Stabilising World CO_2 Emissions: a Bridge Too Far?

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Introduction

Reducing global greenhouse gas emissions by 20 to 50 per cent of prevailing levels to address concerns about climate change would require emissions to be reduced to 3.4 and 2 tonnes of carbon dioxide equivalent per capita, respectively. Even in developed economies which are not predominantly reliant on fossil fuel for electricity generation, emissions far exceed the targets under discussion. US emissions are currently 20 tonnes per capita and the OECD as a whole is at 11.5 tonnes. China already exceeds 3.4 tonnes per capita.

The Task's Magnitude

The Stern Report

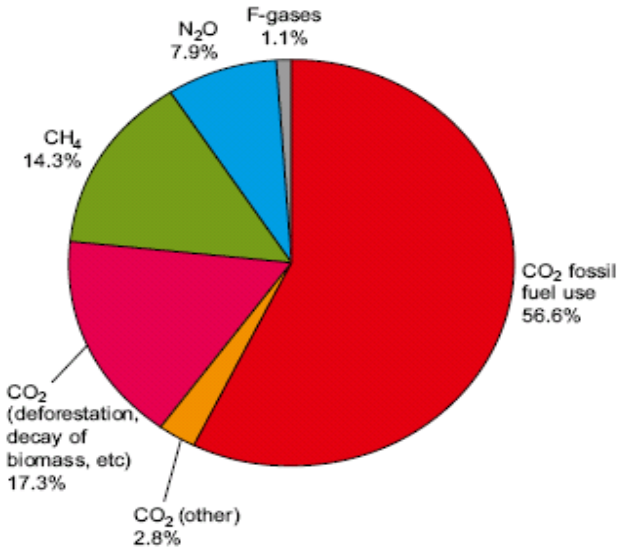
Contrary to many assertions, including those of the Stern report on the *Economics of Climate Change*[1], the costs of reducing emissions of carbon dioxide and other greenhouse gases will be considerable.

IPCC data[2] identifies the share of the various emission sources. CO_2 in fuel is responsible for over half with methane and deforestation comprising most of the rest. Figure 1 illustrates the data.

[1] Stern Review, "Economics of Climate Change", 2006. http://www.hm-treasury.gov.uk/stern_review_final_report.htm

[2] IPCC Fourth Assessment Report, Working Group III Report Mitigation of Climate Change.

Figure 1 Global Share of Gases in CO_2 Equivalents



Source: Technical Summary, WG3 IPCC, Fourth Assessment Report, 2007
http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-ts.pdf p28

The Stern Report sought reductions in global emissions of carbon dioxide by 80 per cent of current levels by 2050. Stern argued that the economic cost will be a total of one per cent of world GDP, "which poses little threat to standards of living given that the economic output in the OECD countries is likely to rise by over 200 per cent and in developing countries by more than 400 per cent" during this period (P.239).

Richard Tol, in a number of articles, has been highly critical of Stern's estimates.[3] He referred to Stern's conclusions on the costs of climate change as "preposterous" and concluded that the report can be "dismissed as alarmist and incompetent".

A gauge of the economic task involved is the modest outcomes of energy policies promoting abatement. Among these is the relatively minor emission reductions achieved in the EU under its Kyoto commitments. This is notwithstanding regulations on energy use, subsidies to renewables and a carbon use restraint program based on cap and trade. The capped emissions price has ranged between €32 and €0.08 per tonne of CO2 and was around €15 per tonne in August 2009, enough to increase the Australian wholesale price of electricity by almost two thirds.

The initial steps taken by the developed countries

All developed countries have incurred considerable costs in subsidising and regulating in favour of high cost energy sources with low emissions. In spite of this, and the fact that the early gains are likely to be the easiest because they tap into the fabled "low hanging fruit", few major signatories will meet their Kyoto obligations.

