A REVIEW OF THE SCIENTIFIC EVIDENCE UNDERLYING THE IMPOSITION OF A CARBON TAX OR ETS IN AUSTRALIA

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John Chambers, Andrew Miller, Richard Morgan, Bob Officer, Mark Rayner, Graham Sellars-Jones and Tom Quirk (Australia)

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A REVIEW OF THE SCIENTIFIC EVIDENCE UNDERLYING THE IMPOSITION OF A CARBON TAX OR ETS IN AUSTRALIA

John Chambers[i], Andrew Miller, Richard Morgan, Bob Officer, Mark Rayner, Graham Sellars-Jones and Tom Quirk*

**For correspondence: twquirk@labyrinth.net.au*

ABSTRACT

On 1 July 2012 the Australian Government's comprehensive carbon tax was levied on those businesses that produce more than 25 Mt annually of greenhouse gas emissions. The evidence justifying the need for such a tax is examined using the geological record, contemporary measurements and their interpretation.

1. INTRODUCTION

Australia has embarked on a comprehensive carbon [1] tax regime with the aim of reducing national greenhouse gas emissions. Inevitably, this will have significant implications for the national economy and its international competitiveness.

The fundamental justification for the introduction of this tax is the acceptance of the proposition, outlined in Australian Government Policy [2], that dangerous global warming can be avoided by reducing carbon dioxide (CO_2), methane and other greenhouse gas emissions caused by human activity.

This review provides an evaluation of the fundamental direct evidence used to support the claim that adverse climate change is a consequence of emissions caused by human activity. It uses information from the Australian Bureau of Meteorology, the CSIRO and other international climate science research institutes. It contains evidence not widely communicated.

Whilst the paper addresses the reasoning that underlies the Australian carbon tax, the conclusions are also relevant to the additional costs being imposed on energy suppliers in other countries through charges on CO_2 emissions, albeit generally at significantly lower levels.

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[i]The authors who prepared this report and analysis are members of The Fair Farming Group of Australia which has two key objectives:

To ensure that discussion of issues related to climate is based on scientific fact and analysis.

To protect Australian agriculture and industry from any unwarranted penalties in the guise of a carbon tax or ETS, either of which would raise costs and have an adverse impact on the farming community and the economy.

2. THE NATURE AND ROLE OF CO_2 FOR LIFE ON EARTH

CO_2 is a molecule, comprising one carbon atom and two oxygen atoms. It is an odourless and colourless gas present in the atmosphere in trace amounts. Plants use the energy in sunlight to break down CO_2 absorbed from the atmosphere to form carbon rich molecules, including cellulose, which store energy derived from the sun, i.e. the process of photosynthesis.

Humans and animals consume certain plants whose carbon rich molecules provide energy. Oxygen inhaled in air, containing 0.04% CO_2, reacts with these molecules releasing their stored energy and forming CO_2, which is exhaled in the breath at a level of about 4%.

Biological activity in grazing animals breaks down cellulose to a more digestible form with methane (CH_4) as a by-product. Methane also forms naturally as plant material breaks down in swamps and marshes.

The present level of CO_2 in the atmosphere is 392 parts per million (ppm) or 0.04%. Over the last 500 million years, atmospheric CO_2 levels have been as high as 7000ppm (0.7%) and earlier in the earth's history even higher [3]. Land plants evolved in an atmosphere rich in CO_2. However there has been a significant decline in atmospheric CO_2 with the equivalent of some 60 million Gt (Gigatonnes - 1,000 million tonnes) of carbon in CO_2 having been removed from the atmosphere, mainly in marine skeletal material, to form limestone [4]. The white cliffs of Dover are an example of these huge deposits.

At the start of the Carboniferous Period (300 million years ago) atmospheric CO_2 was 2000ppm (0.2%) to 3000ppm (0.3%). The earth enjoyed warm temperatures, a humid atmosphere and the development of massive forests. The eminent scientist Dr. Richard Dawkins has described the period as supporting abundant plant and animal life [5]. During the Carboniferous Period some 800 Gt of carbon in CO_2 were captured by forest plants which subsequently formed extensive coal deposits [6].

