Submission to Climate Change Authority
on
Caps and Targets Review

- The Case for Emergency Action –

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Contents:

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Summary

Scientific evidence on climate change, and accelerating extreme weather, suggests that the world is close to passing climatic tipping points, in the Arctic, the Antarctic and elsewhere, which will lock in irreversible runaway global warming unless carbon emissions begin declining rapidly within the next 3 years. At present they are accelerating in line with worst-case scenarios.

Climate change and energy are inextricably linked and pose an unprecedented dilemma for the world. Resource scarcities, particularly oil, are becoming real despite the hype surrounding supposedly new "unconventional" oil sources. The declining Energy Return on Energy Invested (EROEI) for oil and gas will halt economic growth in a world still wedded to these fuels. In any event, climate considerations only allow less than 20% of existing proven fossil-fuel reserves to be consumed. Unless the real implications of this dilemma are honestly acknowledged, and addressed with integrated, systems-based solutions, catastrophic outcomes are inevitable.

There is little evidence that global leaders in both the political and corporate spheres accept that this problem exists. Indeed the failure of the institutional framework within which they operate, with its dominant focus on the short-term, virtually guarantees they will not address long-term issues of this nature.

The policies currently enacted to address climate change, in Australia and globally, are clear evidence of this failure. They are woefully inadequate, leading toward temperature increases in excess of 4°C relative to pre-industrial levels, with catastrophic consequences - a world of 1 billion rather than 7 billion people. The official solutions supposedly complementing these policies are not working, for example carbon capture and storage and other clean coal technologies. The rush to convert from coal to gas consumption will probably worsen warming over the next 50 years. The "official" target of limiting warming to 2°C is far too high.

In summary:

- The climate and energy challenge must be addressed on an integrated basis. It is far greater and more urgent than is acknowledged officially.
- "Official" solutions and processes are not working, and will not deliver the required transformation to low carbon societies either to the extent or in the time required.
- Market forces will not deliver transformation without fundamental regulatory change
- If we are serious about avoiding catastrophic climatic outcomes, sensible risk management dictates that there is no alternative but to take emergency action

Emergency action means putting economies on a war-footing to achieve transition to a zero-carbon society as rapidly as possible, akin to initiatives such as the Marshall Plan in rebuilding Europe post-WW11, or in refocusing the German, British and US economies in preparation for WW11. This may sound extreme, but current challenges are unprecedented and we have left it too late to rely on conventional reform processes. Whilst this cuts across economic orthodoxy and practice, the enormous investment required to rebuild energy, urban and rural infrastructure will provide a sorely needed stimulus for developed and developing economies alike.

Supporting analysis for these views follows.

Recommendations

Given that the Australian government is supposedly seriously committed to addressing climate change, and given the real climate change and energy challenge outlined above, the following recommendations are put forward, based around the concepts of catastrophic risk management outlined in the analysis:

- The Climate Change Authority should propose to government a fundamental reframing of climate change policy on to an emergency footing, designed to meet the following objectives:
  - Global atmospheric carbon concentrations to be reduced to below 350ppm CO_2, corresponding to a temperature limit relative to pre-industrial conditions below 1.5°C. (Given our inaction on emissions reduction to date, it is inevitable that 1.5°C, and 2°C, will be exceeded, but this must remain our medium-term objective)

  - Australian emission reductions of:
    - 50% emission reduction by 2020
    - 100% emission reduction by 2050

  - drawdown of legacy carbon in the atmosphere to achieve the 350ppm CO_2 or less objective.

    These targets should be translated into carbon budget terms, as the most effective means of monitoring action.

- Carbon pricing is essential, but it has to be made meaningful within Australia in the context of the emission reduction task. Emissions trading can be effective, but only if the escape clauses which have rendered emissions reduction in Australia ineffective, such as excessive compensation and offshore purchase of permits, are removed.

- Carbon pricing should not be linked to other international markets, such as the ETS, until the decarbonisation process in Australia is well underway.

- Given the emasculation of carbon pricing and emissions trading arising from the political horsetrading leading to current policies, there is a strong case for replacing them with the simple "fee and dividend" policy proposed by James Hansen and others in the USA[1], with a regularly increasing fee per ton of carbon, the proceeds recirculated directly back to the community.

- Regulatory measures are required to redefine the framework within which the above market mechanisms would work. These should include:
  - a ban on all new high-carbon projects in the absence of secure carbon sequestration mechanisms.
  - the removal of fossil-fuel subsidies.
  - inclusion of aviation and shipping in emission reduction arrangements.
  - stringent vehicle and aviation emission standards.
- The greenhouse gas net should be cast as wide as possible, within sensible technical monitoring constraints

- Global sharing of carbon emission budgets amongst nations should be based, in principle, around the concepts of Contraction and Convergence, with some modifications to identify the most rapid opportunities for emission reduction in emergency circumstances.