[3] See for example Tol, Richard S. J., "The Stern review of the economics of climate change: a comment", Energy and Environment, V 17, No. 6 2006

Individual European Union countries will achieve their targets - Germany because of unification, and the United Kingdom because of the shift from coal powered electricity generation to gas.

Canada, which has often been in the vanguard of countries urging increased action, is among those falling furthest from the goal to which it agreed.[4]

Australia claims to be meeting its (generous) Kyoto 2008-12 target of 108 per cent of 1990 levels but would be 30 per cent above 1990 levels were it not to measure its emissions on the basis of the creative 'Australia clause' in Article 3.7. That clause permits countries to count changes to land-use and forestry as part of their measures of net emissions.

Table 1 is drawn from the latest United Nations Framework Convention report and indicates levels of achievement compared to the 2008-12 targets expressed as theemissions in excess of, or below the 1990 base level. The latest data is for 2005 and the levels are expressed on two bases: with and without counting land use changes as a result of policy towards clearing land for cultivation. Only the EU taken as a whole is close to the targets in the form they were originally agreed.

Table 1 Kyoto Commitments and Achievements over 1990 Baselines

	2008-12	**2005 actual**	
	Target	Inc. clearing	Exc. clearing
Australia	8%	4.5%	25.6%
Canada	-6%	54.2%	25.3%
EU	-8%	-4.0%	-1.5%
Japan	-6%	7.1%	6.9%
NZ	0%	22.7%	24.7%
Norway	1%	-23.1%	8.8%
US	-7%	16.3%	16.3%

Source: UNFCC. http://unfccc.int/resource/docs/2007/sbi/eng/30.pdf

The measures required to bring about abatement

Recognising that any CO_2 reduction would need to address the use of fossil fuels, most studies see a form of carbon tax as the key feature of any policy to limit greenhouse gas emission. Stern estimated a tax would be required at an initial level of US$100 per tonne of CO_2 and envisaged new technologies cutting in by 2030. These new technologies, Stern envisaged would drive down the required tax level to around $US35 per tonne.

In addition to these tax effects, Stern's estimates also include other measures like a continuation of existing energy efficiency taxes and programs. They also incorporate a considerable emphasis on energy saving at the production end. Moreover, the estimates are posited on a major contribution from voluntary energy savings, partly stimulated by education programs, drawing upon what the economist Lionel Robbins famously referred to as "that very scarce commodity, human love".[5]

[4] As described elsewhere in this volume, the province of Ontario plans to phase out its coal by 2014

[5] The University of Aston's Professor Julia King has argued for a plan to 'educate' children so that they can help shape parents purchases of cars etc to be 'green.' Professor King was appointed by then

Achieving Global Emission Reductions

The global setting for an emissions reduction scheme

Difficulties that developed countries have experienced thus far in reducing GHG emission levels would be amplified for developing countries, which as Table 2 illustrates have far lower existing levels of emissions.

Table 2 2004 CO_2 levels

	CO_2 emissions (2004) Per capita
Selected Countries	
India	1.2
China	3.8
Australia	16.2
United States	20.6
Canada	20
UK	9.8
France	6
Aggregate Areas	
Developing countries	2.4
Least developed countries	0.02
East Asia & Pacific	3.5
Former Soviet bloc	7.9
High-income OECD	13.2
World	4.5

Source: UNDP

At the G8 meeting in June 2009 in L'Aquila, leaders agreed a ludicrous set of targets. These involved developed countries reducing their emissions in 2050 by 80 per cent and the developing countries by 50 per cent by 2050. Present per capita emission levels of carbon dioxide are 11.5 and 2.4 tonnes for the developed world and the developing world respectively. The former Soviet bloc stands at 7.9 tonnes.

The targets mean that by 2050 the proposed cuts would leave the developed world with 2.9 tonnes of carbon dioxide per capita and the developing world with less than half of this at 1.2 tonnes per capita. And this is based on the unlikely event of population growth in the developing countries slowing to the level of that in the developed world. Unsurprisingly, China, India and Russia rejected the agreement.