By 30 million years before the present, atmospheric CO_2 is estimated to have declined to 800-1200ppm (0.08 - 0.12%).

It is evident that atmospheric CO_2 levels in the past were well above the present level and that the prevailing climate that accompanied these high CO_2 levels was neither dangerous nor threatening to life on earth.

To put the use of fossil fuels in perspective, the BP Statistical Review [7] and the Energy Information Administration of the United States Department of Energy [8] give currently identified and economically recoverable oil, gas and coal reserves. But, based on the assumptions of the Intergovernmental Panel on Climate Change [9] (IPCC) that 70% of future emissions remain in the atmosphere, burning all these identified fossil fuel reserves including shale gas would only raise the level of CO_2 in the atmosphere to some 660ppm (0.07%). This is not even double the present.

The current level of CO_2 is near the lowest on record over the last 500 million years. It is deficient for optimal growth of many crops and vegetables and constrains food production. For this reason market gardeners for the past 100 years have been adding CO_2 to glasshouses to achieve levels near 1000ppm (0.10%).

S. H. Wittwer, Professor of Horticulture, Michigan State University, reviewed [10] scientific experiments conducted to measure the effects of CO_2 enrichment on specific

plants. For rice, the optimum CO_2 level is between 1500ppm (0.15%) and 2000ppm (0.2%). Greenhouse grown vegetables show yield increases ranging from 10% to 70% with increasing CO_2 levels. Wittwer concluded that in market gardening "carbon dioxide is the most common limiting factor preventing photosynthesis from proceeding more efficiently."

A higher level of CO_2 is especially beneficial to dry farming areas like Australia, where crops are frequently under stress because of insufficient moisture. With more CO_2, plant leaves have fewer stomata and lose fewer water molecules per CO_2 molecule that diffuses in from the surrounding air. This extra benefit of more CO_2 to plants in arid regions shows up very clearly in experiments [11].

3. CARBON DIOXIDE AND ATMOSPHERIC TEMPERATURES

There is an interesting contrast between the predictions of future climate impacts from the IPCC which reflect results from computer models, and the geological record of no runaway temperature increase at much higher atmospheric CO_2 levels than those projected by the IPCC. A global temperature peak was reached some 50 million years ago during a brief episode termed the PETM (Paleocene-Eocene Thermal Maximum [12]). This event may have been due in part to a different arrangement of continents, and perhaps also to the release of sub-seabed methane, but it highlights a fundamental question of the ability of computer models to predict the future evolution of a complex and uncertain climate system and thus temperatures.

The flow of energy in the earth's atmosphere is complex with the primary source of energy coming from the sun with total average radiation of 342 Watts per square metre at the top of the atmosphere [13]. Greenhouse gases in the atmosphere direct 324 Watts per square metre to the surface of the earth.

Water vapour is the major greenhouse gas in the atmosphere, contributing about 94% of the greenhouse effect [14], whilst CO_2 and other minor greenhouse gases contribute the balance. Nevertheless, the principal focus of the global warming debate by the proponents of catastrophic global warming has been on the less important CO_2 released by human activities.

There is general scientific acceptance that increasing CO_2 in the atmosphere will result in a temperature increase as extra heat radiation from CO_2 is directed down towards the earth's surface, the basis of the greenhouse effect. A doubling of CO_2 in the atmosphere from 400ppm to 800ppm increases the heat radiation, directed down to the earth's surface, by only some 10% of the CO2 contribution and this raises the temperature by about 1^0C. However the relationship is not linear, thus a further 1^0C rise would require an increase of 800ppm, that is doubling the CO_2 again from 800ppm to 1600ppm (*Figure 1 is an example of this effect*).

