ECI: ACTIONS ON CLIMATE EMERGENCY

Subject Matter

We call on the European Commission to strengthen action on the climate emergency in line with the 1.5° warming limit. This means more ambitious climate goals and financial support for climate action.

Objectives

1. The EU shall adjust its goals (NDC) under the Paris Agreement to an 80% reduction of greenhouse gas emissions by 2030, to reach net-0 by 2035 and adjust European climate legislation accordingly.
2. An EU Border Carbon Adjustment shall be implemented.
3. No free trade treaty shall be signed with partner countries that do not follow a 1.5° compatible pathway according to Climate Action Tracker.
4. The EU shall create free educational material for all member curricula about the effects of climate change.

Treaties

- **Article 3(1) and (5), TFEU** ("The Union's aim is to promote peace, its values and the well-being of its peoples." and "In its relations with the wider world, the Union shall uphold and promote ... the sustainable development of the Earth")
- **Article 11, TFEU** ("Environmental protection requirements must be integrated into ... the Union's policies and activities…")
- **Article 173 TFEU** ("speeding up the adjustment of industry to structural changes")
- **Article 165(1) and (2) TFEU** ("shall contribute to the development of quality education, if necessary, by supporting and supplementing" and "developing exchanges of information and experience on issues common to the education systems of the Member States")
- **Article 166 TFEU** ("The Union shall implement a vocational training policy which shall support and supplement the action of the Member States")
- **Article 191 et seq. TFEU** (Union policy on the environment)

➔ https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:C:2016:202:FULL&from=EN#page=134

Citizens Committee

Thomas Eitzenberger, Austria – Representative
Astrid Budolfsen, Denmark – Substitute Representative
Ole Müller, Germany
Federica Gasbarro, Italy
Alejandro Martinez Martinez, Spain
Janina Swiersewska, Poland
Guilhem Heuline, France

Annex to the ECI „Actions on Climate Emergency“

The required actions to fight the climate emergency are countless, but need to be taken now! They require definitely more than one ECI to map them out completely. This ECI is intended to start the introspective process needed in order to turn the ship around.
None of the initiators is a climate scientist, politician or lawyer. The following documents were found however, to give a good general knowledge of the problem at hand and a recommended reading for everyone wanting to understand the reasons for, the effects of and strategies to combat the problem at hand:

1. *“What lies beneath”* – A climate report for the Australian Government

2. *“Climate crisis demands more government action as emissions rise”* – Climate Action Tracker

3. “*The EU’s NDC after the Talanoa Dialogue”*–Options for enhancing the EU´s NDC until 2030

4*. “Feeding the Problem”* – The dangerous intensification of animal farming in Europe

2018 RELEASE

WHAT LIES BENEATH

THE UNDERSTATEMENT OF EXISTENTIAL CLIMATE RISK

BY DAVID SPRATT & IAN DUNLOP | FOREWORD BY HANS JOACHIM SCHELLNHUBER

BREAKTHROUGH
National Centre
For Climate
Restoration

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FOREWORD

BY HANS JOACHIM SCHELLNHUBER

Hans Joachim Schellnhuber is a professor of theoretical physics specialising in complex systems and nonlinearity, founding director of the Potsdam Institute for Climate Impact Research (1992-2018) and former chair of the German Advisory Council on Global Change. He is a senior climate advisor to the European Union, the German Chancellor and Pope Francis.

What Lies Beneath is an important report. It does not deliver new facts and figures, but instead provides a new perspective on the existential risks associated with anthropogenic global warming.

It is the critical overview of well-informed intellectuals who sit outside the climate-science community which has developed over the last fifty years. All such expert communities are prone to what the French call *deformation professionelle* and the German *betriebsblindheit*.

Expressed in plain English, experts tend to establish a peer world-view which becomes ever more rigid and focussed. Yet the crucial insights regarding the issue in question may lurk at the fringes, as this report suggests. This is particularly true when the issue is the very survival of our civilisation, where conventional means of analysis may become useless.

This dilemma notwithstanding, the Intergovernmental Panel on Climate Change (IPCC) bravely perseveres with its attempts to assess the multiple cause-and-effect relationships which comprise the climate problem. After delivering five fully-fledged assessment reports, it is hardly surprising that a trend towards "erring on the side of least drama" has emerged.

There are many reasons, both subtle and mundane. Let me highlight just one of each.

Firstly, the IPCC is stricken with the *Probability Obsession*. Ever since statistics was established in the16th century, scientists have tried to capture the complex, stochastic behaviour of a given non-trivial object (such as a roulette wheel) by repeating the same experiment on that object many, many times. If there was a set of well-defined outcomes (such as the ball ending on the red or black of the wheel), then the probability of a specific outcome was simply the number of experiments delivering that outcome divided by the total number of experiments.

This sounds reasonable, but can we even imagine applying that approach to global warming? Strictly speaking, we would have to redo the Industrial Revolution and the greenhouse-gas emissions it triggered a thousand times or so, always starting with the Earth system in its 1750 pre-industrial state.

Then calculate the averaged observed outcome of that planetary experiment in terms of mean surface-temperature rise, global biological productivity, total number of climate refugees, and many other variables. This is a nonsensical notion.

Of course, climate scientists are not trying to treat the Earth like a roulette wheel, yet the statistical approach keeps on creeping into the assessments. How many times did the thermohaline circulation collapse under comparable conditions in the planetary past? How often did the Pacific enter a permanent El Niño state in the Holocene? And so on. These are valuable questions that can generate precious scientific insights.

But we must never forget that we are in a unique situation with no precise historic analogue. The level of greenhouse gases in the atmosphere is now greater, and the Earth warmer, than human beings have ever experienced. And there are almost eight billion of us now living on this planet.

So calculating probabilities makes little sense in the most critical instances, such as the methane-release dynamics in thawing permafrost areas or the potential failing of entire states in the climate crisis. Rather, we should identify *possibilities*, that is, potential developments in the planetary make-up that are consistent with the initial and boundary conditions, the processes and the drivers we know.

This is akin to scenario planning, now being proposed for assessing climate risks in the corporate sector, where the consequences of a number of future possibilities, including those which may seem highly unlikely, but have major consequences, are evaluated. This way one can overcome the probability obsession that not only fantasizes about the replicability of the singular, but also favours the familiar over the unknown and unexpected.

As an extreme example, the fact that our world has never been destroyed previously would conventionally assign probability zero to such an event. But this only holds true under steady-state assumptions, which are practically never warranted.

Secondly, there is the *Devil's Advocate Reward*. In the magnificent tradition of the Enlightenment, which shattered so many myths of the ancient regimes, scientists are trained to be sceptical about every proposition which cannot be directly verified by empirical evidence or derived from first principles (such as the invariability of the speed of light).

So, if a researcher comes up with an entirely new thought, experts tend to reflexively dismiss it as "speculative", which is effectively a death warrant in the academic world. Whereas those who criticize the idea will be applauded, rewarded and promoted! This phenomenon is evident in every seminar, colloquium or learned-society assembly.

In turn, this means that scientific progress is often driven from the periphery, or occasionally, by eminent personalities whose seniority is beyond doubt. This does not at all imply that hypotheses need not be vindicated in due course, but out-of-the-box thinking is vital given the unprecedented climate risks which now confront human civilisation.

In conclusion, one should not be overly critical of the IPCC, since the scientists involved are doing what scientists are expected to do, to the very best of their ability in difficult circumstances.

But climate change is now reaching the end-game, where very soon humanity must choose between taking unprecedented action, or accepting that it has been left too late and bear the consequences.

Therefore, it is all the more important to listen to non-mainstream voices who do understand the issues and are less hesitant to cry wolf.

Unfortunately for us, the wolf may already be in the house.

INTRODUCTION

Three decades ago, when serious debate on human-induced climate change began at the global level, a great deal of statesmanship was on display. There was a preparedness to recognise that this was an issue transcending nation states, ideologies and political parties which had to be addressed proactively in the long-term interests of humanity as a whole. This was the case even though the existential nature of the risk it posed was far less clear cut than it is today.

As global institutions, such as the United Nations Framework Convention on Climate Change (UNFCCC) which was established at the Rio Earth Summit in 1992, were developed to take up this challenge, and the extent of change this would demand of the fossil-fuel-dominated world order became clearer, the forces of resistance began to mobilise. Today, as a consequence, and despite the diplomatic triumph of the 2015 *Paris Agreement*, the debate around climate change policy has never been more dysfunctional, indeed Orwellian.

In his book *1984*, George Orwell describes a double-think totalitarian state where most of the population accepts "the most flagrant violations of reality, because they never fully grasped the enormity of what was demanded of them, and were not sufficiently interested in public events to notice what was happening. By lack of understanding they remained sane."[1]

Orwell could have been writing about climate change and policymaking. International agreements talk of limiting global warming to 1.5–2 degrees Celsius (°C), but in reality they set the world on a path of 3–5°C of warming. Goals are reaffirmed, only to be abandoned. Coal is "clean". Just 1°C of warming is already dangerous, but this cannot be admitted. The planetary future is hostage to myopic national self-interest. Action is delayed on the assumption that as yet unproven technologies will save the day, decades hence. The risks are existential, but it is "alarmist" to say so.

