelling at normal speeds have much lower carbon emissions than aeroplanes, a discussion paper by Professor Roger Kemp of Lancaster University shows that energy consumption rises dramatically at speeds over 200 kmph. Increasing the speed from 225 kmph to 350 kmph, he reveals, almost doubles the amount of fuel they burn. If the trains are powered by electricity, and if that electricity is produced by plants burning fossil fuels, then a journey from London to Edinburgh by a train travelling at 350 kmph, Kemp's figures suggest, would consume the equivalent of 22 litres of fuel for every seat. An Airbus A321 making the same journey uses 20 litres per seat." [p.184]

"Travelling to New York and back on the *QEII*, in other words, uses almost 7.6 times as much carbon as making the same journey by plane." [p.185]

Airships are a possibility. "… their top speeds are currently confined to around 130 kmph: a flight from London to New York would take 43 hours. They also have trouble landing and taking off in high winds and making way if the wind is against them. This makes both take-off times and journey times less reliable than those of jets. But if we really have to cross the Atlantic, and we are to prioritize the reduction of carbon emissions, airships, surprisingly, might be the best kind of transport."

We need to cut air travel by over 96 per cent. [p.186]

"I have sought the means of proving otherwise, not least because it would make my task of persuading people to adopt the proposals in this book much easier. But it has become plain to me that long-distance travel, high speed and the curtailment of climate change are not compatible. If you fly, you destroy other people's lives." [p.188]

10: Virtual Shopping

We need to eat more locally-grown food. [p.190-191]

We need to buy food remotely from warehouses. Stores use too much energy to keep you warm and the food cold, and do it inefficiently. They also use bright lighting and fancy packaging to make the food look good. And too much energy is used by us, driving to / from the store. [p.191-196]

"Local shops (which are less dependent on cars) could remain open, but they would have to start introducing the kind of efficiency measures which apply to the rest of the economy." [p.196]

"… every new home requires about 5 tonnes of cement, which emits 5 tonnes of carbon dioxide. Even if we were to forget about all the other materials from which a house is built, this equates to four times a single person's annual carbon ration in 2030. Altogether, depending on whose figures you believe, cement produces between 5 and 10 per cent of the world's manmade carbon dioxide." [p.198-199]

Can capture carbon dioxide, but burial sites are not always convenient to limestone deposits (the source of cement). [p.199]

AirCrete brings air into the mix, like baking bread. Thus need less cement. But process needs aluminium powder. "Though much smaller quantities are used, the energy costs of smelting aluminium are around forty times as great as the energy costs of manufacturing cement." [p.200]

Could go with High Strength Concrete: need less volume. But need silica fume and finely ground fly ash. "The problem is that the industries which produce silica fume are moving out of the rich nations, which means that the carbon costs of transport will rise, while fly ash is, on the whole, the product of burning coal in power stations, which I am seeking to prevent." [p.200]

Solution is 'geopolymeric cements', which are cheap, and "… their fabrication produces between 80 and 90 percent less carbon dioxide than Portland cement." [p.202]

"I can't pretend that my proposals are anything other than extremely challenging. They can be implemented only if tackling climate change becomes the primary political effort not just in our own country but in all rich nations. They require a good deal of money and a great deal of political will and expertise to enact. But what I hope I have demonstrated is that it is possible to save the biosphere. If it is possible, it is hard to think of a reason why it should not be attempted. It is true that this effort will disrupt our lives. But it will cause less disruption than the alternative, which is to allow manmade global warming to proceed unhindered." [p.203]

11: Apocalypse Postponed

"Underlying this denial is the dissonance with which we face all possible catastrophes: plagues, wars, famines, even death itself. I might be deeply afraid of the impending disaster, but I am also confident that – through the grace of God or the other sources of good fortune that have preserved me so far – it will not apply to me." [p.205]

Explores some ineffective attempts to remove carbon dioxide from the atmosphere. [p.208-209]

Peak oil could help with climate change (by reducing oil consumption) or hinder it (by increasing coal consumption). [p.209]

Discusses the purchasing of ‘carbon offsets’. “Planting trees, for example, means not planting – or not leaving – something else on the same land. You have no means of knowing what, in twenty years’ time, might have stood in their place. If the answer is other trees, then to determine the real carbon uptake caused by your actions, you would have to subtract the carbon that might have been from the carbon that is. As you have no means of determining the value of the first figure, you have no means of completing the sum.” [p.211]

“More importantly, a tonne of carbon saved today is far more valuable, in terms of preventing climate change, than a tonne of carbon saved in twenty years’ time, for the reasons I discussed in Chapter 1.” [p.211]

Similar problem with buying LED light bulbs for poor nations: the benefits come over many years.

“At best these schemes merely delay the point at which emissions are saved. At worst, they allow us to believe that we can carry on polluting, just as, before the Reformation, the sale of absolutions encouraged people to believe that they could carry on sinning.” [p.212]

“But my main objection is this: that in order to deliver a carbon cut of the size I have discussed, *everyone* will have to limit their emissions, either today or, in the poorer nations, in the future. There is no choice to be made about whether to abstain from flying or to help poorer people buy better lightbulbs. We must abstain from flying *and* help poorer people buy better lightbulbs. Buying and selling carbon offsets is like pushing the food around on your plate to create the impression that you have eaten. [p.212]

Governments are moving slowly because people don’t really want them to succeed at reducing emissions. Only if citizens become directly involved will progress be made. [p.213-215]