# The one degree war plan

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## Abstract

**Purpose** – The purpose of this paper is to present the idea of a global crisis plan that will be demanded when global society finally decides that the climate challenge is a real threat, requiring immediate and strong policy action at the super-national level. The authors believe that this demand will arise before 2020, and the authors hope that this paper will encourage others to improve on the plan.

**Design/methodology/approach** – The paper seeks to achieve the purpose by presenting the first draft of such a plan – "The one degree war plan" – in rather concrete terms, and estimating (in quantitative terms) the expected reduction in climate gas emissions that would result from implementing the crisis plan.

**Findings** – The paper finds that it is surprisingly simple to develop a plan which will reduce global emissions by 50 per cent in five years. It also seems possible to lower global emissions to zero in the ensuing decade, and then run negative emissions of 6 GtCO2e/year for the rest of the century (through carbon capture in various forms). The result, using the C-ROADS climate model, is to keep the temperature rise in 2100 below +1°C above the pre-industrial level. Much work needs to assure these conclusions.

**Practical implications** – The authors argue that public awareness of the dangers associated with climate change will increase over the next decade, to the level where it is perceived to be a significant threat to global economic and geopolitical stability. The public will then demand emergency action to cut global climate gas emissions. The authors argue that such emergency action ought to be based on a well-prepared crisis response plan that seeks to keep global warming below +1°C over pre-industrial levels. The paper presents a draft of the crisis response plan and encourages further efforts to improve the plan.

**Social implications** – The social value of having a well-considered and well-prepared climate crisis plan in place once the public demand immediate climate action from their politicians, can hardly be overestimated.

**Originality/value** – To the authors' knowledge, no similar crisis plan has been published.

**Keywords** Environmental management, Global warming, Climatology

**Paper type** Research paper

## Introduction

It is like belonging to a secret society. Conversations held in quiet places, in cafes, bars and academic halls. Conversations held with furrowed brows and worried eyes. Conversations that sometimes give you goose bumps and shivers, and a sense of the surreal – is this conversation really happening?

This is what it is felt like over the past few years, to spend time with some of the world's leading thinkers and scientists on issues around climate change and sustainability. In public, this group generally puts a positive, while still urgent interpretation of their views. The general public position is: "we face serious risks, potentially catastrophic,

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if we don't act urgently and strongly". Of course, "If we don't act" is the key qualifier, with very few prepared in public at least, to cross that dreaded line or to use those words "it's too late".

But in private, often late at night, when we reflect on what we really think and wonder if the battle is lost, it is a different conversation. The talk goes to the potential for self-reinforcing runaway loops and for civilisation's collapse. We discuss geopolitical breakdown, mass starvation and what earth would be like with just a few hundred million people. It is a very strange thing to calmly pontificate the realistic risk of the collapse of civilisation and then go back to work!

Why are the public conversations so different from the private ones?

Changing public opinion and galvanising political and market action is an art rather than a science, but an art made all the more complex by the array of human emotions that discussions like this provoke. If the messages is too soft – the "win, win, we can do this, let's not dwell on doom and gloom" approach – people do not confront the scale of the challenge and find endless reasons for delay. When change is difficult, or failure frightening, then avoidance is a welcome escape.

However, if the message is too hard – the "we're doomed, it's a catastrophe, act now or we'll all die" approach – then people normally switch off, and move into denial, or worse, into resistance.

The balance between these extremes has very much sat at the soft end in recent decades. A combination of fear of generating resistance or backlash and a desire not to be written off as too extreme (and at a personal level, not wanting to lose motivation) has tended to drive experts away from the hard conversations, at least in public.

This has recently become very challenging. The scientific evidence has become overwhelming and with few exceptions has tilted all the uncertainties the wrong way. The Arctic melting way ahead of all previous forecasts including worst-case scenarios, the constantly increasing forecasts for sea level rise, the accelerating species loss, the worsening droughts, the melting glaciers, the tragic fires and so on, all take us to the unavoidable conclusion – things are indeed, to use that delightfully understated English term, rather grim.

We now find ourselves at least once a week having a discussion with someone who asks the question – "Is it too late?" which soon leads into "So what should we do now?"

This paper is our answer to those two questions.

## 1. It is not too late... yet

Too late is not a single line to cross. Except in absolutely catastrophic collapse scenarios, there is no "too late", because action taken today will still reduce the level of future damage and human suffering.

Our view is, however, that given the physical momentum for change already in the climate system and the continuing lack of action on the scale and with the urgency required, it is now too late to prevent major disruption and damage in the decades ahead, as a result of inaction over the past several decades. We believe there will now be an ecological and economic crisis, of a scale that is significant in the history of human life on earth.

But we certainly do not believe it is too late to prevent the collapse of the global economy and civilisation.

This is because our work, described in this paper, leads us to conclude humanity can still prevent a process of runaway, self-reinforcing climate change and maintain a level of global control – i.e. a decision-making framework and capacity to affect actions at a significant global scale. It will, however, require a level of mobilisation so far beyond the current debate that it will seem incomprehensible to most readers. And yet, such mobilisation is possible and could result in rapid and spectacular cuts in greenhouse gas (GHG) emissions and eventually lead to a stable climate.

We firmly believe humanity can rise to the occasion, as evidenced by the mobilisation for, and the results of, World War II (WWII).

The main point of this paper is to detail what the level of mobilisation and action required to stop climate change could look like and to begin the process of refining such a plan.

## 2. Society will respond when it perceives a crisis

It is clear that society is capable of responding dramatically to major threats when there is acceptance of a crisis. At that point, all previous arguments against action are consigned to the dustbin. Modern history's strongest example is WWII; others include 9/11 and the recent financial crisis.

This is how it will be on climate change, but not yet. While the increasingly urgent scientific warnings are causing rapid growth in the number of people who believe, as we do, that we are already facing a civilisation-threatening crisis, it is not yet the dominant view.