There have been suggestions that the developing countries should be brought into an emission reduction scheme by granting them tradable emission rights. This offers ostensibly attractive outcomes of all round wins. Developing countries would be given rights to emit CO_2 that would be surplus to their requirements, rather like when post-communist countries in the former Soviet bloc were brought within the system. Those countries' adoption of capitalist production and pricing methods had encouraged conservation of resources, meaning their previous emission levels were

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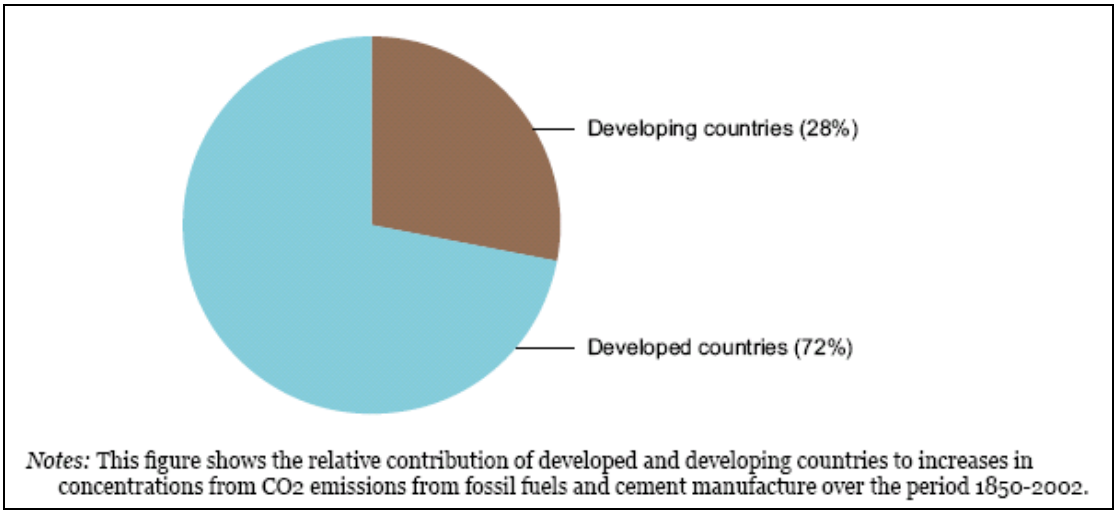
Chancellor of the Exchequer, Gordon Brown, to lead the 'King Review' to examine the vehicle and fuel technologies to help to reduce carbon emissions from road transport. The interim analytical report (Part 1) was published in 2007. Personal communication, Paul Biggs Birmingham University.

far higher than their reformed economies required. Granting them their existing levels of emissions and allowing them to trade the surplus amounts handed them windfall gains.

The treatment of the former Soviet bloc countries in this way was crucial to getting their agreement to the Kyoto Convention and in turn to the Convention receiving the global support necessary for it to come into force as an international treaty. But at the same time this vastly expanded the quantities of permitted emissions by activating "sleeper" emission rights. In this way it somewhat undermined the basic intent of the protocol.

The far greater magnitude of developing country emissions, their less wasteful use of energy and their future need for much higher levels of energy use makes it impossible to adopt a similar approach. This would be even more difficult if developing countries claimed that they should receive credits for their previously low level of emissions. Figure 2 illustrates the overwhelming importance of the developed world in past levels of emissions.

Figure 2 Contributions to atmospheric concentrations of greenhouse gases 1850–2002



Source: Carbon Pollution Reduction Scheme, Australian Green Paper July 2008, derived from Kevin Baumert, Timothy Herzog, Jonathan Pershing 2005, '*Navigating the numbers greenhouse gas data and international climate policy*', World Resources Institute.