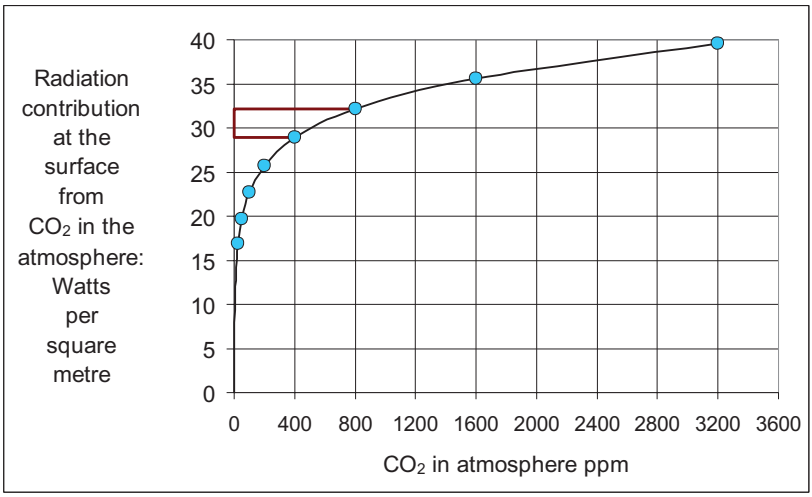

Figure 1 This graph is an example that shows the added radiation caused by additional CO_2 declines with concentration. As the concentration of CO_2 increases, there is increased radiation back to the surface of the earth (the basis of the greenhouse effect). However the relationship is not linear. In fact doubling the concentration of CO_2 from 400ppm to 800ppm only increases the radiation back to the surface by 3.3 watts per square metre or 10% of the CO_2 contribution. (Results derived for US standard atmosphere and cloudless sky from MODTRAN [15], an international and IPCC accepted standard for atmospheric calculations).

It is generally agreed that the 1^0 C direct temperature rise with CO_2 increasing from 400ppm to 800ppm is modified by atmospheric "feedback" effects [16].

The computer models used to supply information to the IPCC amplify the direct effect of CO_2 on temperature by a factor of 2 to 4 times because of an assumed positive "feedback" effect caused by increased cloud cover and water vapour in the atmosphere. The CSIRO uses the top of the range of assumed multiplying factors in determining predictions for climate change, temperature and sea level rises.

However, a number of observations do not support this multiplying factor:

- Direct assessments of the multiplier from satellite data have been made by Professor Richard Lindzen [17] at the Massachusetts Institute of Technology. The conclusion is that the multiplier is significantly less than assumed in climate models.
- Computer models assuming a "feedback" multiplier predict a temperature "hot spot" would be evident at mid-levels in the atmosphere in the tropical zones [18]. However, in spite of strenuous efforts no "hot spot" has been detected. The simplest explanation from Lindzen is that the surface temperatures have not increased as much as claimed.
- Analysis of twelve years of satellite measurements, by Dr Roy Spencer [19] at the University of Alabama at Huntsville, indicates that the multiplier in fact may

be less than one, reducing the estimated 1^0C potential increase from doubled CO_2 in the atmosphere.

- Analysis by Dr. Frank Wentz and colleagues [20] at Remote Sensing Systems in Santa Rosa, California show that the increase in rainfall with warming, as measured by satellite, is some three times that predicted by computer models - a major discrepancy. This work again points to a multiplier of one or less.
- A study [21] by William Kininmonth (former head of the National Climate Centre of Australia) shows that temperature increases are limited by the energy required for evaporation of water from the earth's surface and oceans. This work also supports a multiplier of less than one.

There is no geological evidence of extreme or runaway global temperatures in the past when CO_2 concentrations have been at higher levels [22] which indicates that the greenhouse impact from increasing CO_2 levels in the atmosphere was not enhanced by a temperature "feedback" multiplier of 2 to 4. Clearly, along with CO_2 there are other causes for changes in atmospheric temperature. These include changing ocean currents, planetary alignment and solar activity.

The absence of any such postulated "feedback" multiplier would explain why during the 20th century temperatures were stable or declined for 40% of the time despite increasing CO_2 levels, and again this points to other major determinants of climate. The absence of any significant increase in global temperature over 15 years [23] since 1997 is consistent with this pattern. It is also significant that from 1940 to 1976 the climate cooled whilst CO_2 levels were rising. These are further examples of the shortcomings of IPCC quoted computer models which link rising temperature with CO_2.

The hypothesis that CO_2 could cause dangerous global warming as a result of a 2 to 4 times multiplier "feedback" effect is therefore not established.