- Australian commitments should be made unilaterally, and not be dependent upon action by other nations. Many other countries are far ahead of Australia already. 20th Century concepts of geopolitical game-playing around incremental reform of "business-as-usual", which we have been following to date, will be disastrous. Strong leadership is required if the world is to avoid catastrophic outcomes. This, in turn, will provide a competitive advantage, as the Chinese, Koreans and Germans are now demonstrating

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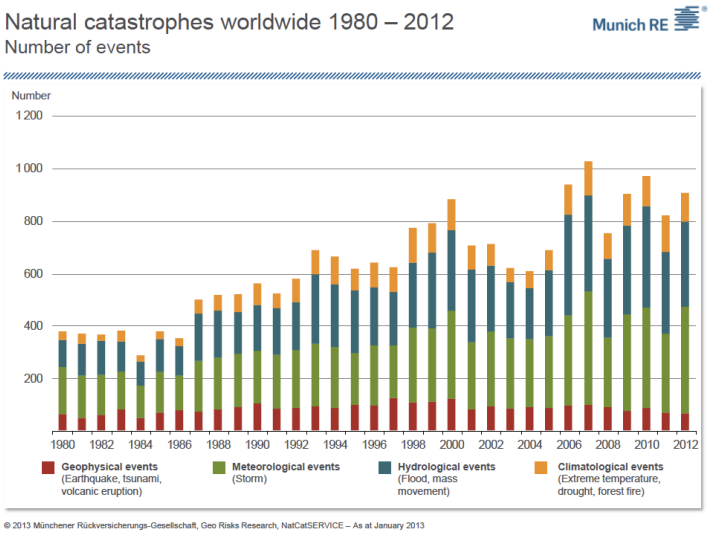
"Want of foresight, unwillingness to act when action would be simple and effective, lack of clear thinking, confusion of counsel until the emergency comes, until self-preservation strikes its jarring gong—these are the features which constitute the endless repetition of history."
Winston S. Churchill - 2nd May 1935

Supporting Analysis

Time to dispense with 'Political Realism"

The official objective of climate change policy, to limit global temperature increase to no more than 2°C above pre-industrial levels, has little scientific validity. It was based on an assessment some years ago, of what was thought to be "politically realistic".

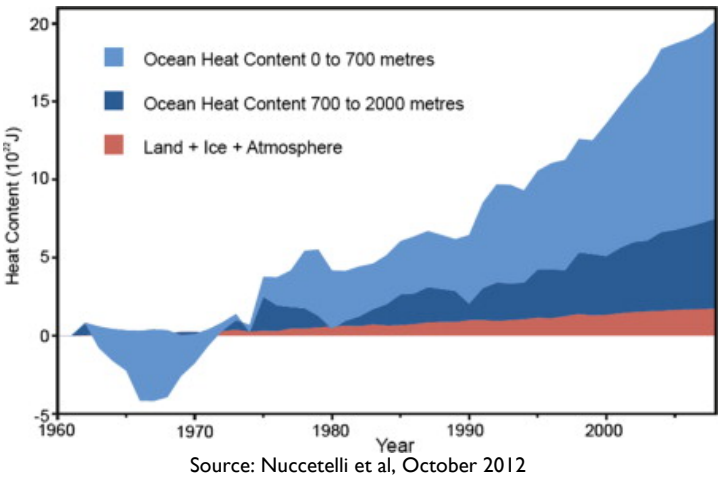
The occurrence of extreme weather events, events which are statistically outside the normal range of historical experience, is accelerating around the world, and is well-documented, as recent analysis by Munich Re shows.



The Appendix lists some of the extreme events which have occurred in the last decade. Science is now able to link these events to long-term climate change trends with increasing confidence [2] [3] [4]. The climate is undoubtedly warming at an accelerating rate, albeit extreme weather, which is the short-term manifestation of long-term climate trends, is highly variable, both regionally and globally. For example it can take the form of excessive heat as recently experienced in Australia [5], or excessive cold as currently evident in China and parts of North America. It may simultaneously result in drought and floods even within one geographic area- witness the Southern USA last year, with severe drought in the South West and severe flooding in the South East [6].

Many claim that the world has not warmed since the anomalously hot year of 1998, and hence the anthropogenic global warming thesis can be discounted. Unfortunately this is not borne out by the facts [7]. Whilst the increase in average global surface temperatures has slowed, much as expected after a record hot year and subsequent La Nina events, the heat content of the oceans, where most of the accumulating net energy is stored, has continued to increase rapidly [8] [9] [10].

Global Warming did not stop in 1998



Source: Nuccetelli et al, October 2012

The question is frequently asked: "Is a particular extreme event caused by climate change". The answer is that all events now have both a natural variability and a climate change component. The latter is due to the fact that the environment in which they occur is now warmer and more moist than it used to be. As warming increases, the climate change component will also increase [11].

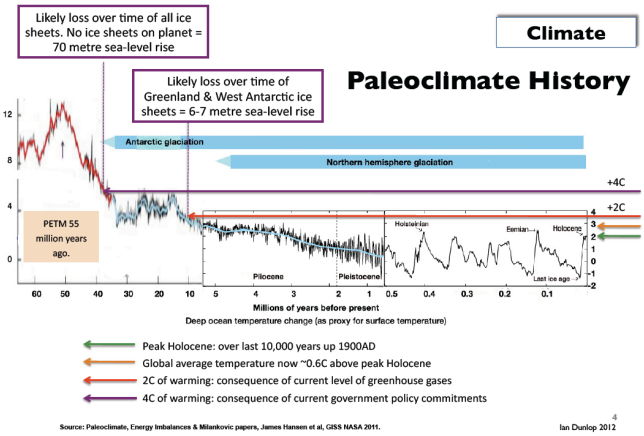
Uncertainty remains over the manner in which climate change will develop in the next decades, but the accelerating warming trend is clear. The uncertainties relate to the manner in which that trend will manifest itself regionally and in the form of extreme events.

