2015 REPORT

RECO$_2$UNT

IT'S TIME TO "DO THE MATH" AGAIN

BY DAVID SPRATT

FOREWORD

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For the last two decades global leaders have been guilty of willful denial regarding human-induced climate change, none more so than in Australia. Despite much rhetoric and endless negotiations, human carbon emissions continue to rise in line with a worst-case scenario. Nothing effective has been done to slow their increase, let alone reduce them.

As extreme events and the economic cost of climate change escalate, the world may be poised to take serious action at the Paris COP21 meeting in December 2015, albeit this is by no means guaranteed.

Unfortunately the years of procrastination have cut off options to solve the climate challenge with a graduated response – emergency action is now inevitable if potentially catastrophic and irreversible impacts are to be avoided.

Such views are dismissed as extremist by political and corporate incumbencies, and by most activist NGOs and investors. However, there has never been an honest official acknowledgment of the real climate challenge; as a result realistic solutions have never been forthcoming.

In the lead-up to Paris, the focus of attention is the need to limit temperature increase to the official 2°C target with a limited carbon budget, but these are not appropriate objectives. Climate change is happening faster and more extensively than officially acknowledged and sensible risk management requires far more stringent action. This paper explains why.

There is only one chance to solve this problem. NGOs and investors must not just go along with the official agenda, but demand that incumbencies develop the right solutions to the real challenge.

REPORT SUMMARY

Climate policy making is based on the twin propositions that two degrees Celsius (2˚C) of global warming is an appropriate policy target, and that there is a significant carbon budget and amount of "burnable carbon" allowable whilst meeting this target.

This survey concludes that the evidence does not support either of these propositions.

The catastrophic and irreversible consequences of 2˚C of warming demand a strong risk-management approach, with a low rate of failure. We should not take risks with the climate that we would not take, for example, with civil infrastructure..

There is no carbon budget available:

- If 2˚C is considered a cap or upper boundary as per the Copenhagen Accord, rather than a hit-or-miss target which can be significantly exceeded;
- If a low risk of exceeding 2˚C is required;
- If higher climate sensitivities incorporating carbon cycle feedbacks are taken into account;
- For developed economies;
- For fossil fuel emissions, after accounting for future food and deforestation emissions.

At just 0.8˚C of global warming, the world is already experiencing dangerous climate change. West Antarctic glaciers are now in "unstoppable" meltdown for 1–4 metres of sea-level rise. This event is "a game changer", and a "tipping point that none of us thought would pass so quickly" according to one leading Australian scientist.

Arctic tipping points have been crossed for sea-ice-free summer conditions, with severe consequences for the future stability of permafrost and frozen methane stores, sea-level rises, as well as accelerated global warming as ice sheets retreat and the Earth's reflectivity decreases.

In reality, 2˚C is the boundary between dangerous and very dangerous climate change and 1˚C warmer than human civilisation has ever experienced.

IT'S TIME TO DO THE MATH AGAIN

In his widely-read "Global warming's terrifying new math" for *Rolling Stone* in 2012, 350.org founder Bill McKibben recognised that:

> So far, we've raised the average temperature of the planet just under 0.8 degrees Celsius (°C), and that has caused far more damage than most scientists expected… in fact, many scientists have come to think that 2°C is far too lenient a target. "Any number much above 1°C involves a gamble," writes Kerry Emanuel of MIT, a leading authority on hurricanes, "and the odds become less and less favorable as the temperature goes up." Thomas Lovejoy, once the World Bank's chief biodiversity adviser, puts it like this: "If we're seeing what we're seeing today at 0.8°C, 2°C is simply too much." NASA scientist James Hansen, the planet's most prominent climatologist, is even blunter: "The target that has been talked about in international negotiations for 2°C of warming is actually a prescription for long-term disaster." At the Copenhagen summit, a spokesman for small island nations warned that many would not survive a 2°C rise: "Some countries will flat-out disappear." When delegates from developing nations were warned that 2°C would represent a "suicide pact" for drought-stricken Africa, many of them started chanting, "One degree, one Africa." [1]

McKibben's work has helped build the divestment campaign to leave fossil fuels in the ground and to popularise the notion that investment in fossil fuels is financially risky and immoral.

