

Introduction

The Failure of Good Intentions

The god thou servest is thine own appetite.

Doctor Faustus, Act II, Scene 1¹

Two things prompted me to write this book. The first was something that happened in May 2005, in a lecture hall in London. I had given a talk about climate change, during which I had argued that there was little chance of preventing runaway global warming unless greenhouse gases were cut by 80 per cent.² The third question stumped me.

'When you get your 80 per cent cut, what will this country look like?'

I hadn't thought about it. Nor could I think of a good reason *why* I hadn't thought about it. But a few rows from the front sat one of the environmentalists I admire and fear most, a man called Mayer Hillman. I admire him because he says what he believes to be true and doesn't care about the consequences. I fear him because his life is a mirror in which the rest of us see our hypocrisy.

'That's such an easy question I'll ask Mayer to answer it.'

He stood up. He is 75, but looks about 50, perhaps because he goes everywhere by bicycle. He is small and thin and fit-looking, and he throws his chest out and holds his arms to his sides when he speaks, as if standing to attention. He was smiling. I could see he was going to say something outrageous.

'A very poor third-world country.'

At about the same time I was reading Ian McEwan's novel *Saturday*. Henry Perowne comes home from his game of squash and steps into the shower.

When this civilisation falls, when the Romans, whoever they are this time round, have finally left and the new dark ages begin, this will be one of the first luxuries to go. The old folk crouching by their peat fires will tell their disbelieving grandchildren of standing naked mid-winter under jet streams of hot clean water, of lozenges of scented soaps and of viscous amber and vermilion liquids they rubbed into their hair to make it glossy and more voluminous than it really was, and of thick white towels as big as togas, waiting on warming racks.³

Was I really campaigning for an end to all this? To ditch the comforts Perowne celebrates and which I – like all middle-class people in the rich world – now take for granted?

There are aspects of this civilization I regret. I hate the lies and the political corruption, the inequality, the export of injustice, the military adventures, the destruction of wild places, the noise, the waste. But in the rich nations most people, most of the time, live as all prior generations have dreamt of living. Most of us have a choice of work. We have time for leisure, and endless diversions with which to fill it. We may vote for any number of indistinguishable men in suits. We may think and say what we want, and though we might not be heeded, nor are we jailed for it. We may travel where we will. We may indulge ourselves 'up to the very limits imposed by hygiene and economics'. We are, if we choose to be, well-nourished. Women – some women at any rate – have been released from domestic servitude. We expect effective healthcare. Our children are educated. We are warm, secure, replete, at peace.

For the first two million years of the history of the genus *Homo*, we lived according to circumstance. Our lives were ruled by the vicissitudes of ecology. We existed, as all animals do, in fear of hunger, predation, weather and disease.

For the following few thousand years, after we had developed a rudimentary idea of agriculture and crop storage, we enjoyed greater food security, and soon destroyed most of our non-human predators. But our lives were ruled by the sword and the spear. We fought, above all,

for land. We needed it not just to grow our crops but also to provide power – grazing for our horses and bullocks, wood for our fires.

Then we began to discover some of the opportunities afforded by fossil fuels. No longer were we constrained by the need to live on ambient energy; we could support ourselves by means of the sunlight stored – in the form of carbon – over the preceding 350 million years. The new fuels permitted the economy to grow – to grow sufficiently to absorb some of the people dispossessed by the previous era's land disputes. Industry and cities boomed. Forced together within the workplace and the warren, the dispossessed could start to organize. The despots empowered by the seizure of land were forced to loosen their grip.

Fossil fuels helped us to fight wars of a horror never contemplated before, but they also reduced the need for war. For the first time in human history – indeed for the first time in biological history – there was a surplus of available energy. We could survive without having to fight someone for the resources we needed. Our freedoms, our comforts, our prosperity are all the products of fossil carbon, whose combustion creates the gas carbon dioxide, which is primarily responsible for global warming. Ours are the most fortunate generations that have ever lived. Ours might also be the most fortunate generations that ever will. We inhabit the brief historical interlude between ecological constraint and ecological catastrophe.

Oh, those distant, sunny days of May 2005, when I believed this problem could be solved with a mere 80 per cent cut! After my talk, a man called Colin Forrest wrote to me. I had failed, he explained, to take note of the latest projections. He sent me a paper he had written whose argument (which I will explain at greater length in the next chapter) I could not fault.⁴

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.

By 'feasibility' I mean compatibility with industrial civilization. Within the environmental movement there are some people who regard the preservation of this state as an unworthy goal. The slogan of North American EarthFirst!, for example, is 'Back to the Pleistocene'. But even if you would prefer to be running around in skins, chasing or being chased by giant aurochs, advocating a return to the economy of the Stone Age is futile, for the great majority of people find this prospect unappealing. Even demanding the restitution of a largely agricultural society, or the economy of 'a very poor third-world country' would be pure self-indulgence. 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. And though I began the search for these solutions almost certain that I would be unsuccessful, I now believe it can be done.

Heat is both a manifesto for action and a thought experiment. Its experimental subject is a medium-sized industrial nation: the United Kingdom. It seeks to show how a modern economy can be decarbonized while remaining a modern economy. Though the proposals in this book will need to be adjusted in countries with different climates and of greater size, I believe the model is generally applicable: if the necessary cut can be made here, it can be made by similar means almost anywhere.

I concentrate on the rich nations for this reason: until we have demonstrated that we are serious about cutting our own emissions, we are in no position to preach restraint to the poorer countries. The rich world's most common excuse for inaction can be expressed in one word: China. It is true that China's emissions per person have been rising by around 2 per cent a year.⁵ But they are still small by comparison to our own. A citizen of China produces, on average,

2.7 tonnes of carbon dioxide a year. A citizen of the United Kingdom emits 9.5, and of the United States, 20.0.⁶ To blame the Chinese for the problem, and to claim that their rapacious appetites render our efforts futile, is not just hypocritical. It is, I believe, another manifestation of our ancient hysteria about the Yellow Peril.

After looking at what the impacts of unrestrained climate change might be, and at why we have been so slow to respond to the threat, I begin my search for solutions within my own home. I show how years of terrible building, feeble regulations and political cowardice have left us with houses scarcely able to perform their principal function, which is keeping the weather out. I look at the means by which our existing homes could be redeemed and better ones could be built, and discover what the physical and economic limits of energy efficiency might be.

I then seek to determine how best their energy might be supplied. Before I began my research on that subject, I thought it would be quite easy to cover: I would need only decide whether we should use wind, waves or solar power, or nuclear energy, or biomass, or a means of stripping carbon dioxide from the exhausts of power stations. But the more I read, the more difficult and contradictory the questions became. The three chapters dealing with this issue are the most technically complex in the book. I believe – though by the skin of my teeth – that I might have found a workable solution.

Next I show how a new system for land transport could cut carbon emissions by 90 per cent with scarcely any reduction in our mobility. But when I come to examine aviation, I discover that there are simply no effective technological solutions: in this chapter I have failed in my attempt to reconcile the luxuries we enjoy with the survival of the biosphere, and I am forced to conclude that the only possible answer is a massive reduction in flights.

Then I look at two industrial sectors – retailing and cement manufacture, both of which produce disproportionate amounts of carbon dioxide – and propose some radical means by which shops can stay in business and houses can be built without melting the ice caps. I have tried throughout this account to identify the methods that are cheapest, that have already been shown to work and that are most compatible with the lives we lead already.

I would like to believe that the changes I suggest could be achieved by appealing to people to restrain themselves. But though some environmentalists, undismayed by the failure of the past forty years of campaigning, refuse to see it, self-enforced abstinence alone is a waste of time.

What is the point of cycling into town when the rest of the world is thundering past in monster trucks? By refusing to own a car, I have simply given up my road space to someone who drives a hungrier model than I would have bought. Why pay for double-glazing when the supermarkets are heating the pavement with the hot air blowers above their doors? Why bother installing an energy-efficient lightbulb when a man in Lanarkshire boasts of attaching 1.2 million Christmas lights to his house? (Mr Danny Meikle told journalists that he needs two industrial meters to measure the electricity he uses. One year his display melted the power cable supplying his village.⁷ The name of the village – which proves, I think, that there is a God – is Coalburn.)

And which of us – except perhaps Mayer Hillman – can really claim to live as we urge others to live? Most environmentalists – and I include myself in this – are hypocrites. I know of a British climate-change campaigner who spends her holidays snorkelling in the Pacific, and she doesn't get there by bicycle. One friend – a prominent environmentalist – burns coal on an open fire. Another – a biodiversity campaigner – serves tuna steaks to his guests. In an interview with the *Guardian* conducted in Las Vegas, Chris Martin, the lead singer of Coldplay, spoke about the songs on his album *X&Y*.

Twisted Logic is an intense, angry track encouraging people to make the right decisions about how they live their lives and how they treat the planet.⁸

A few paragraphs later, he revealed that he was about to

fly by private jet to Palm Springs, 35 minutes from Las Vegas. The band can now afford to fly wherever possible, and the increased privacy and speed mean that Apple will be able to join her father on tour more often. 'I certainly don't want her to stay at home all the time,' Martin says. 'As she gets older, hopefully she'll come out as and when she wants. I always thought it'd be cool to be in school and say, "I'm not coming in today –

I'm off to Costa Rica to see my dad play." I do think that wins you a few points.⁹

At the beginning of his *Organic Bible*, the green gardener Bob Flowerdew explains that organic gardening means 'minimizing ecological damage and making best use of resources'.¹⁰ He goes on to boast that 'when most people are only planting their [new potatoes] on Good Friday, as is traditional in the UK, I am eating mine.'¹¹ How? By growing them in a heated greenhouse.

We might buy eco-friendly washing-up liquid and washable nappies. But we cancel out any carbon savings we might have made ten thousand-fold whenever we step on to an aeroplane. Our efforts are tokenistic. By and large, whatever our beliefs might be, we consume as much as our incomes allow. Environmentalism is for other people.

What this means is that changes of the kind I advocate in this book cannot take place without constraints which apply to everyone, rather than to everyone else. I am sorry to say that only regulation – that deeply unfashionable idea – can quell the destruction wrought by the god we serve, the god of our own appetites. Manmade global warming cannot be restrained unless we persuade the government to force us to change the way we live.

I have mentioned that one of the gifts fossil fuels have granted us is freedom: freedom to choose how we should live, to go where we wish, to buy what we want. A 90 per cent cut in our emissions of carbon dioxide is, I admit, an inherently narrow constraint. I did not invent it – it is what the science appears to demand. But within that constraint, we should be free to live as we wish. The need to tackle climate change must not become an excuse for central planning. The role of government must be to establish the limits of action, but to guarantee the maximum of freedom within those limits. And it must help us by ensuring that even within those constraints, life remains as easy as possible. In Chapter 3 I explain how this might best be done.

I am not writing this book to confirm what you believe to be true. Many of the things I say will disturb and upset people who have taken an interest in this subject. As always, I seem destined to offend everyone. But I am sorry to report that an extraordinary amount of

rubbish has been written by well-meaning people about tackling climate change. It is hard to see how it helps us to pretend that certain measures work when they do not.