So, the evidence will continue to build and then at some point, there will be a "great awakening" – a tipping point where, relatively suddenly, people will perceive the situation as a real crisis. Perhaps, it will be triggered by an event unrelated to actual climate change but symbolic, like a lack of volcanic activity creating three record warm years in a row. Or perhaps, when the Arctic summer is ice-free for the first time. Or, by the current economic crisis bringing our economic growth model into question. Or, it might just happen with no particular trigger.

Whether it occurs because of a climatic event, political leadership or just the great mass of evidence is, while interesting, actually unimportant. Such a "great awakening" will certainly occur. If not next month, at least before too many more years pass.

This is because the momentum for change that humans have now built into the Earth's climate system is like a fast moving, very heavy train. We are standing on the train line, in heavy fog, oblivious to the approaching train. Either the fog will lift, or the train will get so close we will feel its rumble. Then, we will jump.

Our judgement after decades of observation, recent interpretation of the high quality science and various social indicators is that this point will occur before 2020.

When it occurs, we will shift into a "whatever it takes" approach to solving the problem. Given the response will be "late" and climate change is driven by a series of leading causes (i.e. it takes time – decades – before the full impact is felt), the "great awakening" will generate demand for dramatic intervention.

At that time, the global community will – rapidly, though messily – develop a global emergency response to cut climate emissions and pursue a safe climate "whatever the cost".

To succeed, this emergency response will require an extraordinary level of global cooperation and unity of purpose, well beyond anything we have ever seen and

for which the only comparable, though still inadequate, example is the mobilisation of many parts of the world during WWII. It will require a clear goal (a picture of the enemy and of victory), rapid change, considerable dislocation and widespread sacrifice.

Humanity will then enter a multi-decade response period that will see civilisation teeter on the brink of collapse but most likely not fall over that cliff.

So, how will all this unfold?

### 3. The crisis will trigger a demand for a one degree war plan

The logic in any crisis is very simple. The question becomes: what action is necessary to solve the problem? The mindset shifts dramatically and becomes, as articulated by Winston Churchill in WWII:

> It is no use saying, "We are doing our best." You have got to succeed in doing what is necessary.

To the objective observer, the climate science is very clear on what is "necessary". Allowing even 2°C of warming (above pre-industrial temperatures) is too dangerous. Although broadly accepted as an important goal by policy makers, no mainstream science group actually argues this is a "safe" level. Rather, it is assumed to be "the best we can do" based on the analysis of what is politically "realistic". About 2° will in fact lead to widespread environmental, social and economic disruption and – most importantly – pose a significant risk of a runaway, unstoppable warming period that could cause the collapse of civilisation. So, it is an inadequate goal. It is a plan for failure.

The logical, science-based response is to set a target that gives society a "safe" outcome. We believe, based on currently available science, that bringing global warming back to below 1°C from pre-industrial levels, can be considered reasonably "safe" for humanity on a crowded planet. Staying below 1°, in other words, is the solution to the problem. It is "what is necessary".

Therefore, society will, when the crisis hits and the scale of the threat is understood, demand a plan to achieve no more than 1° of warming.

As we have been writing this paper, a debate has begun on the right $CO_2$ concentration target and whether 350 ppm $CO_2$e is more appropriate than 450 ppm $CO_2$e, which is the generally accepted target in the policy community. The former goal is gaining increasing support among serious climate scientists, and is also the focus of an emerging popular movement (see www.350.org). While we are generally more supportive of a temperature target because this is the outcome needed, whereas the concentration of GHG is the driver of that outcome, it is interesting to note that our war plan delivers 350 ppm $CO_2$e. Accordingly, this plan could equally be considered a "350 War Plan"

Whatever the technical detail and advocacy definitions are, our key conclusion is that it is both logical and inevitable that society will at some point demand an effective solution to what is clearly a major threat to the stability of human civilisation and the global economy. We are therefore writing this paper to encourage people to plan for such a one degree war sooner rather than later. The longer humanity works on it, the more robust and effective such a plan will be. It will also have greater public and political acceptance when it comes to implementation.

## 4. A one degree war plan is realistic

The next question becomes: is a one degree war plan "realistic"? There are two parts to this question:

*Q1.* Is it technically and economically possible to rapidly reduce global GHG concentrations to a level that will bring warming back below 1°?

*Q2.* Is an agreement to achieve such a plan politically conceivable?

The answer to the first question is clearly yes. Our analysis indicates that based on current knowledge and technology, a 1° target is completely achievable at an acceptable cost. This paper details an example of a plan that would achieve it. It would be very disruptive to parts of the economy and to many people, and it would require considerable sacrifice, but it certainly "solves the problem".

It would require a level of mobilisation and global cooperation similar to that of a world war, but society is capable of – and critically, experienced in – such mobilisations when it finally decides to solve a problem. Therefore, the key issue is not the technical/economic question of whether we can, but the political question of whether we will ever decide to act.

Clearly, agreement to a one degree war plan is hard to imagine in today's world. However, in both WWII and the current financial crisis, there are clear examples of how fast things can change and how strong opposition and resistance can quickly evaporate. In the case of WWII, the speed of response by the USA was quite extraordinary. For example, whereas in 1940, defence spending was just 1.6 per cent of the economy (measured as gross domestic product (GDP)), within three years it had increased to 32 per cent, and by 1945 to 37 per cent. But the GDP increased itself by 75 per cent in that time, making the observed increases even more extraordinary. The war effort demonstrated a tenfold increase in (inflation adjusted) dollars spent in just the four years from 1941 to 1945 (http://eh.net/encyclopedia/article/tassava.WWII). Similarly, extraordinary political decisions were made to take control of the economy. For example, just four days after the bombing of Pearl Harbour, the auto industry was ordered to cease production of civilian vehicles (Ferguson, 2005).

So it can be done, if we ever decide to act. But how will it be done? It is unlikely that the one degree war will result from a universal global agreement. More likely, a small number of powerful countries, a kind of "Coalition of the Cooling", will decide to act and then others will follow. Some will follow in order to align with the major powers, and some under military, economic and diplomatic pressure. In a technical sense, this process is quite easy. A full 50 per cent of global climate gas emissions will be covered if three "countries" (China, the USA and EU-27) agree to act. If we add another four countries (Russia, India, Japan and Brazil) the coalition will control 67 per cent of global emissions[1].