What people seem to most remember about the article are McKibben's "three simple numbers":

- 2°– the target that "the world settled" on;
- 565 billion tons of carbon dioxide (CO_2) – the amount of carbon dioxide emissions that would give us a "reasonable" chance of staying below 2°C; and
- 2795 billion tons – the amount of emissions in known fossil fuel reserves.

The number "350" (parts per million atmospheric carbon dioxide) on which 350.org was founded does not appear in "Global warming's terrifying new math".

By the time of the "Do the math" speaking tour, the message front and centre was: "We can emit 565 more gigatons of carbon dioxide and stay below 2°C of warming". [2]

This proposition has wide currency, including in the work of Naomi Klein and in a proposed sign-on statement in the lead up to the Paris climate talks published recently in *The Guardian*:

> Scientific assessments of the carbon contained in existing fossil fuel reserves suggest that full exploitation of these reserves is incompatible with the agreed target of no more than 2°C of global warming. The unrestricted extraction of these reserves undermines attempts to limit greenhouse gas emissions. We will start negotiating a global budget for the extraction of fossil fuels from existing reserves, as well as a date for a moratorium on the exploration and development of new reserves. In line with the quantification of the fossil carbon that can be extracted without a high chance of exceeding 2°C of global warming, we will develop a timetable for annual reductions towards that budget. We will develop mechanisms for allocating production within this budget and for enforcement and monitoring. [3]

This framing of an allowable "carbon budget" or "burnable carbon" is deeply troubling to Stanford climate scientist Ken Caldeira:

> "There are no such things as "allowable CO_2 emissions." There are only "damaging CO_2 emissions" or "dangerous CO_2 emissions." Every CO_2 emission causes additional damage and creates additional risk. Causing additional damage and creating additional risk with our CO_2 emissions should not be allowed. If you look at how our politicians operate, if you tell them you have a budget of XYZ, they will spend XYZ. Politicians will reason: "If we're not over budget, what's to stop us spending? Let the guys down the road deal with it when the budget has been exceeded." The CO_2 emissions budget framing is a recipe for delaying concrete action now… the budget for "allowable CO_2 emissions" should be zero."[4]

I agree. Now it's time to "Do the math" again, and set out the scientific evidence showing that two key propositions — the existence of a sizeable carbon budget for 2˚C of warming, and emphasis on the 2˚C goal — are incorrect.

CARBON BUDGET RISK MANAGEMENT

Carbon budgets are framed in risk management terms. The more fossil fuel emissions are allowed in the carbon budget, the higher the risk of exceeding 2˚C. The smaller the budget, the lower the risk of failure. Like drink driving: the more you drink, the more likely a crash.

For example, the IPCC's most recent assessment says the carbon budget for 2˚C is 385 billion tons of carbon (1420 billion tons of CO_2) for a 66% risk of exceeding the target, but 275 billion tons of carbon (1000 billion tons of of CO_2) for a 33% risk of exceeding the target.[5] What it doesn't say is that for a lower – say 10% – risk of exceeding the target, there is no carbon budget available.

So what risk should we take?

Is it reasonable to have a carbon budget that might lead to 3˚C of warming? Of course, we would say no. But the fact is that the most frequently advocated carbon budget is for a 33% risk of exceeding 2˚C and that budget has a range of outcomes between a low of 1˚C but as high as 3.1˚C (95% confidence range).

So if we really don't want to exceed 2˚C of warming, we have to adopt a budget with a low risk - for example less than 10% - of exceeding the target.