Let me give you an example. In 2005 the environmental architect Bill Dunster, who designed the famous BedZed zero-carbon development outside London, published a brochure purporting to show how homes could best be refurbished. 'Up to half of your annual electric needs,' it claimed, 'can be met by a near silent micro wind turbine.'¹² The turbine he specified has a diameter of 1.75 metres.¹³ He suggested it be attached to the gable end of the house. It looks like a bargain, as it costs only £1000.

Later that year the magazine *Building for a Future*, which supports renewable energy, published an analysis of micro wind turbines. It found that a 1.75 metre turbine would produce about 5 per cent of a household's annual electricity demand.¹⁴ To provide the 50 per cent Bill Dunster advertises, you would need a turbine 4 metres in diameter.¹⁵ If you attached a beast like this to the gable end of your house, the lateral thrust it exerted would rip the building to bits. Though it did not say as much, the magazine's analysis made it clear that micro wind turbines are a waste of time and money. In most environmental circles this admission is heresy.

One of the discoveries I have made in writing this book is that my instincts are almost always wrong. Like many environmentalists I have succumbed, for example, to what could be described as the aesthetic fallacy: I have made the mistake of confusing what is aesthetically pleasing with what is environmentally sound. For instance, I have always assumed that candles are more environmentally friendly than electric lighting, for no better reason than that I like them and that they produce less light. In his excellent textbook on energy systems, Godfrey Boyle points out that in terms of the light given off per watt of expended power, a candle is 71 times less efficient than an old-fashioned incandescent bulb, and 357 times worse than a compact fluorescent model.¹⁶ The same applies to oil lamps. Boyle notes that

It is quite remarkable that the complex process of choosing to burn a litre of kerosene in an engine, to drive a generator, to power a fluorescent

lamp, can produce 250–450 times more useful light than burning the same amount in an oil lamp.¹⁷

Nothing here is as it seems. The research for this book has involved me in a long series of surprises. I am sure that they will continue long after it is published, as my findings and proposals are challenged and refined by others. But what I have sought to do throughout the text is to start from first principles, to believe nothing until it is demonstrated, to junk any technology, however pleasing it may be, which does not work. What I am attempting to do is to find the least painful means of making real cuts, rather than the least painful means of being seen to do something.

One of the hardest tasks I have faced is deciding whom to trust. Many of those who have written about climate change have economic interests in the outcome. In some cases, as I will show in Chapter 2 (*The Denial Industry*), these interests have been heavily disguised: the oil companies, for example, speak with many voices. On the other side, environmentalists – as the example I have given suggests – have often made wild claims unsupported by verifiable facts. In some cases such claims support their own economic interests, though these are generally undisguised. One rule I have devised for myself is to trust no one who has something to sell. By tracing the statements different people have made back to their roots, I have developed a kind of hierarchy of credibility.

When trying to decide which solutions work and which ones don't, the organizations I have found most useful are learned societies and special committees – such as the Royal Commission on Environmental Pollution, the House of Lords Science and Technology Committee and the House of Commons Environmental Audit Committee – and academic institutions, such as Oxford University's Environmental Change Institute, the Tyndall Centre on Climate Change, the UK Energy Research Centre and the US National Academy of Engineering. Their reports draw together hundreds of years of collective experience. The International Energy Agency and the US Energy Information Administration, though partisan, are useful sources of raw data. Rather to my surprise, given that it has become so closely associated with spin and the massaging of figures, I have also found

most of the British government's technical reports to be reliable: the data seem to be manipulated only after they have been collected. For news about technological developments, I've found *New Scientist*, *Energy World* and *Building for a Future* especially helpful.

When attempting to determine what climate change will do to the planet, the choice, at first sight, seems simpler: the most credible sources are peer-reviewed academic journals, and particularly the most illustrious ones, such as *Science* and *Nature*. But the science – as science always should be – is contradictory and confusing. There is no 'answer'; simply a story with many tellers, which changes every day. From time to time, committees of scientists try to reach an overview. The most eminent of these, bringing together thousands of researchers, is the Intergovernmental Panel on Climate Change (IPCC), which produces an 'assessment report' every few years. Another useful summary was provided by a conference run by the UK's Meteorological Office in 2005, which tried to work out the total impacts of climate change on different ecosystems and human populations.

But not all the topics I have investigated have been covered by these distinguished bodies. In some important respects they have abandoned us. It has been left to amateurs to try to perform the carbon-cutting calculation I explain in Chapter 1, and to work out a fair method of deciding how the right to pollute should be allocated. None of the official reports I have read will tell you how much electricity a micro wind turbine produces or, for that matter, what percentage of our electricity can be generated by wind or wave or solar power without causing the national grid to collapse. So I have been forced either to rely on less august sources or to try to work out the answers for myself.

In other cases there is too much data, by which I mean that the bodies I have learnt to trust have produced conflicting estimates, and I have no means of deciding which one should be believed. This is especially true when it comes to the costs of energy, over which there is a remarkable degree of dispute. In these cases, I have published a range of estimates.

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I have one purpose in writing this book: to persuade you that climate change is worth fighting. I hope I have been able to demonstrate that it is not – as some people (notably the geophysicist James Lovelock) have claimed – too late. In doing so, I hope to prompt you not to lament our governments' failures to introduce the measures required to tackle it, but to force them to reverse their policies, by joining what must become the world's most powerful political movement.

Failing all that, I have one last hope: that I might make people so depressed about the state of the planet that they stay in bed all day, thereby reducing their consumption of fossil fuels.

A Faustian Pact

*The framing of this circle on the ground
Brings whirlwinds, tempests, thunder and lightning
Doctor Faustus, Act II, Scene 1¹*

There was more than one Faust. The name, which means 'the fortunate' in Latin, was used by German magicians much as conjurers today might call themselves 'the magnificent' or 'the incredible'. But we know which one he was. In 1513 in Erfurt a Conrad Mudt heard an 'immoderate and Foolish Braggart' describe himself as the 'demigod from Heidelberg'.² His name was 'Georg Faust'. In 1528, a 'Jörg Faust' was thrown out of the town of Ingolstadt, and in 1532 a 'Dr Faust, the great sodomite and necromancer' was denied entry to Nuremberg.³ People were plainly afraid of him. When he died in Württemberg in 1540 or 1541, the locals claimed that the Devil had taken him home.

After his death, his story began to spread, and in 1587 an amplified version was published by an anonymous theologian in Frankfurt.⁴ Two years later it was translated into English as *The History of the Damnable Life and Deserved Death of Doctor John Faustus*. This was the source for Christopher Marlowe's play *The Tragical History of Doctor Faustus*, which appears to have been written in 1590.

Marlowe tells the story of a brilliant scholar, 'glutted . . . with learning's golden gifts',⁵ who reaches the limits of human knowledge. Bored by terrestrial scholarship, he plots, by means of necromancy, to break into

... a world of profit and delight
Of power, honor, of omnipotence.⁶

When, he believes, he has acquired his demonic powers, spirits will fetch him everything he wants:

I'll have them fly to India for gold,
Ransack the ocean for orient pearl,
And search all corners of the new-found world
For pleasant fruits and princely delicates.⁷

So Faustus draws a circle and summons the Devil's servant, Mephistopheles. He offers him a deal: if the Devil will grant him twenty-four years in which to 'live in all voluptuousness',⁸ Faustus will, at the end of that period, surrender his soul to hell. Mephistopheles explains the consequences, but the doctor refuses to believe him.

Think'st thou that Faustus is so fond to imagine
That, after this life, there is any pain?
Tush, these are trifles and mere old wives' tales.⁹

So the bargain is struck and signed in blood, and Faustus acquires his magical powers. With the help of a flying 'chariot burning bright', he takes a sightseeing tour around Europe. He performs miracles. He summons fresh grapes from the southern hemisphere in the dead of winter. After twenty-four years, the devils come for him. He begs for mercy, but it is too late. They drag him down to hell.

If you did not know any better, you could mistake this story for a metaphor of climate change.

Faust is humankind, restless, curious, unsated. Mephistopheles, who appears in the original English text as 'a fiery man',¹⁰ is fossil fuel. Faust's miraculous abilities are the activities fossil fuel permits. Twenty-four years is the period – about half the true span – in which they have enabled us to live in all voluptuousness. And the flames of hell – well, I think you've probably worked that out for yourself.

In 1590 the economy was powered largely by wood, water, wind and horses. The English did burn some fossil fuel: we know, for example, that in 1585 London imported about 24,000 tons of coal.¹¹

That coal would have provided as much energy as the United Kingdom now consumes in half an hour.*

Liquid fossil fuels were not to be widely used for almost three centuries. Europe was submerged in the Little Ice Age: temperatures were one to one and a half degrees cooler than they are today. Science, with a few exceptions, was a muddle of alchemy, theology and magic. If man-made climate change had taken place by then, the people of the sixteenth century would have had no means of detecting it. *The Tragical History of Dr Faustus* is not an allegory of climate change. But the intention of the poet does not affect the power of the metaphor. Our use of fossil fuels is a Faustian pact.

To doubt, today, that manmade climate change is happening, you must abandon science and revert to some other means of understanding the world: alchemy perhaps, or magic.

Ice cores extracted from the Antarctic show that the levels of carbon dioxide and methane in the atmosphere (these are the two principal greenhouse gases) are now higher than they have been for 650,000 years.^{14,15} Throughout that period, the concentration of these gases has been closely tracked by global temperatures.¹⁶

Carbon dioxide (CO₂) levels have been rising over the past century faster than at any time over the past 20,000 years.¹⁷ The only means by which greenhouse gases could have accumulated so swiftly is human action: carbon dioxide is produced by burning oil, coal and gas and by clearing forests, while methane is released from farms and coal mines and landfill sites.¹⁸

Both gases let in heat from the sun more readily than they let it out. As their levels in the atmosphere increase, the temperature rises. The concentration of carbon dioxide, the more important of the two, has risen from 280 parts per million parts of air (ppm) in Marlowe's time to 380 ppm today.¹⁹ Most of the growth has taken place in the

* The government's Department of Trade and Industry gave the UK's use of coal in 2003 as 68.7 million short tons.¹² One short ton = 2000lb; one ton = 2240lb. $68.7 \div 2240 \times 2000 = 61.3$ m tons. The US Energy Information Administration reports that coal provides a 15 per cent share of the UK's total energy consumption¹³ $61.3 \div 15 \times 100 = 408.7$ mt. $408,700,000 \div 24,000 = 17,029$. In one year, there are 8,760 hours. $8,760 \div 17,029 = 0.514$.

past fifty years. The average global temperature over the past century has climbed, as a result, by 0.6° centigrade.* According to the World Meteorological Organization, 'the increase in temperature in the twentieth century is likely to have been the largest in any century during the past 1000 years'.²⁰

If you reject this explanation for planetary warming, you should ask yourself the following questions:

1. Does the atmosphere contain carbon dioxide?
2. Does atmospheric carbon dioxide raise the average global temperature?
3. Will this influence be enhanced by the addition of more carbon dioxide?
4. Have human activities led to a net emission of carbon dioxide?