So the issue is not humanity's capacity to act, but the conditions being such that humanity decides to act. This will be when it is broadly accepted that the threat posed by not acting is greater than the threats posed by strongly acting.

Core to our argument therefore, is that the physical momentum for change in the climate system is now so strong that it is inevitable the public view will change. This is because physical reality will overcome the current and proposed attempts at adaptation and mitigation, which are, relative to the problem, feeble and certain to create little impact. When the dominant view becomes that climate change threatens

the viability of civilisation and the collapse of the global economy, a crisis response will rapidly follow. Then society's framework will change from "what is politically possible" to Churchill's "what is necessary".

While we contend this transition is inevitable, the timing is certainly debatable. It is our view that these conditions will emerge before 2020. For planning purposes, we are assuming 2018.

## 5. The one degree war plan in overview

As stated earlier, our objective is a safe climate for humanity and that requires, on current science, ultimate temperature increase limited to about 1°C. This is the objective of the one degree war plan and would be the outcome if this draft plan was implemented[2].

In order to achieve this, humanity will need quick and dramatic reductions in emissions of climate gases. Achieving these reductions is the core of our plan. However, because of the long lag between emissions reduction and impact on temperature, these reductions will need to be supplemented with actions that directly slow the rate of temperature increase and we also propose these. Both these sets of measures will need to be supplemented with adaptation measures intended to reduce the impact of unavoidable migration and widespread hardship. Adaptation measures will be important parts of a mature one degree war plan, but our early version focuses primarily on effort to solve the underlying emissions problem.

It is a symptom of the magnitude of the task, that even with the dramatic action we propose, our plan would see warming continuing to increase above 1° until the middle of this century, before falling back to +1°C by 2100.

We suggest fighting the one degree war in three phases:

(1) *Climate war (years 1-5)*. Modelled on the action following the entry of the USA into WWII, this would be the launch of a world war level of mobilisation to achieve a global reduction of 50 per cent in climate gas emissions within five years. This crisis response would shock the system into change, and get half of the job done. We call it the "C-war" for brevity. This is detailed in Section 6 including a summary of the C- war's emissions reductions and their distribution among sectors.

(2) *Climate neutrality (years 5-20)*. This would be a 15-year long push to lock in the 50 per cent emergency reductions, and move the world to net zero climate emissions by year 20 (i.e. in 2038 if we start the C-war in 2018). This will be a major global undertaking, requiring full utilization of all technological opportunities, supported by behaviour and culture change. We call it the "C-push". This is detailed in Section 7.

(3) *Climate recovery (years 20-100)*. This would be the long haul effort towards global climate control – the effort to create a stable global climate and a sustainable global economy. Achieving this will require a long period of negative emissions to move the climate back towards the pre-industrial "normal". For instance, some refreezing of the Arctic icecap will require removing $CO_2$ from the atmosphere through geo-engineering actions, like burning plantation wood in power stations and storing the emissions underground using carbon capture and storage (CCS). Also, enough solar capacity will have to be introduced to power

and heat the world without the use of fossil fuels. We believe humanity can complete the job in the first decades after 2100 or thereabout, and we name it the "C-century". This is detailed in Section 8.

The overall emission reductions proposed (including the suggested distribution among sectors) are shown in Table I. The emissions pathway over time is shown in Figure 1.

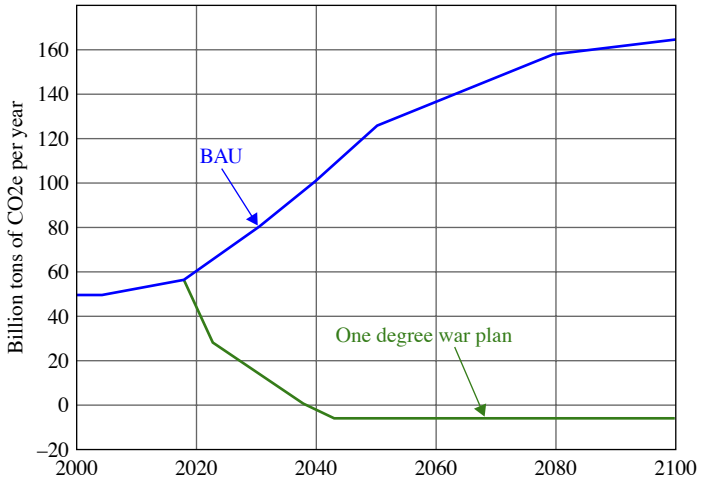
We have tested our suggested emission cuts in a global climate model[3], and confirmed that implementation would deliver the following results:

- The $CO_2e$ concentration falls below 350 ppm by the end of the century, after peaking at around 440 ppm (Figure 2).
- Global temperature does temporarily rise above +1°C, in mid-century, but then falls below +1°C around the end of this century (Figure 3).
- The average sea level rises by 0.5 metres around 2100, and continues rising to a peak of 1.25 metres around 2300. While still very disruptive, we believe this is manageable with good preparation given the longer time frames (Figure 4).

| Source | Emissions in 2018 | Emissions after C-war 2023 | Emissions after C-push 2038 | Emissions after C-century 2100 |
|---|---|---|---|---|
| Energy supply | 15 | 8 | 1 | 0 |
| Transport | 7 | 4 | 1 | 0 |
| Buildings | 4 | 1 | 0 | 0 |
| Industry | 11 | 6 | 0 | 0 |
| Agriculture | 8 | 4 | − 1 | − 3 |
| Forestry | 10 | 5 | − 1 | − 3 |
| Waste | 2 | 1 | 0 | 0 |
| Sum emissions | 56 | 28 | 0 | −6 |