4. CARBON DIOXIDE AND MEASURED TEMPERATURE CHANGE

Temperatures rose in Australia [24] during the last century by 0.8°C. However, 0.5° of this increase was in association with the Great Pacific Climate Shift [25] of 1976-77, an event which is recognised by the IPCC [26] as not related to increasing atmospheric CO_2 and attributed by oceanographers to the Pacific Decadal Oscillation. After allowing for the Great Pacific Climate Shift, the temperature increase which might be attributable to rising CO_2 as the primary cause is then 0.3°C for the century [27], not the full measured 0.8° centigrade increase.

In the twentieth century atmospheric CO_2 increased by 15ppm in the first half and by 70ppm in the second half of the century. In the corresponding periods the Australian temperature increased by 0.15°C in the first half and by 0.15°C in the second half of the century (after adjusting for the Great Pacific Climate Shift). If applied, the IPCC quoted computer models would have incorrectly predicted larger temperature increases in the second half with increasing additions of CO_2 to the atmosphere.

It must be recognised there has been a long term increasing trend in atmospheric temperature, although with fluctuations independent of CO_2 levels, as the world has recovered from the depth of the "Little Ice Age", the Maunder Minimum, around 1670.

Given this long term warming trend it is neither surprising, nor particularly

relevant, that "the past decade was the warmest on record". What is very much more significant is the steady increase in atmospheric CO_2 that has occurred since 1997 without any parallel increase in global temperature [28].

5. TEMPERATURE CHANGE AND OCEAN LEVELS

The last Ice Age ended some 19,000 years ago. At that time Australia was connected to Tasmania by land. Over the next 12,000 years sea levels rose by about 120m, an average of 10mm per year largely due to melting ice. Over the same period temperatures in Antarctica estimated from ice cores rose some 10°C and, with a time lag of 800 years, CO_2 rose from 200ppm to 270ppm [29]. All this was of course well before industrialisation.

Over the most recent 6,000 years sea levels have had long term average annual increases of 2mm or less, one-fifth of the earlier rate.

Predictions of rising temperatures have led the IPCC to forecast an acceleration in the rate of rise in ocean levels to rates several times the 2-3mm per year measured over the past 100 years. However, this has not been observed to date, despite rising CO_2 levels. This is a matter of importance because of the constraints on development being imposed on coastal land in Australia and elsewhere by authorities that depend upon IPCC and, in Australia, CSIRO sea level projections.

Actual sea levels derived from satellite altimeter measurements by University of Colorado scientists [30] demonstrate no measurable global increase in the rate of annual sea level rise over the period 1993 to 2010. Indeed they show that the annual rate of sea level rise over this period has, with the exception of the Indian Ocean, actually declined in more recent years as shown in the following table.

Oceans	Annual sea level rise from 1993 to 2010 - mm per year	Annual sea level rise from 2002 to 2010 - mm per year
Global — all oceans	3.1 +/- 0.4	2,2 +/- 0.3
Pacific Ocean	2.8 +/- 0.2	0.9 +/- 0.3
Atlantic Ocean	2.8 +/- 0.2	1.6 +/- 0.6
Indian Ocean	3.7 +/- 0.2	4.8 +/- 0.5

Source: University of Colorado

The predictions from climate models are not consistent with these recent observations. It is the higher temperatures predicted by computer models resulting from the assumed positive 2 to 4 times "feedback" (which has not been supported by evidence) that give rise to the IPCC forecast of an acceleration in the rate of rise in ocean levels.

The reported rise in sea levels on some Pacific Islands can in many cases be shown to be due to the slow consolidation of underlying coral sand, causing land subsidence. The mining and erosion of protective reefs makes islands such as Tuvalu [31] more vulnerable to storms, and the draw down of freshwater aquifers by rapidly increasing population numbers often causes subsidence.

There are significant regional differences. The oceans to the east and west of Australia show quite different annual sea level rises. This may reflect ocean

atmosphere interactions, plate tectonic movement [32] or even instrumental problems. Professor Nils Axel Moerner has made extensive measurements of sea levels in the Maldives in the Indian Ocean [33]. These do not show a rising sea level.