A one-in-two or one-in-three chance of missing a goal is normalised as reasonable. Moral hazard permeates official thinking, in that there is an incentive to ignore the risks in the interests of political expediency.

Climate policymaking for years has been cognitively dissonant, "a flagrant violation of reality". So it is unsurprising that there is a lack of understanding amongst the public and elites of the full measure of the climate challenge. Yet most Australians sense where we are heading: three-quarters of Australians see climate change as catastrophic risk,[2] and half see our way of life ending within the next 100 years.[3]

Politics and policymaking have norms: rules and practices, assumptions and boundaries, that constrain and shape them. In recent years, the previous norms of statesmanship and long-term thinking have disappeared, replaced by an obsession with short-term political and commercial advantage. Climate policymaking is no exception.

Since 1992, short-term economic interest has trumped environmental and future human needs. The world today emits 50% more carbon dioxide (CO_2) from the consumption of energy than it did 25 years ago, and the global economy has more than doubled in size. The UNFCCC strives "to enable economic development to proceed in a sustainable manner", but every year humanity's ecological footprint becomes larger and less sustainable. Humanity now requires the biophysical capacity of 1.7 Earths annually as it rapidly chews up natural capital.

A fast, emergency-scale transition to a post-fossil fuel world is absolutely necessary to address climate change. But this is excluded from consideration by policymakers because it is considered to be too disruptive. The orthodoxy is that there is time for an orderly economic transition within the current short-termist political paradigm. Discussion of what would be safe — less warming than we presently experience — is non-existent. And so we have a policy failure of epic proportions.

1 Orwell, G 1949, *Nineteen Eighty-Four. A Novel*, Secker and Warburg, London.

2 CommunicateResearch 2017, 'Global Challenges Foundation global risks survey', ComRes, 24 May 2017, <http://www.comresglobal.com/polls/global-challenges-foundation-global-risks-survey>.

3 Randle, MJ & Eckersley, R 2015, 'Public perceptions of future threats to humanity and different societal responses: a cross-national study', *Futures*, vol. 72, pp. 4-16.

Policymakers, in their magical thinking, imagine a mitigation path of gradual change to be constructed over many decades in a growing, prosperous world. The world not imagined is the one that now exists: of looming financial instability; of a global crisis of political legitimacy and "fake news"; of a sustainability crisis that extends far beyond climate change to include all the fundamentals of human existence and most significant planetary boundaries (soils, potable water, oceans, the atmosphere, biodiversity, and so on); and of severe global energy-sector dislocation.

In anticipation of the upheaval that climate change would impose upon the global order, the IPCC was established by the United Nations (UN) in 1988, charged with regularly assessing the global consensus on climate science as a basis for policymaking. The IPCC *Assessment Reports* (*AR*), produced every five-to-eight years, play a large part in the public framing of the climate narrative: new reports are a global media event. *AR5* was produced in 2013-14, with *AR6* due in 2022. The IPCC has done critical, indispensable work of the highest standard in pulling together a periodic consensus of what must be the most exhaustive scientific investigation in world history. It does not carry out its own research, but reviews and collates peer-reviewed material from across the spectrum of this incredibly complex area, identifying key issues and trends for policymaker consideration.

However, the IPCC process suffers from all the dangers of consensus-building in such a wide-ranging and complex arena. For example, IPCC reports, of necessity, do not always contain the latest available information. Consensus-building can lead to "least drama", lowest-common-denominator outcomes, which overlook critical issues. This is particularly the case with the "fat-tails" of probability distributions, that is, the high-impact but lower-probability events where scientific knowledge is more limited.

Vested-interest pressure is acute in all directions; climate denialists accuse the IPCC of alarmism, whereas many climate action proponents consider the IPCC to be far too conservative. To cap it all, the IPCC conclusions are subject to intense political oversight before being released, which historically has had the effect of substantially watering-down sound scientific findings.

These limitations are understandable, and arguably were not of overriding importance in the early period of the IPCC. However, as time has progressed, it is now clear that the risks posed by climate change are far greater than previously anticipated. We have moved out of the twilight period of much talk, but relatively limited climate impacts, into the harsh light of physically-evident existential threats. Climate change is now turning nasty, as we have witnessed recently in the North America, East and South Asia, the Middle East and Europe, with record-breaking heatwaves and wildfires, more intense flooding and more damaging hurricanes.

The distinction between climate science and risk is the critical issue, for the two are not the same. Scientific reticence — a reluctance to spell out the full risk implications of climate science in the absence of perfect information — has become a major problem. Whilst this is understandable, particularly when scientists are continually criticised by denialists and political apparatchiks for speaking out, it is extremely dangerous given the fat-tail risks of climate change. Waiting for perfect information, as we are continually urged to do by political and economic elites, means it will be too late to act. Time is not on our side. Sensible risk management addresses risk in time to prevent it happening, and that time is now.

Irreversible, adverse climate change on the global scale now occurring is an existential risk to human civilisation. Many of the world's top climate scientists — Kevin Anderson, James Hansen, Michael E. Mann, Michael Oppenheimer, Naomi Oreskes, Stefan Rahmstorf, Eric Rignot, Hans Joachim Schellnhuber, Kevin Trenberth and others — who are quoted in this report well understand these implications and are forthright about their findings, where we are heading, and the limitations of IPCC reports.

This report seeks to alert the wider community and business and political leaders to these limitations and urges changes to the IPCC approach, to the wider UNFCCC negotiations, and to national policymaking. It is clear that existing processes will not deliver the transformation to a carbon-negative world in the limited time now available.

We urgently require a reframing of scientific research within an existential risk-management framework. This requires special precautions that go well beyond conventional risk management. Like an iceberg, there is great danger in "what lies beneath".

“We are climbing rapidly out of mankind's safe zone into new territory, and we have no idea if we can live in it."

Prof. Robert Corell, 2007


RISK
UNDERSTATEMENT

EXCESSIVE CAUTION

A 2013 study by Prof. Naomi Oreskes and fellow researchers examined a number of past predictions made by climate scientists. They found that scientists have been "conservative in their projections of the impacts of climate change" and that "at least some of the key attributes of global warming from increased atmospheric greenhouse gases have been under-predicted, particularly in IPCC assessments of the physical science". They concluded that climate scientists are not biased toward alarmism but rather the reverse of "erring on the side of least drama, whose causes may include adherence to the scientific norms of restraint, objectivity, skepticism, rationality, dispassion, and moderation". This may cause scientists "to underpredict or downplay future climate changes".[4]

This tallies with the view of economist Prof. Ross Garnaut, who in 2011 reflected on his experience in presenting two climate reports to the Australian Government. Garnaut questioned whether climate research had a conservative "systematic bias" due to "scholarly reticence". He pointed to a pattern across diverse intellectual fields of research predictions being "not too far away from the mainstream" expectations and observed that in the climate field that this "has been associated with understatement of the risks".[5]

As far back as 2007, then NASA climate science chief Prof. James Hansen suggested that scientific reticence hinders communication with the public about the dangers of global warming and potentially large sea-level rises. More recently he wrote that "the affliction is widespread and severe. Unless recognized, it may severely diminish our chances of averting dangerous climate change."[6]

Ten years after his 2006 climate report to the UK government, Sir Nicholas Stern reflected that "science is telling us that impacts of global warming — like ice sheet and glacier melting — are now happening much more quickly than we anticipated".[7] In 2013, he said that "Looking back, I underestimated the risks… Some of the effects are coming through more quickly than we thought then."[8]

A recent study of climate scientists found "a community which still identified strongly with an idealised picture of scientific rationality, in which the job of scientists is to get on with their research quietly and dispassionately".[9] The study said most climate scientists are resistant to participation in public/policy engagement, leaving this task to a minority who are attacked by the media and even by their own colleagues.

Kevin Trenberth, head of climate analysis at the US National Center for Atmospheric Research and a lead author of key sections of the 2001 and 2007 IPCC reports, says: "We're underestimating the fact that climate change is rearing its head… and we're underestimating the role of humans, and this means we're underestimating what it means for the future and what we should be planning for."[10]

Prof. Michael E. Mann of Pennsylvania State University says the IPCC's 2012 report on climate extremes missed an opportunity to provide politicians with a clear picture of the extent of the climate crisis: "Many scientists felt that report erred by underplaying the degree of confidence in the linkage between climate change and certain types of severe weather, including heat wave severity, heavy precipitation and drought, and hurricane intensity."[11]

4 Brysse, K, Oreskes, N, O'Reilly, J & Oppenheimer, M 2013, 'Climate change prediction: Erring on the side of least drama?', *Global Environmental Change*, vol. 23, no. 1, pp. 327-337.

5 Garnaut, R 2011, *Update Paper 5: The science of climate change*, Garnaut Climate Change Review Update, Canberra, pp. 53-55.

6 Hansen, J 2007, 'Scientific reticence and sea level rise', *Environmental Research Letters*, vol. 2, no. 2, 024002.

7 McKee, R 2016, 'Nicholas Stern: cost of global warming "is worse than I feared"', *The Guardian*, 6 November 2016.

8 Stewart, H & Elliott, L 2013, 'Nicholas Stern: "I got it wrong on climate change – it's far, far worse"', *The Guardian*, 27 January 2013.

