

# Submission to Climate Change Authority regarding its Caps and Targets Review -Issues Paper April 2013

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## Introduction

If the elevation in atmospheric greenhouse gases is going to force the climate to change, and the impacts of that climate change are going to cost a lot in terms of damage and lost potential – scientific reckoning concludes that this is very likely – then action has to be effective and policy needs to support and probably drive that effective action. The size of this global problem is big, very big. The size of the change that needs to occur in Australia alone is big, nearly 600 million tonnes CO<sub>2</sub>-e per year just to become carbon neutral (not including economic growth driving an expected 24% increase in emissions by 2020 if we were to continue under a business-as-usual approach). Then we will need to draw down atmospheric CO<sub>2</sub>-e levels to offset inertia in the system and grapple with negative impacts of ocean acidification.

Finding a commercial solution is very unlikely to occur without regulation.

At present, a tax on positive CO<sub>2</sub>-e emissions is the main regulation; called the carbon pricing mechanism. That may change soon to an emissions trading scheme (ETS), depending on who wins the next federal election and then how they decide to take action against global warming. With the ETS, government sets a target to reach by a certain date and a trajectory to reach that target. Government sets a cap on covered emissions to try to follow that trajectory, taking account of estimates of emissions from uncovered sectors as well; and if Australia rises above the trajectory government can purchase overseas CO<sub>2</sub>-e emissions offset units (i.e. carbon credits) to get back on track. The cap is set in practice by selling (auctioning) permits which allow CO<sub>2</sub>-e emissions. Those entities covered by the ETS can buy permits but can also buy CO<sub>2</sub>-e emissions offset units to meet their particular CO<sub>2</sub>-e emissions needs. Offset units can be created via development of CO<sub>2</sub>-e sinks in either the covered or uncovered sectors and, once linked to ETSs overseas, also in other countries. The revenue raised by selling permits will be used by government to help with economic and social adjustments – to compensate energy consumers for small (~\$10/week) expected rises in energy costs passed on by energy suppliers, and to help businesses improve their energy efficiencies and compensate for any loss of competitiveness in markets overseas – and to invest in CO<sub>2</sub>-e emissions reduction technology. It is a little more complex than this but those are the basics. When the ETS functions as planned, Australia should follow its trajectory and reach its target by 2050 of say 80% reduction in CO<sub>2</sub>-e emissions relative to that in the year 2000.

Given that the Climate Change Authority will recommend the settings for the target, trajectory and cap, i.e. the specific parameters of the ETS, it is important to bear the following in mind. In spite of all policy effort and reported reductions in CO<sub>2</sub>-e emissions world wide the measured global atmospheric CO<sub>2</sub> concentration trajectory

appears to be unaffected. While the scale of action may have increased across the world, the quantity of emissions reduction and negative emissions action combined, remains negligible relative to the size of the problem. In 1990 the first IPCC Assessment Report (1990) was published and atmospheric CO<sub>2</sub> concentration was at about 355 ppm and after nearly 25 years it will be at about 400 ppm, that is over a 12% increase; in the 25 years prior to 1990 the increase was around 11% (e.g. NOAA). Taking action against climate change has to be effective action. This policy, including the parameters set for ETS, must drive effective action.

Although the details on issues below apply to setting the parameters of an Australian ETS, the strategy is also more generally applicable to achieving effective action on global warming.

According to national reports, in the two decades 1990-2010, renewable energy hovered around 5% and fossil fuel energy accounted for 95% of energy used in Australia; renewable energy rose near 30% but fossil fuel energy rose 50% in the same period. The proportion of renewable energy generated in 1990 was around 10% but was driven down to only 6.5% by 2008, and has since climbed above 8% (source: ABS2012) – setting the renewable energy target (RET) probably helped this climb.

After considering the following, increasing the RET in a practical way may do more than help emissions reduction.