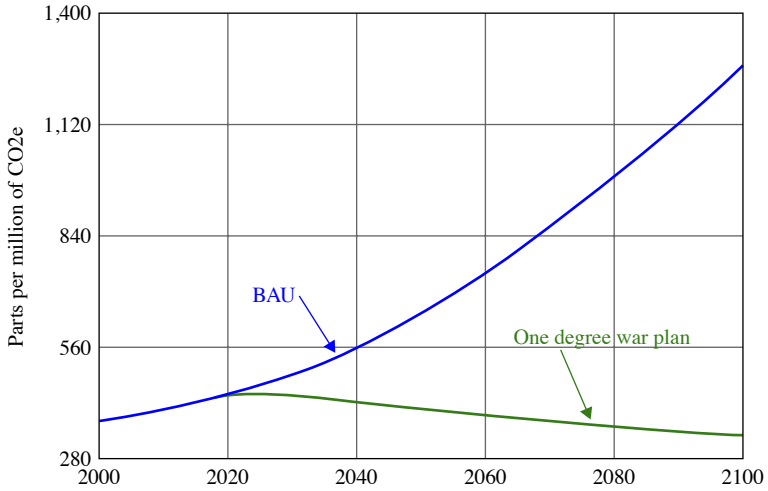
**Note:** All items in billion tons of $CO_2$-equivalents per year ($GtCO_2e$/year)

**Table I.**
Overview of one degree war



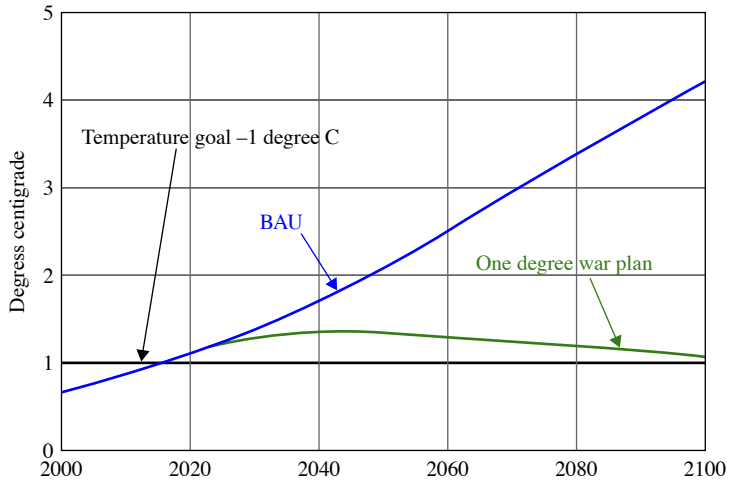

**Source:** Siegel *et al*. (2009), using C-ROADS

**Figure 1.**
GHG emissions into the atmosphere – $GtCO_2e$/year




**Source:** Siegel *et al*. (2009), using C-ROADS

**Figure 2.**
GHG concentration in the atmosphere – ppm $CO_2e$



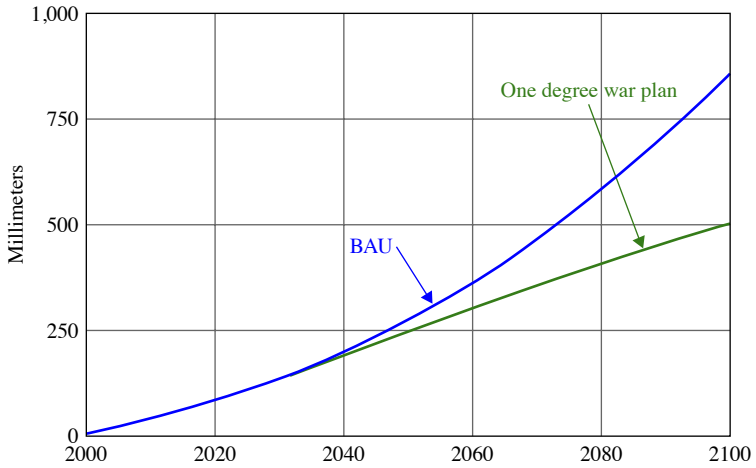

**Source:** Siegel *et al*. (2009), using C-ROADS

**Figure 3.**
Global temperature change relative to pre-industrial

The following Sections 6-8 provide more details for each phase of the plan.

We note that the science will continue to develop and that different targets for $CO_2e$ concentrations, temperature and sea-level rise may well become more appropriate as humanity gets greater clarity on what is "safe" and what is "necessary".

Therefore, even more radical action may become necessary if tipping points within the earth's climate systems require greater step changes to reverse them than those anticipated in current state-of-the-art linear models.




**Source:** Siegel *et al*. (2009), using C-ROADS

**Figure 4.**
Sea level rise from year 2000

## 6. Phase 1 – Climate war years 1-5

*Overview*

We propose a forceful start of the one degree war, for two reasons:

(1) There is disproportionate value in early actions[4]. Given society will be starting action with the crisis in full swing, a forceful start will be necessary and beneficial.

(2) History indicates successful responses to crises tend to involve urgent, dramatic actions rather than slower, steady ones. This engages the public and breaks the tyranny of tradition. It can also be easier to get support for spectacular decisions.

Our one degree war plan therefore proposes a series of global measures to achieve a rapid halving of $CO_2$-emissions during the initial five-year C-war, through linear reductions of 10 per cent per year.

Other authors, like Intergovernmental Panel on Climate Change (IPCC) and McKinsey & Co., have also described climate gas reduction strategies, aiming for deep cuts by 2030 or 2050. These amount to reducing emissions by one-third and two-thirds by 2030[5]. But in order for the world to stay below 1° warming, more dramatic cuts are necessary. The C-ROADS model indicates that it takes cuts of 50 per cent by 2023 to reach our goal. This cut must be followed by reductions to zero net emissions by 2038 and net absorption of 6 $GtCO_2e$/year for the rest of the century. While the initial 50 per cent in five-years is very challenging, we will show it is do-able. Critically, a slower start would make it very challenging to achieve the 1° goal because of the physical challenge of removing additional billions of tonnes of climate gases from the atmosphere.