9 Hoggett, P & Randall, R 2016, 'Socially constructed silence? Protecting policymakers from the unthinkable', Transformation, 6 June 2016, <https://www.opendemocracy.net/transformation/paul-hoggett-rosemary-randall/socially-constructed-silence-protecting-policymakers-fr>.

10 Scherer, G 2012a, 'How the IPCC underestimated climate change', *Scientific American*, 6 December 2012.

11 Scherer, G 2012b, 'Climate science predictions prove too conservative', *Scientific American*, 6 December 2012.

Prof. Kevin Anderson of the University of Manchester says there is "an endemic bias prevalent amongst many of those building emission scenarios to underplay the scale of the 2°C challenge. In several respects, the modelling community is actually self-censoring its research (focus) to conform to the dominant political and economic paradigm…"[12]

A good example is the 1.5°C goal agreed to at the Paris December 2015 climate policy conference. IPCC assessment reports until that time (and in conformity with the dominant political paradigm) had not devoted any significant attention to 1.5°C emission-reduction scenarios or 1.5°C impacts, and the Paris delegates had to request the IPCC to do so as a matter of urgency. This is a clear case of politics driving the science research agenda. Research needs money, and too often money is allocated according to the political priorities of the day.

Anderson says it is incumbent on the scientific community to communicate research clearly and candidly to those delivering on the climate goals established by civil society, and "to draw attention to inconsistencies, misunderstandings and deliberate abuse of the scientific research. It is not our job to be politically expedient with our analysis or to curry favour with our funders. Whether our conclusions are liked or not is irrelevant."[13]

THINKING THE UNTHINKABLE

Successful risk management requires thinking "outside the box" to avoid a failure of imagination, but this is a skill rarely found at the senior levels of government and global corporations.

A 2016 report, *Thinking the unthinkable*, based on interviews with top leaders around the world, found that: "A proliferation of 'unthinkable' events… has revealed a new fragility at the highest levels of corporate and public service leaderships. Their ability to spot, identify and handle unexpected, non-normative events is… perilously inadequate at critical moments."[13]

The report findings are highly relevant to understanding the failure of climate policymaking, and the failure to adequately communicate and think about the full range of potential climate warming risks. It found that:

- The emerging picture is both scary and of great concern. Remarkably, there remains a deep reluctance, or what might be called "executive myopia" amongst top leaders in both the public and private sectors, to see and contemplate even the possibility that "unthinkables" might happen, let alone how to handle them.
- The rate and scale of change is much faster than most are even prepared to concede or respond to. At the highest board and C-suite levels, executives and their public service equivalents confess to often being overwhelmed.
- Time is at such a premium that the pressing need to think, reflect and contemplate in the ways required by the new "unthinkables" is largely marginalised.

Often blind eyes were turned, either because of a lack of will to believe the signs, or an active preference to deny and then not to engage.

While the phrase, "Thinking the unthinkable", has an attractive rhetorical symmetry, a more appropriate and accurate phrase might in many cases therefore be "Thinking the unpalatable".

These deficiencies are clearly evident at the upper levels of climate policymaking, nationally and globally. They must be corrected as a matter of extreme urgency.

12 Anderson, K 2016, 'Going beyond 'dangerous' climate change', LSE presentation, 4 February 2016, <http://www.lse.ac.uk/newsAndMedia/videoAndAudio/channels/publicLecturesAndEvents/player.aspx?id=3363>.

13 Anderson, K 2015, 'Duality in climate science', *Nature Geoscience*, vol. 8, pp. 898–900.

14 Gowing, N & Langdon, C 2016, *Thinking the Unthinkable: A new imperative for leadership in the digital age*, Chartered Institute of Management Accountants, London.

THE UNDERESTIMATION OF RISK

There are fundamental challenges in understanding and communicating risks. These include "the importance of complex interactions in shaping risks, the need for rigorous expert judgment in evaluating risks, and the centrality of values, perceptions, and goals in determining both risks and responses".[15]

IPCC reports have underplayed high-end possibilities and failed to assess risks in a balanced manner. The failure to fully account for potential future changes to permafrost (frozen carbon stores on land and under the seabed) and other carbon-cycle feedbacks is just one example.

Dr Barrie Pittock, a former leader of the Climate Impact Group in CSIRO, wrote in 2006 that "until now many scientists may have consciously or unconsciously downplayed the more extreme possibilities at the high end of the uncertainty range, in an attempt to appear moderate and 'responsible' (that is, to avoid scaring people). However, true responsibility is to provide evidence of what must be avoided: to define, quantify, and warn against possible dangerous or unacceptable outcomes."[16]

The situation has not improved. Sir Nicholas Stern said of the IPCC's *Fifth Assessment Report:* "Essentially it reported on a body of literature that had systematically and grossly underestimated the risks [and costs] of unmanaged climate change."[17]

Prof. Ross Garnaut has also pointed to the "understatement of the risks", in that we seem to be playing scientific catch-up, as reality is consistently on the most pessimistic boundary of previous projections. The Australian Climate Council reported in 2015: "Changes in the climate system are occurring more rapidly than previously projected, with larger and more damaging impacts now observed at lower temperatures than previously estimated."[18] Such a situation is not a satisfactory basis on which to plan our future.

Former senior coal fossil fuel executive and government advisor, Ian Dunlop, notes that "dangerous impacts from the underlying (warming) trend have also manifested far faster and more extensively than global leaders and negotiators are prepared to recognise".[19]

Researchers say it is important to carry out analyses "to identify what risky outcomes are possible — cannot be ruled out — starting with the biggest ones. In such analyses, it is useful to distinguish between two questions: 'What is most likely to happen?' and 'How bad could things get?'"[20]
In looking at how to reframe climate change assessments around risk, it is important to:

> " … deal adequately with low-probability, high-consequence outcomes, which can dominate calculations of total risk, and are thus worthy of special attention. Without such efforts, we court the kinds of 'failures of imagination' that can prove so costly across risk domains. Traditional climate assessments have focused primarily on areas where the science is mature and uncertainties well characterized. For example, in the IPCC lexicon, future outcomes are considered 'unlikely' if they lie outside the central 67% of the probability distribution. For many types of risk assessment, however, a 33% chance of occurrence would be very high; a 1% or 0.1% chance (or even lower probabilities) would be more typical thresholds."[21]

They emphasise that "the envelope of possibilities", that is, the full range of possibilities for which one must be prepared, is often more important than the most likely future outcome, especially when the range of outcomes includes those that are particularly severe. They conclude that the "application of scientific rather than risk-based norms in communicating climate change uncertainty has also made it easier for policymakers and other actors to downplay relevant future climate risks".[22]

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15 Mach, K, Mastrandrea, MD, Bilir, TE & Field, CB 2015, 'Understanding and responding to danger from climate change: the role of key risks in the IPCC AR5', *Climatic Change*, vol. 136, pp. 427-444.

16 Pittock, AB 2006, 'Are scientists underestimating climate change?', *EOS*, vol. 87, no. 34, pp. 340-41.

17 Stern, N 2016, 'Economics: Current climate models are grossly misleading', *Nature*, vol. 530, pp. 407-409.

18 Steffen, W, Hughes, L & Pearce, A 2015, *Climate Change: Growing risks, critical choices*, Climate Council, Sydney.

19 Dunlop, I 2016, Foreword to Spratt, D 2016, *Climate Reality Check*, Breakthrough, Melbourne.

20 Weaver, C, Moss, R, Ebi, K, Gleick, P, Stern, P, Tebaldi, C, Wilson, R & Arvai, J 2017, 'Reframing climate change assessments around risk: recommendations for the US National Climate Assessment', *Environmental Research Letters*, vol. 12, no. 8, 080201.

21 ibid.

22 ibid.

A prudent risk-management approach means a tough and objective look at the real risks to which we are exposed, especially those high-end events whose consequences may be damaging beyond quantification, and which human civilization as we know it would be lucky to survive. It is important to understand the potential of, and plan for, the worst that can happen, and be pleasantly surprised if it doesn't. Focusing on middle-of-the-road outcomes, and ignoring the high-end possibilities, may result in an unexpected catastrophic event that we could, and should, have seen coming.

Prof. Robert Socolow of Princeton University says the IPCC "should communicate fully what the science community does and does not understand about high consequence outcomes.The policymaking community needs information about both probable and improbable outcomes."[23]

Integral to this approach is the issue of lower-probability, high-impact consequences known as fat-tail risks, in which the likelihood of very large impacts is actually greater than we would expect under typical statistical assumptions. A normal distribution, with the appearance of a bell curve, is symmetric in probabilities of low outcomes (left of curve) and high outcomes (right of curve) as per Figure 1(a). But, as Prof. Michael E. Mann explains, "global warming instead displays what we call a 'heavy-tailed' or 'fat-tailed' distribution, there is more area under the far right extreme of the curve than we would expect for a normal distribution, a greater likelihood of warming that is well in excess of the average amount of warming predicted by climate models,"[24] as per Figure 1(b).