An alternative approach to the carrot of incentives to developing country participation is the stick of penalties for non-participation. For example, Australia's Garnaut Report cites, with apparent approval, the suggestion of the economist Joseph Stiglitz that a tariff be placed on goods for recalcitrant countries which are not playing the game. Garnaut also notes that the head of the WTO, Pascal Lamy supports such penalties as a "distant second best solution".[6]

[6] Garnaut Draft Climate Change Review, http://www.garnautreport.org.au/draft.htm p.324, July 2008. Border tariffs on carbon intensive products from countries that fail to take action comparable to the US also feature in the Waxman-Markey Bill.

While measures like WTO tariffs on carbon contents of goods may be a background threat to be used to encourage a "voluntary" solution. Should a voluntary solution not emerge, such countervailing duty measures would prove extremely difficult to devise. They would entail a careful estimate of the fossil fuel content of every good and service, an estimate that would clearly be highly variable between products and over time. In the face of sharp disagreements, it is not difficult to see an attempt to require such compliance as bringing about the end of the present rules under which the global trading system operates.

Posner and Sunstein[7] reject the case for developing countries to receive more generous credits as a result of the historic "over-allocation" that other countries have acquired. They argue that developed countries' previous growth also brought benefits to developing countries. Posner and Sunstein also point to further difficulties that might emerge in determining a fair allocation of costs. These include the different levels of benefits said to accrue from taking action; Russia for example would be likely to obtain gains from warming and China, the US and Japan are forecast to incur relatively low losses.

The CO_2 emission reduction task

In 2004, global greenhouse gas emissions (in CO_2 equivalents) were 28,790 million tonnes. Just over 10 per cent of these were from the former Soviet bloc with the rest split fairly evenly between the OECD countries and the developing world. Emissions from OECD countries grew at 1.3 per cent per annum between 1990 and 2004. Those of the developing countries, however, saw annual growth at 5.7 per cent during the same period while the former Soviet bloc's emissions fell by 1.7 per cent per annum.

By 2008, developing countries' emissions exceeded those of the OECD countries. The faster growth in emissions within developing countries will increasingly dilute any actions taken by the developed OECD nations, the only group seriously considering abatement measures at the present. The dilution is further amplified if abatement in the OECD is achieved by the established trend of smelting and other energy intensive activities being re-located to developing countries. The IPCC report tended to downplay this leakage issue arguing: "Estimates of carbon leakage rates for action under Kyoto range from 5 to 20% as a result of a loss of price competitiveness, but they remain very uncertain."[8] Given the globalised nature of production and the incentives and necessities of businesses to relocate to venues where even modest cost savings are available, the IPCC's range for carbon leakage may be too modest.

A summary of the recent trends in emissions is shown in Table 3.

[7] Posner A. E. and Sunstein C.R., Global Warming and Social Justice, Regulation, Spring 2008.
[8] http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter11.pdf p622

Table 3 Growth of CO_2 equivalent emissions by region (m tonnes)

	1990	2004	Annual Increase
OECD	11205	13319	1.3%
Former Soviet bloc	4182	3168	-1.7%
Developing Countries	6833	12303	5.7%
Total	22220	28790	2.1%

Source: Human Development Report 2007/2008, UNDP

It would require the adoption of as yet unknown fundamental technological developments to achieve any form of stabilisation at 2004 levels of 28,790 million tonnes. If the trajectory were global, stabilisation by 2030 with OECD countries reducing their emission levels by 20 per cent and the former Soviet bloc holding their emissions constant, then this would require developing countries to limit their increases in emissions to 15 GT (by 22 per cent). The contrast of this and business-as-usual (BAU) is illustrated in Table 4.

Table 4 Emission Stabilisation Scenario (million tonnes of CO_2 equivalent)

	2004	2030	2030 bau[9]
OECD	13319	10655	18350
Former Soviet bloc	3168	3168	3168
Developing Countries	12303	14967	36671
Total	28790	28790	58188

Source: Derived from Human Development Report 2007/2008, UNDP

While superficially generous to the developing countries, the 22 per cent increase is a massive reduction compared with business-as-usual growth levels. Compared with the 15 billion tonnes of carbon dioxide equivalent projected under this scenario, business-as-usual levels - based on previous growth rates - would see developing countries emitting over 37 billion tonnes in 2030.