The good news is that cutting by 50 per cent by 2023 can be achieved with the types of initiatives that McKinsey thinks will cost society less than €60/$tCO_2e$. The bad news is that doing these cuts at our faster speed will, by conventional wisdom, increase the cost. This is based on infrastructure having to be scrapped before the end of its useful

life, and because technologies will have to be implemented before they are commercially mature. If this is accurate, it is the unfortunate consequence of acting late, as we are now, but delaying action longer will just make that worse.

There is a counter argument that we have not modelled but are inclined to support, that a war like mobilisation of the global economy to transform our energy and transport infrastructure will not only be affordable but also may in fact trigger so much innovation and economic activity that it ends up being positive economically. Either way, it has to occur so we will leave that judgement to history.

Our assessment indicates that the following actions, or others with equivalent impact, would be required to ultimately bring global temperature increase below +1°C. Our list is not a fully and comprehensively analysed plan, but a draft for discussion to establish the approach as viable.

The climate war plan is divided into four sections.

*1. Actions to reduce emissions*

We propose the following actions to reduce global climate gas emissions by 50 per cent during the five year long climate war:

- *Cut deforestation and other logging by 50 per cent.* Reduce by one half the ongoing net forest removal and land clearing across the world, including tropical deforestation. At the same time, concentrate commercial forestry operations into plantations managed to maximise carbon uptake. This will require significant payments to developing countries, for the climate services provided by their intact forests, but is surprisingly cost effective and doable (Prince's Rainforests Project, 2009).
- *Close 1,000 dirty coal power plants within five years.* Close down a sufficient number of the world's dirtiest coal fired power plants to cut the climate gas emissions from power production by one-third. We estimate this implies closing down 1,000 plants[6], resulting in a parallel reduction in power production of one-sixth. (Power production would fall proportionally less than emissions, because the dirtiest plants emit more $CO_2$ per unit of energy).
- *Ration electricity, get dressed for the war and rapidly drive efficiency.* In response to lower supply, launch an urgent efficiency campaign matched with power rationing. Include a global campaign to change the temperature by 1-2°C in all temperature-controlled buildings (increase/decrease according to season). Make this part of the "war effort" as a public engagement technique with large immediate power savings. On the back of this, launch an urgent mass retrofit program including insulating walls and ceilings, installing efficient lighting and appliances, solar hot water, and so on across both residential and commercial buildings.
- *Retrofit 1,000 coal power plants with CCS.* Build $CO_2$-capture and storage capacity on 1,000 of the remaining power plants[6]. This huge investment would be much simpler through international standardisation. The CCS technology will also be needed for removal of $CO_2$ from the atmosphere later in the one degree war (generating power using biomass and sequestrating the $CO_2$). CCS is not yet commercially viable, and will require heavy government intervention.
- *Erect a wind turbine or solar plant in every town.* Build in every town of 1,000 inhabitants or more at least one wind turbine. If there is no meaningful

wind, build a solar thermal or solar power plant instead. Beyond the $CO_2$ and technology acceleration benefits, this would have the powerful impact of giving most people in the world a tangible, physical connection to the "war effort".

- *Create huge wind and solar farms in suitable deserts.* Launch a massive renewable energy program focused primarily on concentrated solar thermal, solar photovoltaic device and wind power – on land and off shore. Given the urgency, the initial focus will need to be on those areas with most short-term potential for mass roll-out with finance supported by global agreement. The Desertec initiative provides an interesting concept of what would be possible with a multilateral focus (www.desertec.org). On a global scale, various studies have shown how we could move to a 100 per cent renewable energy system relatively rapidly. A recent global study showed how this could be achieved by 2030 with full base load coverage. Of particular interest is that it concluded it would actually be cheaper than fossil fuels and nuclear power, due to the efficiency inherent in an energy system based on renewable generation and electricity use[7].
- *Let no waste go to waste.* Ensure that all used materials are recycled and reused, at the very least to recover the embedded energy. To force this, limit production of virgin aluminum, cement, iron, plastics and forest products – possibly through international agreements to restrict their use through higher price or a special global emissions tax on virgin materials. Drive public recycling as part of the war effort (there are good examples here also from WWII where mass public recycling drives focused on key materials).
- *Ration use of dirty cars to cut transport emissions by 50 per cent.* Launch large-scale replacement of fossil fuel cars with chargeable electric vehicles – running on climate neutral power – along with a massive boost in fuel efficiency standards, bans on gas-guzzlers and greater use of hybrid cars. Public repurchase and destruction of the most inefficient vehicles ("cash for clunkers" schemes) would help speed the transition. Given the time it will take to scale up production there will need to be rationing of the purchase of fossil fuels and other restrictions on their use such as special speed limits on fossil fuel cars. These measures would in turn help drive the uptake of electric and efficient vehicles. In WWII, fuel in the USA was rationed at 4 gallons (per vehicle per week) then reduced to 3 gallons, and finally in 1944 to 2 gallons. Alongside this, a national 35 mile per hour speed limit was imposed and anyone breaking the limit risked losing their fuel and tire rations. The government ran marketing campaigns to support these measures such as advertisements asking "Is this trip necessary" and educations campaigns on "How to spend a weekend without a car"[8].
- *Prepare for bio-power with CCS.* Interestingly, the C-war may not see a large increase in the use of biofuels for transport (not even second generation fuels made from cellulose). It seems better for the climate to grow the cellulose and burn it in power stations with CCS, thereby removing $CO_2$ from the atmosphere while making power and heat. For this reason, boosting cellulose production (in plantations and elsewhere) will be key.
- *Strand half of the world's aircraft.* Reduce airplane capacity by a linear 10 per cent per year through regulatory intervention and pricing to achieve a 50 per cent

reduction in airline emissions by the end of year 5. This will force the rapid development of bio-fuels for aircraft and force a cultural shift to electronic communication and away from frivolous air travel.