In *Climate Shock: The Economic Consequences of a Hotter Planet*, economists Gernot Wagner and Martin Weitzman explore the implications of this fat-tail distribution for climate policy, and "why we face an existential threat in human-caused climate change".[25] Mann explains:

> " Let us consider… the prospects for warming well in excess of what we might term "dangerous" (typically considered to be at least 2°C warming of the planet). How likely, for example, are we to experience a catastrophic 6°C warming of the globe, if we allow greenhouse gas concentrations to reach double their pre-industrial levels (something we're on course to do by the middle of this century given business-as-usual burning of fossil fuels)? Well, the mean or average warming that is predicted by models in that scenario is about 3°C, and the standard deviation about 1.5°C. So the positive tail, defined as the +2 sigma limit, is about 6°C of warming. As shown by Wagner & Weitzman [Figure 1(b)], the likelihood of exceeding that amount of warming isn't 2% as we would expect for a bell-curve distribution. It's closer to 10%!
>
> In fact, it's actually even worse than that when we consider the associated risk. Risk is defined as the product of the likelihood and consequence of an outcome. We just saw that the likelihood of warming is described by a heavy-tailed distribution, with a higher likelihood of far-greater-than-average amounts of warming than we would expect given typical statistical assumptions. This is further compounded by the fact that the damages caused by climate change — i.e. the consequence — also increases dramatically with warming. That further increases the associated risk.
>
> With additional warming comes the increased likelihood that we exceed certain tipping points, like the melting of large parts of the Greenland and Antarctic ice sheet and the associated massive rise in sea level that would produce… Uncertainty is not our friend when it comes to the prospects for dangerous climate change."[26]

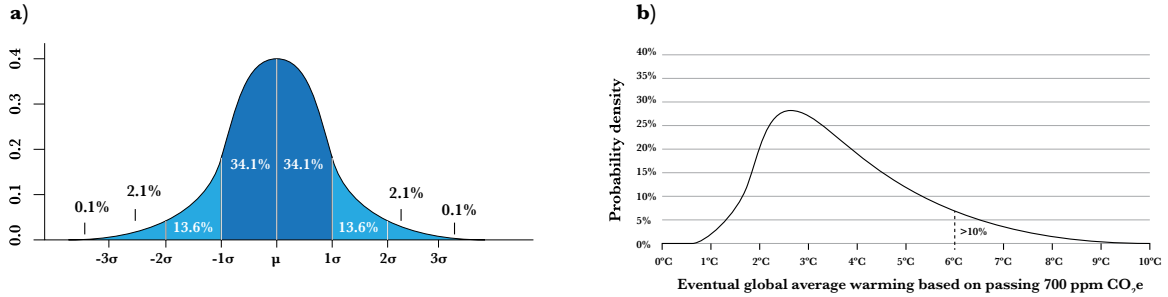

Figure 1: Normal and "fat tail" probability distributions. (a) Normal probability distribution, and (b) an estimate of the likelihood of warming due to a doubling of greenhouse gas concentrations exhibiting a "fat tail" distribution (Credit: Wagner & Weitzman 2015, *Climate Shock: The Economic Consequences of a Hotter Planet)*.

23 Socolow, R. 2011, 'High-consequence outcomes and internal disagreements: tell us more, please', *Climatic Change*, vol. 108, pp. 775-790.

24 Mann, M 2016, 'The 'fat tail' of climate change risk', *Huffington Post*, 11 September 2016.

25 Ibid.

26 Ibid.

As Mann notes, risk is defined as the product of the likelihood and consequence of an outcome. This is illustrated in Figure 2, which although applied to the question of climate sensitivity (see discussion on pp. 22-23), has general applicability. The likelihood of a high-end outcome may be relatively low (right side of curve in (a)), but impacts increase at the high-end (b), showing the high risk of very unlikely events (c).

IPCC reports have not given attention to fat-tail risk analysis, in part because the reports are compiled using a consensus method, as discussed above. Prof. Stefan Rahmstorf of Potsdam University says that:

> " The magnitude of the fat-tail risks of global warming is not widely appreciated and must be discussed more. For over two decades I have argued that the risk of a collapse of the Atlantic meridional overturning circulation (AMOC) in this century is perhaps five per cent or so, but that this is far too great a risk to take, given what is at stake. Nobody would board an aircraft with a five per cent risk of crashing."[27]

He adds that: "Defeatism and doomerism is not the same as an accurate, sincere and sober discussion of worst-case risks. We don't need the former, we do need the latter." It should be noted that Rahmstorf was one of the authors of research released in April 2018 showing that, in fact, there has already been a 15% slowdown in the AMOC since the mid-twentieth century.[28]

"When all the new knowledge that challenges the old is on the more worrying side, one worries about whether the asymmetry reflects some systematic bias… I have come to wonder whether the reason why most of the new knowledge confirms the established science or changes it for the worse is scholarly reticence."

Prof. Ross Garnaut, 2011

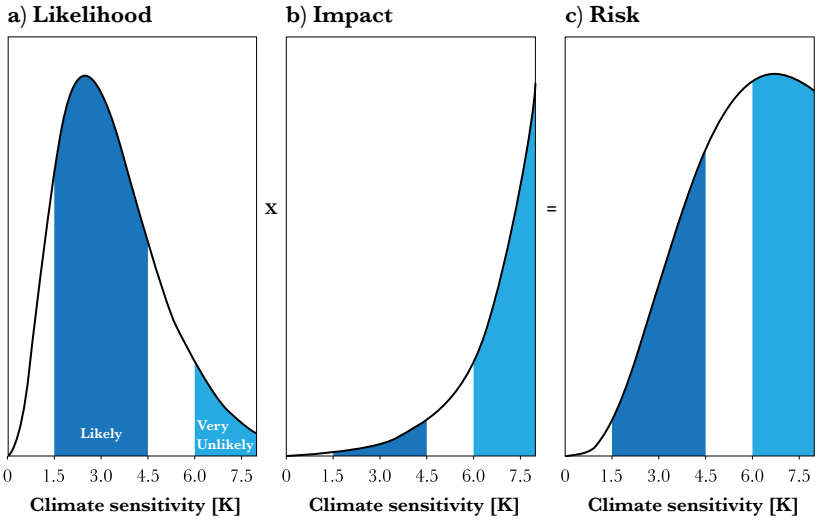

Figure 2: Schema of climate-related risk. (a) Event likelihood and (b) Impacts produce (c) Risk. Lower likelihood events at the high end of the probability distribution have the highest risk (Credit: RT Sutton/E Hawkins).

27 Rahmstorf, S, pers. comm., 8 August 2017.

28 Caesar, L, Rahmstorf, S, Robinson, A, Feulner, G. & Saba, V 2018, "Observed fingerprint of a weakening Atlantic Ocean overturning circulation', Nature, vol. 556, pp. 191-192.

EXISTENTIAL RISK TO HUMAN CIVILISATION

In 2016, the World Economic Forum survey of the most impactful risks for the years ahead elevated the failure of climate change mitigation and adaptation to the top of the list, ahead of weapons of mass destruction, ranking second, and water crises, ranking third. By 2018, following a year characterised by high-impact hurricanes and extreme temperatures, extreme-weather events were seen as the single most prominent risk. As the survey noted: "We have been pushing our planet to the brink and the damage is becoming increasingly clear."[29]

Climate change is an existential risk to human civilisation: that is, an adverse outcome that would either annihilate intelligent life or permanently and drastically curtail its potential.

Temperature rises that are now in prospect, after the *Paris Agreement*, are in the range of 3–5°C. At present, the *Paris Agreement* voluntary emission reduction commitments, if implemented, would result in planetary warming of 3.4°C by 2100,[30] without taking into account "long-term" carbon-cycle feedbacks. With a higher climate sensitivity figure of 4.5°C, for example, which would account for such feedbacks, the Paris path would result in around 5°C of warming, according to a MIT study.[31] A study by Schroder Investment Management published in June 2017 found — after taking into account indicators across a wide range of the political, financial, energy and regulatory sectors — the average temperature increase implied for the *Paris Agreement* across all sectors was 4.1°C.[32]

Yet 3°C of warming already constitutes an existential risk. A 2007 study by two US national security think-tanks concluded that 3°C of warming and a 0.5 metre sea-level rise would likely lead to "outright chaos" and "nuclear war is possible", emphasising how "massive non-linear events in the global environment give rise to massive nonlinear societal events".[33] The Global Challenges Foundation (GCF) explains what could happen:

> " If climate change was to reach 3°C, most of Bangladesh and Florida would drown, while major coastal cities — Shanghai, Lagos, Mumbai — would be swamped, likely creating large flows of climate refugees. Most regions in the world would see a significant drop in food production and increasing numbers of extreme weather events, whether heat waves, floods or storms. This likely scenario for a 3°C rise does not take into account the considerable risk that self-reinforcing feedback loops set in when a certain threshold is reached, leading to an ever increasing rise in temperature. Potential thresholds include the melting of the Arctic permafrost releasing methane into the atmosphere, forest dieback releasing the carbon currently stored in the Amazon and boreal forests, or the melting of polar ice caps that would no longer reflect away light and heat from the sun."[34]

29 World Economic Forum, 2018, *The Global Risks Report 2018: 13th Edition*, World Economic Forum, Geneva.

30 Climate Action Tracker 2017, 'Improvement in warming outlook as India and China move ahead, but Paris Agreement gap still looms large", 13 November 2017, <http://climateactiontracker.org/publications/briefing/288/Improvement-in-warming-outlook-as-India-and-China-move-ahead-but-Paris-Agreement-gap-still-looms-large.htm>.