World population growth rate since 1960 has seen the population double about every 40 years. World population was around 3 billion in 1960, 6 billion in 2000, and would be 12 billion by 2040 if that growth rate persisted. However, comprehensive forecasting, accounting for limits to growth, estimates world population to reach only around 9 billion by 2040. In ecological terms, the Earth's carrying capacity of the human species is about 9 billion people; implying that resource limitations are expected to bite harder than usual in the near term, denying the realisation of a 12-billion-people world. On the flip side, however, 9 billion people by 2040 means that in the next 27 years (approximately one generation) there will be another 2 billion people on Earth; that's over 28% more people than there are now in 2013. As millions of people are rising out of poverty with development, the scale and speed of this population increase is likely to drive a mega-trend in energy demand. Under stable economic conditions, energy demand will grow and under worsening climatic conditions the demand for energy with neutral or negative CO<sub>2</sub>-e emissions will grow. Therefore, energy with neutral or negative CO<sub>2</sub>-e emissions (like Green Power or cleantech), is a strong emerging area ripe for large, long-term investment.

Two main policy settings would help here. The first is setting long-term goals for emissions reductions (e.g. 90% reduction from 2000 level by 2050) with uncomplicated trajectories (e.g. a straight line). Why? This will **send a clear signal** to project developers, who create and implement solutions, and to investors, who will fund that (green)economic activity for a reasonable return on investment (e.g. 15-20% p.a. over 10-30 years), and most importantly it will send a clear signal to society, who will buy the clean energy. Secondly, setting government's (public sector) purchasing policy to buy clean energy over dirty energy, will **generate a substantial clean energy market that will have government backing** and thus, this area will be made even stronger for investment – akin to investing in government bonds with a AAA

credit rating – and thus suitable, therefore, for investment by superannuation funds and the like. There are bonuses for Australia and politicians from this. The outcomes of such policy strategy will be a stimulation of economic growth, which is great for jobs and great for politicians trying to fund all the services Australians have come to expect. Being a global leader on this will attract investors and developers currently looking globally for good projects to get involved in.

This (green)economic growth strategy defines clear long-term goals with an uncomplicated trajectory that society and investors can grow to rely on. This economic growth stimulus strategy in the clean energy direction is also a strategy to manage risk and grapple with uncertainty. It is a strategy that: acknowledges and responds to the science behind the problem; puts Australia in an advantageous position in the global economy, approaching its share of global emissions reductions as an opportunity; outcompetes other countries with what they are doing; has only positive economic and social implications for Australia.

Converting goals to caps should also be as clear as possible to the whole of society, and to external onlookers. Setting them relative to a straight forward trajectory to our long-term goal will make them clear and predictable from one year to the next. By taking a proactive approach, such as the strategy outlined above, Australia will be doing the best it can do, and attracting investment that will stimulate the economy in the process. Investment into a growing clean energy market in Australia, backed by government, will directly replace dirty energy with clean energy that will be used throughout society and reduce emissions in all sectors. The clear signal will likely also drive the development of CO<sub>2</sub>-e sinks resulting in eligible carbon credits that can be traded internationally.

By taking a proactive approach such as the strategy outlined above, Australia will make world's best progress on per capita emissions reduction, and stimulate the economy in the process. The outcomes of such a strategy are almost certainly likely to drive reduction in Australia's emissions, greater than any drivers behind variation in Australia's emissions since 1990 to the present, because they will be larger in scale, reducing greater quantities of emissions per annum. Taking such a proactive approach also removes the need for monitoring of emissions in sectors *in fine-scale* in attempts to understand their underlying drivers; targeting energy will have a pervading effect on all other sectors as they use energy, and it will have an effect on the national emissions budget (i.e. measured total annual emissions rather than the budget set in policy – the target for the particular year).

Driving Australia's economy with clean energy is crucial to economic and ecological sustainability, and is an important transition to make.

*Taking a proactive approach as a best strategy for Australia's transition to a low-emissions economy.* Because there is a lot of merit in this approach it dominates my perspective on issues given in the Issues Paper.

In the rest of this submission I address the issues identified in Chapter 6 of the Issues Paper:

## **Australia's emissions reduction goals**

When developing its recommendations for Australia's emissions reduction goals, the Authority will need to consider a number of general questions:

- the extent to which specific recommendations for emissions reduction goals beyond 2020 should be made, and the merits of different approaches (for example, a long term national budget or a long term indicative national trajectory) – discussed in Section 3.1.1;
- whether Australia's emissions reduction goals should be aligned with its commitments under the Kyoto Protocol, or instead address a wider range of emissions and activities (for example, emissions from international shipping and aviation) – Section 3.1.2; and
- how targets, trajectories, budgets and caps might be framed to help reduce uncertainty, and assist in managing risks in Australia's transition to a low-emissions economy – Section 1.2.3.