- *Capture or burn methane.* Put in place a global program to ensure that a significant proportion of the methane from agricultural production and landfills are either captured for energy purposes or at least burnt to reduce the warming effect of that methane by a factor of 23.
- *Move away from climate unfriendly protein.* Move society towards a diet with much less climate unfriendly red meat – through public education backed by legislation and pricing. This should not be against particular meat, but against the associated emissions, so that preference is given to protein produced with lower emissions. There are large differences between protein types – emissions differ from soy, chicken, pork and beef (and within beef, from grass vs grain fed). Therefore, science-based policy should be made to encourage the most impactful behaviour change. We note the US Government ran an effective "meat free Tuesday" campaign during WWII.
- *Bind 1 Gigatonne of $CO_2$ in the soil.* Develop and introduce agricultural methods that reduce climate gas emissions from agriculture and maximise soil carbon. This will require significant changes in farm technology and farmer psychology, and we are unlikely to get far during C-war. But the effort should be started immediately in preparation for the large-scale binding of carbon in forestry and agriculture which will be necessary from the 2030s in order to drive down the $CO_2$-concentration in the atmosphere during the rest of the century. In both cases, the object will be to grow as much plant material as possible, and ensure that the bound carbon ends in the soil or in subsurface storage, not back in the atmosphere. Currently, global forests bind some 3 $GtCO_2e$/year. Hopefully – through the use of fast growing tropical plantations, supplemented with industrial growth of algae – one could achieve the binding (and safe storage) of some 6 $GtCO_2e$/year from forestry and agriculture combined.
- *Launch a government and community led "shop less, live more" campaign.* In order to free up finance, manufacturing capacity and resources for critical war effort activities, a very large-scale campaign to reduce carbon-intensive consumption, or at least stabilise it, would be of great help. This will align well with the general need to shift the economy away from carbon-intensive activities towards climate-friendly experiences. We would propose a bottom-up and top-down campaign to highlight the quality of life benefits of low-carbon lives.

While all these actions may seem draconian or unrealistic by the standards of today's debate, they will seem far less so when society moves to a war footing and a focus on "what is necessary". Once more, WWII demonstrated that seemingly unachievable actions quickly became normal when delivered in the context of a war effort. They ranged across dramatic increases in the level of taxation, the direction by government of manufacturing, and engagement campaigns to drive public behaviour shift. So, once more, we assert that the challenge is not to find appropriate actions, but to make the decision to move on the problem.

*2. Actions to immediately slow temperature increase*

Our one degree war plan will achieve significant reductions within five years, but won't lower global temperatures until much later (after 2040, as per Figure 3). In order to reduce the risk of triggering runaway positive feedbacks[9] in the meantime, we propose an urgent initiative to lower the temperature immediately by temporary means. While the science in this area is still under development, we conclude based on current knowledge that the safest and fastest way to achieve this is by directly increasing the reflectivity of the earth. Alas! it may prove necessary to do much more risky geo-engineering – like introducing particles in the atmosphere to reduce the incoming solar heat – if we want to have significant effect. Or to invest in much more expensive projects – like placing huge shades in space. We would rather avoid these, if at all possible, but they should certainly also be further investigated:

- *The white roofs campaign.* What we do propose for implementation, because it is very low risk, is a "white roofs campaign" to paint white (or cover with highly reflective materials) most upward sloping surfaces in urban areas to substantially increase the reflectivity of the planet. By reflecting back, some of the incoming solar energy, one can compensate for the warming effect of part of the $CO_2$ in the atmosphere. The urban roofs campaign should be supplemented with efforts to increase the reflectivity of other large areas: like brighter agricultural crops or mirrors in the deserts[10]. Such actions to brighten the world would not solve the climate problem, but could give society some more time to get the one degree war up to speed and to understand tipping point risks.

  The white roofs campaign would deliver a powerful signal. It has the great benefit of being easy to implement without negative impacts on the local ecosystem, at least compared to other geo-engineering proposals such as creating artificial smog in the atmosphere. It would also have excellent symbolic impact, be capable of engaging people everywhere and create a large numbers of jobs.

  The white roofs would have a limited, but lasting cooling effect (at least as long as they stay white). But white roofs would do nothing to reduce the climate gas concentration in the atmosphere, nor the increasing acidity of the ocean. All it would do is to delay the temperature rise. Thus, the campaign should only be used to compensate for the lateness of action, not to replace other actions. The white roofs campaign would simply give us more time to win the one degree war[11].

*3. Actions to organise and finance the war*

The following actions address the most challenging area of climate change action: global distribution of actions, costs and benefits. Like in any war, this will inevitably end up as a compromise between real power, equity and what can be achieved.

Our suggested framework consists of four key actions, described below: establishing a multinational command structure, imposing a globally harmonised carbon tax, establishing a system for distributing the funds and stopping pollution subsidies:

- *Establish the climate war command.* Create a "climate war command" controlled by those countries participating in the war. Combine the expertise and the lessons of institutions like the IMF (for professional advice on macroeconomics), the IPCC (for advice on climate issues) and various multi-national military commands. The climate war command would have a variety of powers including the authority to ensure that funds are distributed according to a harmonised

global strategy, and to impose equivalent tariffs on imports from any countries that do not agree to the tax.

- *Introduce a carbon tax of US$100 per tonne of $CO_2$.* Impose a global tax on $CO_2$ levied at source on all fossil fuels (i.e. coal, oil and gas), Start at US$20/tonne in year 1 and increasing by US$20/tonne per year over the five-year duration of the C-war. This would initially raise some US$800 billion per annum, increasing to US$1,900 billion per annum in year 5[12]. This would be around 1-3 per cent of the GDP at the time, and actually less than the amounts put into stabilise the global economy during the finance crisis in the Fall of 2008.
- *Redistribute the proceeds of the carbon tax.* The global carbon tax should be used for two purposes: to fund the war effort (i.e. the development and implementation of the various actions described above) and to alleviate the resulting hardship – primarily among the poor (globally speaking).

  The latter could be achieved through equal payments from the climate war command to all global citizens of half the proceeds of the global tax. They would start at US$45 per person year and increase to US$225 at the end of the C-war.

  This compensation for the disproportionate hardship of the poor during the one degree war could be supplemented by rationing systems to ensure each global citizen receives a fair share of those goods and services that temporarily will be in short supply – for example, food, power and fuel.