Catastrophic and irreversible consequences at 2˚C of warming demand a strong risk management approach:

- We should not take risks with the climate that we would not take with civil infrastructure, where risks of failure are less than one in 10,000 to less than one in a million, or 0.01–0.0001%;
- The 2009 Copenhagen Accord emphasised that 2˚C is not a hit-or-miss "target" (which can be exceeded) but is a "cap" (an upper boundary): "To hold the increase in global temperature **below** 2˚C, and take action to meet this objective consistent with science and on the basis of equity".[6] Accepting 2˚C as a cap necessarily implies a very low or nil risk of exceeding the target; and
- Accounting for carbon cycle feedbacks requires a low risk of exceeding the target because the available budget is reduced by the feedbacks.

The IPCC's published carbon budgets do not include significant events that are happening now, and which will accelerate in the near-term, significantly reducing the available budget. These events include "long-term" feedbacks, in which warming produces conditions that generate more warming. Examples are changes in the large polar ice sheets that alter the planet's reflectivity and trigger the release of large permafrost carbon stores, and impact other carbon cycle components so that carbon sinks such as the oceans and forests become less efficient in storing carbon.

It is conventionally considered that these feedbacks operate on millennia timescales. But the rate at which human activity is changing the Earth's energy balance is without precedent, and the rate of change in energy forcing is now so great that these "long-term" feedbacks are already occurring on short timeframes. For example, the Arctic is likely to be a carbon source, rather than sink, by the mid-2020's. [7]

In 2007 the IPCC said that "with feedbacks included, stabilising at 450 parts per million carbon dioxide equivalent (ppm CO2e) correlates with cumulative emissions some 27 per cent lower than without feedbacks, over a 100-year period".[8]

One of the most significant research findings in 2014 was that the "tipping point' has already passed for one of these "long-term" events. Scientists found that "the retreat of ice in the Amundsen Sea sector of West Antarctica was unstoppable, with major consequences – it will mean that sea levels will rise 1 metre worldwide... Its disappearance will likely trigger the collapse of the rest of the West Antarctic ice sheet, which comes with a sea level rise of between 3–5 metres. Such an event will displace millions of people worldwide". [9]

What was also significant was the strong reaction to this news from the climate science community, because it represented a clear case of an event generally considered to be "long term" in nature having already occurred. Dr Malte Meinshausen called the evidence "a game changer", and a "tipping point that none of us thought would pass so quickly", noting that we are "committed already to a change in coastlines that is unprecedented for us humans".[10]

NO CARBON BUDGET REMAINS FOR 2°C CAP

There is strong evidence that for a low risk of exceeding 2°C, there is no carbon budget remaining.

• There are **no scenarios available** with a "very likely chance (>90%)" of not exceeding the 2˚C target without net negative industrial emissions" and "no ensemble member (including even the most stringent mitigation scenarios) limits warming to less than 1.5˚C throughout the entire century for any of the probability options".[11]

• Research by Global Carbon Project founders Raupach and Canadell show there is **no carbon budget left for a 10% risk of exceeding the target** (see Figure 1. page 7).[12]

• "Achieving the 2˚C warming target, requires a further reduction in cumulative emissions of roughly 180 petagrams of carbon. This implies that we have **already surpassed the cumulative emission limit** and so emissions must ramp down to zero immediately".[13]

• The IPCC reported that "to provide a 93% mid-value probability of not exceeding 2˚C, the concentration (of atmospheric greenhouse gases) would need to be stabilised at, or below, 350 ppm CO2e", that is, below current levels, which means no carbon budget available for 2˚C.[14]

[CO2e is carbon dioxide equivalent and includes the other greenhouse gases including methane and nitrous oxide which have a much shorter life span than CO2].

Dr Michael E. Mann shows that to limit global warming to below 2˚C forever, CO2 concentrations must be kept close to 450 ppm (for mid-range climate sensitivity). Ironically, he adds, if the world burns significantly less coal, that would lessen CO2 emissions but also reduce aerosols in the atmosphere that block the sun (such as sulphate particulates), so "nations will have to keep CO2 levels below 405 ppm".[15] Yet we are just three years away from reaching the 405 ppm level!

It has also been demonstrated[16] that:

• The upper boundary of the "likely" range (i.e. 90% chance) of staying below 2˚C means stabilisation at 378 ppm CO2e; and

• Holding to 2˚C is only likely at 400 ppm CO2e or below (e.g. long-term 350 ppm).