6. POLAR ICE CAPS

Melting Arctic and Antarctic ice, when covering land masses, has contributed to rising sea levels but floating ice of course has no impact on sea levels. Recent satellite measurements [34] show that the Antarctic land-ice cover has remained constant for the last three decades although retreating in some areas and increasing in others. However a further retreat might be expected as the earth recovers from the Little Ice Age. Arctic floating ice cover has retreated over the past three decades, possibly driven by warm currents from the far North Atlantic Ocean entering the Arctic Ocean [35].

Arctic Ocean variations have occurred in the past and even Greenland was once farmed. In 1922 the US Weather Bureau reported "The Arctic Ocean is warming up, icebergs are growing scarcer and in some places the seals are finding the water too hot. Reports all point to a radical change in climate conditions and hitherto unheard-of temperatures in the arctic zone." Subsequently the ice cover returned.

These, and other examples, show that Arctic ice cover retreats and advances due to natural variability rather than because of rising industrial CO_2 emissions. Receding ice is not a new phenomenon.

6. CARBON DIOXIDE AND CLIMATE VARIABILITY

Climate variability, in particular rainfall variability, is a key measure in assessing farming risk in Australia. Greater climate variability is predicted by computer models as a result of higher CO_2 levels. The 1963 study [36], by Sir Samuel Wadham Professor of Agriculture and his colleagues at Melbourne University, compared rainfall variability in Australia with that overseas, using the percentage variation each year compared with the average as its measure. The same measure can be used to compare the rainfall of the first half of the 20^{th} century with the second half.

The average variability of rainfall in Australia's Murray-Darling Basin during the first half of the century was 24% compared with 22% in the second half. On the other hand, average annual rainfall in the first half of the century was 451mm but increased in the second half to 496mm (*Figure 2*). Climate computer models in contrast, and wrongly, predict less rain and more variability under the higher CO_2 levels of recent years.

The 50-year periods for comparison are chosen because selected shorter periods often delineate trends that are misleading out of context, and can cause unnecessary concerns about global cooling or global warming. For example, during the period 1940 to 1976, despite increasing CO_2, levels the climate started to cool. Time, National Geographic and Newsweek publications warned that humankind will endure a new ice age. Books were written expressing alarm. "The Cooling", Lowell Ponte's 1975 book [37] on the threat of global cooling, for example, states:

> "Global cooling presents humankind with the most important social, political, and adaptive challenge we have had to deal with for 110,000 years. Your stake

in the decisions we make concerning it is of ultimate importance: the survival of ourselves, our children, our species."

The study of Australian climate by Sir Samuel Wadham concluded that "nowhere in the world is there such a huge area of pastoral land of such erratic rainfall as this pastoral country of Australia."

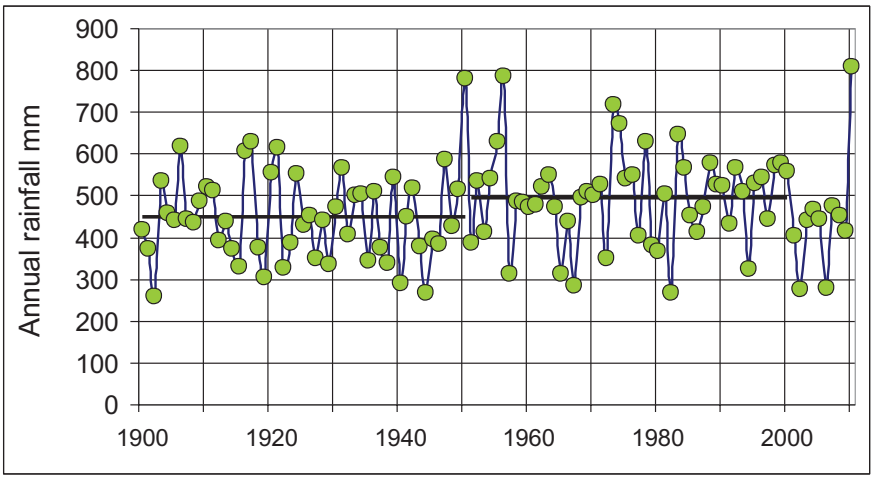

Figure 2: Yearly rainfall in the Murray-Darling Basin: Mean annual rainfall for 1900-1950 451 +/- 15 mm and for 1951-2000 496 +/- 15 mm. Source – Australian Bureau of Meteorology.