  The remaining funds should be used as agreed by the war command to help fund the development of new technology, to help pay for restructuring costs including paying developing countries an annual fee for prevented deforestation and to finance disaster response and adaptation costs.
- *Shift subsidies from fossil energy to human employment.* Phasing out over five years all subsidies that support climate gas emissions, and use the proceeds to help soften transitional unemployment problems. This will shift the subsidies from carbon intensive sectors (fossil power and gasoline) to climate friendly sectors (like renewable energy, CCS and battery logistics) – boosting their employment. By some estimations, these subsidies amount to US$ 700 billion per year globally[13] – more than enough to matter.

*4. Actions to improve adapation*

The accelerating deterioration of the ecosystem and the slow human response is exacerbating what was already inadequate planning for adaptation to climate impacts. This situation can be expected to worsen by 2018, so a mature one degree war plan will need to address urgent adaptation needs.

The following three areas will be central:

(1) *A resettlement plan for millions of climate refugees.* Many of these refugees will be internal, but many will need to cross international borders to find suitable homes. The wealthy countries will have to contribute substantially to addressing this migration challenge if we are to avoid the worst geopolitical threats that this will present.

(2) *An adaptation strategy for low lying coastal areas.* The sea level will rise during the twenty-first century and adaptation efforts will be required at the local and national level. International cooperation will increase the effectiveness and

reduce the cost of such measures, for example, dikes, staged retreat, floating cities and flood resistant agriculture. This challenge is certainly not limited to developing countries, the industrial world has significant sea rise challenges, for example, in Florida and The Netherlands.

(3) *A mitigation strategy for large-scale famine.* Climate change is very likely to impact negatively on the world's agriculture, particularly towards the middle of the century. Disaster relief organisations and the military should make concrete plans for such developments and their geopolitical implications.

*Conclusions on the challenges of the C-war*

Of course, the whole approach we outline is hard to imagine in the current context, but again we remind readers how fast things changed in WWII and how quickly things changed recently during the global financial crisis.

Humanity is capable of extraordinary change when it decides to act. Nevertheless, there will be some critical challenges to manage during this process, and these challenges are worthy of considerable discussion as this plan is revised.

The main challenge, beyond agreeing to start the C-war, will be in softening the problems for those hardest hit by expensive or unavailable energy, food, transport and housing. As suggested above, this can best be addressed through a combination of economic compensation and rationing. Our plan generates at year 5 around $2,500 billion per annum to be used for compensation, structural adjustment in the economy and adaptation planning. We also propose a well functioning rationing system to ensure a fixed minimum amount of these commodities for each global inhabitant. While these are important, it should be noted that this plan is going to require sacrifice and this cannot be avoided.

Against this, we have as our constant reference point the human suffering and economic cost of the alternative of a rapidly collapsing global economy.

The second challenge would be to help those who lose their jobs in the transition. This could be done by diverting current subsidies and using tax income, but also would be helped by the significant employment effect of the war-like production increase in climate-friendly output and other actions such as expanding renewable energy production and the white roofs campaign.

Third, and perhaps hardest to plan for, will be the great need for leadership. This will be needed globally, but also at the national level and then further down in the climate army to the local level.

Although not the focus of this plan, we see great potential for bottom up community action and leadership in this overall effort. While we do not analyse this in detail here because it is hard to quantify, we see enormous potential and note the efforts underway all around the world such as the transition towns movement (Table II).

## 7. Phase 2 – Climate neutrality years 6-20

Phase 2 would be a 15-year continuing push to lock in the 50 per cent reductions achieved during the C-war, making them permanent and launching the programs that would see global $CO_2e$ neutrality by year 20 (i.e. zero net global emissions by 2038).

The actions in Phase 2 would be influenced by the experience of the five-year C-war and the scientific and technological developments of the time. In most cases, it would

| Source | Emissions 2018 | Emissions 2023 | Initiatives |
|---|---|---|---|
| Energy supply | 15 | 8 | Close the 1,000 most climate intensive power plants. Introduce CCS on 1,000 of the remaining plants. Large-scale expansion of wind and solar energy |
| Transport | 7 | 4 | Rapid electrification of car fleet, forced shift to small cars and rationing of daily driving. Dramatic reduction in air travel |
| Buildings | 4 | 1 | Dramatic increase in energy efficiency. Change indoor temp 2°C up or down depending on season |
| Industry | 11 | 6 | Shift to recycled metals and fibre, limit production of aluminium, cement, iron and forest products. Shifting to renewable materials and increasing energy efficiency |
| Agriculture | 8 | 4 | Shift away from red meat, increase the carbon content of the soil |
| Forestry | 10 | 5 | Halving of all harvesting of wood |
| Waste | 2 | 1 | Capturing all methane from landfills, and burning all waste for energy |
| Sum | 56 | 28 | |

**Note:** In $GtCO_2e$ per year

**Table II.**
Details of Phase 1 – climate war

be a matter of continuing these programs and expanding them, but in some cases new initiatives would be taken. Examples of approaches might include:

- Create the global "Climate Stability Commission" to determine the $CO_2$ concentration required to stabilise the climate as the science develops, to investigate and agree necessary geo-engineering projects to achieve stabilisation, and to monitor their implementation. This review would include CCS with biofuels and other approaches to remove $CO_2$ from the atmosphere, reforestation, soil carbon and soil char, the white roofs campaign, mirrors in the desert, atmospheric seeding, reflectors in space and all other ideas.
- Rapidly rollout any geo-engineering projects with short-term benefits – be they reduction in temperature or removal of $CO_2$ – after careful scrutiny of the environmental impacts both in the short term and in the long run. Considering the environmental risks probably leads to preference for increasing reflectivity over atmospheric seeding.
- Eliminate all remaining net deforestation and promote the widespread use of timber in ways which maintains its store of $CO_2$, like in buildings and other long-lived products.
- Implement adaptation plans designed during the C-war including preparing for migration, sea level rise, and famine.
- Regulatory action to close the loop on all consumer products and the diversion of all waste from landfill to force greater recycling. This should include the composting of all organic waste to immediately reduces waste volumes and prevent longer term methane emissions from organic waste.

