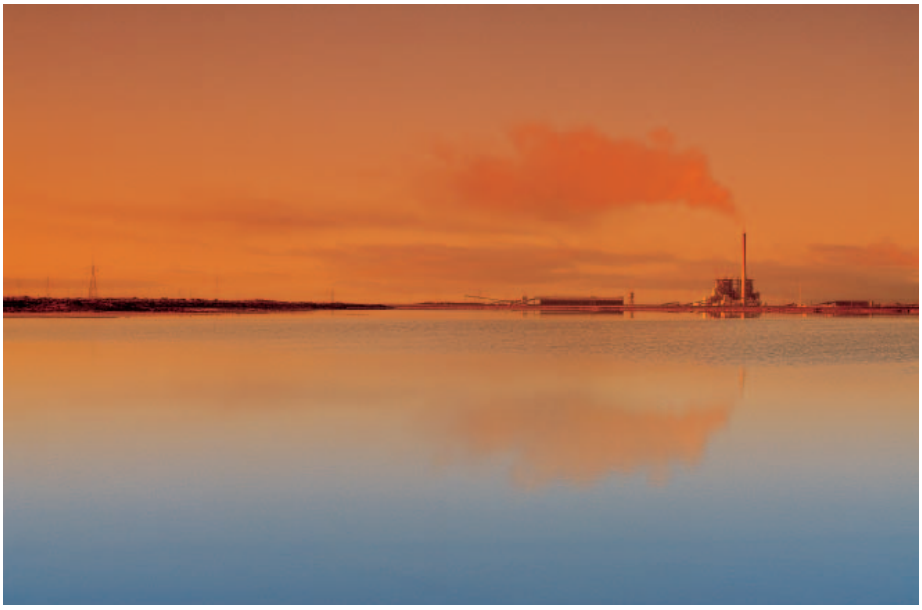
The benefit to the economy of early climate change action

Climate change policy debates have been preoccupied with the economic cost of taking action to reduce greenhouse gas emissions. Yet recent assessments have reframed the question, focusing instead on the cost of inaction. In fact, the damage caused by unmitigated climate change may be the bigger threat to the global economy. **Benjamin Preston** and **Roger Jones** elaborate.



Sunrise over the Port Augusta Power Station at the head of Spencer Gulf, SA. CSIRO Land and Water

For years economic rationalists have warned that the costs of reducing greenhouse gas (GHG) emissions will undermine not only Australia's economy but also the world's. In short, argue the rationalists, GHG mitigation is a bad investment, the consequences of which are disproportionately large relative to the potential benefits in avoiding climate change damages.

Rather than walk down the mitigation road, the rationalists have adopted the principles of the late Julian Simon – resurrected in the current century by Denmark's Bjorn Lomborg[1] – namely, that the betterment of the environment and the human condition can collectively be pursued through the growth of market economies.

The foundation of this argument rests on two assumptions. The first is that the costs of GHG mitigation are sufficiently large to raise concerns about economic recession. Yet for several years now, the exact opposite message has been emerging from the offices of economists. Stanford University's eminent Stephen Schneider[2] in conjunction with Göteborg University's Christian Azar found that even with pessimistic assumptions about the costs of mitigation, the ultimate impact on the global economy was effectively negligible – delaying the time required for a 10-fold increase in global wealth by just two years.

More recently, the UK's Stern Review[3] estimated the costs of GHG mitigation to be on the order of 1 per cent of global GDP by 2050 – granted, billions of dollars, but in the context of the size of the world's economy, a sum that poses no barrier to sustained global economic growth.

These findings have held at the national scale as well. As discussed in an earlier article by Steve Hatfield Dodds in *Ecos*,[4] economic modelling for Australia has consistently found the costs of mitigation to be no threat to the long-term growth of the nation's economy. It appears that the economic bogey man of mitigation that has caused so many to not only live in fear, but spread that fear to the general public, is dying a slow death.

So what about the second assumption? For any rational economic argument, one needs to know not only the costs of a policy action, but also the benefits – and there's the rub. Even if one accepts that the costs of GHG mitigation are not prohibitively high, the question remains whether such mitigation represents a good investment. Are the benefits of avoided climate change damages sufficiently large to offset the costs? Making such a determination requires knowing something about the costs of climate damages in the absence of efforts to control GHGs.

As it turns out, this may be one of the most uncertain elements of climate policy analysis.