The implications of recent extreme weather events, and our preparedness to handle their likely evolution, can only realistically be assessed in the context of the real climate change and resource scarcity challenges we face. These are far greater and more urgent than is acknowledged by political and business leaders, as discussed below.

Given the evidence, "political realism" must now be dispensed with, and climate change policy based normatively on scientifically-determined objectives.

The Real Climate Challenge

As Voltaire put it: "Men Argue, Nature Acts".



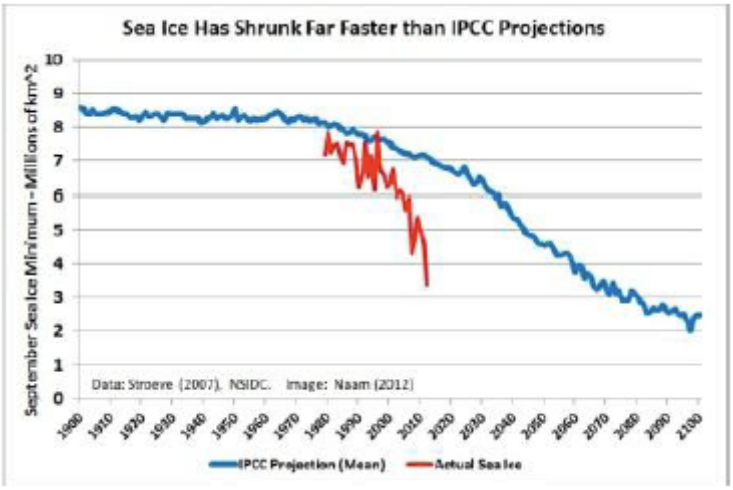
Paleoclimate analysis suggests that current global average temperature is around 0.6^0C above the peak temperature of the Holocene period of the 10,000 years prior to 1900, during which time humanity

as we know it developed. The thermal inertia of historic emissions is likely to translate, in due course, into a 2^0C temperature increase. Once equilibrium is reached, this will be sufficient for large parts of the Greenland and West Antarctic ice sheets to melt, leading to sea level rises of 6-7 metres over time. This would wipe out cities such as New York, London, Tokyo and Shanghai in their current form.

Current climate policies such as the Australian Clean Energy Futures package, if fully implemented, are supposedly intended to limit temperature increase to the official UNFCCC target of 2°C. In reality they are likely to result in an increase in excess of 4^0C, sufficient over time to melt all ice sheets, leading to a sea level rise of around 70 metres, which would a catastrophic outcome for humanity. It is unclear how rapidly these changes might occur, but the empirical evidence suggests that we are badly underestimating both the speed and extent of climate change.

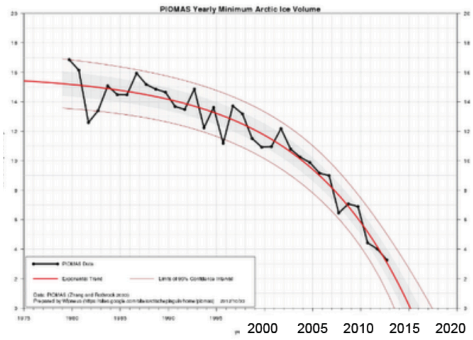
Due to our refusal to heed continued scientific warnings on the need to reduce greenhouse gas emissions, we have probably passed climate tipping points in the Arctic which have the potential to halt human development as we know it.

Arctic Sea Ice Extent – Annual Minimum



The Arctic is now warming at around 3 times the rate of the planet in general. The resulting large and unexpected changes are further accelerating warming via positive feedbacks [12] [13] [14] [15] [16]. For example less reflective ice, more solar radiation warming the ocean, more permafrost melt [17] and methane emissions [18], hence even more warming. Annual minimum Arctic sea ice volume, as opposed to the areal extent above, has reduced by 80% since 1979, 40% in the last 7 years. On current trends, the Arctic will be sea ice-free in summer by around 2015, something which was not previously predicted to occur until late in the 21st Century.

Arctic Sea Ice Volume – Annual Minimum

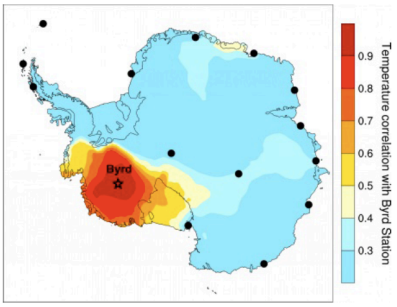


80% of summer sea-ice **volume** lost since 1979: 16,855 cubic kms to 2012: 3,263 cubic kms ice

Half of loss in last 7 years

Unexpected changes are also occurring in the Antarctic. The West Antarctic ice sheet, for example, has been warming faster than virtually anywhere else on the planet [19].