31 Reilly, J, Paltsev, S, Monier, E, Chen, H, Sokolov, A, Huang, J, Ejaz, Q, Scott, J, Morris, J & Schlosser, A 2015, *Energy and Climate Outlook: Perspectives from 2015*, MIT Program on the Science and Policy of Global Change, Cambridge MA.

32 Schroder Investment Management 2017, *Climate change: calibrating the thermometer*, Schroders Investment Management, London.

33 Campbell, K, Gulledge, J, McNeill, JR, Podesta, J, Ogden, P, Fuerth, L, Woolsley, J, Lennon, A, Smith, J, Weitz, R & Mix, D 2007, *The Age of Consequences: The foreign policy and national security implications of global climate change*, Centre for Strategic and International Studies & Centre for New American Security, Washington.

34 Global Challenges Foundation 2017, *Global Catastrophic Risks 2017*, Global Challenges Foundation, Stockholm.

Warming of 4°C or more could reduce the global human population by 80% or 90%,[35] and the World Bank reports "there is no certainty that adaptation to a 4°C world is possible".[36] Prof. Kevin Anderson says a 4°C future "is incompatible with an organized global community, is likely to be beyond 'adaptation', is devastating to the majority of ecosystems, and has a high probability of not being stable".[37] This is a commonly-held sentiment amongst climate scientists. A recent study by the European Commission's Joint Research Centre found that if the global temperature rose 4°C, then extreme heatwaves with "apparent temperatures" peaking at over 55°C will begin to regularly affect many densely populated parts of the world, forcing much activity in the modern industrial world to stop.[38] ("Apparent temperatures" refers to the Heat Index, which quantifies the combined effect of heat and humidity to provide people with a means of avoiding dangerous conditions.)

In 2017, one of the first research papers to focus explicitly on existential climate risks proposed that "mitigation goals be set in terms of climate risk category instead of a temperature threshold", and established a "dangerous" risk category of warming greater than 1.5°C, and a "catastrophic" category for warming of 3°C or more. The authors focussed on the impacts on the world's poorest three billion people, on health and heat stress, and the impacts of climate extremes on such people with limited adaptation resources. They found that a 2°C warming "would double the land area subject to deadly heat and expose 48% of the population (to deadly heat). A 4°C warming by 2100 would subject 47% of the land area and almost 74% of the world population to deadly heat, which could pose existential risks to humans and mammals alike unless massive adaptation measures are implemented."[39]

A 2017 survey of global catastrophic risks by the Global Challenges Foundation found that: "In high-end [climate] scenarios, the scale of destruction is beyond our capacity to model, with a high likelihood of human civilization coming to an end."[40] 84% of 8000 people in eight countries surveyed for the Foundation considered climate change a "global catastrophic risk".[41]

Existential risk may arise from a fast rate of system change, since the capacity to adapt, in both the natural and human worlds, is inversely proportional to the pace of change, amongst other factors. In 2004, researchers reported on the rate of warming as a driver of extinction.[42] Given we are now on a 3–5°C warming path this century, their findings are instructive:

- If the rate of change is 0.3°C per decade (3°C per century), 15% of ecosystems will not be able to adapt.
- If the rate should exceed 0.4°C per decade, all ecosystems will be quickly destroyed, opportunistic species will dominate, and the breakdown of biological material will lead to even greater emissions of CO_2.

At 4°C of warming "the limits for adaptation for natural systems would largely be exceeded throughout the world".[43] Ecological breakdown of this scale would ensure an existential human crisis.

By slow degrees, these existential risks are being recognised. In May 2018, an inquiry by the Australian Senate into national security and global warming recognised "climate change as a current and existential national security risk… defined as 'one that threatens the premature extinction of Earth-originating intelligent life or the permanent and drastic destruction of its potential for desirable future development'".[44] In April 2018, the Intelligence on European Pensions and Institutional Investment think-tank warned business leaders that "climate change is an existential risk whose elimination must become a corporate objective".[45] However the most recent IPCC *Assessment Report* did not consider the issue. Whilst the term "risk management" appears in the 2014 IPCC *Synthesis Report* fourteen times, the terms "existential" and "catastrophic" do not appear.

35 Anderson, K 2011, 'Going beyond dangerous climate change: Exploring the void between rhetoric and reality in reducing carbon emissions', LSE presentation, 11 July 2011.

36 World Bank 2012, *Turn Down the Heat: Why a 4°C warmer world must be avoided*, World Bank, New York.

37 Roberts, D 2011 "The brutal logic of climate change", Grist, 6 December 2011, <https://grist.org/climate-change/2011-12-05-the-brutal-logic-of-climate-change/>.

38 Ayre, J 2017, 'Extreme heatwaves with 'apparent temperatures' as high as 55° celsius to regularly affect much of world', Clean Technica, 11 August 2017, <https://cleantechnica.com/2017/08/11/extreme-heatwaves-apparent-temperatures-high-55-celsius-regularly-affect-much-world-4-celsius-warming-pre-industrial-levels/>.

39 Xu, Y & Ramanathan, V 2017, 'Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes', *Proceedings of the National Academy of Sciences*, vol. 114, pp. 10315-10323.

40 Global Challenges Foundation 2017, op cit.

41 Goering, L 2017, '8 in 10 people now see climate change as a 'catastrophic risk' – survey', Thomson Reuters Foundation, 23 May 2017, <http://news.trust.org/item/20170523230148-a90de>.

42 Leemans, R, & Eickhout, B 2004, 'Another reason for concern: regional and global impacts on ecosystems for different levels of climate change', *Global Environmental Change*, vol. 14, pp. 219–228.

43 Warren, R 2011, 'The role of interactions in a world implementing adaptation and mitigation solutions to climate change', *Philosophical Transactions of the Royal Society A*, vol. 369, pp. 217-241.

44 Commonwealth of Australia 2018, *Inquiry into the Implications of climate change for Australia's national security*, Foreign Affairs, Defence and Trade Committee, Department of the Senate, Parliament House, Canberra.

45 Murray, D & Murtha, A 2018, 'Climate risk: Running out of time', Intelligence on European Pensions and Institutional Investment, April 2018, <https://www.ipe.com/reports/special-reports/thought-leadership/climate-risk-running-out-of-time/10023906.article>.

Existential risks require a particular approach to risk management. They are not amenable to the reactive (learn from failure) approach of conventional risk management, and we cannot necessarily rely on the institutions, moral norms, or social attitudes developed from our experience with managing other sorts of risks. Because the consequences are so severe — perhaps the end of global human civilisation as we know it — "even for an honest, truth-seeking, and well-intentioned investigator it is difficult to think and act rationally in regard to… existential risks".[46]

Existential risk management requires brutally honest articulation of the risks, opportunities and the response time frame, the development of new existential risk-management techniques outside conventional politics, and global leadership and integrated policy. Since it is not possible to recover from existential risks, "we cannot allow even one existential disaster to happen; there would be no opportunity to learn from experience",[47] but at the moment we are facing existential disasters on several climate fronts, seemingly without being able even to articulate that fact.

The failure of both the research community and the policymaking apparatus to consider, advocate and/or adopt an existential risk-management approach is itself a failure of imagination with catastrophic consequences.

PUBLIC SECTOR DUTY OF CARE ON CLIMATE RISK

Private-sector company directors internationally are facing legal action and personal liability for having refused to understand, assess and act upon climate risk, or for misrepresenting that risk. Compensation is being sought from carbon polluters for damage incurred from climate impacts. Legal opinions suggest similar action in Australia would be firmly based.

Such a duty of care extends to the public sector, including not only ministers and senior public servants, but regulators and board members of statutory authorities. As a general principle, officials in the public sector should not be held to a lower standard of account than employees of publicly listed companies. That duty has already been successfully tested in the courts in The Netherlands.

The first duty of a government is to protect the people. A government derives its legitimacy and hence its authority from the people, and so has a fiduciary duty to act in accordance with the interests of all the people with integrity, fairness and accountability.

In the climate arena, this duty has been recognised in several quarters, including by Australian Prudential Regulatory Authority Executive Director Geoff Summerhayes and Australian Securities and Investments Commissioner John Price.

This duty has a particular sharpness in the new era of disruption and existential risk that will manifest as a consequence of the global failure, and the failure of successive Australian governments, to rein in global warming.

In these circumstances, our public sector leaders have a number of specific duty-of-care responsibilities which at present are being ignored. Being a climate denier does not absolve ministers and parliamentarians of the fiduciary responsibility to set aside personal prejudice and act in the public interest.

The Australian Public Service Impartiality Value requires advice given to government to be "apolitical, frank, honest, timely and based on the best available evidence", but the overriding impression is that the federal bureaucracy, with some notable exceptions, is not treating climate change with anywhere near the seriousness and urgency it demands. Dismal reports such as the December 2017 *Review of Climate Change Policy.* are a scientifically reticent whitewash of wholly inadequate and inconsistent policies.