### **Regarding Section 3.1.1**

A long term goal should be set, with an uncomplicated trajectory to that goal, to send a very clear signal to society, and to project developers and investors. Political will and market demand are inherent to society. Creative solutions and their implementations are performed by project developers and investors. Large investments in activities located in Australia will stimulate GDP.

### **Regarding Sections 3.1.2 & 1.2.3**

A Kyoto Protocol+ approach could be taken as emissions reduction is approached as an economic opportunity, where Kyoto Protocol+ represents the Kyoto Protocol plus a wider range of opportunities such as shipping and aviation. The transition of the Australian economy to a low-emissions economy signals investment opportunities in Australia. This sits within the much larger transition of the global economy to a relatively low-emissions economy. Taking the lead within this global transformation presents the best opportunities for Australia and is also a strategy to manage risk associated with uncertainty. Starting with a government-backed, significantly sized demand for clean energy which is expected to grow over future decades, large investment into the projects required will stimulate economic activity.

A wider range of emissions reduction opportunities promotes international participation and therefore promotes global-scale action. According to science, global-scale action is required to stop atmospheric CO<sub>2</sub> rising beyond 450 ppm or 550 ppm. Greater international participation will also make it easier, geopolitically, to set border tariffs on imported goods made in countries that do not take action to reduce global emissions; revenue raised this way needs to be directed into cleantech projects to pay for the emissions reduction (offsets) that other countries do not make.

Taking a proactive approach to emissions reduction, turning it into (green)economic opportunities that will achieve effective action on CO<sub>2</sub>-e emissions, will be a stimulus to GDP, and will have positive economic and social impacts – this is a strategic approach to managing risk associated with much uncertainty.

Policymaking alone is not enough here. Even under a well-consulted and thought-out carbon pricing mechanism, Australia has failed to attract the kind of investment required to tackle the problem of dumping too much CO<sub>2</sub>-e into the global atmosphere, at too fast a rate. Political rhetoric has successfully undermined the market signal intended by the policy setting. As a matter of urgency now, a clear policy signal must be sent to society and to the project developers and investors who

we need to attract to the problem and help solve it. Setting a long-term goal and an uncomplicated trajectory to that goal, in combination with government backed clean energy (green power) market development for the long term, will send a clear and strong signal and will help to boost effective action, with positive economic and social implications; and it also acts as a strategy to manage risks associated with much uncertainty outlined in Section 1.2.3 (CCA Issues Paper 2013).

### **Considering the science, approach to sharing, what other countries are doing, and the economic & social impacts in Australia**

The Authority will focus on four broad issues in recommending emissions reduction goals: the science-related aspects of global emissions budgets; approaches to sharing global emissions budgets among nations; the extent and nature of international action to reduce emissions; and the economic and social implications of different emissions reduction goals for Australia. Behind these broad issues lie many specific issues, including:

- the global emissions budget of most relevance to Australia's emissions reduction goals – Section 3.2.1;
- the merits of different principles and approaches to determining Australia's fair and defensible share of the relevant global emissions budget – Section 3.2.3;
- the extent to which the Government's existing 2020 target conditions have been met – Section 3.2.2;
- the countries (for example, other developed countries with a similar standard of living, other major emitting economies or trade competitors) Australia should compare itself with in determining its appropriate emissions reduction goals, and the appropriate comparative metrics for this purpose – Section 3.2.2;
- assessing whether – and to what extent – Australia's actions might influence other countries – Section 3.2.2;
- how Australia's carry over of emission units from the first commitment period of the Kyoto Protocol might best be used – Section 3.1.2; and
- the likely impact of Australia's emissions reduction goals on the carbon price, and economic and social conditions in Australia – Section 3.2.4.

#### Regarding Section 3.2.1

Setting a long-term goal and an uncomplicated trajectory also sets the domestic budget relevant to sending a clear signal to society, project developers and investors (as above). The global emissions budget most relevant to Australia's emissions reduction in a proactive approach would be one that peaked earlier than later. Science predicts climate change impacts will be substantial particularly in Australia, as has already been demonstrated by extreme weather events over the past decade or more (drought, fires, floods), with significant negative impacts on GDP. Therefore, it is in Australia's economic and social interest to promote widespread (global) effective action on emissions reduction. Taking a proactive strategy will make Australia a leader in global emissions reduction on a per capita basis, which should result in meeting our share of a global emissions budget that peaked earlier than later.