This is consistent with a 2006 paper which found: If "the probability of overshooting a 2˚C climate target … shall not be increased above 30%, it seems necessary to peak CO2 equivalence concentrations around 475 ppm and return to lower levels after peaking (below 400 ppm)."[17]
This is consistent with the Michael Mann result discussed above.

From this we can see that:
• For a 70% chance of staying below 2˚C: peak at 475 ppm CO2e then return to 400 ppm CO2e;
• For a 90% chance of staying below 2˚C: peak at 400 ppm CO2e then return to 350 ppm CO2e.

Given that CO2e levels today exceed 475 ppm, we can see that **not only is there no carbon budget left for a 10% risk of exceeding the target, but there may also be no carbon budget remaining for up to a 30% risk of exceeding the target.**

Multiple lines of evidence lead to the conclusion that the 2˚C carbon budget has expired for the developed economies and for the fossil fuel sector, even for high probabilities of exceeding the target:

• If we make optimistic assumptions about less-developed (non-Annex 1) economies of emission reductions peaking in 2025 and reducing by 7% per year from then on, then for the higher-emitting developed (Annex 1) economies the carbon budget remaining is… zero (as of 2010).[18]

• If some reasonably optimistic assumptions are made about deforestation and food-related emissions for the rest of the century, then most emission reduction scenarios are incompatible with holding warming to 2˚C even with a high 50% probability of exceeding the target. There is certainly no budget left for fossil fuel emissions.[19]

In addition, as far back as 2008, it was demonstrated that if the current greenhouse gas level was maintained over time, it was sufficient to produce 2.4˚C of warming, without taking long-term feedbacks into account.[20]

In summary, there is no carbon budget:

• If 2˚C is considered a cap or upper boundary as per the Copenhagen Accord, rather than a hit-or-miss target which can be significantly exceeded;

• If a low risk of exceeding 2˚C is required;

• If higher climate sensitivities incorporating carbon cycle feedbacks are taken into account;

• For developed economies;

• For fossil fuel emissions, after accounting for future food and deforestation emissions.

2°C TARGET IS NOT SAFE

We have already crossed dangerous climate tipping points at just 0.8˚C warming. In the words of former senior Obama advisor John Holdren in 2008: "the world is already experiencing 'dangerous anthropogenic interference in the climate system".[21]

Evidence includes:

• At less than 1˚C of warming, West Antarctic glaciers are in "unstoppable" meltdown for 1-4 metres of sea-level rise.[22]

• Arctic tipping points have been crossed[23] for sea-ice-free summer conditions, with severe consequences for the future stability of permafrost and frozen methane stores, sea-levels rises, as well as accelerated global warming as ice sheets retreat and the Earth's albedo (reflectivity) decreases.

• Extreme weather events are being made worse, with record heat and drought such as in California at present, and more intense cyclones including Superstorm Sandy and Typhoon Haiyan, both of whose impacts had a climate-warming component.

• The paleoclimate record also tells us that even the current level of CO2 (without accounting for 75 ppm of non-CO2 greenhouse gases we have added to the atmosphere) is enough for 3˚C or more of warming at equilibrium:

  • During middle Miocene, 16-14 million years ago, when temperatures were ~3 to 6˚C warmer and sea levels 25 to 40 metres higher than at present, the CO2 level was similar to modern levels (between 350 and 400 ppm).[24]

  • In the early-to-mid Pliocene, 5–3 million years ago, temperatures were 3˚C above pre-industrial and CO2 levels were 360-400 ppm, very similar to today. The northern hemisphere was free of glaciers and ice sheets, beech trees grew in the Transantarctic Mountains and sea levels were 25 metres higher.[25]

There is also a variety of evidence that 2˚C is not safe target for significant planetary systems:

• An estimated tipping point for Greenland Ice Sheet is 1.6˚C (with an uncertainty range of 0.8 to 3.2˚C).[26]