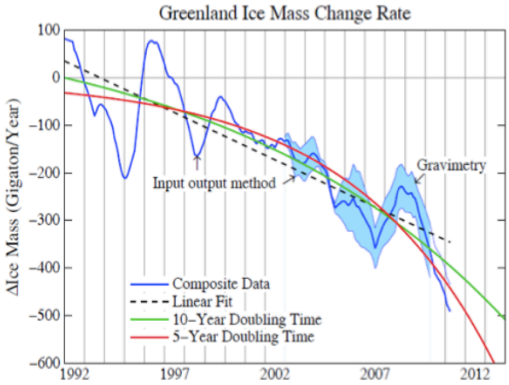
West Antarctic Ice Sheet Warming



Western Antarctic Ice Sheet
is warming nearly twice as fast as previously thought — an increase of 2.4C in average annual temperature between 1958 and 2010

These changes have enormous impact on the global climate system and on sea level rise. For example, sea ice melt has a relatively minor impact on sea level rise as the ice is already floating. However, the land-based Greenland ice sheet is another matter as its melt water directly increases sea level. Recent evidence suggests that the ice sheet melt is speeding up.

How Rapidly is The Greenland Ice Sheet Melting?



There is insufficient data over a long enough period as yet, but if current trends eventually confirm an exponential ice mass loss rate:

- A 10-year doubling time (green line) would lead to
  1 metre sea level rise by 2067 & 5 metres by 2090
- A 5-year doubling time (red line) would lead to
  1 metre sea level rise by 2045 & 5 metres by 2057

Source: "Update of Greenland Ice Sheet Mass Loss: Exponential? J Hansen & M Sato, December 2012 [20]

The dilemma is that, given the likely non-linear acceleration of melting, by the time this becomes clear, it will probably be too late to take corrective action These estimates stand in stark contrast to the sea level rise planning parameter used by many authorities, of around 1 metre by 2100.

Whilst evidence of rapid climate change is obvious in the polar regions, multiple signs are also evident elsewhere. For example ocean acidification, record sea surface temperatures, coral reef disintegration, biodiversity loss, rainforest dieback, glacier melt, record droughts and flooding etc.

Science has clearly established human carbon emissions as a prime cause of climate change [21] [22] [23] [24] [25]. These major changes are happening at the 0.8°C temperature increase we have already experienced relative to pre-industrial conditions, let alone the additional 0.6°C to 3.5°C to which we may already be committed as the full effect of historic emissions is felt [26]. If nothing is done to counteract these trends, by cutting carbon emissions rapidly, it will be impossible to prevent catastrophic outcomes.

"Official" solutions to reducing emissions, such as carbon capture and storage, and clean coal technology, are not working and even if they did, it would require decades for them to take effect, time we no longer have [27] [28]. The fact that the fossil fuel industries are not seriously investing in them is a sure sign these technologies are in trouble.

Current climate policy commitments, if fully implemented will result in 4-6^0 C mean warming, with the Arctic experiencing 10-16^0 C regional warming - way beyond the official target of 2°C - worsening an already very dangerous situation [29] [30] [31]. This could occur long before 2100.

A 4ºC World - 1 Billion People.

Political and business leaders glibly talk about adapting to a 4°C world with little idea of what it means - which is a world of 1 billion people or less, not 7 billion [32].

As the UK Royal Society put it January 2011, *"In such a 4ºC world, the limits for human adaptation are likely to be exceeded in many parts of the world, while the limits for adaptation for natural systems would largely be exceeded throughout the world"* [33].

When asked at the Melbourne 4 Degree Conference in July 2011 to explain the difference between a 2°C and a 4°C world, Hans Joachim Schellnhuber, Director of the Potsdam Institute for Climate Impact Research replied simply: *"human civilisation"* [34].

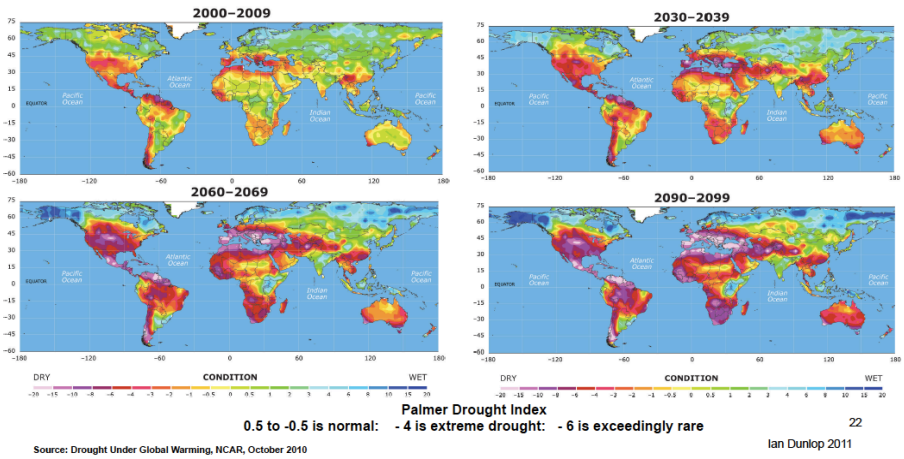
Kevin Anderson, Deputy Director of the UK Tyndall Centre for Climate Change Research summarises the dilemma as follows:

"For humanity it's a matter of life or death. We will not make all human beings extinct as a few people with the right sort of resources may put themselves in the right parts of the world and survive. But I think it's extremely unlikely that we wouldn't have mass death at 4°C. If you have got a population of nine billion by 2050 and you hit 4°C, 5°C or 6°C, you might have half a billion people surviving." [35]

"It is fair to say, based on many discussions with climate change colleagues, that there is a widespread view that a 4°C future is incompatible with any reasonable characterisation of an organised, equitable and civilised global community. A 4°C future is also beyond what many people think we can reasonably adapt to. Besides the global society, such a future will also be devastating for many if not the majority of ecosystems." [36]

Large parts of the world would be subject to extreme drought, with severe impact on food and water supply and human health, whilst other parts experience intense rainfall and flooding, sometimes both in short order, as per recent Australian experience [37] [38].

Increasing Extreme Drought



An analogy with human physiology is appropriate. Normal body temperature is 37ºC. Add 2ºC and you have high fever. Add 4ºC and you are probably dead. Just so with the climate.

In short, as the World Bank emphasises [39], if we have any sense of responsibility to current and future generations, a 4°C world is to be avoided at all costs.

Realistic Targets to Prevent Catastrophic Climate Change

Gradually, the world is starting to understand that, if catastrophic outcomes are to be avoided, on the balance of probabilities the real target for a safe climate is to prevent global mean temperature rising more than 1.5°C above pre-industrial levels. This requires a rapid reduction of atmospheric carbon

concentrations back toward the pre-industrial levels below 350ppm CO_2 from the current 400 ppm CO_2.

For developed countries like Australia, this will require global emission reductions in the order of 50% by 2020, almost complete de-carbonisation by 2050 and continuing efforts to draw down legacy carbon from the atmosphere [40] [41] [42] [43] [44]. Already total greenhouse gas concentrations, including gases such as methane and nitrous oxide in addition to carbon dioxide, are around 470ppm CO_2equivalent, in excess of the official UNFCCC and International Energy Agency (IEA) 450ppm CO_2e stabilization target, which supposedly corresponds to the maximum 2°C temperature increase. At present the full warming of this CO_2e concentration is reduced by the cooling effect of aerosols produced mainly by coal combustion.

Looked at from a total carbon budget perspective, to have a less than 25% chance of exceeding the 2°C target relative to pre-industrial levels, the world can only emit a further 800 Gigatonnes CO_2 in toto from today, a budget which would be used up in less than 20 years [45]. The Australian budget, as one of the world's highest per capita carbon emitters, runs out in 5-8 years – no more carbon emissions after say 2020.

If the temperature target has to be less than 1.5°C, as is now the case, the budgets are considerably lower. This requires global emissions to peak in the next year or so, and then fall in the 9 -10% pa range, something never previously achieved in human history. An equitable approach would require developed world emissions to fall rapidly, while developing world emissions continued to rise for a period before also falling [46] [47].

Given our inaction to date, it is almost inevitable we will overshoot the 1.5^0C, and probably the 2^0C, target, but it has to remain our medium-term objective.

The cost of this degree of change is probably in the range 3-5% of global GDP, rising the longer real action is delayed. This is a manageable amount. However, the potentially catastrophic cost of continuing inaction would be in excess of 20% of GDP, equivalent to the costs of WWI, WWII and the Great Depression combined, let alone the deaths and human suffering involved. We only play the fossil-fuel emissions game once, there is no trial run; we need to get it right first time.

In short, we are faced with an unprecedented task to transform global society on to a low-carbon basis, a task which becomes far harder with every year of procrastination.