If you are able to answer 'no' to any one of them, you should put yourself forward for a Nobel Prize. You will have turned science on its head.

But the link has also been established directly. A study of ocean warming over the past forty years, for example, published in the journal *Science* in 2005, records a precise match between the distribution of heat and the intensity of manmade carbon dioxide emissions.²¹ Its lead author described his findings thus:

The evidence is so strong that it should put an end to any debate about whether humanity is causing global warming.²²

This sounds like a strong statement, but he is not alone. In 2004, another article in *Science* reported the results of a survey of scientific papers containing the words 'global climate change'.²³ The author found 928 of them on the database she searched. 'None of the papers,' she discovered,

disagreed with the consensus position . . . Politicians, economists, journalists and others may have the impression of confusion, disagreement, or discord among climate scientists, but that impression is incorrect.²⁴

* All temperatures in this book are expressed in centigrade.

In 2001 the Royal Society, the United Kingdom's pre-eminent scientific institution, published the following statement:

Despite increasing consensus on the science underpinning predictions of global climate change, doubts have been expressed recently about the need to mitigate the risks posed by global climate change. We do not consider such doubts justified.²⁵

It was also signed by the equivalent organisations in fifteen other countries.*

Similar statements have been published by the US National Academy of Sciences,²⁶ the American Meteorological Society,²⁷ the American Geophysical Union²⁸ and the American Association for the Advancement of Science.²⁹

Until 2005, there was one remaining line of evidence permitting some people to claim that manmade climate change could still be disputed. A study of satellite measurements conducted in 1992 by the atmospheric scientists Roy Spencer and John Christy found that part of the atmosphere (the lower troposphere) had cooled over the preceding thirteen years.³⁰ This, in a warming world, should not have been possible. In 2005, three separate studies showed that the data had been misread.^{31,32,33} Professor Christy admitted that his results were incorrect and agreed that the atmosphere had warmed. As the author of one of the studies pointed out,

there is no longer any data contradicting the predictions of global warming models.³⁴

Already sea ice in the Arctic has shrunk to the smallest area ever recorded.³⁵ In the Antarctic, scientists watched stupefied in 2002 as the Larsen B ice shelf collapsed into the sea.³⁶ A paper published in

* The Australian Academy of Sciences, the Royal Flemish Academy of Belgium for Sciences and the Arts, the Brazilian Academy of Sciences, the Royal Society of Canada, the Caribbean Academy of Sciences, the Chinese Academy of Sciences, the French Academy of Sciences, the German Academy of Natural Scientists Leopoldina, the Indian National Science Academy, the Indonesian Academy of Sciences, the Royal Irish Academy, the Accademia Nazionale dei Lincei (Italy), the Academy of Sciences Malaysia, the Academy Council of the Royal Society of New Zealand, the Royal Swedish Academy of Sciences.

Science concluded that its disintegration was the result of melting caused by a warming ocean.³⁷ The global sea level has been rising by around 2 millimetres a year,³⁸ partly because water expands as it warms, partly because of the melting of ice and snow.

Almost all the world's glaciers are now retreating.^{39,40} Permafrost in Alaska and Siberia, which has remained frozen since the last Ice Age, has started to melt.^{41,42} Parts of the Amazon rainforest are turning to savannah as the temperatures there exceed the point at which trees can survive.⁴³ Coral reefs in the Indian Ocean and the South Pacific have begun to wilt. The World Health Organization estimates that 150,000 people a year are now dying as a result of climate change, as diseases spread faster at higher temperatures.⁴⁴ All this is happening with just 0.6° of warming.

The Intergovernmental Panel on Climate Change (IPCC), a committee of climate specialists which assesses and summarizes the science, estimated in 2001 that global temperatures will rise by between 1.4 and 5.8° this century.⁴⁵ Since then, some climate scientists have come to believe that this range is too low: one study published in 2005, for example, suggests that the maximum possible temperature rise which could be caused by a doubling of carbon dioxide concentrations is 11.5°.⁴⁶ An increase as big as this, however, is very unlikely.

But even a much smaller rise is likely to cause great harm to some human populations. Professor Martin Parry of the UK's Meteorological Office estimates that a rise of just 2.1° will expose between 2.3 and 3 billion people to the risk of water shortages.⁴⁷ The disappearance of glaciers in the Andes and the Himalayas will imperil the people who depend on their meltwater, particularly in Pakistan, western China, Central Asia, Peru, Ecuador and Bolivia.^{48,49} As rainfall decreases, there are likely to be longer and more frequent droughts in southern Africa, Australia and the countries surrounding the Mediterranean.⁵⁰ In northern Europe, summer droughts and winter floods will both become more frequent. Very wet winters, for example, which until now have troubled us every forty years or so, could recur one year in every eight.⁵¹

The UN Food and Agriculture Organisation warns that

in some forty poor, developing countries, with a combined population of two billion . . . [crop] production losses due to climate change may drastically increase the number of undernourished people, severely hindering progress in combating poverty and food insecurity.⁵²

The reason is that, in many parts of the tropics, crop plants are already close to their physiological limits. If, for example, temperatures stay above 35° for one hour while rice is flowering, the heat will sterilize the pollen.⁵³ The International Rice Research Institute has found that rice yields fall by 15 per cent with every degree of warming.⁵⁴

When I first read about this, I thought it equated to a formula for worldwide famine, and said as much in the *Guardian*. I was wrong to do so. Climate scientists, I later discovered, were confident that lower crop yields in some parts of the tropics would be offset by higher crop yields in temperate countries.⁵⁵ In the cooler parts of the world, the productive season lengthens and both higher temperatures and higher carbon dioxide levels should allow crop plants to grow faster.

But now, I am sorry to say, it seems that I might have been right, though for the wrong reasons. In late 2005, a study published in the *Philosophical Transactions of the Royal Society* alleged that the yield predictions for temperate countries were 'over optimistic'.⁵⁶ The authors had blown carbon dioxide and ozone, in concentrations roughly equivalent to those expected later this century, over crops in the open air. They discovered that the plants didn't respond as they were supposed to: the extra carbon dioxide did not fertilize them as much as the researchers predicted, and the ozone reduced their yields by 20 per cent.⁵⁷ Ozone levels are rising in the rich nations by between 1 and 2 per cent a year, as a result of sunlight interacting with pollution from cars, planes and power stations. The levels happen to be highest in the places where crop yields were expected to rise: western Europe, the midwest and eastern US and eastern China. The expected ozone increase in China will cause maize, rice and soybean production to fall by over 30 per cent by 2020. These reductions in yield, if real, are enough to cancel out the effects of both higher temperatures and higher carbon dioxide concentrations.^{58,59}

Another paper in the same journal pointed out that, as carbon

dioxide levels rise, plants release less water from their leaves.⁶⁰ This reduces local rainfall, which in many regions will have declined already because of climate change. The result, which has not been anticipated in the standard climate models, could be a further decline in crop production. It now seems possible that the world could be pushed towards famine.

The effects of crop losses are likely to be compounded by other problems. Though this prediction is controversial, some scientists suggest that, as temperatures rise, the incidence of malaria will increase. One study maintains that temperatures 2.3° higher than today's will expose a further 180–230 million people to the risk of catching the disease.⁶¹ Diarrhoea and cholera are both associated with rising temperatures.^{62,63}

If the earth warms by a moderate amount and sea levels increase by some 40 centimetres (roughly in the middle of the expected range for this century), the number of people in danger of saltwater floods caused by storm surges could grow from some 75 million (today) to around 200 million.⁶⁴ As the sea rises, salt water will pollute the drinking water on which some of the biggest coastal cities – Shanghai, Manila, Jakarta, Bangkok, Kolkata, Mumbai, Karachi, Lagos, Buenos Aires and Lima – depend.⁶⁵ In some cases, according to the International Association of Hydrogeologists, this problem could be big enough to necessitate the cities' abandonment.⁶⁶

The West Antarctic Ice Sheet contains enough water to raise sea levels by a further 3 metres,⁶⁷ enough to inundate parts of New York, London, Tokyo, Mumbai, indeed of most of the world's major cities. The ice sheet appears to be starting to disintegrate.⁶⁸ There is great controversy about how long this process will take. The sheet is propped up by ice shelves extending into the sea, like a roof kept aloft by the walls of a house. If they collapse as the Larsen B did, the ice sheet could begin to slide into the ocean. No one knows how swiftly this would happen, but it is unlikely that the entire sheet could dissolve in less than 300 years. If just 10 per cent of it fell into the sea this century, the results would be catastrophic for many coastal peoples.

When the IPCC produced its last overview of the science of climate change, it found that 'there was no compelling evidence' to indicate

that storms in and around the tropics had become worse.⁶⁹ But in 2005 two papers, published in *Science* and *Nature*, suggested that the intensity of hurricanes had increased since the mid 1970s.^{70,71} It is not yet clear whether this is connected to climate change, though there is a relationship between the temperature of the sea surface and the strength of a storm.⁷² In March 2004 the first hurricane ever recorded in the South Atlantic hit the coast of Brazil.

The number of extreme weather events of all kinds appears to have quintupled since the 1950s, according to the insurance company Munich Re.⁷³ The summer of 2003 seems to have been the hottest in Europe since at least the year 1500.⁷⁴ Thousands of people in Europe and India died as a result of the heatwave. According to a paper published in *Nature*, human influence has at least doubled the chances of its recurrence.⁷⁵ In northern Europe, however, the number of people dying because of extreme temperatures is likely to drop, as our winters become warmer.⁷⁶

Other species will be hit sooner and harder than humans. In 2004 researchers on five continents surveyed the ecosystems covering 20 per cent of the earth's surface. They found that, if temperatures rise to about the middle of the expected range, between 15 and 37 per cent of the world's species are 'committed to extinction' by 2050.⁷⁷ With just 1.4° of warming, the coral reefs in the Indian Ocean will become extinct.⁷⁸ With 2°, some 97 per cent of the world's reefs will bleach – which means the coral animals eject the algae which keep them alive, and are likely to die as a result.⁷⁹ As increasing levels of carbon dioxide dissolve in seawater, the oceans will acidify. Their pH could fall from 8.2 to 7.7 by the end of the century,⁸⁰ and by 2050 the water could become too acid for shells to form. This will be devastating to sea life, wiping out much of the plankton upon which the marine ecosystem depends. With 2° of warming, all the sea ice in the Arctic could melt in summer, killing the polar bears, the walrus and much of the rest of the ecosystem.⁸¹

In one of the most depressing papers I have ever read, researchers from University College London and the Met Office reported in 2005 that 'the Amazonian forest is currently near its critical resiliency threshold.' With just a small degree of warming 'the interior of the Amazon Basin becomes essentially void of vegetation.'⁸²

The problem is that the trees in some parts of the forest are responsible for as much as 74 per cent of local rainfall.⁸³ As they start to die when the temperature rises, less water is released into the air by the forest. This has three effects: there is less rainfall to sustain the remaining trees, more sunlight reaches the forest floor (drying it and making the forest more susceptible to fires), and less heat is lost through evaporation. The rising temperature and decreasing rainfall kill more trees, and the chain reaction continues. It could happen soon and swiftly: 'we suggest,' the researchers say, 'that this threshold exists very near to current climatic conditions.'⁸⁴