Moreover, because of their population growth, limiting developing countries' emission levels to 15 billion tonnes of carbon dioxide equivalent would result in their emissions per head actually *falling*. Developing countries in 2030 are estimated to have a population at 7.2 billion,[10] and under the scenario in Table 4 their per capita emissions would fall from 2.4 tonnes to 2.3 tonnes. This is one fifth of the OECD 2004 per capita average of 11.5 tonnes and only a quarter of the OECD average in 2030 (7.9 tonnes) once a 20 per cent reduction and population growth is incorporated.

Perhaps the most readily supported basis of allocating emissions would be on an equal per capita basis for all countries. With a 20 per cent reduction, this would require emissions per capita to be limited to 3.4 tonnes. Such a task would be Herculean for those countries presently in the over 15 tonne per capita category. Chancellor Merkel's proposal of halving present global emission levels would further magnify the difficulties involved.

[9] Based on projecting emissions per head forward at the compound average rates 1990 -2004 for OECD (1.24%) and DCs (4.29%) with the former Soviet bloc constant

[10] Derived from http://www.prb.org/Datafinder/Geography/MultiCompare.aspx?variables=6,7,4&regions=1,2,3,

Modelled paths to emission reductions

Barring some presently unforeseen technology breakthroughs, if developing countries were somehow forced to hold their emissions at their present levels, they would be unable to close the gap with the developed world's living standards. If developed countries were required to reduce their emissions to the current world average of around 4 tonnes per capita, this could only be possible with (1) a fundamental shift to low-carbon economies, (2) a markedly reduced living standards, or (3) a drastically different lifestyle.

A radical nuclearisation of electricity generation would produce less than a 40 per cent reduction in carbon dioxide equivalents. It would also be a 'one-shot' reduction requiring additional emission reductions or substitutions out of energy if living standards were to be allowed to increase. Even a massive conversion to nuclear would come at considerable cost in the abandonment of wealth in such assets as coal and in the diversion of capital from more productive venues.

There is, of course, the prospect of new technologies emerging. Draconian cuts in emission levels would require taxes or prices on emission levels that would certainly stimulate the discovery of these as well as economies in energy use. But the necessary technological breakthroughs are, as yet, commercially unproven.

Those promoting actions are more sanguine. The IPCC and others have modelled many scenarios, which purport to show the task, one example of which may be found in Table 5.

This estimates the sort of reductions expected from different effective tax rates. It illustrates two of the 40 "storylines and scenarios" suggesting that even with no tax 5-14 per cent reduction in emissions will take place, that a tax of $50 per tonne of CO_2 would increase that to 13-52 per cent and a tax of $100 would increase it to 16-63 per cent.

Table 5. Global economic mitigation potential in 2030 estimated from bottom-up studies[11]

Carbon price (US$/tCO$_2$-eq)	Economic potential (GtCO$_2$-eq/yr)	Reduction relative to SRES A1 B (68 GtCO$_2$-eq/yr) (%)	Reduction relative to SRES B2 (49 GtCO$_2$-eq/yr) (%)
0	5-7	7-10	10-14
20	9-17	14-25	19-35
50	13-26	20-38	27-52
100	16-31	23-46	32-63

Source: http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-ts.pdf p77

The numbers are however little more than conjecture. Though the economic modelling driving them is based on empirical observation, the uncertainties of their projections going decades into the future are seldom raised.

[11] The estimates refer to SRES A1 B: a high economic growth scenario with a median forecast of technology development introducing reduced emissions; and SRES B2 with lower economic growth and diminished material intensity of the GDP and a relatively rapid innovation and take-up of resource efficient technologies. The 2030 CO_2 equivalent of compounding the 1990-2004 growth rates of the OECD and developing countries (with the former Soviet bloc constant at 2004 levels) is 58 Gt.