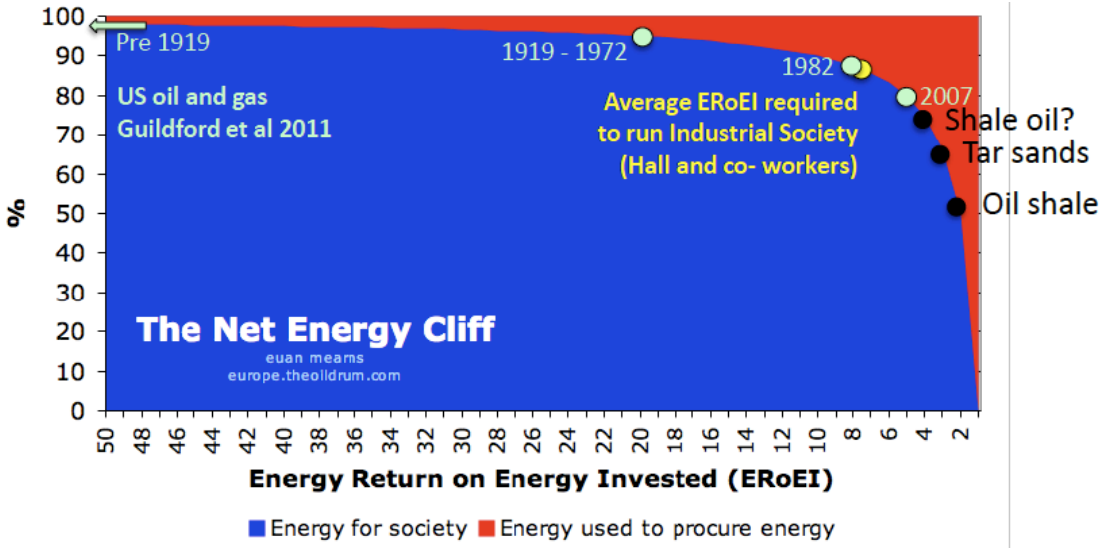
Resource Scarcity

The critical resource scarcity confronting us is the lack of disposal space to dump the carbon waste from our profligate use of fossil fuels, and other pollution. We can no longer use the atmosphere as a free dumping ground if we wish to avoid catastrophic climate change, and much-vaunted carbon capture and storage solutions are not working. Hence the need for rapid emission reductions. That said, there are other critical resource scarcities developing.

Cheap conventional oil supply peaked globally in 2005 and has since been stagnant. Increasing global demand is being met by new high-cost supply from unconventional sources such as tar sands and shale oil. The rapid decline of existing oil reservoirs globally is not being offset by these new sources, official and media hype about a glorious unconventional oil and gas future notwithstanding. Price rises and supply shortages will be the inevitable outcome if demand continues to grow. Further, the carbon emissions, and other resource demands of unconventional oil and gas, such as water, are disastrously high [48].

Complacent official assumptions on oil supply, that "the market will always provide" as prices rise, are dangerously irresponsible in these circumstances [49].

A critical factor is the "Energy Return on Energy Invested"(EROEI); how many energy units are produced for the energy invested in producing it. Historically, this ratio has been 100:1 or more for large onshore oilfields. The global average is now around 20:1, dropping with our increasing reliance on unconventional fuel sources. Shale gas and coal seam gas are in the 10-15:1 range if their full costs are accounted for, with shale oil and tar sands being considerably lower at around 3-5:1 [50] [51] [52].



The average ERoEI to run industrial society as we know it is around 10:1. The implication of a falling ERoEI, is that conventional economic growth cannot continue as the amount of surplus energy available to fuel economic activity falls.

However, the most important factor is that, as a result of our collective inaction to reduce emissions, the world can now only burn less than 20% of existing proven fossil-fuel reserves if catastrophic climate change is to be avoided [53] [54] [55], which removes any justification for continued exploration for, and development of, fossil-fuel resources.

Accordingly, we must be careful to use the fossil-fuels which we can burn before the budget runs out, to establish low-carbon alternatives, rather than waste them on perpetuating the status quo.

The global rush from coal to gas is accelerating warming, not reducing it, due to leakage of methane and the removal of aerosols in the atmosphere. Coal seam gas (CSG) is particularly damaging; methane leakage is high, its impact on water resources and arable land is poorly understood, and its production potential is considerably less than its proponents maintain [56].

Water and food security are acute problems globally [57], exacerbated by both population growth and climate change. In Australia, the rush for short-term profit from CSG is destroying arable land and water resources, resources which will be of infinitely greater, and lasting, importance than gas given the likely severe impact of climate change.

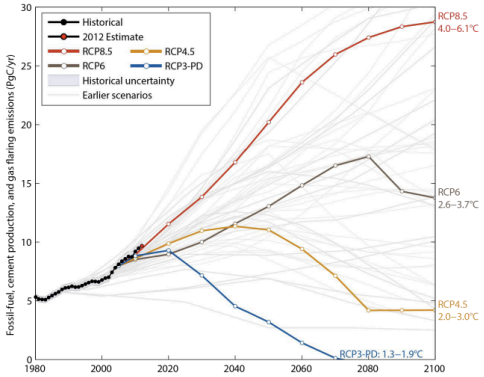
So What Are We Doing ?

In the 20 years since negotiations on reducing carbon emissions commenced, virtually nothing has been done to curb emissions, and there are no signs of that occurring via international treaties in the short term. Meanwhile, after a brief pause during the Global Financial Crisis, emissions continue to rise at record rates [58].

Global Fossil Fuel & Cement Emissions

Emissions are heading to a 4.0-6.1ºC "likely" increase in temperature

Large and sustained mitigation is required to keep below 2ºC



Linear interpolation is used between individual datapoints

Source: Global Carbon Budget 2012

The inertia of the climate system means that our emissions today virtually lock-in potentially catastrophic outcomes for decades ahead.

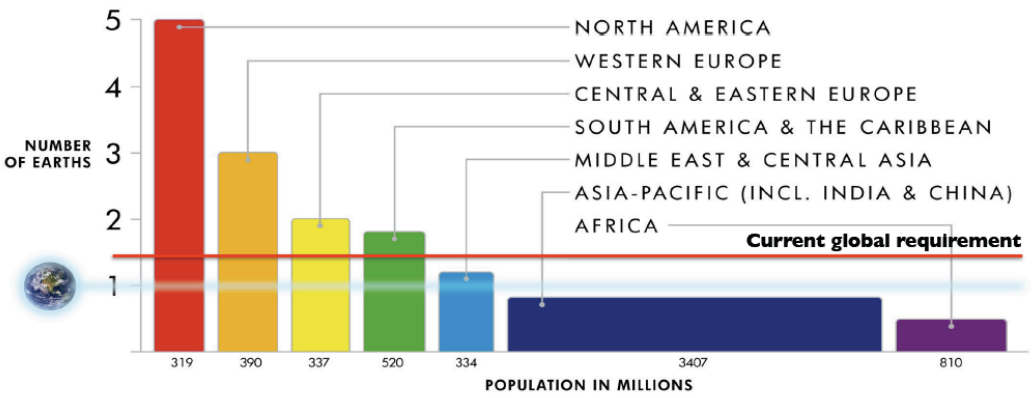
The real tragedy of international climate policy is the total disconnect between the supposed commitment of governments and business in major emitting countries, to serious action on climate change on the one hand, and energy and economic policies on the other which continue to expand and subsidise the fossil fuel industries, particularly coal, the most emission-intensive source.