- Continue the massive renewable energy program to first replace supply for the dirty generators turned off in the C-war, and then to turn off the remaining dirty coal generators by the end of year 10 and most gas generators by year 15[14].
- Continue the transport replacement program from the C-war so that all transport is zero $CO_2e$ by the end of year 20.
- Continue the energy efficiency program with incentives to reduce rationing of supply to the most efficient houses and buildings.

## 8. Phase 3 – Climate recovery years 21-100

For years 21-100, the challenge will be to rebuild the global economy based on renewable (solar, wind, hydro, geo, etc.) energy in a sustainable model, to lock in the reductions achieved, and to then stabilise the global climate by taking GHGs out of the atmosphere. Actions might include:

- Launch those geo-engineering projects that were found acceptable by the Climate Stability Commission's investigations. This will involve removing $CO_2e$ from the atmosphere through a series of programs involving bio-sequestration and under ground storage.
- Develop the global economy with a focus on sustainability, the elimination of poverty and closed loop, zero waste and zero net $CO_2e$ production and consumption. Shift economic policy to a focus on quality of life vs material growth for its own sake.
- Widespread application of approaches to help stabilise the climate, probably primarily agricultural, forestry and soil carbon-related activities.

## 9. Conclusions and next steps

What this paper shows, at least at a high level, is basically good news, and writing it lifted our spirits. It showed that even though we will inevitably respond to climate change "late", it will still be possible to stabilise the climate and human society.

Advocating urgent action remains crucial because the earlier we act, the safer we will be, and the less disruptive the inevitable process of rapid change will be.

While hard to imagine today, this plan can be implemented relatively cheaply compared to the costs of failure. Various analyses made since 2005 indicate the societal cost of drastic emission cuts to stabilise around 450 and 550 ppm are about 1-2 per cent of the gross world product. The costs will inevitably be higher when the one degree war plan is implemented because of the speed required. But there is every reason to believe that the war can be won with 5-10 per cent of annual GDP allocated to the task. That would in turn translate into using roughly 5-10 per cent of the workforce, and result in 5-10 per cent drop in average disposable income. It is not without sacrifice, and certainly involves significant dislocation for many people, but again not compared to the alternative of a collapsing economy.

Over the ensuing period of restructuring, wealth levels would gradually move back toward current levels, though distribution would be more even. Well being may increase with stronger common purpose and sense of community, stronger global governance and cooperation and many improvements in transport, urban design and energy.

While the total cost is manageable, the distribution of costs and the benefits will raise some very challenging political and social issues, as indicated by the actions we

have proposed in order to finance the one degree war and distribute the burden. This would particularly apply to industries heavily affected and to developing countries, particularly poor people within them.

Society has some experience of managing economic restructuring under emergency conditions. Sometimes it is done well and sometimes badly. It is clear the better one plans, the less painful the transition will be for those most affected. The problems cannot be eliminated (again, war provides a good analogy), so it will be important for both humanitarian reasons and the chances of success to prepare well.

Since it appears likely that humanity will not respond until the approaching damage is perceived as a true crisis, society should get to work on the crisis response plan now.

**Notes**

1. World Resources Institute (2009), these percentages are based on 2005 emissions, excluding land use, land use change and forestry.
2. As noted earlier, this also aligns well with those who argue for a 350-ppm target.
3. We ran our assumed emission scenario (along with an IPCC business as usual scenario) through the C-ROADS model with the kind help of Siegel *et al.* (2009).
4. McKinsey & Co. (2009) shows how for every year of delay, the peak atmospheric concentration of $CO_2e$ could be expected to be 5 ppm higher for the same level of action. Stern also argues the economic value case for "strong and early action" in the executive summary of Stern (2006), executive summary.
5. Other cut strategies have been outlined, for example, in IPCC Fourth Assessment Report (2007) and McKinsey & Co. (2009).
6. In this paper, we assume there will be some 6,000 major power plants in operation in 2018 (against some 5,000 today). We assume that 1,000 of these are closed down during the C-war in 2018-2023 (reducing emissions by 5 $GtCO_2e$/year), and that a further 1,000 plants will be retrofitted with CCS equipment (reducing emissions by a further 2 $GtCO_2e$ by 2023). A big CCS plant sequesters on average 2 $MtCO_2$/year – roughly 1 in a gas fired utility, and roughly 3 in a coal fired utility).
7. See Jacobson and Delucchi (2009), where a paper summarises their full study.
8. See Cardozier (1995), especially Chapter 10: The Home Front.
9. One of the key reasons scientists fear higher temperatures is that they may trigger runaway climate change. This is so-called self-reinforcing or positive feedbacks. One such feedback process is the loss of reflectivity caused by the loss of ice. Ice as a highly reflective surface reflects radiation from the sun back into space, thereby reducing the amount of heat trapped on earth. When sea-ice is replaced by dark blue water it absorbs more heat and creates greater warming, which then melts more ice, potentially creating a self-reinforcing or positive feedback.
10. See Lenton and Vaughan (2009). This paper compares the effectiveness of a large number of techniques to counteract the warming effect of increased climate gas concentrations in the atmosphere.
11. We have not included the impact of the white roofs campaign in Figures 1-4 because it is unclear how effective it would be in quantitative terms.
12. Assuming that two-thirds of all emissions come from fossil sources (according to Table I, this is $0.67 * 56 = 38$ $GtCO_2e$/year in 2018 and $0.67 * 28 = 19 GtCO_2e$/year in 2023) and that the tax goes from 20 US$/$tCO_2e$ in 2018 to 100 US$/$tCO_2e$ in 2023.

13. Myers and Kent (1998) found US$145 billion in subsidies for fossil fuels and nuclear, with a further US$558 billion for road transportation (i.e. petrol) subsidies.
14. We assume that by 2038 most power plants have been replaced by renewable energy, or have been retrofitted with CCS.

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