It is entirely appropriate, when the political system fails, for affected parties to take legal action to correct such failure.

46 Bostrom, N & Cirkovic, MM 2008, *Global Catastrophic Risks*, Oxford University Press, Oxford.

47 Op. cit.

“We’ve reached a point where we have a crisis, an emergency, but people don’t know that. ...There’s a big gap between what’s understood about global warming by the scientific community and what is known by the public and policymakers”.

Prof. James Hansen, 2008


SCIENTIFIC
UNDERSTATEMENT

CLIMATE MODELS

Climate modelling is at the core of the work by the IPCC, and in developing future emission and warming scenarios, but it is often too conservative and underestimates future impacts.

A 2007 report on climate change and national security by the US Center for Strategic and International Studies and the Center for a New American Security recognised that: "Recent observations indicate that projections from climate models have been too conservative; the effects of climate change are unfolding faster and more dramatically than expected" and that "multiple lines of evidence" support the proposition that the 2007 IPCC reports' "projections of both warming and attendant impacts are systematically biased low". For instance:

> " The models used to project future warming either omit or do not account for uncertainty in potentially important positive feedbacks that could amplify warming (e.g., release of greenhouse gases from thawing permafrost, reduced ocean and terrestrial CO_2 removal from the atmosphere), and there is some evidence that such feedbacks may already be occurring in response to the present warming trend. Hence, climate models may underestimate the degree of warming from a given amount of greenhouse gases emitted to the atmosphere by human activities alone. Additionally, recent observations of climate system responses to warming (e.g., changes in global ice cover, sea-level rise, tropical storm activity) suggest that IPCC models underestimate the responsiveness of some aspects of the climate system to a given amount of warming."[48]

In 2015, researchers reported on the long-term feedbacks that global climate models ignore, as illustrated in Figure 3, where grey bars within the middle blue ellipse signify processes that are assumed to be (partly) inactive or non-existent in global climate models, but in reality are not.[49]

In the 2017 *Fourth National Climate Assessment,* US government agencies found that "positive feedbacks (self-reinforcing cycles) within the climate system have the potential to accelerate human-induced climate change and even shift the Earth's climate system, in part or in whole, into new states that are very different from those experienced in the recent past", and whilst some feedbacks and potential state shifts can be modelled and quantified, "others can be modeled or identified but not quantified and some are probably still unknown". Hence:

> " While climate models incorporate important climate processes that can be well quantified, they do not include all of the processes that can contribute to feedbacks, compound extreme events, and abrupt and/or irreversible changes. For this reason, future changes outside the range projected by climate models cannot be ruled out. Moreover, the systematic tendency of climate models to underestimate temperature change during warm paleoclimates suggests that climate models are more likely to underestimate than to overestimate the amount of long-term future change."[50]

At the 2017 climate policy conference in Bonn, Phil Duffy, the Director of the Woods Hole Institute, explained that "the best example of reticence is permafrost… It's absolutely essential that this feedback loop not get going seriously, if it does there is simply no way to control it." He says the scientific failure occurs because "none of this is in climate models and none of this is considered in the climate policy discussion… climate models simply omit emissions from the warming permafrost, but we know that is the wrong answer because that tacitly assumes that these emissions are zero and we know that's not right".[51]

48 Campbell et al. 2007, op cit.

49 Knutti, R, & Rugenstein MAA 2015, 'Feedbacks, climate sensitivity and the limits of linear models', *Philosophical Transactions of the Royal Society A*, vol. 373, 20150146.

50 USGCRP 2017, *Climate Science Special Report: Fourth National Climate Assessment*, Volume I, [Wuebbles, DJ, DW Fahey, KA Hibbard, DJ Dokken, BC Stewart & TK Maycock (eds.)], US Global Change Research Program, Washington, DC, USA..

51 UPFSI 2017, 'James Hansen: Scientific Reticence A Threat to Humanity and Nature', media conference, Bonn, 19 November 2017, <https://www.youtube.com/watch?v=S7z61UZoppM>

There is a consistent pattern in the IPCC of presenting detailed, quantified (numerical) modelling results, but then briefly noting more severe possibilities — such as feedbacks that the models do not account for — in a descriptive, non-quantified form. Sea levels, polar ice sheets and some carbon-cycle feedbacks are three examples. Because policymakers and the media are often drawn to headline numbers, this approach results in less attention being given to the most devastating, high-end, non-linear and difficult-to-quantify outcomes.

Consensus around numerical results can result in an understatement of the risks. Oppenheimer et al. point to the problem:

> " The emphasis on consensus in IPCC reports has put the spotlight on expected outcomes, which then become anchored via numerical estimates in the minds of policymakers… it is now equally important that policymakers understand the more extreme possibilities that consensus may exclude or downplay… given the anchoring that inevitably occurs around numerical values, the basis for quantitative uncertainty estimates provided must be broadened to give observational, paleoclimatic, or theoretical evidence of poorly understood phenomena comparable weight with evidence from numerical modeling… One possible improvement would be for the IPCC to fully include judgments from expert elicitations."[52]

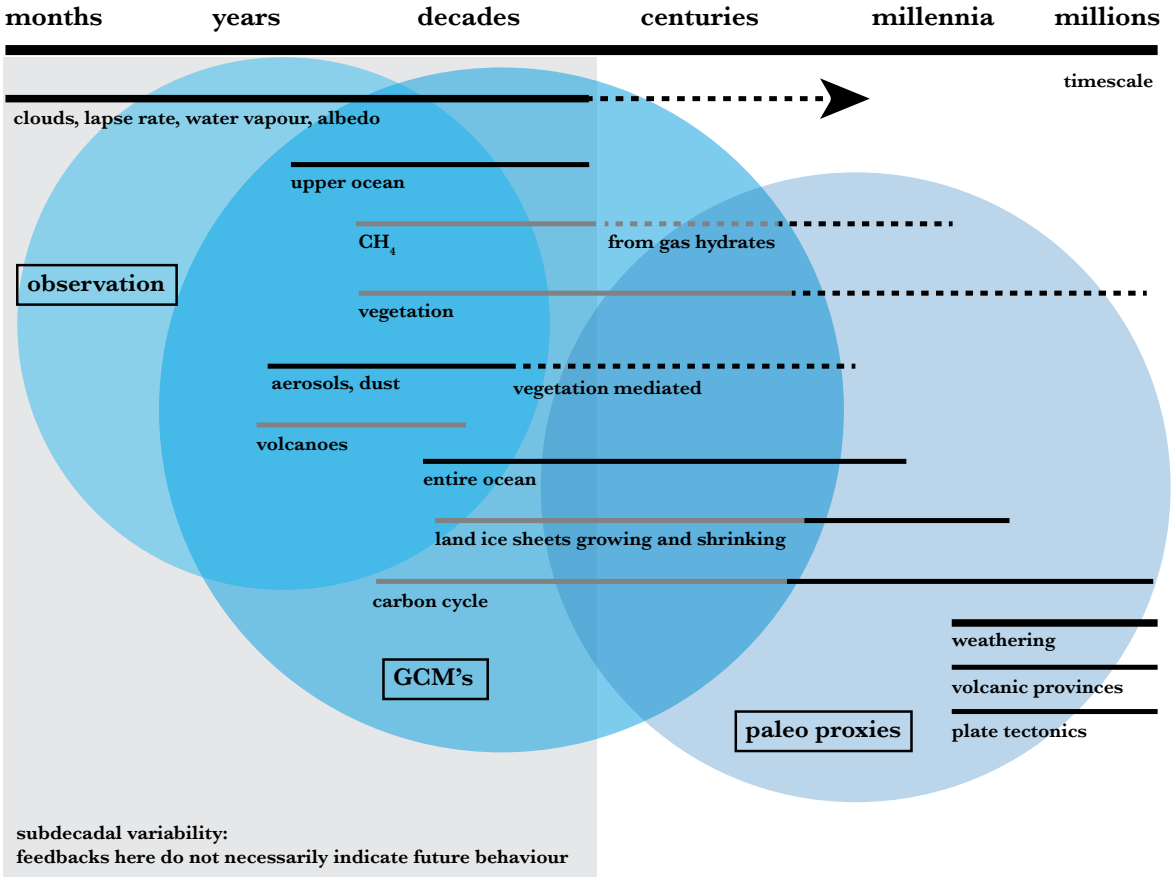

Figure 3: Timescales of climate processes and inclusions of feedbacks in climate models. The coloured ellipses each cover different methods used to estimate climate sensitivity: observations (left), global climate models (GCMs) (centre) and paleoclimate proxies (right). Light grey bars indicate processes that act on timescales that a GCM can resolve, but are usually assumed to be (partly) inactive or non-existent. Dashed lines indicate timescales where specific feedbacks are weaker or only operate under certain circumstances. The arrow for clouds, lapse rate, water vapour and albedo indicates that those feedbacks operate on short timescales but, because the surface warming takes centuries or more to equilibrate, these feedbacks continue to change and affect the overall response of the systems up to millennia (Credit: Knutti & Rugenstein 2015).