The models themselves rest on demand and supply responses estimated as a result of known relationships between different products. But information on the relationships that are central to modelling forecasts is based on quite narrow ranges of observations, and the relationships can also change markedly over time, as we have seen as a result of IT innovations.

Many relationships within the operational parameters of these models are likely to be stable. We can be pretty certain, for example, of the elasticity of demand for, say, coal and the implications throughout the economy where price rises by 10 per cent. We would see some shift to other energy sources which have costs below the 10 per cent price increase; we would see some reduction in the end products using coal as a result of higher costs. And we would see some expansion in demand for products that use less coal and less energy, since these will have become relatively cheaper. All these changes would offset somewhat the initial loss caused by the increased cost.

We also have experience of considerable changes in energy supply and the associated price increases. During the 1970s the price of crude oil quadrupled over a short period of time. This caused major economic dislocation and the worst recession since World War II. However, adjustments were made relatively easily because ways were found to economise on oil. These included substitutions by coal and natural gas and, for those nations not spooked by green witchcraft, nuclear power. The higher prices also stimulated increased oil supplies.

In the present modelling situation, such secondary effects would be confined to an expansion of nuclear power, currently representing 16 per cent of world electricity supplies, since this is the only feasible replacement for carbon-based fuels.

At issue is whether the situation being modelled is comparable to what we would face in estimating the effects of a tax designed to eliminate a product within a class of goods or that designed to eliminate the entire class. This can be visualised best with respect to the food sector. We could, for example, be quite confident of assessing the effects of a tax that drove out the use of oranges. People would choose alternative goods; there would be some loss of welfare, perhaps measurable in terms of gross national income. But there would be little major change.

Substitute for that measure a tax designed to eliminate consumption of all known foods. Clearly there would be mass starvation, and considerable loss of income, though new foods might be developed to allow continued human existence.

The question about a carbon tax designed to stabilise global CO_2 emissions that required countries such as the US and Australia to reduce their emissions by 80 per cent is whether the better analogy is like the tax on oranges or a tax on the whole class of foods.

Present-day energy consumption is highly reliant on carboniferous fuels. Energy itself is, second to food, the basic building block of all human activities. The only substitute we have for carbon-based energy is nuclear energy. With a carbon tax we have only the flimsiest of experience on which to model the effects. Unlike the case with oil in the 1970s, the substitutes do not exist, except for nuclear, and to enable that to replace

carboniferous fuels requires great ingenuity—especially in finding ways to replace oil for motor vehicles, ships and aircraft.