The Amazon is the most biodiverse place on earth, but the problem does not stop with other species. It produces the rain which sustains much of South America. And trees, roughly speaking, are sticks of wet carbon. As they burn or rot – as they oxidize in other words – they turn into carbon dioxide. The Amazon has the potential to release 730 million tonnes of carbon – about 10 per cent of manmade emissions – a year for seventy-five years.⁸⁵

This is just one of the means by which climate change begets climate change. A paper published in *Geophysical Research Letters* in 2003 predicted that, as a result of global warming, by about 2040 living systems on the land will start to release more carbon dioxide than they absorb. By 2100, it suggests, the surface of the earth will be emitting around 7 billion tonnes of carbon a year,⁸⁶ which is roughly what human beings produce today. This is an example of 'positive feedback': climate change accelerating itself. Positive feedback was not fully considered by the IPCC when it predicted that the temperature would rise by between 1.4 and 5.8°.⁸⁷

One of the reasons why the terrestrial biosphere begins to release more carbon dioxide than it absorbs is that, as we have seen, plants in the tropics and even some temperate regions⁸⁸ may shrivel or die when the temperature rises. But there are several others. Soil, for example, becomes a net source of carbon when temperatures rise, as the metabolism of the microbes it contains speeds up. This was not supposed to happen for several decades,⁸⁹ but in 2005 British scientists reported that soils in England and Wales had already become carbon sources.⁹⁰ The carbon dioxide they were releasing had cancelled out all the cuts that the UK had made since 1990. Before the end of the

century, the world's soils will eject the manmade carbon they have absorbed over the past 150 years.⁹¹

As the permafrost in the far north melts, it starts to release methane. The West Siberian bog alone, which began melting in 2005, is believed to contain 70 billion tonnes of the gas,⁹² whose liberation would equate to 73 years of current manmade carbon dioxide emissions.*

The National Center for Atmospheric Research in the US estimates that 90 per cent of the top 10 feet of permafrost throughout the Arctic could thaw by 2100.⁹³ These positive feedbacks – and there are many more – extend the possible range of global temperatures. In doing so, they make a truly catastrophic event more likely to happen.

One such event has seized the imagination of people in northern Europe. The region is kept warm in the winter – relative to parts of the world at the same latitude – by the northwards transport of water from the Caribbean – a current known as the Gulf Stream. The Gulf Stream is part of a general oceanic circulation, which is mostly driven by the sinking of surface waters in the far north of the Atlantic. As they roll southwards over the seabed, they create the currents which, after a long journey, return to northern Europe, carrying heat from the tropics.

The reason they sink is that they are both cold and salty, and therefore denser than the waters beneath them. The phenomenon is known as 'thermohaline circulation', or THC. For at least twenty years, some oceanographers have warned that this sinking, and therefore the 'overturning circulation' (the deep ocean currents which drive the whole system), could either weaken or stop altogether because meltwater flowing into the Arctic seas would dilute the salty surface waters. If this happened, northern Europe could be reduced to tundra, while the tropics, as heat was not transported away from them, would become very much hotter. This has taken place before. As the northern hemisphere began to warm after the last Ice Age, the ice dam holding back a vast lake in North America burst. The freshwater thundering into the north Atlantic appears to have shut down

* Methane has a warming effect 23 times as great as carbon.⁹³ Manmade carbon dioxide emissions are currently around 22 billion tonnes a year (this is 3.667 × the weight of the carbon they contain).⁹⁴

the ocean circulation, with the result that temperatures in Europe fell by 5°. They did not recover for 1,300 years.

Many climate scientists believe that a total shutdown of this nature is impossible: there is simply not enough freshwater in the far north to prevent the surface waters from sinking.⁹⁶ At most, a slightly weakened current might reduce the rate of warming in northern Europe. In July 2005, the British House of Lords examined the evidence for the possible impacts of climate change and concluded that 'changes in the THC are not at all likely to occur, as we understand it, in the next 100 years.'⁹⁷ This was a reasonable summary of the existing science.

Five months later, *Nature* reported

the first observational evidence that . . . a decrease of the oceanic overturning circulation is well underway.⁹⁸

Researchers from the National Oceanography Centre in the United Kingdom claimed to have discovered that the circulation had in fact been weakening for fifty years, but that it had not hitherto been detected.⁹⁹ It appears to have slowed down by 30 per cent.

At the same time, the overflow waters and in turn the deep waters of the North Atlantic have significantly freshened . . . Increased freshwater input into the Nordic Seas will initially weaken the circulation only slowly. But when a certain threshold is reached, the circulation may jump abruptly to a new state in which there is little or no heat flux to the north.¹⁰⁰

If this occurs, it would have

devastating effects on socio-economic conditions in the countries bordering the eastern North Atlantic.¹⁰¹

The possible switch from one stable state (a smoothly flowing Gulf Stream) to another (no Gulf Stream at all) is an example of what climate scientists call 'non-linearity'. They point out that some of the earth's systems are unlikely to respond smoothly to changes in the climate: they could flip suddenly from one condition to another.¹⁰²

I have concentrated so far on the effects which could take place within the IPCC's range of 1.4–5.8° of global warming. But there

are, as I have mentioned, some climate scientists who maintain that the temperature this century could rise much further.

The Nobel laureate Paul Crutzen, having taken into account the falling levels of particles produced by heavy industry in the atmosphere, which have so far sheltered us from some of the sun's heat, has made a rough estimate that the temperature could rise by between 7 and 10°. ¹⁰³ In 2005, British scientists published the results of a computer simulation larger and more detailed than its predecessors. It revealed that a doubling of carbon dioxide concentration in the atmosphere could lead to temperatures ranging anywhere from 1.9 and 11.5° above their pre-industrial levels.¹⁰⁴ This does not mean that all temperatures in this range are equally likely – the extremes are much less probable than the temperatures in the middle – but the researchers found that none of them could be ruled out.¹⁰⁵

So what happens if average global temperatures rise by more than 6°? There could be a historical precedent.

The Permian period came abruptly to an end 251 million years ago. In China, South Africa, Australia, Greenland, Russia and Spitsbergen, the rocks record the same sequence of events, taking place almost instantaneously.¹⁰⁶ The marine sediments deposited at the time show two sudden changes. The red or green rock laid down in the presence of oxygen is replaced by black muds of the kind deposited when oxygen is absent. An instant shift in the ratio of the isotopes (alternative forms) of carbon within the rocks suggests a very rapid change in the concentration of atmospheric gases. On land, gently deposited mudstones and limestones give way to great dumps of pebbles and boulders.

The Permian was one of the most biologically diverse periods. Sabre-toothed reptiles hunted herbivores the size of rhinos through forests of tree ferns and flowering trees. Among the coral reefs lived great sharks, fish of all kinds and hundreds of species of shelly creatures. At the point at which the sediments change, 251 million years ago, the fossil record very nearly stops dead. The reefs die instantly, and do not reappear on earth for 10 million years. All the large and medium-sized sharks disappear, most of the shelly species, even the

majority of the plankton. Among many classes of marine animals, the only survivors were those adapted to the near-absence of oxygen.¹⁰⁷

Plant life was almost eliminated from the earth's surface. The four-footed animals, the group to which humans belong, were nearly exterminated: so far only two fossil reptile species have been found anywhere on earth which survived the end of the period. The world's surface came to be dominated by just one of these, which was about the size and shape of a pig. It became ubiquitous because nothing else was left to compete with it or to prey upon it. Altogether, some 90 per cent of the earth's species appear to have been wiped out:^{108,109} this represents by the far the biggest of the mass extinctions. The world's 'productivity' (the total mass of biological matter) collapsed.

These events coincided with a series of volcanic eruptions in Siberia; the eruptions which gave rise to the Siberian Traps. The volcanoes produced great quantities of two gases: sulphur dioxide and carbon dioxide. These gases appear to have caused the extinctions. The sulphur and other effusions caused acid rain, but would have bled from the atmosphere quite quickly. The carbon dioxide, on the other hand, persisted. The rising temperatures caused by the gas appear to have warmed the world sufficiently to have destabilized a super-concentrated form of methane which was found then (and is still found today) in large quantities in the sediments beneath the polar seas. The release of methane into the atmosphere might explain the sudden shift in carbon isotopes. The temperature rose by between 6°¹¹⁰ and 8°.¹¹¹

Ocean circulation appears to have dropped, for reasons which will now be familiar to you, to about one twentieth of current levels,¹¹² depriving the deeper waters of oxygen. As the plants on land died, their roots would no longer have held the soil and loose rock together, with the result that erosion rates greatly increased.

This does not mean that we can make a direct comparison between the events which brought the Permian to an end and the possible effects of manmade climate change today. Many of the plants on land were doubtless killed by acid rain rather than by high temperatures. Though some countries seem to be doing their best to replicate both conditions, sulphur emissions are much lower today than they were 251 million years ago. But it does give us an indication of the possible

scale of ecological change a temperature rise of this magnitude could provoke.

Various other outcomes of climate change have been proposed, of which the most intriguing is one suggested by a reader of mine.

Thank you for drawing attention to the threat of global warming. I wish the world would wake up to how serious it is. If we don't do something soon the whole planet could turn into a desert.

This is a tempting prospect, but I regret to say that the science does not support it.

Curtailling climate change must, in other words, become the project we put before all others. If we fail in this task, we fail in everything else. But is it possible? Is it, as James Lovelock sometimes suggests,¹¹³ too late?

I don't believe it is. 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,^{114,115} 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,¹¹⁶ droughts spread in the Sahel region of Africa,¹¹⁷ water quality falls and coral reefs start to die.¹¹⁸ At 1.5° or less, an extra 400 million people are exposed to water stress and another 5 million to hunger,¹¹⁹ 18 per cent of the world's species will be lost¹²⁰ and the 'onset of complete melting of Greenland ice' is triggered.¹²¹ 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 2030.¹²²

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 Germany 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.¹²³ 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.¹²⁴ 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,^{*125} 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.†¹²⁶ By contrast, the Kyoto Protocol to the United Nations Framework Convention on Climate Change – the only international agreement that has been struck so far – commits its signatories to cut their carbon emissions by a total of 5.2 per cent by 2012.

* This measures just the carbon in carbon dioxide. To obtain the weight of CO₂, you must multiply this figure by 3.667, which gives the UK's emissions a value of 9.5 tonnes.
† This assumes that the other greenhouse gases, such as methane, nitrous oxide, hydrofluorocarbons and sulphur hexafluoride, are cut at the same rate.

These could be underestimates. The Potsdam Institute calculates that with the equivalent of 440 ppm of carbon dioxide in the atmosphere, there is a 67 per cent chance of holding the temperature rise to below 2°. ¹²⁷ Another study suggests that to obtain a 90 per cent chance of stabilization below 2°, you would need to keep the concentration below 400 parts per million – 40 or 50 parts below the current level.¹²⁸ Because the carbon released now stays in the atmosphere for some 200 years,¹²⁹ 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°.

But I am writing this book in the spirit of optimism, so I refuse to believe it.