#### Regarding Section 3.2.3

Equal per capita emissions is favoured because it is simple and transparent. National emissions would vary with temporal variation in Australia's population. As population variation is small but rising slowly our national emissions budget should vary accordingly. This could have a limiting effect on economic growth in boom times if it were not for a proactive approach on emissions reductions targeting energy;

energy which is used in most sectors of society and would therefore have a pervading effect, and a sum total effect on national emissions. An equal per capita emissions approach scales up to a fair and defensible share of the global emissions budget. A proactive approach on emissions reduction targeting energy will effectively increase Australia's efficiency in terms of GDP per unit CO<sub>2</sub>-e emitted, which is presently the lowest out of Australia, United States, Republic of Korea, Japan, European Union (27 member states), China, Indonesia and India (see GDP/CO<sub>2</sub>-e, Fig. 1 in this submission).

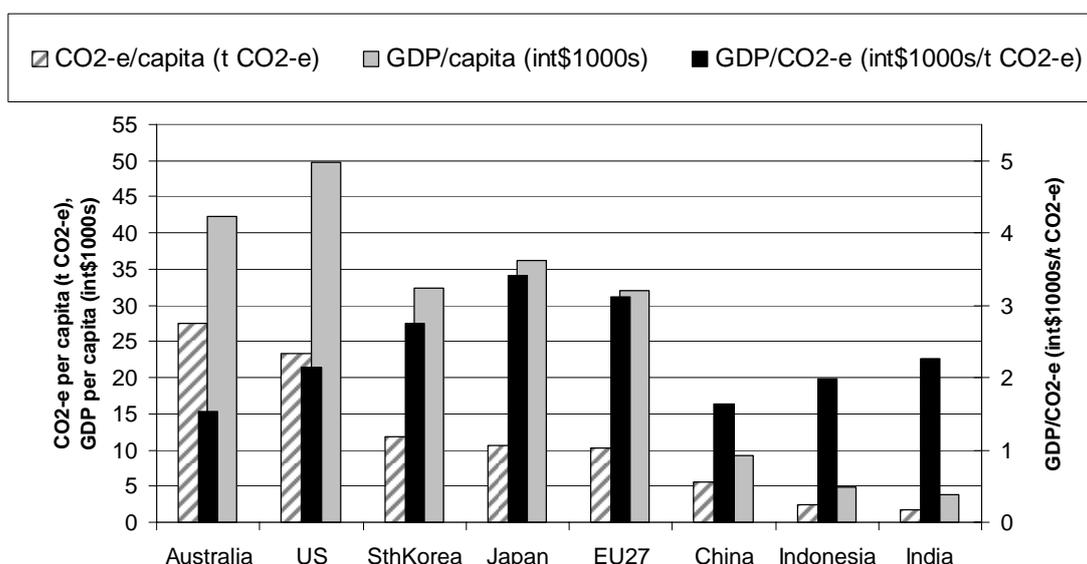


Fig. 1 Australia has the highest CO<sub>2</sub>-e emissions per capita and a very strong GDP but the lowest efficiency in terms of GDP per t CO<sub>2</sub>-e emitted (data from Table 3 in CCA Issues Paper 2013).

### Regarding Section 3.2.2

There is a sense that the tide has turned and, whether sitting under the Kyoto Protocol or not (e.g. USA, Canada), the major emitters including the USA, China and India have set substantial goals by 2020 and have signalled their commitment to achieving those goals. There is clearly a case for setting Australia's goal by 2020 at 15% reduction from 2000 levels. If Australia took a proactive approach (outlined above) it would be consistent with the attitude of several advanced economies within the European Union; a move that would probably catalyse stronger global action. In the past decade or so, carbon capture and storage (CCS) and bioenergy carbon capture and storage (BECCS) have been demonstrated, biofuels have been demonstrated, biochar has been demonstrated and renewable energy (solar, wind, biomass) has been demonstrated; they simply await reliable market signals. This technology is ready now to be deployed and scaled up to help achieve a peak in global emissions by 2020. Therefore, there is a clear pathway to achieving an early global peak in total emissions. Current investments into cleantech are substantial and new technologies are expected to emerge soon that may be implemented in 10, 20 or 30 years time. We can implement these after 2020; we must use what we have available now.