52 Oppenheimer, M, O'Neill, B, Webster, M & Agrawala, S 2007, 'The Limits of Consensus', *Science*, vol. 317, pp. 1505-1506.

Glaciologist Prof. Eric Rignot, says that "one of the problems of IPCC is the strong desire to rely on physical models". He explains:

> " For instance, in terms of sea-level rise projection, the IPCC tends to downplay the importance of semi-empirical models. In the case of Antarctica, it may be another ten years before fully-coupled ice sheet–ocean–sea ice–atmosphere models get the southern hemisphere atmospheric circulation, the Southern Ocean and the ice sheet right using physical models, with the full physics, at a high spatial resolution. In the meantime, it is essential to move forward our scientific understanding and inform the public and policy makers based on observations, basic physics, simpler models, well before the full-fledged physical models eventually get there."[53]

It is important to understand the distinction between full climate models and the semi-empirical approach, because IPCC reports appear to privilege the former at the expense of the latter. Sea-level-rise projections are a good example of this.

FULLY-COUPLED MODELS

Fully-coupled global climate models or general circulation models (GCMs) are mathematical representations of the Earth's climate system, based on the laws of physics and chemistry. Run on computers, they simulate the interactions of the important drivers of climate, including atmosphere–oceans–land surface–ice interactions, to solve the full equations for mass and energy transfer and radiant exchange. Models are tested in the first instance by hindsight: how well, once loaded with the observed climate conditions (parameters) at a time in the past, do they reproduce what has happened since that point. They are limited by the capacity of modellers to understand the physical processes involved, so as to be able to represent them in quantitative terms. For example, ice sheet dynamics are poorly reproduced, and therefore key processes that control the response of ice flow to a warming climate are not included in current ice sheet models. GCMs are being improved over time, and new higher-capacity computers allow models of finer resolution to be developed.[54]

SEMI-EMPIRICAL MODELS

A semi-empirical model is a simpler, physically plausible model of reduced complexity that exploits statistical relationships. It combines current observations with some basic physical relationships observed from past climates, and theoretical considerations relating variables through fundamental principles, to project future climate conditions. For example, semi-empirical models "can provide a pragmatic alternative to estimate the sea-level response".[55] Observing past rates of sea-level change from the climate record when the forcing (energy imbalance in the system) was similar to today, gives insights into how quickly sea levels may rise in the next period. Thus a semi-empirical approach to projecting future sea-level rise may relate the global sea-level rise to global mean surface temperature. This approach was used by Rahmstorf in 2007, to project a 0.5–1.4 metres sea-level rise by 2100, compared to the IPCC's 2007 report, based on GCMs, which gave a figure of 0.18–0.59.[56]

Semi-empirical models rely on observations from climate history (paleoclimatology) to establish relationships between variables. In privileging GCMs over semi-empirical models, the IPCC downplays insights from Earth's climate history.

53 Rignot, E, pers. comm., 8 August 2017.

54 Rahmstorf, S 2007, 'A semi -empirical approach to projecting future sea-level rise, *Science* vol. 315, pp. 368-370.

55 Ibid.

56 Ibid.

TIPPING POINTS

A tipping point may be understood as the passing of a critical threshold in an Earth climate system component — such as major ocean and atmospheric circulation patterns, the polar ice sheets, and the terrestrial and ocean carbon stores — which produces a step change in the system.

Progress toward a tipping point is often driven by positive feedbacks, in which a change in a component leads to further changes that eventually "feed back" onto the original component to amplify the effect. A classic case in global warming is the ice–albedo feedback, where decreases in the area of polar sea ice change surface reflectivity, trapping more heat from the sun and producing further sea-ice loss.

In some cases, passing one threshold will trigger further threshold events, for example, where substantial greenhouse gas releases from polar permafrost carbon stores increase warming, releasing even more permafrost carbon in a positive feedback, but also pushing other systems, such as polar ice sheets, past their threshold point.

In a period of rapid warming, most major tipping points once crossed are irreversible in human time frames, principally due to the longevity of atmospheric CO_2 (a thousand years).[57] For this reason, it is crucial that we understand as much as possible about near-term tipping points.

Large-scale human interventions in slow-moving earth system tipping points might allow a tipping point to be reversed; for example, by a large-scale atmospheric CO_2 drawdown program, or solar radiation management.

The scientific literature on tipping points is relatively recent. Our knowledge is limited because a system-level understanding of critical processes and feedbacks is still lacking in key Earth climate components, such as the polar regions, and "no serious efforts have been made so far to identify and qualify the interactions between various tipping points".[58]

As discussed above, climate models are not yet good at dealing with tipping points. This is partly due to the nature of tipping points, where a particular and complex confluence of factors abruptly change a climate system characteristic and drive it to a different state. To model this, all the contributing factors and their forces have to be well identified, as well as their particular interactions, plus the interactions between tipping points. Researchers say that "complex, nonlinear systems typically shift between alternative states in an abrupt, rather than a smooth manner, which is a challenge that climate models have not yet been able to adequately meet".[59]

The GCF says that despite scientific evidence that risks associated with tipping points "increase disproportionately as temperature increases from 1°C to 2°C, and become high above 3°C",[60] political negotiations have consistently disregarded the high-end scenarios that could lead to abrupt or irreversible climate change. In its *Global Catastrophic Risks 2017* report, the Foundation concludes that "the world is currently completely unprepared to envisage, and even less deal with, the consequences of catastrophic climate change".[61]

The IPCC has published few projections regarding tipping-point thresholds, nor emphasised the importance of building robust risk-management assessments of them in the absence of adequate quantitative data.

57 Solomon, S, Plattner, GK, Knutti, R & Friedlingstein, P 2008, 'Irreversible climate change due to carbon dioxide emissions', *Proceedings of the National Academy of Sciences*, vol. 106, no. 6, pp. 1704–1709.

58 Schellnhuber, HJ 2009, 'Tipping elements in the Earth system', *Proceedings of the National Academy of Sciences*, vol. 106, no. 49, pp. 20561–20563.

59 Duarte, C, Lenton, T, Wadhams, P & Wassmann, P 2012, 'Abrupt climate change in the Arctic', *Nature Climate Change*, vol. 2, pp. 60–62.

60 GFC 2017, op. cit.

61 ibid.

CLIMATE SENSITIVITY

The question of climate sensitivity is a vexed one. Climate sensitivity is the amount by which the global average temperature will rise due to a doubling of the atmospheric greenhouse gas level, at equilibrium. (Equilibrium refers to the state of a system when all the perturbations have been resolved and the system is in balance.)

IPCC reports have focused on what is generally called Equilibrium Climate Sensitivity (ECS). The 2007 IPCC report gives a best estimate of climate sensitivity of 3°C and says it "is likely to be in the range 2°C to 4.5°C". The 2014 report says that "no best estimate for equilibrium climate sensitivity can now be given because of a lack of agreement on values across assessed lines of evidence and studies" and only gives a range of 1.5°C to 4.5°C. This was a backward step.[62]

What the IPCC reports fail to make clear is that the ECS measure omits key "long-term" feedbacks that a rise in the planet's temperature can trigger. These include the permafrost feedback and other changes in the terrestrial carbon cycle, a decrease in the ocean's carbon-sink efficiency, and the melting of polar ice sheets creating a cold ocean-surface layer underneath that accelerates the melting of ice shelves and hastens the rate of ice-mass loss.

Climate sensitivity which includes these feedbacks — known as Earth System Sensitivity (ESS) — does not appear to be acknowledged in the 2014 IPCC reports at all. Yet, there is a wide range of literature which suggest an ESS of 4–6°C.[63]

It is conventionally considered that these "long-term" feedbacks — such as changes in the polar carbon stores and the polar ice sheets — operate on millennial timescales. Yet the rate at which human activity is changing the Earth's energy balance is without precedent in the last 66 million years, and about ten times faster than during the Paleocene–Eocene Thermal Maximum 55 million years ago, a period with one of the largest extinction events on record.

The rate of change in energy forcing is now so great that these "long-term" feedbacks have already begun to operate within short time frames. The IPCC is not forthcoming on this issue. Instead it sidesteps with statements (from 2007) such as this: "Models used to date do not include uncertainties in climate–carbon cycle feedback... because a basis in published literature is lacking... Climate–carbon cycle coupling is expected to add CO_2 to the atmosphere as the climate system warms, but the magnitude of this feedback is uncertain." This is the type of indefinite language that politicians and the media are likely to gloss over, in favour of a headline number.

It should be noted that carbon budgets — the amount of carbon that could be emitted before a temperature target is exceeded — are generally based on a climate sensitivity mid-range value around 3°C. Yet this figure may be too low. Fasullo and Trenberth found that the climate models that most accurately capture observed relative humidity in the tropics and subtropics and associated clouds were among those with a higher sensitivity of around 4°C.[64] Sherwood et al. also found a sensitivity figure of greater than 3°C.[65] Zhai et al. found that climate models that are consistent with the observed seasonal variation of low-altitude marine clouds have an average sensitivity of 3.9°C.[66] Recently it has been demonstrated the models that best capture current conditions have a mean value of 3.7°C compared to 3.1°C by the raw model projections.[67]

The work on existential climate risks by Xu and Ramanathan, cited above, is also important in assessing what is an appropriate climate sensitivity for risk-management purposes, for three reasons.