• Preserving more than 10% of coral reefs worldwide would require limiting warming to below 1.5˚C (range: 1.3–1.8˚C).[27]

• "1.5˚C appears to be something of a tipping point" for extensive permafrost thaw.[28]

In the first few months of 2015, new lines of evidence have been published suggesting that more elements of the system may be heading towards tipping points or experiencing qualitative change, including: the slowing of the Atlantic conveyor likely linked to climate change;[29] accelerating ice mass loss from Antarctic ice shelves;[30] the vulnerability of East Antarctica glaciers;[31] declining carbon efficiency of the Amazon forests[32] and other sinks;[33] accelerated ice-mass loss from the Greenland Ice Sheet;[34] rapid thinning of Arctic sea-ice;[35] a new record low winter maximum for Arctic sea-ice extent;[36] the vulnerability of Arctic permafrost;[37] and the origins and possible proliferation of Siberian methane craters.

In reality, 2˚C is in fact the boundary between dangerous and very dangerous climate change, and 1˚C warmer than human civilisation has ever experienced.

REPORT CONCLUSION

In the lead up to the forthcoming Paris talks, policy makers through their willful neglect of the evidence are in effect normalising a 2.5–3˚C global warming target. It's time to "do the math" again.

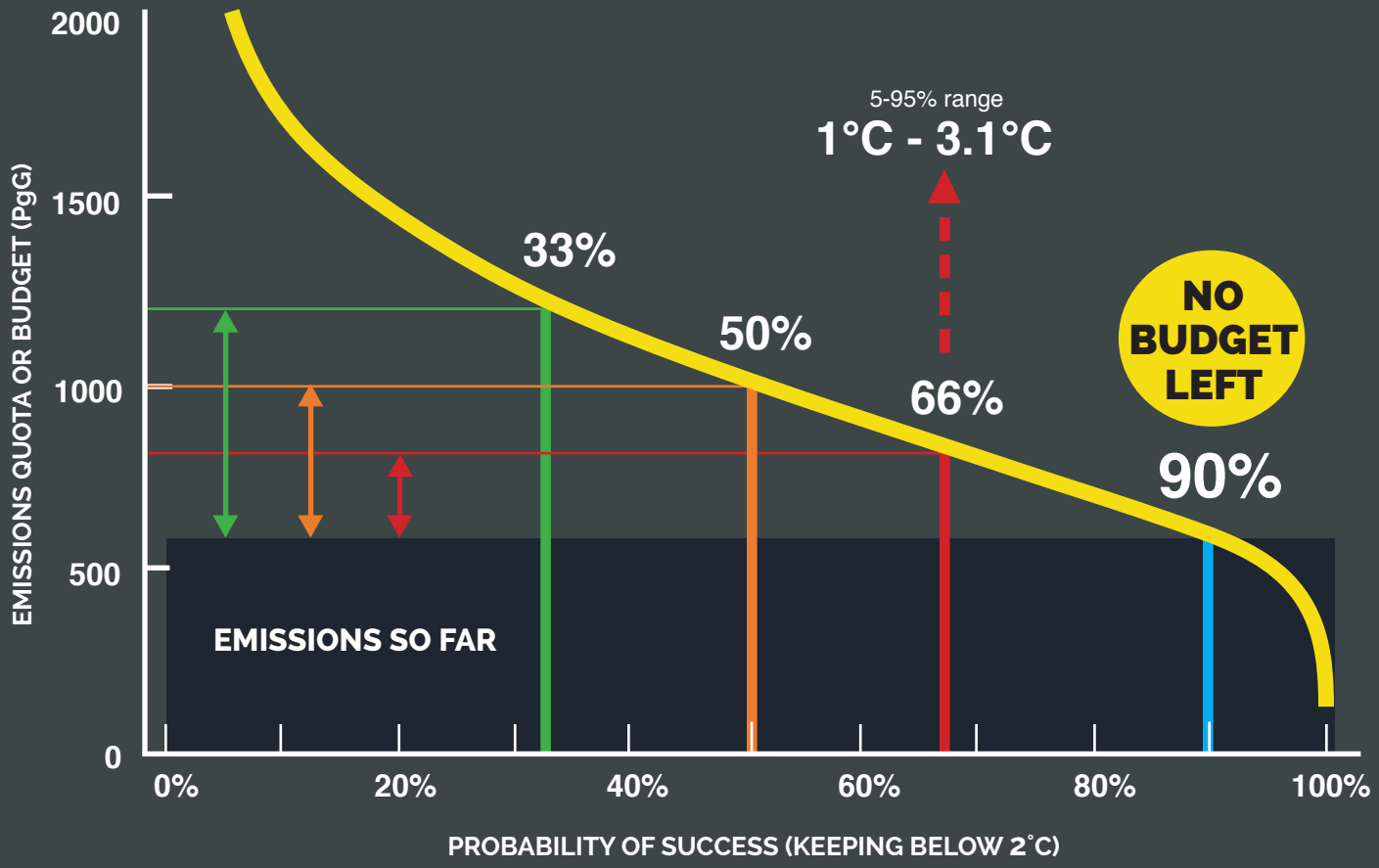
Effective policy making can only be based on recognising that climate change is already dangerous, and we have no carbon budget left to divide up. Big tipping-point events irreversible on human time scales and large-scale positive feedbacks are already occurring at less than 1˚C of warming. It is clear that 2˚C of climate warming is not a safe cap.