Every new fossil-fuel project now represents death and destruction for communities somewhere in the world.

Emergency Action Required

Humanity is now the dominant global force. What was workable in a relatively empty world of 2-3 billion people post-WWII is not workable in today's full world of 7 billion, let alone the 9 or 10 billion to come. Humanity today requires on average the biophysical capacity of 1.5 planets to survive [59]. If everyone lived at US levels, we would require 5 planets, at Australian levels around 4 planets. This cannot continue any longer as we are fast destroying the global commons of clean air, water and the fertile soil and oceans on which we depend for our food supply and life support.

Humanity today needs 1.5 planets to survive



Source: Global Footprint Network

Our ideological preoccupation with a market economy, based on political expediency and short-term profit maximization, is rapidly leading toward an uninhabitable planet, as sustainability issues of

theoretical concern for decades manifest themselves physically, particularly in regard to climate, energy, water and food [60] [61].

Progressive business leaders around the world are beginning to recognize that change is urgently needed. For example the annual World Economic Forum Global Risks Report [62] has, for several years, acknowledged climate change as one of the major risks to business viability. Sadly it has had little impact so far on the actions of prestigious leaders attending the annual WEF Davos meeting. Others, for example McKinsey and the World Business Council for Sustainable Development, urge a move away from short-termism, refocusing on the long term and incorporating a wider range of social and environmental considerations in decision-making [63] [64]. These efforts, whilst laudable, to date have not produced a discernible change in business short-termism, certainly not embracing the need for emergency action on climate change. However, pressure is mounting, particularly from the major supranational organizations [65] [66] [67] [68]. As Christine Lagarde, Head of the IMF bluntly put it at the 2013 Davos meeting: "*Unless we take action on climate change, future generations will be roasted, toasted, fried and grilled* " [69].

However, what our leaders are not facing up to, is that the only realistic way to avoid catastrophic climate change, is to immediately halt any new high-carbon development and to initiate emergency action. Action which places key economies on a war-footing, to rapidly implement low-carbon re-structuring; akin to the manner in which preparations were made for WW2 in the UK, Germany & the US, or the way in which the Marshall Plan was implemented in reconstructing Europe post-WW2 [70] [71] [72].

There is no inkling of this anywhere in the "official futures" of most governments; there is a passing nod to climate change, and oil scarcity is ignored. The entire focus of mainstream political and business thinking is to squeeze the last drop of juice from traditional high-carbon lifestyles.

Given that our leaders are well aware of the extreme risks we now run, in maintaining this attitude they are wilfully perpetuating nothing less than a crime against humanity.

Humanity has enormous ingenuity, low-carbon resources and opportunities, but only if there is honesty about the real challenges we face and a preparedness to initiate emergency action. This must include new approaches to risk management.

The Need for Forward-Looking Catastrophic Risk Management

Climate change and extreme weather events are essentially matters of risk management, but not in the conventional government, business, financial markets or insurance sense. These changes have potentially catastrophic outcomes, with the ability to destroy communities, businesses, countries and indeed the world as we know it. As such, these strategic risks have to be handled entirely differently from conventional practice. This is particularly so where actions we take today lock in potentially catastrophic outcomes for decades, indeed centuries, to come - factors which humanity has never previously had to confront.

Catastrophic risk management has to be forward-looking, factoring in the best scientific advice to anticipate the impact of our current economic and social system on the climate, and to take proactive steps to avoid the worst outcomes. It should not rely on backward-looking historical analysis as a guide to action, as we are currently doing, otherwise it will be too late to prevent irreversible outcomes, a point emphasised by numerous global experts [73] [74] [75].

In 2008 Ross Garnaut wrote: *"prudent risk management would suggest that it is worth the sacrifice of a significant amount of current income to avoid a small chance of a catastrophic outcome …."* [76] . Since then the chance of catastrophic outcomes has risen substantially.

The following catastrophic risk management framework is suggested:

1. **Normative Policy**. *"Politically realistic*", incremental change from "business-as-usual" is not tenable. This must be replaced with a normative view of the targets required to avoid catastrophic consequences, based on the latest science. Action is then determined by the imperative to achieve the target, not by incremental, art-of-the-possible, change from business-as-

usual. This will involve both mitigation – *avoiding the unmanageable,* and adaptation – *managing the unavoidable*.