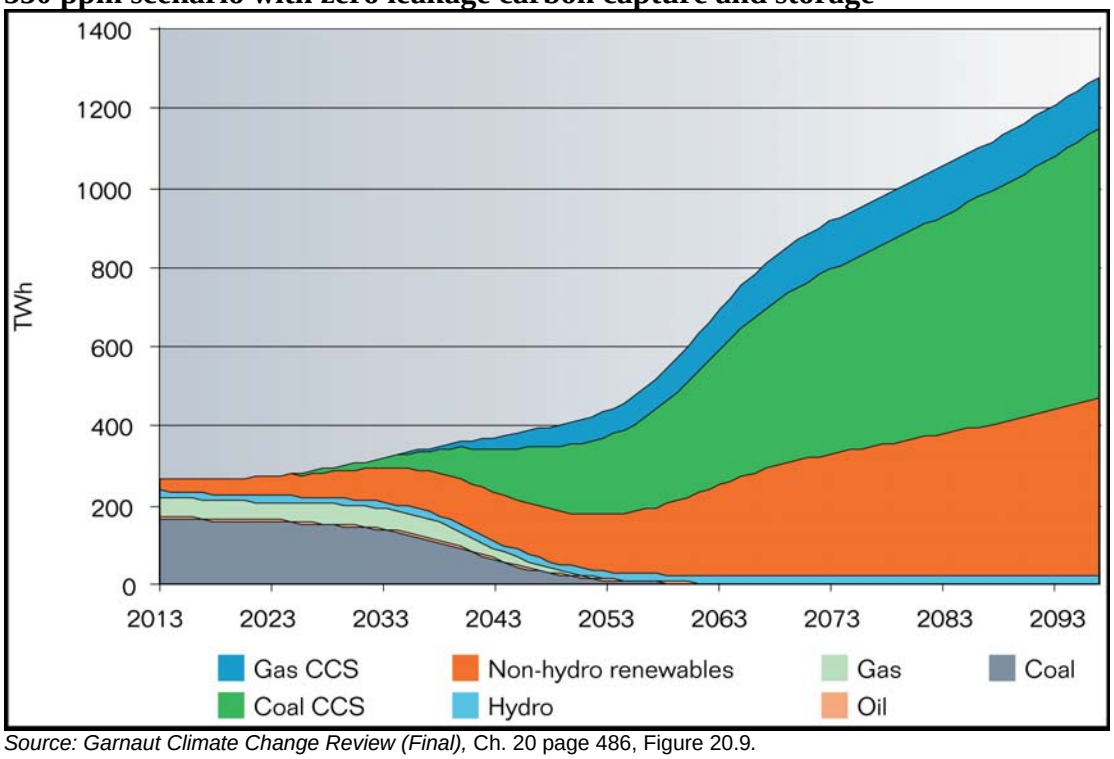
In addition to such considerations, the modelling assumes a steady state movement from one pattern of the economy to another—it assumes that we simply move from coal to gas to some as-yet-undiscovered renewable, carbon capture, or nuclear. Such a movement is unlikely to occur without, at the very least, considerable transitory turmoil.

Importantly, modelling, in addressing a frictionless move to alternative energy sources, is driven by assumptions about new technologies yet to be devised like Carbon Capture and Storage (CCS).

It is because of these sorts of uncertainties, that long-term economic modelling is termed 'storylines and scenarios' by the IPCC. This recognises that the vast changes (policy shocks) are not susceptible to the normal standards of modelling rigour. New technologies are assumed to develop without any evidence that this is possible. Without that, the costs of forcing emission reductions would be driven to astronomical levels and would bring a rapid reduction in living standards.

Even so, quite detailed pictures are painted. Figure 3 reproduces one scenario which the Australian Treasury envisages from the taxation regime recommended. By around 2050, 80 per cent of electricity is modelled as coming from exotic renewables and from gas and coal incorporating CCS.

Figure 3 Australia's electricity generation technology shares, 550 ppm scenario with zero leakage carbon capture and storage



Source: Garnaut Climate Change Review (Final), Ch. 20 page 486, Figure 20.9.

Concluding comments

Tol has highlighted the fact that there are major savings to be achieved by delaying taking action.[12] He estimates that deferring cuts until later in the century would, for the same quantity of emission reductions, reduce costs to little more than 10 per cent of those entailed with an early start.

From the Australian Treasury modelling it is possible to infer the costs of doing nothing to 2020 and then catching up with the 2050 target thereafter should the need and achievability of such action prove necessary. That cost according to the Treasury model is 0.3 per cent of GDP by 2050. Even if this is not overstated, 0.3 per cent of GDP seems a reasonable insurance policy price to pay rather than imminently embarking on measures that would have dramatic consequences on a small economy that is highly dependent on carboniferous fuels. By 2020 we will be clearer on the need for emission reduction policies and we will, presumably, have access to all the technological advances that modellers claim will be forthcoming.

There may be a risk from severe anthropogenic induced climate change. But there is also a risk of severe economic consequences in seeking to address such change.

[12] An Analysis of Mitigation as a Response to Climate Change, Richard S. J. Tol, Copenhagen Consensus Center.
For a summary see
Lomborg, B., Cut carbon later on, 20 August, the Australian
http://www.theaustralian.news.com.au/story/0,,25954076-7583,00.html