Australia in many respects is a unique case in terms of emissions (Fig 1), which makes it difficult to easily compare to another country. A very large dry island located in the South Pacific with easy access to coal, sunshine, wind, waves, and a medium-

sized population limited by arable land. The combination of skilled human resources, with a moderate to high work ethic, abundant mineral resources and proximity to developing countries (China, India, Indonesia), the prudent management of its financial sector, and a carefree use of relatively cheap (fossil fuel) energy has produced a high standard of living. According to the United Nations Development Programme (UNDP) 2012, we are ranked #2 in the world but have the highest per capita emissions (Table 3, CCA Issues Paper 2013), and the lowest productivity efficiency in terms of GDP per unit CO<sub>2</sub>-e emissions (Fig 1 this submission). While per capita emissions might be high, from this height we have tremendous potential for emissions reduction relative to other countries; that is, we have great potential for change in per capita emissions and change in productivity efficiency (GDP/emissions). These are the metrics we should use to compare ourselves with other countries including developing countries like China, India and Indonesia.

Australia's economy is large enough to demonstrate a proactive approach to emissions reduction, and influence other countries. Making the strategic policy settings for the long term, developing a substantial kick-start market for clean energy, and thus sending this strong signal to society, project developers and investors, will stimulate economic activity, bolster Australia's GDP and manage risk associated with uncertainties. Demonstrating this with a middle-sized economy like Australia's will influence other countries to take a more proactive approach to their emissions reduction. As other countries also demonstrate emissions reduction it will promote global action, which is what is required to tackle this global problem.

Regarding Section 3.1.2

Australia should hold any extra emission units achieved under the Kyoto Protocol as insurance against any unusual extra emissions associated with, for example, early (green)economic stimulation, a surge in fugitive emissions or other uncertainty.

Regarding Section 3.2.4

Taking a proactive approach to emissions reduction, turning it into (green)economic opportunities that will achieve effective action on CO<sub>2</sub>-e emissions, will be a stimulus to GDP, and will have positive economic and social impacts – this is a strategic approach to managing risk associated with much uncertainty.

Australia has failed to attract the kind of investment required to tackle the problem of dumping too much CO<sub>2</sub>-e into the global atmosphere, at too fast a rate. Any market signal intended by the well-consulted and thought-out carbon pricing mechanism policy, has been successfully undermined by political rhetoric. It is a matter of urgency now to amplify a clear policy signal to society, project developers and investors. Setting a long-term goal, an uncomplicated trajectory to that goal, and government-backed green power market development for the long term, will send a clear and strong signal. This will boost effective action, with positive economic and social implications, and will also act as a strategy to manage risks associated with much uncertainty as outlined in Section 1.2.3 (CCA Issues Paper 2013).

Taking a proactive approach to emissions reduction, by definition will reduce emissions and effectively bring Australia under its emissions budget. Emissions reduction projects invested in and implemented will be there reducing emissions year after year. If Australia comes in under its emissions budget, by implication there will

be emission units (carbon credits) in its economy and they will be available for sale in international markets. While a proactive approach is likely to put downward pressure on carbon price domestically, because we directly account for only 1.5% of global emissions (under Kyoto Protocol inclusions and exclusions), it is likely to have negligible effect on the international carbon price.

### **Converting goals into caps**

The Authority is required to translate its recommended national emissions reduction goals into caps for the first five trading years of the carbon pricing mechanism. In recommending caps, the Authority will, among other things, consider:

- whether tighter caps might provide a hedge against the uncertainty inherent in future uncovered emissions levels, or whether caps should be based on the best (central) estimate of uncovered emissions – Section 4.2.1;
- whether emissions caps should follow the path of the national trajectory on a year-by-year basis, or whether there are benefits to following a different path – Section 4.1;
- the extent to which large fuel users are likely to opt-in to the carbon pricing mechanism – Section 4.2.3; and
- the appropriate treatment of emissions from heavy on-road vehicles – Section 4.2.3.

