CHAPTER 9

Where We Are Headed

To help think about possible future trajectories of human-produced greenhouse gases, the IPCC has developed six sets of scenarios, each of which makes different assumptions about future emissions, land use, technologies, and forms of economic development. The scenarios range from those that assume large reductions in greenhouse-gas emissions to those that assume a world of 'business as usual' practices and, as such, imagine the most pessimistic, fossil-fuel-intensive emissions future. The current IPCC scenarios were prepared for the panel's 2001 report and are now almost a decade old, lagging well behind reality. As Roger Jones of the CSIRO says, 'At the time of their release in 2000, [the scenarios] were state-of-the-art … Now, the world is growing faster and is richer than the scenario authors assumed.'

According to the most recent IPCC report, human-caused carbon dioxide emissions increased 70 per cent between 1970 and 2004, and are rising at an even faster rate now. Their annual increase jumped from an average of just over 1 per cent for the period from 1990–1999 to more than 3 per cent from 2000–2004. The actual growth rate of carbon-dioxide emissions since 2000 is greater than growth rates for the most fossil-fuel-intensive of the IPCC emissions scenarios.

A study led by the CSIRO's Michael Raupach, co-chair of the Global Carbon Project, has found that no region is effectively decarbonising its energy supply. Raupach says that a major driver accelerating the growth rate in global emissions is that we're now burning more carbon for every dollar of wealth we create: 'In the last few years, the global use of fossil fuels has actually become less efficient. This adds to pressures from increasing population and wealth.'

In Australia, Raupach says, carbon emissions have grown at about twice the global average during the past 25 years, and have almost doubled the growth rate of emissions in the United States and Japan. He believes that because 'emissions are increasing faster than we thought … the impacts of climate change will also happen even sooner than expected'.

According to the October 2007 World Bank report *Growth and Carbon Dioxide Emissions: how do different countries fare?*, Australia increased its carbon dioxide emissions by 38 per cent between 1994 and 2004, to become the sixth-highest per capita emitter (on a base that excludes land use, land-use change, and forestry). Australia's emissions-increase was more than the total of Britain, France, and Germany which, combined, have a population ten times that of Australia.

The rising rate of global carbon dioxide emissions is reflected in a larger annual increase in the level of carbon dioxide in the air. The average increase of 1.5 parts per million for the period from 1970–2000 has jumped to 2.1 parts per million since 2001. NASA's James Hansen told the *Independent* in January 2007 that 'if we go another ten years, by 2015, at the current rate of growth of carbon dioxide emissions, which is about 2 per cent per year, the emissions in 2015 will be 35 per cent larger than they were in 2000'. He says that this would take the emissions scenarios necessary to avoid dangerous climate change beyond reach.

Atmospheric carbon dioxide levels are now rising faster than at any time in the past 800,000 years. The level rose 30 parts per million over the past 17 years; yet ice cores drilled in Antarctica show that in the past million years, prior to recent times, the fastest increase of carbon dioxide was 30 parts per million over a period of a thousand years.

The increasing use of energy is also going to increase emission levels. In 2004, the International Energy Agency (IEA) projected that annual carbon dioxide emissions by 2030 would be 63 per cent higher than in 2002. According to the European Union's 2007 *World Energy Technology Outlook*, 'business as usual' will see global energy use more than double by 2050, with 70 per cent of the increase coming from fossil fuels. The report assumes that energy efficiency will almost double, in order to support an economy four times larger than today. The result would be a carbon dioxide concentration in the atmosphere of 900–1000 parts per million by 2050. It says: 'This value far exceeds what is considered today as an acceptable range for stabilisation of the concentration.' The conclusion is that carbon emissions cuts will come too late to avert 'runaway' climate change if current policy trends continue, and that this would happen despite a 'massive' growth in renewable energy after 2030, including rapid deployment of new technologies, such as offshore wind.

While the IEA predicts annual growth in global power consumption of 3.3 per cent per year to 2015, a study by

Oxford Economics analysts shows that, when trends in developing countries are studied in more detail, the rate would be even higher, at 5 per cent.