1 Lomborg B (2001). *The Sceptical Environmentalist: Measuring the Real States of the World*. Cambridge University Press, Cambridge, UK.
2 Azar C and Schneider SH (2003). Are the economic costs of stabilising the atmosphere prohibitive? *Climatic Change* **42**, 73–80.
3 Stern N (2006). *The Economics of Climate Change: The Stern Review*. Cambridge University Press, Cambridge, UK.
4 Hatfield Dodds S (2007). The economic impacts of deep cuts to Australia's greenhouse emissions. *Ecos* **134**, 12.

Tagged canisters in CSIRO's air and aerosol archive provide historic snapshots of atmospheric make-up. CSIRO Marine and Atmospheric Research

Assessing climate damage

At the broadest level, the concern about unmitigated GHG emissions is that they will cause 'dangerous anthropogenic interference with the climate system', a concept encapsulated within the 1992 United Nations Framework Convention on Climate Change (UNFCCC).[5] The UNFCCC suggested that 'dangerous interference' refers to things such as threats to ecosystems, food security and economic development.

O'Neill and Oppenheimer[6] proposed more specific criteria, such as the collapse of the oceanic thermohaline circulation system, the loss of the world's great ice sheets of Greenland and West Antarctica and the destruction of coral reef ecosystems.

Yet this is certainly not a comprehensive listing. There are many other damages that may be construed as dangerous – for example, significant declines in rice yields in Asia, sea-level rise in Bangladesh or reduced inflows into Australian water storages.

Despite the varying definitions of 'dangerous interference,' it is clear that potentially dangerous climate consequences are a likely outcome of continued climate change. Global warming thresholds function as indices of such consequences. In a review of 'dangerous' global warming thresholds conducted for the Australian Climate Change and Business Roundtable, CSIRO researchers found estimates ranging from 1.5–2.0°C of global warming relative to pre-industrial temperatures.

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In fact, this threshold is likely to be exceeded even with significant mitigation. This poses a challenge to policy analysis. Such fixed, 'all-or-nothing' temperature thresholds assume damages are effectively negligible below the threshold, and total or infinite above the threshold. So as suggested by the Prime Ministerial Task Group of Emissions Trading,[7] long-term temperature targets must first be translated into emissions targets and trajectories if they are to be useful for assessing the costs and benefits of different policy actions.

Hence, a more robust method for assessing the consequences of climate change may be to determine the marginal damage or risk associated with increases in global mean temperature under different assumptions about future emissions.

Traditionally, this type of analysis has involved integrated assessment (IA) models, developed to explore the relationships between socio-economic drivers of climate change, social and environmental impacts, and the effect of policy interventions. A review of such studies appeared in the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPCC),[8] with damage estimates ranging from 1 to 5 per cent of GDP for a global temperature increase of 4.0°C.

IA models commonly cover measurable climate damages such as market consequences associated with agricultural impacts and emergency management, or adaptation costs of coastal systems. However, they have limitations in accounting for non-market impacts, uncertain implications of positive feedbacks, non-linear consequences or catastrophic outcomes. This means that IAs underestimate climate damages, and, subsequently, the benefits of mitigation.

In the past, IA estimates have also failed to account for uncertainty in the relative likelihood of different climate futures. While the associated damages of 2°C of warming over the 21st century are a cost that society is likely to have to bear in the future, the larger damages associated with 5°C of warming are an outcome of a lower likelihood. How do we weigh these different risks in accounting for climate damages?

Recent IA models have introduced more nuanced approaches to addressing these uncertainties. The most well known of these are found in the Stern Review. Drawing from a broad range of literature on climate change consequences and probability distributions for changes in global temperature, the Stern Review estimated the direct damages of climate change to be 5–7 per cent of global consumption.

This range is consistent with the estimated impacts appearing in the IPCC's Third Assessment Report. However, when feedback processes and indirect effects were considered, estimated damages jumped to 11–14 per cent of consumption

5 UNFCCC (1992). *United Nations Framework Convention on Climate Change.* United Nations, New York, NY.
6 O'Neill BC and Oppenheimer M (2002). Dangerous climate impacts and the Kyoto Protocol. *Science* **296**, 1971–1972.
7 Prime Ministerial Task Group on Emissions Trading (2007). Report of the Task Group on emissions trading. Canberra, Australia.
8 IPCC (2001). *Climate Change 2001: Impacts, Adaptation and Vulnerability.* Cambridge University Press, Cambridge, UK.