#### Regarding Section 4.2.1

Converting goals to caps should also be as clear as possible to the whole of society, and to any external onlookers. Setting them relative to a straight forward trajectory to our long-term goal will make them clear and predictable from one year to the next. By taking a proactive approach, such as the strategy outlined above, Australia will be doing the best it can do, and attracting investment that will stimulate the economy in the process. Investment into a growing clean energy market in Australia, backed by government, will directly replace dirty energy with clean energy that will be used throughout society and reduce emissions in all sectors. The clear signal will likely also drive the development of CO<sub>2</sub>-e sinks resulting in eligible carbon credits that can be traded internationally.

Taking a proactive approach to emissions reduction will allow Australia to set tighter caps rather than aim for the central estimate of uncovered emissions. The carbon pricing mechanism applies to covered emissions. Sending a clear signal to society is likely to help induce a consumer sentiment that expects emissions reduction from business and households as part of a sustainability effort or part of corporate social responsibility. Sending a clear signal that Australia is taking a proactive approach to emissions reduction is more likely to result in effective action, in investment and (green)economic activity, and emissions reduction activity in the uncovered sector.

#### Regarding Section 4.1

Setting tighter caps relative to a straightforward trajectory to a long-term goal is a crucial part of strategically sending a clear signal. When business is given clear, long-term signals, policy stability, it can adapt in response. Business can adapt fairly quickly when given a change followed by policy stability. Under a proactive approach, where emissions reduction is viewed as opportunity, and best-case outcomes result, tighter caps will not be daunting. As has been flagged already, Government is willing to purchase emission units (carbon credits) from overseas in the event that Australia's emissions reduction is handled so badly that we exceed our

emissions budget. This sends a positive signal to carbon sink developers overseas. Instead, Government could set policy so that it (the public sector) purchased clean energy over dirty energy and thereby develop a significant clean energy market mechanism in Australia that would complement the carbon pricing mechanism. Helping develop carbon sinks in developing countries under the Kyoto Protocol could continue, as the international market for carbon credits will be much larger than Australia's needs and promises to provide a return on investment into developing eligible carbon credits.

#### Regarding Section 4.2.3

Consumer sentiment might influence large fuel users or heavy on-road vehicles to some small extent. Consumer sentiment is likely to have stronger impact at small local scales rather than on large transport networks. A government backed, development of a biofuels market (i.e. create a significant demand for biofuels, which are carbon neutral and also displace some petrol, diesel, LPG use) would lead to increased availability of biofuels and associated technology that large fuel users or heavy on-road vehicles might take advantage of incrementally and come in under cover. Hopefully this particular sector will have recommendations of its own. Regarding legislation uncertainty, move in favour of tighter caps.

### **Australia's progress on emissions reduction**

As to its obligation to report on Australia's progress in reducing emissions, the Authority will review emissions trends during the past two decades, and examine the main factors underlying those trends. The Authority also proposes to identify milestones to gauge Australia's future progress towards its medium and long term targets. To these ends, the Authority will:

- examine the drivers of change in Australia's emissions since 1990, and the relative contributions of government policies, business cycles and long term structural change in the economy – Section 5.2.1;
- develop an evaluation framework to assess Australia's future progress and identify strategic milestones for domestic emission reductions, including for the power sector – Section 5.2.2; and
- explore the opportunities and risks associated with linkages between the domestic carbon pricing mechanism and international carbon markets over the long term – Section 5.2.2.

#### Regarding Section 5.2.1

By taking a proactive approach such as the strategy outlined above, Australia will make world's best progress on per capita emissions reduction, and stimulate the economy in the process. This approach will drive a reduction in Australia's emissions, and be a greater driver than any drivers behind variation (fluctuations + systematic trend) in Australia's emissions since 1990 to the present, because it will drive effective action that is larger in scale, reducing greater quantities of emissions per annum. Taking such a proactive approach also lessens our dependence on monitoring of emissions in sectors *in fine-scale* to understand weaker underlying drivers; targeting energy will have a pervading effect on all other sectors as they use energy, and it will have an clear effect on the measured national emissions budget.

#### Regarding Section 5.2.2

Analysis of the major drivers of emissions reduction should be done about every 5 years to allow time for bedding in new emissions reduction projects. Variation in

emissions and the relative contributions of government policies, business cycles and long term structural change in the economy should continue to be monitored.