Increasing energy use and rates of greenhouse-gas emissions mean only one thing: it will get hotter, quicker. The IPCC's conservative estimate is a rise of 4 degrees by 2100 for the most pessimistic 'business as usual' scenario, yet our emissions are currently rising faster than this scenario envisages. The ten warmest years on record have all occurred since 1995, and one study predicts a 0.3-degree increase for the period from 2004–2014 alone.

Before the Arctic big melt of 2007, Hansen and his colleagues, by comparing sea-surface temperatures in the Western Pacific with historical climate data, suggested that this critical ocean region, and probably the planet as a whole, is 'approximately as warm now as at the Holocene maximum [the period of the highest temperature within the last 11,500 years] and within *one degree of the maximum temperature of the past million years*' [our emphasis]. They conclude that global warming 'of more than one degree, relative to 2000, will constitute "dangerous" climate change as judged from likely effects on sea level and extermination of species'.

Rates of warming since the mid-19th century are higher than those of the last ice age by more than a factor of ten, increasing to a factor of twenty from the mid-1970s. The atmosphere is now heating up more quickly than modern humans have ever experienced. 'We really are in a situation where we don't have an analogue in our records,' says Eric Wolff from the British Antarctic Survey. According to Wolff, it is generally accepted that at some stage a 'step change' or 'tipping point' is reached, after which global warming accelerates exponentially. According to new evidence, he says, 'we could expect that tipping point to arrive in ten years' time.' Recent observations from the Arctic, and their implications for the Greenland ice sheet and sea-level rises, suggest that we may have already passed that point.

When accepting the WWF Duke of Edinburgh Conservation Medal in November 2006, James Hansen told his audience that the human race must begin to move its energy systems in a fundamentally different direction within about a decade, or 'we will have pushed the planet past a tipping point beyond which it will be impossible to avoid far-ranging undesirable consequences'. He warned that global warming of 2 to 3 degrees above the present temperature would produce a planet without Arctic sea-ice; a catastrophic sea-level rise of around 25 metres; and a super-drought in the American west, southern Europe, the Middle East, and parts of Africa. Such a scenario, he says, 'threatens even greater calamity, because it could unleash positive feedbacks such as melting of frozen methane in the Arctic, as occurred 55 million years ago, when more than 90 per cent of species on Earth went extinct'.

The ANU's Will Steffen argues that the Earth's climate system 'is highly non-linear and is prone to abrupt changes, threshold effects and irreversible changes' in a human time frame, so that very small changes in a forcing factor 'can trigger surprisingly large and sometimes catastrophic changes in a system … [and] propel the Earth into a different climatic and environmental state'. Examples he cites include 'the rapid disintegration of the large ice sheets on Greenland and Antarctica or large-scale and uncontrollable feedbacks in the carbon cycle: activation of methane clathrates [frozen water and methane] buried under sediments on the ocean floor, the rapid loss of methane from warmer and drier tundra ecosystems, increasing wildfires in the boreal and tropical zones, the conversion of the Amazon rainforest to a savannah and the release of carbon dioxide from warming soils'. Once we cross critical thresholds and trigger these processes, Steffen says no policy or management approach could slow, or reverse, the process.

Hansen agrees. He says the tipping point occurs when the climate state is close to triggering very strong positive-feedback effects, so that a small perturbation can cause large climate change.

Today, the Arctic sea-ice, the West Antarctic ice sheet, and the Greenland ice sheet can provide such feedbacks. Little additional forcing is needed to trigger these feedbacks, because of the warming that is already in the pipeline. Hansen concludes wryly: 'We have to be smart enough to understand what is happening early on.'

Tony Blair and his Dutch counterpart Jan Peter Balkenende told European leaders in 2006 that, 'without further action, scientists now estimate we may be heading for temperature rises of at least 3 to 4 degrees above pre-industrial levels … We have a window of only ten to 15 years to avoid crossing catastrophic tipping points. These would have serious consequences for our economic growth prospects, the safety of our people, and the supply of resources—most notably, energy.'

This statement was made before the imminent loss of the Arctic sea-ice, and the consequences of that loss, were as clear as they are today. When that event is taken into account, the ten-to-15-year window looks to be closed already.