Whether or not it is too late to hold global temperatures below the critical threshold, it is clear that the greater the cuts we make, the lesser the eventual impact will be. A 90 per cent cut should make the sort of warming that took place at the end of the Permian impossible. It is also clear that the sooner we act, the more effective the cut will be. There are several reasons for this, but the most obvious is illustrated by the two graphs on p. 18. In both cases we reach the target of a 90 per cent reduction by 2030, but in the second graph, where we delay the cut for longer, our total emissions are higher.

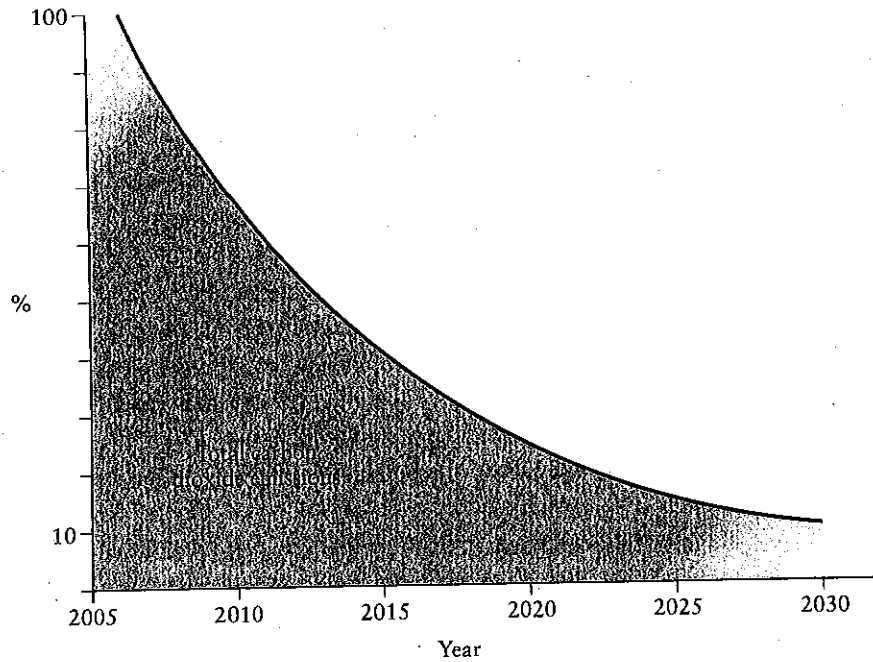
Two centuries after the *Tragic History of Doctor Faustus* was published, Johann Wolfgang von Goethe rewrote the magician's story. In his version – *Faust* – the doctor's bargain with Mephistopheles changes. He offers Mephistopheles his soul, but on one further condition: hell can have him only if he stops striving and succumbs to 'smug complacency'.¹³⁰

You heard me, there can be no thought of joy,
Frenzy I choose, most agonizing lust,
Enamored enmity, restorative disgust.¹³¹

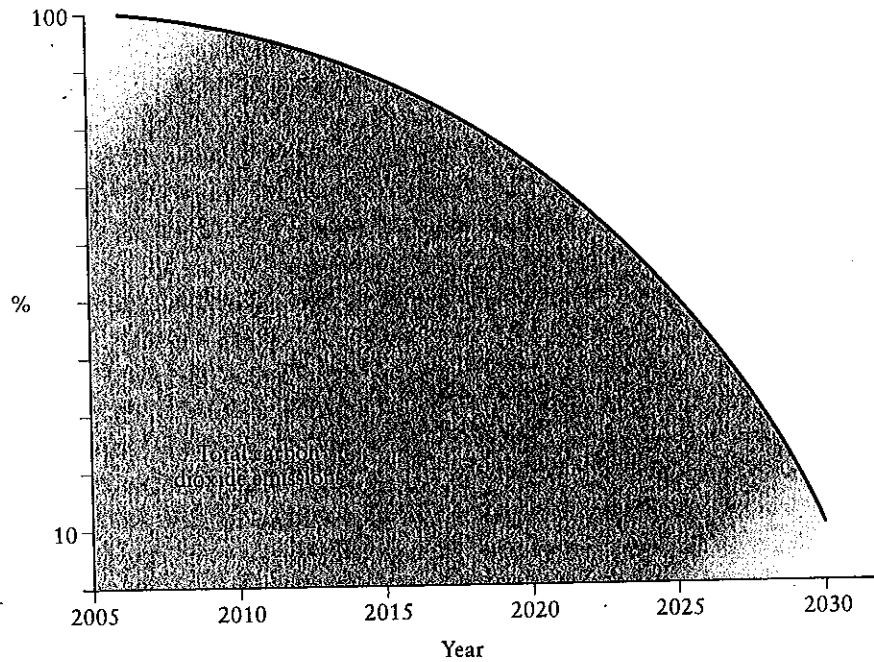
Faust acquires his powers and performs his miracles, but he never relaxes. As the story progresses, he becomes less interested in living in all voluptuousness and begins pouring his demonic energies into other schemes. Towards the end of his life he starts planning a development project. He will create 'room to live for millions', sheltered

from the storms and tides.¹³² He will use wave power to provide energy for them and human ingenuity to rescue land from the sea. He dies in the midst of his labours, and Mephistopheles is cheated of his prey. Angels descend and bear Faust's soul up to heaven.

Faust, in other words, is redeemed by working, with frenzy and agonizing lust (and, I am sorry to say, a good deal of brutality), for the greater human good. While he still possesses his dark powers – his command of technology and labour, his ability to effect political and economic change – he uses them to create a world in which a free and comfortable society can persist. The gifts which threatened to destroy him are deployed instead to save him. This book seeks to explain how it might best be done.



1. Fast carbon reduction



2. Slow carbon reduction

Carbon emissions as a percentage of the current total

The Denial Industry

*Look at the canting holy-oilers!
Thus they have snatched from us so many a prize,
With our own weapons they would foil us;
They too are devils, only in disguise.*

Faust, Part II, Act V¹

But first I want to examine why we have been so slow to act.

On almost every other serious issue, the professional classes appear to be better informed than the rest of the population. On climate change the reverse seems to be true. The only people I have met over the past three years who haven't the faintest idea what manmade climate change is or how it is caused are university graduates. In 2004, for example, I had to tell a press officer at the British government's Department for Transport what carbon dioxide was. In 2005, I heard an insurer explain that he was failing to persuade the financial markets to take climate change seriously, as the senior managers either hadn't understood it or didn't believe in it.² In 2006, I spoke to a journalist of 20 years' standing about the problem of rising carbon emissions, and was asked 'what are carbon emissions and why are they a problem?' But over the same period – and perhaps I don't get out enough – I have never spoken to a shop assistant, taxi driver, bar tender or vagrant who did not possess at least a vague idea of what climate change means and why it is happening.

From this I deduce that the problem is not that people aren't hearing about it, but that they don't want to know. The professional classes have the most freedom to lose and the least to gain from an attempt

to restrain it. The effort to tackle climate change suffers from the problem of split incentives: those who are least responsible for it are the most likely to suffer its effects.

Bangladesh and Ethiopia are two of the countries which will be hit hardest. A sea level rise of 1 metre could permanently flood 21 per cent of Bangladesh, including its best agricultural land, pushing some 15 million people out of their homes.³ Storm surges of the kind the country experienced in 1998 are likely to become more common: in that instance, 65 per cent of Bangladesh was temporarily drowned, and its farming and infrastructure ruined.⁴ By 2004, half of Bhola, the country's largest island, on which 1.6 million people live, had already been washed away. Climate scientists blamed this on rising sea levels: the erosion rate has accelerated since the 1960s.⁵

Ethiopia has already been suffering a series of droughts linked to climate change. A paper published in the *Philosophical Transactions of the Royal Society*⁶ shows that the spring rains have steadily diminished since 1996. It blames the trend on rising sea surface temperatures in the Indian Ocean.⁷ In 2005, partly as a result of the droughts caused by the failure of these rains, between 8 and 10 million Ethiopians were at risk of starvation.

Most of the rich countries, being located in temperate latitudes, will, in the initial stages at least, suffer lesser ecological effects. They will also have more money with which to protect their citizens from floods, droughts and extremes of temperature. Within these countries, the richest people, who can buy their way out of trouble, will be harmed last. The blame, as this table suggests, is inversely proportional to the impacts.⁸

country	carbon dioxide emissions, 2003 (tonnes per capita)
Luxembourg	24.3
United States	20.0
United Kingdom	9.5
Bangladesh	0.24
Ethiopia	0.06

Source: US Energy Information Administration.⁹

The Ethiopians, on average, emit one 400th of the carbon dioxide produced by the people of Luxembourg, the country which has the highest gross domestic product per person.¹⁰

So asking wealthy people in the rich nations to act to prevent climate change means asking them to give up many of the things they value – their high-performance cars, their flights to Tuscany and Thailand and Florida – for the benefit of other people.

The problem is compounded by the fact that the connection between cause and effect seems so improbable. By turning on the lights, filling the kettle, taking the children to school, driving to the shops, we are condemning other people to death. We never chose to do this. We do not see ourselves as killers. We perform these acts without passion or intent.

Many of those things we have understood to be good – even morally necessary – must also now be seen as bad. Perhaps the most intractable cause of global warming is ‘love miles’: the distance you must travel to visit friends and partners and relatives on the other side of the planet. The world could be destroyed by love.

To make this even more difficult, the early effects of climate change, for those of us who live in the temperate countries of the rich world, are generally pleasant. Our winters are milder, our springs come sooner. We have suffered the occasional flood and drought and heat-wave. But the overwhelming sensation, just when we need to act with the greatest urgency, is that of being blessed by our pollution.

A wealthy society’s split incentives are shared by its government. As Tony Blair has remarked, ‘there is a mismatch in timing between the environmental and electoral impact.’¹¹ By the time the decisions he has made come home to roost, he will have been out of office for years. If a government allows the growth of air travel to continue, for example, the effects are delayed, diffuse and hard to blame on any one source. If, by contrast, it restricts or reverses the growth in flights, the effects are immediately attributable to its actions. Everyone knows who is responsible if we may no longer fly to Thailand.

But it is not just a matter of a failure to engage. Assisting our reluctance is an active campaign of dissuasion.

I first became aware of it after reading a series of truly idiotic

articles in the British press. In some newspapers, as the following examples suggest, a total absence of scientific knowledge is no barrier to publication.