The study warns "the immediate effects of violent fluctuations of climate on the development of agriculture are considerable..." The harsh Federation drought at the end of the 19th century and the recent 10 year drought followed by severe floods are symptomatic of these "violent fluctuations" of the Australian climate, which, however, are entirely of natural origin..

Past climate events also demonstrate that many major climate changes have occurred independently of CO_2 levels. For example, cooler periods during the "Little Ice Age" such as the Maunder Minimum (circa 1670) have been associated with low sunspot activity. There is growing concern that the present pattern of sunspot activity is similar to the pattern observed at that time [38].

8. CARBON DIOXIDE AND OCEAN ALKALINITY

The oceans are alkaline with a pH range from 7.9 to 8.5 depending on location, and with an average of 8.2 pH - less than 7pH is acidic. Minerals dissolved in seawater or available at the seafloor buffer the pH level by reacting with dissolved CO_2 to form neutral compounds, thereby safeguarding the ocean against any significant change in pH levels. This would occur even with massive absorption of CO_2 well in excess of that generated by human activity.

The oceans contain about 50 times as much dissolved CO_2 as is contained in the atmosphere (38,000 Gt of carbon compared with 780 Gt of carbon in the atmosphere [39]). On this basis, even a doubling of CO_2 in the atmosphere will only equate to a 1% increase in the total CO_2 dissolved in the oceans.

9. METHANE

Methane is a greenhouse gas associated with grazing animals and decaying plant material in swamps and marshes. It has been claimed as a factor contributing to global warming because of an alleged warming effect that is assumed by the IPCC to be 21 times more potent as a greenhouse gas than CO_2. However, when calculated correctly [40] on the basis of atomic weight, the actual multiplier is only 7 and, moreover , the concentration of methane in the atmosphere is about 200 times less than that of CO_2. Methane in the atmosphere is broken down to CO_2 and water over a period averaging some 12 years.

The CO_2-equivalent contribution of methane from grazing animals is estimated by various Australian government agencies to be 5 to 10% of national emissions of greenhouse gases. However, these estimates also show no increase in methane from agricultural emissions over the last 20 years.

Recent research shows that the increase in atmospheric methane levels since about 1940 can be explained by the dramatic increase in natural gas (fossil methane) use and leakage from badly managed transmission and distribution systems in the Northern Hemisphere [41]. With the improvement of these systems leakage has been reduced and there has only been a slight methane increase since 1990 - the level has in fact varied with El Ninos and La Ninas (*Figure 3*) and methane from grazing animals has not made a measureable contribution.

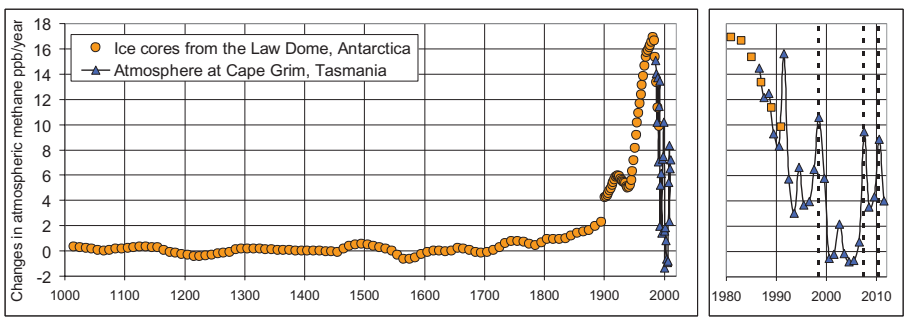

Figure 3: Annual changes in atmospheric methane in parts per billion derived from ice core up to 1990 and direct atmospheric measurements from 1983 to 2011 AD. The annual increase in atmospheric methane from 2000 to 2011 is 2.5 ppb/year, about the rate at the end of the nineteenth century. The peaks in the direct atmospheric measurements reflect the influence of El Ninos. The peak in 1991 is an indirect effect from the eruption at Mt. Pinatubo in June 1991 and the 1998, 2006 and 2010 El Nino's are marked by dashed lines. Data source CSIRO [42].