This evidence demonstrates that action is necessary at a faster pace than most policy makers conceive is possible. Decades of procrastination mean there is no longer sufficient time for an incremental and non-disruptive reduction in emissions.

Only a whole-of-society rescue plan, understood as action at emergency speed outside of the business-as-usual political mode, can provide hope of retaining a livable planet for ourselves and future generations.

FIGURE 1.

2˚C CARBON BUDGET & PROBABILITY OF SUCCESS



SOURCE: Raupach (2013, unpublished), based on Raupach, M. R., I.N Harman and J.G Canadell (2011) "Global climate goals for temperature concentrations, emissions and cumulative emissions".

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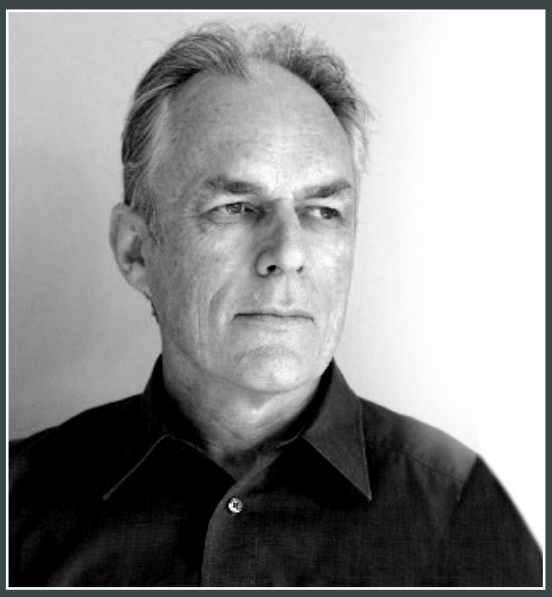

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His work focuses on communicating climate science, policy-making and movement politics, drawing on experiences including the peace and solidarity social movements.

His recent work has included the carbon budget & the myth of "burnable carbon", climate movement strategy in Australia, and connecting the dots to win on climate.

OTHER PUBLICATIONS & WRITINGS

Climate Code Red: The case for emergency action
Dangerous Climate Warming: Myth, reality and risk management
Always Look On The Bright Side Of Life
Sea Level Rise: The case for a 2-metre standard
4 Degrees Hotter: A primer
Climate Policy Dissonance
Our Climate: Past and future
A Carbon Tax .... And Then?
A Rough Guide To Door Knocking On Climate
High Stakes: Climate change, the Himalayas, Asia and Australia
Permafrost: Bubbling our way to the apocalypse
The Big Melt

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