George W. Bush is right. The Kyoto Treaty is a silly waste of time. The greenhouse effect probably doesn’t exist. There is as yet no evidence for it (Peter Hitchens, *Mail on Sunday*).¹²

And if the climate is indeed overheating, that does not mean that manmade emissions are necessarily to blame. Indeed, it is extremely unlikely that they would be since carbon dioxide forms a relatively small proportion of the atmosphere, most of which consists of water vapour (Melanie Phillips, *Daily Mail*).¹³

The greenhouse effect, first observed in the middle of the nineteenth century, is the phenomenon which keeps this planet warm enough to sustain life. Peter Hitchens appears to have confused it with manmade climate change. But this did not prevent him from feeling qualified to continue thus:

Global warming is probably caused by, would you believe it, the sun. The temperature of the atmosphere, measured by NASA, has not risen in the past 22 years. There was global warming between 1870 and 1940, when there were far fewer greenhouse gases than now. The only reason these facts are so little-known is that a self-righteous love of ‘the environment’ has now replaced religion as the new orthodoxy . . . Why are we so blinkered to these lies?¹⁴

If most of the atmosphere consisted of water vapour, we would need gills. But Melanie Phillips is sure enough of her atmospheric physics to allege that

. . . the theory that global warming is all the fault of mankind is a massive scam based on flawed computer modelling, bad science and an anti-Western ideology . . . The majority of well-meaning opinion in the Western world believes a pack of lies and propaganda.¹⁵

At first I mistook all this for native idiocy, and doubtless this plays a supporting role. But it was after I investigated another set of assertions

that I began to see that these claims did not originate in the newspapers.

Unlike most of those who have maintained in the media that climate change is not happening, David Bellamy is, or was, a scientist, formerly a senior lecturer in botany at the University of Durham. He was also an environmentalist and a famous and rather wonderful television presenter. In the early 2000s, he decided that climate change wasn't happening. Here is what he wrote in an article published in 2004 in the *Daily Mail*, under the title 'Global Warming? What a Load of Poppycock!'

The link between the burning of fossil fuels and global warming is a myth. It is time the world's leaders, their scientific advisers and many environmental pressure groups woke up to the fact.¹⁶

In April 2005, I read a letter of his in *New Scientist*.

Further to your coverage of climate change and melting ice in the Himalayas, it should be pointed out that glaciers in many other parts of the world are not shrinking but in fact are growing . . . Indeed, if you take all the evidence that is rarely mentioned by the Kyotoists into consideration, 555 of all the 625 glaciers under observation by the World Glacier Monitoring Service in Zurich, Switzerland, have been growing since 1980.¹⁷

I was astonished by this claim: it conflicted with everything I had read about 'glacier mass balance' – the degree to which they are advancing or retreating. So I telephoned the World Glacier Monitoring Service and read out Bellamy's letter. 'This,' they told me, 'is complete bullshit.'¹⁸ The latest studies show unequivocally that most of the world's glaciers are retreating.¹⁹

But Bellamy's figures must have come from somewhere, so I e-mailed him to ask for his source. After several requests, he explained that he had found them on a website called www.iceagenow.com. I urge you to visit it: it is an extraordinary production. But there indeed was all the material Bellamy had cited in his letter, including the figures – or something resembling the figures – he quoted.

Since 1980, there has been an advance of more than 55 per cent of the 625 mountain glaciers under observation by the World Glacier Monitoring group in Zurich.^{20,21}

The source, which Bellamy also cited in his e-mail to me, was given as 'the latest issue of *21st Century Science and Technology*'.

This, I found, is a publication belonging to the American millionaire Lyndon Larouche. Larouche has claimed that the British royal family is running an international drugs syndicate,^{22,23,24} that Henry Kissinger is a communist agent,²⁵ that the British government is controlled by Jewish bankers,²⁶ and that modern science is a conspiracy against human potential.²⁷ In 1989 he received a fifteen-year sentence for conspiracy, mail fraud and tax-code violations.^{28,29}

21st Century Science and Technology gave no source for its figures; but the same data could be found all over the internet. They were first published online by the 'Science and Environmental Policy Project', which is run by an environmental scientist called Dr S. Fred Singer. After they were posted on his website – www.sepp.org – they were reproduced by several other groups, such as the Competitive Enterprise Institute,³⁰ the National Center for Public Policy Research³¹ and The Advancement of Sound Science Coalition.³² They had also found their way into the *Washington Post*.³³ But where did they come from? Fred Singer cited half a source:

a paper published in *Science* in 1989.³⁴

I went through every edition of *Science* published in 1989, both manually and electronically. Not only did it contain nothing resembling those figures; throughout that year there was no paper published in this journal about glacial advance or retreat. Satisfied that the figures were nonsense, I left it there.

* You may have noticed that while Bellamy's source claimed that 55 per cent of 625 glaciers are advancing, Bellamy claimed that 555 of them – or 89 per cent – are advancing. This figure seems to have existed nowhere else. But on the standard English keyboard, '5' and '%' occupy the same key. If you try to hit '%', but fail to press shift, you get 555, instead of 55%. This is the only explanation I can produce for his figure. When I challenged him, he admitted that there had been 'a glitch of the electronics'.²⁰

But after I had published these findings in the *Guardian*,³⁵ one of my readers wrote to Dr S. Fred Singer.

Dear Professor Singer,

How do you answer the statement by George Monbiot, writing in the *Guardian* newspaper on Tuesday, that you cited a non-existent paper in an unspecified 1989 edition of *Science* as the only source for a claim that most of the world's glaciers were advancing?³⁶

Singer's response was interesting, and unexpected.

Monbiot is confused – or simply lying . . . he has a vivid imagination that borders on being slanderous . . . I know nothing about a 1989 paper in *Science*. This is the same Monbiot who along with other 'climate campaigners' complained in *Nature* (31 March 2005) that some of us are creating the impression that 'climate scientists are deeply divided' while – acc. to him – there is a 'robust' consensus about anthropogenic global warming. Obviously, he has been smoking something or other.³⁷

My correspondent wrote back:

Dear Professor Singer,

Thank you for your quick reply to my query. However, I found your statements very puzzling . . . When I did a Google search of www.sepp.org, I did find two pages that made exactly the same claim that Monbiot ascribed to you. It seems that he was neither lying nor confused . . . Could you please be specific about this 1989 paper in *Science*? It looks very unlikely that the WGMS would have said what you claim.³⁸

This time Singer replied in less aggressive tones: the claim, he said, had been posted on his site by 'former SEPP associate Candace Crandall'. It 'appears to be incorrect and has been updated'.³⁹ He forgot to add that Candace Crandall was his wife. Almost a year later, when writing this book, I checked his website, and found this paragraph:

The World Glacier Monitoring Service in Zurich, in a paper published in *Science* in 1989, noted that between 1926 and 1960, more than 70 per

cent of 625 mountain glaciers in the United States, Soviet Union, Iceland, Switzerland, Austria and Italy were retreating. After 1980, however, 55 per cent of these same glaciers were advancing.⁴⁰

It had not been changed. What I also found, on the SEPP site and the others which had published the glacier figures, were most of the allegations, however daft or misleading, which had later been made in the press by David Bellamy, Peter Hitchens, Melanie Phillips, the novelist Michael Crichton and most of the other prominent repudiators of manmade climate change. The groups I've listed appear to have compiled and distributed the facts and figures the writers used. The groups have something else in common: they have all been funded by Exxon.*¹⁹

ExxonMobil is the world's most profitable corporation. In autumn 2005, it reported *quarterly* profits of almost \$10 billion, the highest corporate earnings on record.⁴¹ It makes most of this money from oil, and has more to lose than any other company from efforts to tackle climate change. Its approach to the issue could be summed up thus:

Should the public come to believe that the scientific issues are settled, their views about global warming will change accordingly. Therefore, you need to continue to make the lack of scientific certainty a primary issue in the debate.

These words are not mine. Nor are they Exxon's. They were written for Republican Party activists by a political consultant named Frank Luntz, during the first mid-term election campaign in George W. Bush's presidency.⁴² As we will see, there are plenty of places in which Exxon finds itself at home. But in other respects it has difficulties: it must confront a scientific consensus as strong as that which maintains that smoking causes lung cancer or that HIV causes AIDS.

The website www.exxonsecrets.org, using data found in the company's official documents, lists 124 organizations which have taken money from the company or work closely with those which have. They take a consistent line on climate change: that the science is contradictory, the scientists are split, environmentalists are charlatans,

*This is not to suggest that Bellamy, Hitchens, Phillips or Crichton have themselves taken any money from Exxon.

liars or lunatics, and if governments took action to prevent global warming, they would be endangering the global economy for no good reason. The findings these organizations dislike are labelled 'junk science'. The findings they welcome are labelled 'sound science'.

Among the organizations that have been funded by Exxon are some well-known websites and lobby groups, such as TechCentralStation, the Cato Institute and the Heritage Foundation. Some of those on the list have names which make them look like grassroots citizens' organizations or academic bodies: the Center for the Study of Carbon Dioxide and Global Change, for example; the National Wetlands Coalition; the National Environmental Policy Institute; the American Council on Science and Health.⁴³ One or two of them, such as the Congress of Racial Equality and George Mason University's Law and Economics Center, *are* citizens' organizations or academic bodies, but the line they take on climate change is very much like that of the other sponsored groups. While all these groups are based in the United States of America, their publications are read and cited, and their staff are interviewed and quoted, all over the world.

By funding a large number of organizations, Exxon helps to create the impression that doubt about climate change is widespread. For those who do not understand that scientific findings cannot be trusted if they have not appeared in peer-reviewed journals, the names of these institutes help to suggest that serious researchers are challenging the consensus.

This is not to claim that all the science these groups champion is bogus. On the whole, they use selection, not invention. They will find one contradictory study – such as the discovery of tropospheric cooling I mentioned in the previous chapter and which, in a garbled form, was used by Peter Hitchens – and promote it relentlessly. They will continue to do so long after it has been disproved by further work. Though, for example, John Christy, the author of the troposphere paper, admitted in August 2005 that his figures were incorrect,⁴⁴ his initial findings are still being circulated and championed by many of these groups, as a quick internet search will show you.

But they do not stop there. The chairman of Fred Singer's Science and Environmental Policy Project (Singer is the president) is a man called Frederick Seitz. Seitz is a physicist, who in the 1960s was

president of the US National Academy of Sciences. In 1998, he wrote a document, known as the 'Oregon Petition', which has been cited by almost every journalist who claims that climate change is a myth.

The petition reads as follows:

We urge the United States government to reject the global warming agreement that was written in Kyoto, Japan, in December, 1997, and any other similar proposals. The proposed limits on greenhouse gases would harm the environment, hinder the advance of science and technology, and damage the health and welfare of mankind.

There is no convincing scientific evidence that human release of carbon dioxide, methane, or other greenhouse gasses is causing or will, in the foreseeable future, cause catastrophic heating of the Earth's atmosphere and disruption of the Earth's climate. Moreover, there is substantial scientific evidence that increases in atmospheric carbon dioxide produce many beneficial effects upon the natural plant and animal environments of the Earth.⁴⁵

Anyone with a degree could sign it. It was attached to a letter written by Seitz, entitled *Research Review of Global Warming Evidence*:

Below is an eight-page review of information on the subject of 'global warming', and a petition in the form of a reply card. Please consider these materials carefully.

The United States is very close to adopting an international agreement that would ration the use of energy and of technologies that depend upon coal, oil, and natural gas and some other organic compounds.

This treaty is, in our opinion, based upon flawed ideas. Research data on climate change do not show that human use of hydrocarbons is harmful. To the contrary, there is good evidence that increased atmospheric carbon dioxide is environmentally helpful.