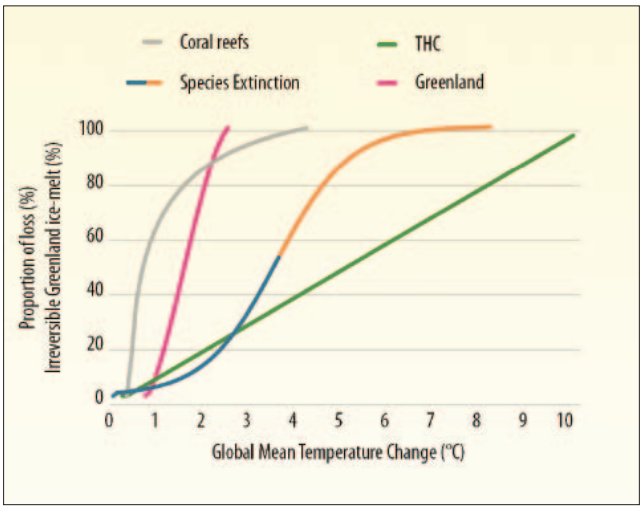
and up to around 20 per cent when distributional impacts on the poor were taken into account.

The heat is on

Less than a month after the release of the Stern Review, the CSIRO-initiated Energy Futures Forum (EFF) launched its report, *The Heat is On: The Future of Energy in Australia*.[9] The EFF was set up in 2004 by the CSIRO Energy Transformed Flagship to investigate Australia's future energy mix under climate change.

The EFF constructed a number of qualitative GHG emissions scenarios that were intended to explore a range of plausible emissions futures. The Australian Bureau of Agricultural and Resource Economics (ABARE) translated several of these scenarios into quantitative emissions pathways, comprising reference and mitigation scenarios to facilitate economic and risk modelling.

The EFF assessment also generated estimates of the climate change consequences that would result from these scenarios. Like the Stern Review, this assessment of the costs of global climate damages to GDP was based upon different assumptions about the trajectory of future damages. This analysis identified a range of GDP impacts in the order of 4–16 per cent by 2100 – similar to those of the Stern Review, despite the use of different methodologies.



Projected losses of some key biophysical indices, including the thermohaline circulation (THC), with increased temperature. CSIRO

Because purely economic estimates could not capture all potential consequences of climate change, the assessment also developed a series of damage functions for global biophysical consequences (see graph), including some of the commonly cited 'dangerous' impacts of climate change.

In the absence of mitigation, the ocean's thermohaline circulation was projected to decline by 35–45 per cent, 60–80 per cent of species were projected to be at risk, virtually all of the world's coral reef area was projected to be damaged, and the irreversible melting of the Greenland ice sheet was a certainty.

Although the economic implications of such consequences have not been estimated, they add another dimension to the climate change problem, and provide further justification of high damage estimates suggested by market assessments.

The global balance sheet

One of the most publicised outcomes of the Stern Review is that the estimated economic consequences of climate change are more substantial than estimated mitigation costs. Hence mitigation is not only affordable, it represents a good investment. What the Stern Review neglected to spell out, however, was an estimate of the return on that investment.

In contrast, the EFF analysis took two different approaches to measuring the benefits of different mitigation scenarios.

First, the use of risk-weighted impacts enabled the benefits of mitigation to be expressed as a reduction in risk. For example, the mitigation scenarios examined by the EFF resulted in significant reductions in both the number of species at risk and the magnitude of the impact on ocean circulation. However, significant damage to coral reefs and a high likelihood of loss of the Greenland ice sheet remained probable.

Second, the analysis developed a new technique for evaluating the economic benefits of mitigation. The technique compared the economic costs of

Major perspective from the Energy Futures Forum. CSIRO

ABARE's mitigation scenarios to 2050 with the minimum economic benefits of avoided climate damages out to 2100. This represents a fairly conservative approach to the magnitude of mitigation benefits; though hardly precautionary, the approach reflects the economically risk-averse atmosphere in which many policy decisions are made.

Even after accounting for uncertainty in climate damages and a heavy bias toward protecting the economy, all of the ABARE mitigation scenarios could be justified with ample room to spare. Hence, as with the Stern Review, given the estimated climate change damages, the costs of GHG mitigation are justified.

As a first step toward an 'Australian-centric' integrated assessment of climate change, the EFF analysis shows much promise as a framework for assessing the costs and benefits of climate policy.

Yet clearly there is opportunity to further develop the methodology and downscale the approach to the national level. This requires knowing much more about the likelihood of different climate changes across the nation, their economic and environmental implications and the preferences of Australians with respect to appropriate balance between climate and policy risk.

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More information:
Energy Futures Forum report, *The Heat is On: The Future of Energy in Australia.*
www.csiro.au/resources/pfnd.html

9 EFF (2006). *The Heat is On: The Future of Energy in Australia*. CSIRO Energy Futures Forum, Canberra, Australia.