In short, the target for stabilisation of atmospheric carbon to avoid dangerous consequences is now less than 350ppm CO_2. Our objective must be to reach that target as rapidly as possible. Many will dismiss this as unattainable given that current concentrations are 400ppm CO_2; it will require not only the rapid curtailment of emissions, but the re-absorption of some carbon already in the atmosphere. We have the technology to achieve this; so far we have lacked the will to make it happen.

The target is only unattainable when viewed with a business-as-usual mindset, influenced by established vested interests. When real emergencies loom, as at present, then remarkable change is possible, but only with a paradigm shift in thinking.

2. **Change Mindsets**, to now regard the climate change challenge as a genuine global emergency, to be addressed with an emergency global response. This is not extremist nonsense, but a call echoed by an increasing numbers of world leaders as the science is better understood.

3. **Moral & Ethical Considerations.** Climate change, and its potential to trigger catastrophic failure, must be thought of differently from short term economics, risk assessment and cost benefit analysis which have dictated policy thus far. Irreversible climate change scenarios require that we base our response primarily on moral and ethical considerations than on quantitative economics. Under these circumstances, we should be prepared to pay a great deal to maintain societal, environmental and economic flexibility for both current and future generations. Economic analysis is valuable in charting the most efficient pathway to reach the targets, but it should not be the prime consideration in determining the targets themselves. They must be set based on the latest science and its moral and ethical implications.

   It is clear that the existing economic system, based on conventional growth, is broken. Rather than being paralysed by the prospect of having to move away from conventional economic and business concepts, we should recognise that we now have a unique opportunity to establish our society and economy on a genuinely sustainable footing. Further, the economic and business opportunities presented by the required restructuring will, in the medium to long term, far outweigh the inevitable short term costs of change. There is no point in pouring billions of dollars into shoring up an existing system which is fundamentally unsustainable; indeed to do so will only compound the problem.

   The potential for catastrophe also requires the creation of a margin of safety, or insurance, against its occurrence. A margin of safety can be "purchased" by the use of innovative scenario and real option techniques to maintain flexibility, approaches which are not part of current policy formulation. Most importantly, sensible risk management, given climate change lag and the escalating probability of catastrophic impact, demands early and rapid action to curtail emissions, not the gradual incremental response now being advocated.

4. **Genuine Global Leadership.** Current responses reflect the dominance of managerialism – an emphasis on optimising the conventional political and corporate paradigms by incremental change, rather than adopting the fundamentally different normative leadership needed to contend with the potential for catastrophic failure. In practical terms, genuine leadership means committing today to rapid, deep emission reductions, and actively promoting concrete proposals to involve the developing world, for example Contraction and Convergence concepts. The conditional approach, where Australia's emission reduction task is made dependent upon other countries undertakings, guarantees failure. A nexus-breaker is urgently needed, and Australia is ideally placed to provide the leadership required, with the potential for considerable national benefit.

5. **Integrated Policy.** Climate change, though difficult, is only one of a number of critical, inter-related, issues now confronting the global community, which threaten the sustainability of humanity as we know it. The immediate pressure point is the convergence of climate change with the peaking of global oil supply, water and food shortages and the financial crisis. Rather

than viewing these issues separately in individual "silos" as at present, integrated policy is essential if realistic solutions are to be implemented [77].

6. **Honesty.** There needs to be an honest articulation of the catastrophic risks and the integrated sustainability challenge we now face, with extensive community education to develop the platform for commitment to the major changes ahead. This must include a more mature and responsible political approach, as catastrophic risk cannot be handled realistically with current negativity and adversarial attitudes.

"They go on in strange paradox, decided only to be undecided, resolved to be irresolute, adamant for drift, solid for fluidity, all-powerful to be impotent……Owing to past neglect, in the face of the plainest warnings, we have now entered upon a period of great danger….. The era of procrastination, of half-measures, of soothing and baffling expedients, of delays, is coming to a close. In it's place we are entering a period of consequences….. We cannot avoid this period, we are in it now…..

Winston S. Churchill - 12th November 1936

Appendix: Typical Extreme Weather Events 2003-13

1. European Heatwave 2003
2. Hurricane Katrina, New Orleans 2005
3. Greek Bushfires 2007
4. Californian Bushfires 2007
5. Cyclone Sidr, Bangladesh 2007
6. Cyclone Nargis, Myanmar 2008
7. Darfur, ongoing extreme drought
8. North Queensland floods, 2009
9. Victorian Bushfires, 2009
10. High temperatures and/or flooding 2010 & 2011
    a. USA
    b. Northern Europe
    c. Russia
    d. Pakistan
    e. China
    f. Japan
    g. Thailand
    h. Australia
11. Russia wheat harvest destruction 2010
12. Cyclone Yasi, Australia 2011
13. Syrian extreme drought 2006-10
14. Texas & Oklahoma extreme drought 2011-12
15. East Siberian Arctic Shelf methane emissions 2008-12
16. Arctic sea ice & Greenland ice sheet melt 2012
17. Hurricane Sandy 2012
18. Queensland & NSW floods 2013
19. Australia Heat Dome 2013

"None can be put down to global warming exclusively, but they are in line with its forecast evolution"

Would these events have happened at pre-industrial levels of CO_2?

"Almost certainly not"

James Hansen, Director, Goddard Space Institute, NASA

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