... Frederick Seitz. Past President, National Academy of Sciences.⁴⁶

The lead author of the 'review' which followed Frederick Seitz's letter is a Christian fundamentalist called Arthur B. Robinson. He has never worked as a climate scientist.⁴⁷ It was co-published by Robinson's organization – the Oregon Institute of Science and Medicine – and an outfit called the George C. Marshall Institute, which has received \$630,000 from ExxonMobil since 1998.⁴⁸ The other three authors

were Arthur Robinson's 22-year old son⁴⁹ and two employees of the George C. Marshall Institute.^{50,51} The chairman of the George C. Marshall Institute was Frederick Seitz.⁵²

The paper maintained that

As coal, oil, and natural gas are used to feed and lift from poverty vast numbers of people across the globe, more carbon dioxide will be released into the atmosphere. This will help to maintain and improve the health, longevity, prosperity, and productivity of all people. . . . We are living in an increasingly lush environment of plants and animals as a result of the carbon dioxide increase. Our children will enjoy an Earth with far more plant and animal life than that with which we now are blessed. This is a wonderful and unexpected gift from the Industrial Revolution.⁵³

It was printed in the font and format of the *Proceedings of the National Academy of Sciences*: the journal of the organization of which Frederick Seitz – as he had just reminded his correspondents – was once president.

Soon after the petition was published, the National Academy of Sciences released this statement:

The Council of the National Academy of Sciences is concerned about the confusion caused by a petition being circulated via a letter from a former president of this Academy . . . The petition was mailed with an op-ed article from *The Wall Street Journal* and a manuscript in a format that is nearly identical to that of scientific articles published in the *Proceedings of the National Academy of Sciences*. The NAS Council would like to make it clear that this petition has nothing to do with the National Academy of Sciences and that the manuscript was not published in the *Proceedings of the National Academy of Sciences* or in any other peer-reviewed journal. The petition does not reflect the conclusions of expert reports of the Academy.⁵⁴

But it was too late. Seitz, the Oregon Institute and the George C. Marshall Institute had already circulated tens of thousands of copies, and the petition had established a major presence on the internet. Some 17,000 graduates signed it, the great majority of whom have no background in climate science. It has been repeatedly cited – by David Bellamy, Melanie Phillips and the rest – as a petition by climate scientists. It is promoted by the Exxon-sponsored sites

as evidence that there is no scientific consensus on climate change.

All this is now well-known to climate scientists and environmentalists. But the most interesting thing I have discovered while researching this issue is that the corporate campaign to deny that manmade climate change is taking place was not initiated by Exxon, or by any other firm directly involved in the fossil fuel industry. It was started by the tobacco company Philip Morris.

In December 1992, the US Environmental Protection Agency published a 500-page report called *Respiratory Health Effects of Passive Smoking*. It found that

. . . the widespread exposure to environmental tobacco smoke (ETS) in the United States presents a serious and substantial public health impact.

In adults: ETS is a human lung carcinogen, responsible for approximately 3,000 lung cancer deaths annually in US nonsmokers.

In children: ETS exposure is causally associated with an increased risk of lower respiratory tract infections (LRIs) such as bronchitis and pneumonia. This report estimates that 150,000 to 300,000 cases annually in infants and young children up to 18 months of age are attributable to ETS.⁵⁵

Had it not been for the settlement of a major class action against the tobacco companies in the United States, we would never have been able to see what happened next. But in 1998 they were forced to publish their internal documents and post them on the internet.

Within two months, Philip Morris, the world's biggest tobacco firm, had devised a strategy for dealing with the passive-smoking report. In February 1993 Ellen Merlo, its senior vice president of corporate affairs, sent a letter to William I. Campbell, Philip Morris's chief executive officer and president, explaining her intentions.

Our overriding objective is to discredit the EPA report . . . Concurrently, it is our objective to prevent states and cities, as well as businesses, from passive-smoking bans.⁵⁶

To this end, she had hired a public relations company called APCO. She had attached the advice it had given her. APCO warned that

No matter how strong the arguments, industry spokespeople are, in and of themselves, not always credible or appropriate messengers.⁵⁷

So the fight against a ban on passive smoking had to be associated with other people and other issues. Philip Morris, APCO said, needed to create the impression of a 'grassroots' movement – one that had been formed spontaneously by concerned citizens to fight 'over-regulation'.⁵⁸ It should portray the danger of tobacco smoke as just one 'unfounded fear' among others, such as concerns about pesticides and cellphones.⁵⁹ APCO proposed to set up

a national coalition intended to educate the media, public officials and the public about the dangers of 'junk science'. Coalition will address credibility of government's scientific studies, risk assessment techniques and misuse of tax dollars . . . Upon formation of Coalition, key leaders will begin media outreach, e.g., editorial board tours, opinion articles, and brief elected officials in selected states.⁶⁰

APCO would found the coalition, write its mission statements, and 'prepare and place opinion articles in key markets.' For this it required \$150,000 for its own fees and \$75,000 for the coalition's costs.⁶¹

By May 1993, as another memo from APCO to Philip Morris shows, the fake citizens' group had a name: The Advancement for Sound Science Coalition, or TASSC.⁶² It was important, further letters stated, 'to ensure that TASSC has a diverse group of contributors';⁶³ to 'link the tobacco issue with other more "politically correct" products'; and to associate scientific studies which cast smoking in a bad light with 'broader questions about government research and regulations', such as

- Global warming
- Nuclear waste disposal
- Biotechnology.⁶⁴

APCO would engage in the

intensive recruitment of high-profile representatives from business and industry, scientists, public officials, and other individuals interested in promoting the use of sound science.⁶⁵

By September 1993, APCO had produced a 'Plan for the Public Launching of TASSC'.^{66,67} The media launch would not take place in

Washington, DC or the top media markets of the country. Rather, we suggest creating a series of aggressive, de-centralized launches in several targeted local and regional markets across the country. This approach: . . .

- Avoids cynical reporters from major media: less reviewing/challenging of TASSC messages.⁶⁸

The media coverage, the public relations company hoped, would enable TASSC to 'establish an' image of a national grassroots coalition'.⁶⁹

In case the media asked hostile questions, APCO circulated a sheet of answers, drafted by Philip Morris.⁷⁰ The first question was:

Isn't it true that Philip Morris created TASSC to act as a front group for it?

A: No, not at all. As a large corporation, PM belongs to many national, regional, and state business, public policy, and legislative organizations. PM has contributed to TASSC, as we have with various groups and corporations across the country.⁷¹

The fifth question was:

What areas of public policy would you like to see TASSC investigate?

A: We are not in a position to suggest that TASSC examine any issue; it's an independent organization and will no doubt proceed as best they determine.⁷²

It should already have become clear that there are similarities between the language used and the approaches adopted by Philip Morris and by the organizations funded by Exxon. The two lobbies use the same terms, which appear to have been invented by Philip Morris's consultants. 'Junk science' meant peer-reviewed studies showing that smoking was linked to cancer and other diseases. 'Sound science' meant studies sponsored by the tobacco industry suggesting that the link was inconclusive.⁷³ Both lobbies recognized that their best

chance of avoiding regulation was to challenge the scientific consensus. As a memo from the tobacco company Brown and Williamson noted,

Doubt is our product since it is the best means of competing with the 'body of fact' that exists in the mind of the general public. It is also the means of establishing a controversy.⁷⁴

Both industries also sought to distance themselves from their own campaigns, creating the impression that they were spontaneous movements of professionals or ordinary citizens: the 'grassroots'.

But the connection goes much further than that. TASSC, the 'coalition' created by Philip Morris, was the first and most important of the corporate-funded organizations denying that climate change is taking place. It has done more damage to the campaign to halt it than any other body.

TASSC did as its founders at APCO suggested, and sought funding from other sources. Between 2000 and 2002 it received \$30,000 from Exxon.⁷⁵ The website it has financed⁷⁶ – www.JunkScience.com – has been the main entrepot for almost every kind of climate change denial that has found its way into the mainstream press. While Fred Singer was the first to have posted the glacier figures on the web, it was JunkScience.com that popularized them. In fact you can still find them there today.⁷⁷ It equates environmentalists with Nazis, communists and terrorists. It flings at us the accusations which could justifiably be levelled against itself: the website claims, for example, that it is campaigning against 'faulty scientific data and analysis used to advance special and, often, hidden agendas'.⁷⁸ I have lost count of the number of correspondents who, while questioning manmade global warming, have pointed me there.

The man who runs it is called Steve Milloy. In 1992, he started working for APCO – Philip Morris's consultants.⁷⁹ While he was there, he set up the JunkScience site.^{80,81} In March 1997, the documents show, he was appointed TASSC's executive director.⁸² By 1998, as he explained in a memo to the board members, his JunkScience website was being funded by TASSC.⁸³ Both he and the 'coalition' continued to receive money from Philip Morris. An internal document dated February 1998 reveals that TASSC took \$200,000

from the tobacco company in 1997.⁸⁴ Philip Morris's 2001 budget document records a payment to Steven Milloy of \$90,000.⁸⁵ Altria, Philip Morris's parent company, admits that Milloy was under contract to the tobacco firm until at least the end of 2005.⁸⁶

He has done well. You can find his name attached to letters and articles seeking to discredit passive-smoking studies all over the internet and in the academic databases. He has even managed to reach the *British Medical Journal*: I found a letter from him there which claimed that the studies it had reported 'do not bear out the hypothesis that maternal smoking/passive smoking increases cancer risk among infants'.⁸⁷ TASSC paid him \$126,000 in 2004 for fifteen hours of work a week.⁸⁸ Two other organizations are registered at his address: the Free Enterprise Education Institute and the Free Enterprise Action Institute.⁸⁹ They have received \$10,000 and \$50,000 respectively from Exxon.⁹⁰ The secretary of the Free Enterprise Action Institute is a man called Thomas Borelli.⁹¹ Borelli was the Philip Morris executive who oversaw the payments to TASSC.⁹²

Milloy also writes a weekly 'Junk Science' column for Fox News. Without declaring his interests, he has used this column to pour scorn on studies documenting the medical effects of second-hand tobacco smoke and showing that climate change is taking place.^{93,94,95,96,97} Even after Fox News was told about the money he had been receiving from Philip Morris and Exxon,⁹⁸ it continued to employ him, without informing its readers about his interests. It still describes him thus:

Steven Milloy publishes JunkScience.com, CSRWatch.com. He is a junk-science expert, an advocate of free enterprise and an adjunct scholar at the Competitive Enterprise Institute.⁹⁹

TASSC's headed notepaper names an advisory board of eight people.¹⁰⁰ Three of them are listed by Exxonsecrets.org as working for organizations taking money from Exxon. One of them is Frederick Seitz, the man who wrote the Oregon Petition, and who chairs Fred Singer's Science and Environmental Policy Project.

In 1979, Seitz became a permanent consultant to the tobacco company RJ Reynolds.¹⁰¹ He worked for the firm until at least 1987,¹⁰² for an annual fee of \$65,000.¹⁰³ He was in charge of deciding which medical research projects the company should fund,¹⁰⁴ and handed

out millions of dollars a year to American universities.¹⁰⁵ The purpose of this funding, a memo from the chairman of RJ Reynolds shows, was to 'refute the criticisms against cigarettes'.¹⁰⁶ An undated note in the Philip Morris archive shows that it was planning a 'Seitz symposium' with the help of TASSC, in which Frederick Seitz would speak to '40-60 regulators'.^{107,108}

S. Fred Singer also had connections with the tobacco industry. In March 1993, APCO sent a memo to Ellen Merlo, the vice president of Philip Morris who had just commissioned it to fight the Environmental Protection Agency.