Grazing animals only release carbon in methane that has been removed from the atmosphere by the pastures they consume. This process, which recycles carbon over the short term, is carbon neutral as methane is broken down in the atmosphere to form CO_2 which is recycled to plants with no net additions to the atmosphere. It is the same as the CO_2 closed cycle for human energy needs. Indeed, this same closed cycle is recognised to justify biofuels. Accordingly there is no cause for concern about methane from grazing animals.

The contribution that methane might make to future global temperature changes has been overestimated in computer projections. The IPCC scenarios assume that methane contributions to the atmosphere will continue to grow at rates of 12 parts per billion per year whereas for the last 10 years the rate has been less than 3 parts per billion per year (*Figure 3*). This extreme assumption of 12 parts per billion per year is used in the CSIRO modelling for sea level changes.

The inclusion of methane in the carbon tax regime and the resources devoted to reducing methane from farming practices, are both inappropriate and unnecessary.

CONCLUSION

Atmospheric CO_2 is a component of the carbon cycle on which life on earth depends; it is not a threat to the planet, but a vital building block for most ecosystem resources.

Mankind is simply returning CO_2 to the atmosphere whence it came. The burning of fossil fuels only returns to the atmosphere CO_2 that was there in the first place, and which was accommodated without runaway temperature change in the geological past. CO_2 is essential for nearly all life on earth, and thus is not a pollutant at any forecast level in the atmosphere.

At present, an historically low level of CO_2 is limiting plant growth when more food is required for a growing world population. Australia has the environment and capacity to be a significant clean food producer and is already a major exporter of meat and cereals. From the perspective of food production, a carbon tax and an ETS to suppress greenhouse gas emissions are both equally counterproductive and inappropriate.

Our review demonstrates that concerns about dangerous global warming caused by human-related carbon dioxide emissions:

- are not supported by rigorous evaluation of scientific facts, or by objective measurements;
- ignore the evidence from geological history. Solar activity, planetary alignments and changing ocean currents have been the determinants of climate in the past, and there is no evidence that they will not continue to be so in the future. Models used to prepare information for the IPCC ignore these major climate determinants;
- are based on projections from inadequate computer modelling, built upon questionable or simply wrong assumptions. None of the factual observations referred to in this paper are consistent with the predictions of computer models that are used to support global warming fears; and
- fail to acknowledge the dramatic fall in annual increases in methane that have followed from improvements in gas pipeline technology.

The hypothesis that carbon dioxide generated by mankind can cause dangerous global warming lacks compelling evidence. The hypothesis is not sustained. The historical evidence demonstrates reducing CO_2 emissions as a precautionary measure will have very little, if any, influence on the timing, direction or extent of climate change.

It is acknowledged that there is a considerable body of opinion which supports the contrary view that man-made activity will cause dangerous global warming. A challenge to the scientific evidence and conclusions outlined in this paper would need to be supported by credible observations. As no such evidence has been forthcoming, the paper's conclusions stand.

On these grounds a carbon tax or an ETS is not justified. Nor would a tax on emissions from grazing animals be justified.

Australia currently causes only 1.3% of world-wide fossil fuel emissions and no other country has chosen to follow Australia's lead of a tax with such an economy-wide impact. With a 5% reduction in emissions which total only 1.3% of the world total it is clear Australia will achieve no significant reduction in atmospheric CO_2 levels, despite its heavy economic cost.

The tax will severely compromise the production of low cost energy based on Australia's abundant fossil fuel resources, and significantly drive up costs throughout the economy, thereby damaging international competitiveness. Export industries will suffer a cost penalty and the local market will be more vulnerable to imports. In particular, agriculture, mineral processing and manufacturing will all be affected by increased energy costs, with a consequent adverse impact with loss of jobs and investment opportunities.

Australia is one of the world's largest exporters of coal and natural gas for energy generation in other countries, and massive expansion of these export volumes is underway. It is ironic that at the same time, Australia is about to pay much more for its own energy needs because the level of its self-imposed carbon tax will significantly reduce its long standing advantage of low cost coal for power generation.

Worldwide, it is clear that the extensive resources being directed to trying to reduce human-related greenhouse gas emissions cannot be justified. These resources are being wasted, and come at the expense of important and pressing development programs such as infrastructure, health, nutrition and environmental protection or improvement.

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