The overarching evaluation framework to assess Australia's progress is whether Australia's measured emissions are tracking the trajectory towards the long-term goal without Government buying overseas carbon credits. Given that the vast bulk of Australia's emissions come from energy a strategic use of fossil fuels (coal, oil, gas) is required. Continued use of fossil fuels must couple with increasing levels of negative emissions activities such as CCS, BECCS, biochar methods existing now and new technologies as they come along. Alternatively, an increasing energy supply must come from renewable energy technologies existing now and new technologies as they come along.

Linkages between the domestic carbon pricing mechanism and international carbon markets will benefit Australia. From a governance perspective, it will promote international participation and therefore global-scale action. From a technology perspective, it will promote the development of emissions reduction technologies (including bioenergy, CCS, BCCS, biochar, etc), an appropriate scale of development, economies of scale and returns on investment (required to get projects going). From a business perspective, it will allow companies to purchase additional carbon credits they might require to expand production from time-to-time. Because carbon price correlates with economic activity, during an economic slump overseas Australian companies may take advantage of lower carbon price without jeopardising a global emissions budget. From a carbon farming (carbon sink developer) perspective, it provides a large market. The most important aspect of international carbon trading will be to have confidence in eligible carbon units – the Australian Government needs to promote the importance of trading only eligible carbon units in the international market. Over the long-term, such as out to 2050 as Australia and many other countries approach their emissions reduction goals, the demand for carbon units should taper off but be influenced along the way by the level setting of the cap.

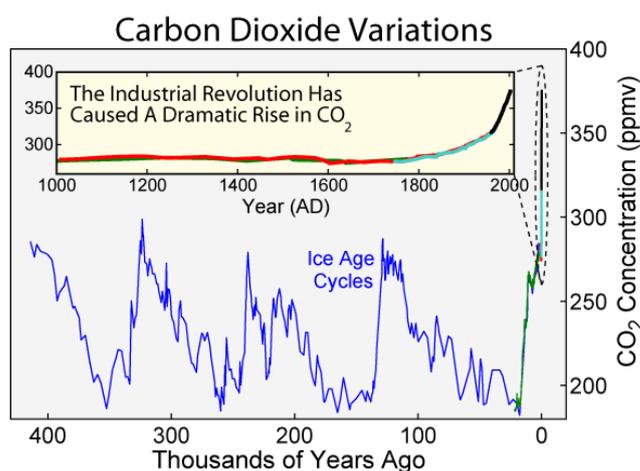


Fig. 2 Records of atmospheric CO<sub>2</sub> concentration, showing serial spikes in CO<sub>2</sub> concentration, each followed by a gradual fall back to pre-spike levels; and showing the largest spike presently occurring (reaching 400 ppm this year, NOAA 2013)

Beyond 2050, negative emissions will still be required to remove CO<sub>2</sub>-e from the atmosphere back to 300 to 350 ppm (and begin cooling Land and Ocean reservoirs).

As is clear from long records of atmospheric CO<sub>2</sub> concentration (e.g. Fig. 2), it has taken more than one hundred thousand years for spikes of 100 ppm to recover back to baseline level. To be clear, the spike about 140,000 years ago (Fig. 2) increased the atmospheric CO<sub>2</sub> level close to 300 ppm, which then took about 100,000 years to fall back to pre-spike levels just below 200 ppm. It is uncertain how long it would take a spike in atmospheric CO<sub>2</sub> level above 400 ppm to fall 100 ppm in a warmer world. Prolonged acidification of oceans caused by high atmospheric CO<sub>2</sub> levels could have a large negative impact on the ocean's web of life.

David Pepper  
30 May 2013

I declare an interest in helping to enable action to reduce greenhouse gas emissions and to develop negative emissions, via public policy and/or commercial means. I have done advanced studies in ecosystem science, particularly in relation to environmental change including elevated atmospheric CO<sub>2</sub> concentration and climate change.

## References

ABS2012

<http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/4628.0.55.001main+features70May+2012>

Fig. 2 Source: [http://en.wikipedia.org/wiki/Atmospheric\\_CO2](http://en.wikipedia.org/wiki/Atmospheric_CO2)

IPCC Assessment Report 1990

[http://www.ipcc.ch/publications\\_and\\_data/publications\\_and\\_data\\_reports.shtml](http://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtml)

NOAA <http://www.esrl.noaa.gov/gmd/ccgg/trends/mlo.html>

NOAA 2013

<http://researchmatters.noaa.gov/news/Pages/CarbonDioxideatMaunaLoareaches400ppm.aspx>