As you know, we have been working with Dr. Fred Singer and Dr. Dwight Lee, who have authored articles on junk science and indoor air quality (IAQ) respectively. Attached you will find copies of the junk science and IAQ articles which have been approved by Drs Singer and Lee. . . . We discussed with Dr Singer Ellen's suggestion for the junk science article to have a more personal introduction, however he is adamant that this would not be his style. Please review the articles and let us know as soon as possible whether you have any comments or questions about them.¹⁰⁹

Singer's article, entitled *Junk Science at the EPA*, claimed that

The latest 'crisis' - environmental tobacco smoke - has been widely criticized as the most shocking distortion of scientific evidence yet.¹¹⁰

He alleged that the Environmental Protection Agency had had to 'rig the numbers' in its report on passive smoking. This was the report that Philip Morris and APCO had set out to discredit a month before Singer wrote his article.

In another note, APCO reveals that it has discussed with Fred Singer the means of organizing an international movement to support TASSC's aims.¹¹¹

I have no evidence that Fred Singer or his organization have taken money from Philip Morris. But many of the other bodies which have been sponsored by Exxon and have sought to repudiate climate change were also funded by the tobacco company.¹¹² Among them are some of the world's best-known 'think tanks': the Competitive Enterprise Institute, the Cato Institute, the Heritage Foundation, the Hudson Institute, the Frontiers of Freedom Institute, the Reason

Foundation and the Independent Institute, as well as George Mason University's Law and Economics Center.¹¹³ I can't help wondering whether there is any aspect of 'conservative' thought in the United States which has not been formed and funded by the corporations.

Until I came across this material, I believed that the accusations, the insults and the taunts such people had slung at us environmentalists were personal: that they really did hate us, and had found someone who would pay to help them express those feelings. Now I realise that they have simply transferred their skills.

But they are taken seriously throughout the English-speaking media. This is how the BBC introduced an online debate it hosted in July 2004:

Ask the experts: What does the future hold for climate change? . . . Your questions were answered by former Environment Minister Michael Meacher and global climate-change expert Dr S. Fred Singer.¹¹⁴

The BBC's debate pitches a non-scientist against a scientist: the authority, in other words, appears to lie with the 'global climate-change expert' Dr Singer, though his publication record over the past twenty years has been sparse. The BBC chose him rather than any of the thousands of environmental scientists with stronger credentials because its editors believed that this was where the debate lay: between those who claimed climate change was happening, and those who claimed it was not. They believed it, despite several reminders to the contrary from the Royal Society, because Fred Singer and Steve Milloy and others had created this impression through their appearances in the media. The story was self-perpetuating.

Until mid 2005, the BBC seemed incapable of hosting a discussion on climate change without bringing in one of the Exxon-sponsored deniers to claim that it was not taking place. On only one occasion did it tell its listeners that the 'expert' it had chosen had been funded by an oil company.¹¹⁵ It could be argued that by failing to declare their interests it was providing free, unacknowledged airtime for the corporation. It now appears to have woken up to the extent to which it has been (in the words of one senior executive I spoke to) 'fooled by those people'. But in the United States and Australia, Exxon's experts are still being presented as serious scientists. Steve Milloy, for

example, has appeared on CNN, ABC, MSNBC, National Public Radio and most of the major programmes on the Fox News network.¹¹⁶

They are also taken seriously by politicians. In 2003, James Inhofe, the Republican senator from Oklahoma, delivered a speech to the Senate called 'The Science of Climate Change'. Here is an extract.

The claim that global warming is caused by manmade emissions is simply untrue and not based on sound science.

Carbon dioxide does not cause catastrophic disasters – actually it would be beneficial to our environment and our economy.

... With all of the hysteria, all of the fear, all of the phoney science, could it be that manmade global warming is the greatest hoax ever perpetrated on the American people? It sure sounds like it.¹¹⁷

How did he know? Because he had spoken to 'the nation's top climate scientists', whom he then proceeded to list. The list began with Dr S. Fred Singer. It went on to name Frederick Seitz, the two employees of the George C. Marshall Institute who wrote the 'review' Seitz had circulated, and eight others working with organizations sponsored by Exxon.¹¹⁸ Alarming, Inhofe continues to chair the Senate Committee on Environment and Public Works.

In 2004, *Harper's* magazine published a leaked memo from Myron Ebell of the Competitive Enterprise Institute to Phil Cooney, the chief of staff of the White House Council on Environmental Quality. The Competitive Enterprise Institute has been given over \$2m by Exxon.¹¹⁹ In 1997, the only year for which I have records, it received \$125,000 from Philip Morris.¹²⁰ Ebell's memo showed that the White House and the Institute had been working together to discredit a report on climate change produced by the Environmental Protection Agency, whose head at the time was Christine Todd Whitman.

Dear Phil,

Thanks for calling and asking for our help ... As I said, we made the decision this morning to do as much as we could to deflect criticism by blaming EPA for freelancing. It seems to me that the folks at EPA are the obvious fall guys, and we would only hope that the fall guy (or gal) should be as high up as possible. I have done several interviews

and have stressed that the President needs to get everyone rowing in the same direction. Perhaps tomorrow we will call for Whitman to be fired.¹²¹

The New York Times later discovered that Phil Cooney, who is a lawyer with no scientific training, had been imported into the White House from the American Petroleum Institute, to control the presentation of climate science.¹²² He edited scientific reports, striking out evidence that glaciers were retreating and inserting phrases suggesting that there was serious scientific doubt about global warming.¹²³ When the revelations were published he resigned and took up a post at Exxon.¹²⁴

The oil company also has direct access to the White House. On 6 February 2001, seventeen days after George W. Bush was sworn in, A. G. (Randy) Randol, ExxonMobil's senior environmental adviser, sent a fax to John Howard, an environmental official at the White House.¹²⁵ It began by discussing the role of Robert Watson, the head of the Intergovernmental Panel on Climate Change. It suggested he had a 'personal agenda' and asked

Can Watson be replaced now at the request of the US?¹²⁶

It went on to ask that the United States be represented at the panel's discussions by a Dr Harlan Watson.¹²⁷ Both requests were met. One Watson was sacked, the other was appointed, and he continues to wreak havoc at international climate meetings.

While they have been most effective in the United States of America, the impacts of the climate-change deniers sponsored by Exxon and Philip Morris have been felt all over the world – I have seen their arguments endlessly repeated in Australia, Canada, India, Russia and the United Kingdom. By dominating the media debate on climate change during seven or eight critical years in which urgent international talks should have been taking place, by constantly seeding doubt about the science just as it should have been most persuasive, they have justified the money their sponsors spent on them many times over. I think it is fair to say that the professional denial industry has delayed effective global action on climate change by several years.

None of this is to suggest that the science should not be subject to constant scepticism and review, or that environmentalists should not be held to account. It is only through repeated challenges to accepted wisdom that science has progressed. Climate-change campaigners have no greater right to be wrong than anyone else: if we mislead the public, we should expect to be exposed. We also need to know that we are not wasting our time: there is no point in devoting your life to fighting a problem that does not exist.

But the people who have been paid by Exxon are not, as they claim, 'climate sceptics'. They do not fit the usual definition of 'sceptic':

A seeker after truth; an inquirer who has not yet arrived at definite conclusions.¹²⁸

They are members of a public relations industry, which begins with a conclusion and then devises arguments to support it.

Nor is this to suggest that political resistance to dealing with climate change is entirely the work of these people. The US government, for example, doesn't need Exxon's help to sabotage the international climate negotiations. One of the reasons why the professional climate-change deniers have been so successful in penetrating the media is that the story they have to tell is one that people want to hear.

In one respect, almost everyone – including the campaigners – is in denial about climate change. We have chosen to believe that the targets set by some of the more progressive governments provide realistic means of dealing with it. The United Kingdom, for example, intends to cut carbon emissions by 60 per cent by 2050. This is one of the world's most ambitious objectives. It is also, as I hope the previous chapter demonstrated, next to useless. But most of the climate-change reports produced by the major environmental groups seek to demonstrate that this target can be met without major economic loss. Whether or not it can be met is irrelevant: it is the wrong target. None of them has yet stepped forward to say that we need a cut of the magnitude the science demands.

The British government's chief scientist, Sir David King, has been heroic in drawing attention to the dangers of climate change, and he

has taken plenty of flak for it. In a speech in October 2004, he said the following:

So what is the point at which the Greenland ice sheet will start melting? The latest indication is when the temperature around the Greenland land mass area is 2.7° centigrade above the pre-industrial level . . . What level of carbon dioxide therefore do we need to avoid going beyond in order to avoid testing this theory of melting of the Greenland ice sheet? . . . I used to say 550 parts per million, I'm now thinking that that might be pushing it a bit. So we are talking about perhaps 500 parts per million as the level beyond which we shouldn't go.¹²⁹

In September 2005, I attended a conference in London at which Sir David was speaking. He told it that a 'reasonable' target for stabilizing carbon dioxide in the atmosphere was 550 parts per million. This happens to be the target set by the British government. It would be 'politically unrealistic', he said, to demand anything lower.¹³⁰ Simon Retallack from the Institute for Public Policy Research stood up and reminded Sir David that as chief scientist his duty is not to represent political reality, but to represent scientific reality. Retallack's own work shows that at 550 parts per million the chances of preventing more than 2° of global warming are just 10–20 per cent.¹³¹ Sir David replied that if he recommended a lower limit, he would lose credibility with the government.

I think many people feel like him: that if they adopted the position determined by science rather than the position determined by politics, no one would take them seriously.

But the thought that worries me most is this. 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 ever rioted for austerity.

This is a gloomy thought. But it does reinforce my belief that we must make the necessary changes as painless as possible.

A Ration of Freedom

If thou repent, devils shall tear thee in pieces.

Doctor Faustus, Act II, Scene 3¹

Making the necessary changes as painless as possible means, among other measures, making them as fair as possible. Even if we put the moral considerations aside, there is a good political reason for fairness. People are more willing to act if they perceive that everyone else is acting. In his book *Happiness: Lessons from a New Science*, Professor Richard Layard observes that

The only situation where we might willingly accept a pay cut is when others are doing the same. That is why there was so little economic discontent during the Second World War.²

George Orwell made a similar point in his essay *The Lion and the Unicorn*, published in December 1940.

The lady in the Rolls-Royce car is more damaging to morale than a fleet of Goering's bombing planes.³

In other words, one of the criteria for success in cutting greenhouse gas emissions by 90 per cent is that the cut applies to everyone. This would ensure that I was no longer confronted with the utter futility of buying an energy efficient bulb while Mr Meikle from Coalburn attaches a million Christmas lights to his house.

If we attempted to suppress climate change entirely by means of energy taxes, two things would happen. The poor would be hit much harder than the rich, as the costs took up a higher proportion of their