62 References to the IPCC are drawn from the relevant Working Group, Synthesis and the Summary for Policymakers reports.

63 The Geological Society 2013, *An addendum to the Statement on Climate Change: Evidence from the geological record*, The Geological Society, London, December 2013; Hansen, J, Sato, M, Russell, G & Kharecha, P 2013, 'Climate sensitivity, sea level and atmospheric carbon dioxide', P*hilosophical Transactions of the Royal Society A*, vol. 371, no. 2001, 20120294.

64 Fasullo, J & Trenberth, K 2012, 'A less cloudy future: the role of subtropical subsidence in climate sensitivity', *Science*, vol. 338, no. 6108, pp. 792-794.

65 Sherwood, S, Bony, S & Dufresne, JL 2014, 'Spread in model climate sensitivity traced to atmospheric convective mixing', *Nature*, vol. 505, pp. 37-42.

66 Zhai, C, Jiang, J & Su, H 2015, 'Long-term cloud change imprinted in seasonal cloud variation: More evidence of high climate sensitivity', *Geophysical Research Letters*, vol. 42, no. 20, pp. 8729-8737.

67 Brown, P & Caldeira, K 2017, 'Greater future global warming inferred from Earth's recent energy budget', *Nature*, vol. 552, pp. 45-50.

They say that:

1. Taking into account the biogeochemical feedbacks (such as less efficient land/ocean sinks, including permafrost loss) effectively increases carbon emissions to 2100 by about 20% and can enhance warming by up to 0.5°C, compared to a baseline scenario.
2. Warming has been projected to increase methane emissions from wetlands by 0–100% compared with present-day wetland methane emissions. A 50% increase in wetland methane emissions by 2100 in response to high-end warming of 4.1–5°C could add at least another 0.5°C.
3. It is important to use high-end climate sensitivity because some studies have suggested that climate models have underestimated three major positive climate feedbacks: positive ice albedo feedback from the retreat of Arctic sea ice; positive cloud albedo feedback from retreating storm track clouds in mid-latitudes; and positive albedo feedback by the mixed-phase (water and ice) clouds. When these are taken into account, the ECS is more than 40% higher than the IPCC mid-figure, at 4.5-4.7°C, before adding up to another 1°C of warming as described in 1. and 2. above.[68]

In research published in 2016, Friedrich et al. show that climate models may be underestimating climate sensitivity because it is not uniform across different circumstances, but in fact higher in warmer, interglacial periods (such as the present) and lower in colder, glacial periods.[69] Based on a study of glacial cycles and temperatures over the last 800,000 years, the authors conclude that in warmer periods climate sensitivity averages around 4.88°C. The higher figure would mean warming for 450 parts per million (ppm) of atmospheric CO_2 (a figure on current trends we will reach within 25 years) would be around 3°C, rather than the 2°C bandied around in policy making circles. Professor Michael Mann, of Penn State University, says the paper appears "sound and the conclusions quite defensible".[70]

"We are now at a tipping point that threatens to flip the world into a full blown climate emergency."

Tony de Brum, Mary Robinson and Kelly Rigg, 2013

68 Xu, Y & Ramanathan, V 2017, 'Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes', *Proceedings of the National Academy of Sciences*, vol. 114, pp. 10315-10323.

69 Friedrich, T, Timmermann, A, Timm, OE & Ganopolski, A 2016, 'Nonlinear climate sensitivity and its implications for future greenhouse warming', *Science Advances*, vol. 2, no. 11, e1501923.

70 Johnston, I 2016, 'Climate change may be escalating so fast it could be "game over", scientists warn', *Independent*, 9 November 2016.

CARBON BUDGETS

A carbon budget is an estimate of the total future human-caused greenhouse gas emissions, in tons of carbon, CO_2 or CO_2 equivalent, that would be consistent with limiting warming to a specified figure, such as 1.5°C or 2°C, with a given risk of exceeding the target, such as a 50%, 33% or 10% chance.

The discussion of carbon budgets is frequently opaque. Often, it is difficult to ascertain whether the assumptions are realistic, for example whether a budget includes non-CO_2 forcings such as methane and nitrous oxide. Too often, the risk of failure is not clearly spelt out, especially the fat-tail risks. Contrary to the tone of the IPCC reports, the evidence shows we have no carbon budget for 2°C for a sensible risk-management, low-probability (of a 10%, or one-in-ten) chance of exceeding that target. The IPCC reports fail to say there is no carbon budget if 2°C is considered a cap (an upper boundary not to be exceeded) as per the *Copenhagen Accord*, rather than a target (an aspiration which can be significantly exceeded). The IPCC reports fail to say that once projected emissions from future food production and deforestation are taken into account, there is no carbon budget for fossil-fuel emissions for a 2°C target.[71]

Carbon budgets are routinely proposed that have a substantial and unacceptable risk of exceeding specified targets and hence entail large and unmanageable risks of failure.

Research published in December 2017 compared "raw" climate models (used by the IPCC) with models that are "observationally informed" and best capture current conditions. The latter produce 15% more warming by 2100 than the IPCC suggests, thus reducing the carbon budget by around 15% for the 2°C target. Hence, as one example, the actual warming for the RCP4.5 emissions path is in reality likely to be higher, similar to that projected by raw models for RCP6.0.[72] (RCPs are representative concentration pathways of greenhouse gas emission trajectories. RCP2.6 is the lowest and RCP8.5 is the highest.) This is consistent with findings five years earlier that climate model projections which show a greater rise in global temperature are likely to prove more accurate than those showing a lesser rise.[73]

As well, the IPCC uses a definition of global mean surface temperature that underestimates the amount of warming over the pre-industrial level. When estimates for the effect of calculating (1) warming for total global coverage rather than for the coverage for which observations are available, (2) warming using surface air temperature measurements (SATs) over the entire globe instead of the observational blend of sea surface temperatures (SSTs) and SATs, and (3) warming from a pre-industrial, instead of a late-nineteenth century baseline, are taken into account, the underestimation is around 0.3°C. This results in a significant overestimation of allowable emissions.[74]

For example, for stabilization at 2°C, allowable emissions decrease by as much as 40% when earlier than nineteenth-century climates are considered as a baseline.[75]

There are also problems with carbon budgets which incorporate "overshoot" scenarios, in which warming exceeds the target before being cooled by carbon drawdown. Pam Pearson, Director of the International Cryosphere Climate Initiative, says that most cryosphere thresholds are determined by peak temperature, and the length of time spent at that peak, warning that "later, decreasing temperatures after the peak are largely irrelevant, especially with higher temperatures and longer duration peaks". Thus "overshoot scenarios", which are now becoming the norm in policymaking circles, hold much greater risks.[76]

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71 Raupach, M 2013, pers. comm, 20 October 2013, based on Raupach, M, Harman, IN & Canadell, GJ 2011, *Global climate goals for temperature, concentrations, emissions and cumulative emissions*, The Centre For Australian Weather and Climate Research, Melbourne 2011, discussed at http://www.climatecodered.org/2014/05/thereal-budgetary-emergency-burnable.html; Arora, VK, Scinocca, JF, Boer, GJ, Christian, RJ, Denman, KL, Flato, GM, Kharin, VV, Lee, WG & Merryfield, WJ 2015, 'Carbon emission limits required to satisfy future representative concentration pathways of greenhouse gases', *Geophysical Research Letters*, vol. 38, L05805; Meinshausen, M 2008, 'The EU, the IPCC and the science of climate change: The 2°C target', IES Autumn lecture series, 8 October 2008, Brussels; Anderson, K & and Bows, A 2008, 'Reframing the climate change challenge in light of post-2000 emission trends, *Philosophical Transactions of the Royal Society A*, vol. 366, pp. 3863-3882.

72 Brown, P & Caldeira, K 2017, 'Greater future global warming inferred from Earth's recent energy budget', *Nature*, vol. 552, pp. 45-50.

73 Fasullo, JT & Trenberth, KE 2012, 'A Less Cloudy Future: The Role of Subtropical Subsidence in Climate Sensitivity', *Science*, vol. 338, pp. 792-794.

74 Schurer, AP, Cowtan, K, Hawkins, E, Mann, ME, Scott, V & Tett, SFB 2018, 'Interpretations of the Paris climate target', *Nature Geoscience*, vol 11, pp. 220.

75 Schurer, A, Mann, ME, Hawkins, E, Tett, SFB & Hegerl, GC 2017, 'Importance of the pre-industrial baseline for likelihood of exceeding Paris goals', *Nature Climate Change*, vol. 7, pp. 563-568.

76 UPFSI 2017, op cit.

PERMAFROST AND THE CARBON CYCLE

The failure to adequately consider long-term feedbacks in IPCC estimates of climate sensitivity in climate models, and hence in projections of future warming, lies at the heart of the problem with the IPCC reporting process. Over century time-scales, amplifying feedbacks may ultimately contribute 28–68% of total warming, yet they comprise only 1–7% of current warming.[77] The land sink (storage capacity) for CO_2 appears much smaller than is currently factored into some climate models.[78] Thus, future patterns of warming may be distinctly different from past patterns, making it difficult to predict future warming by relying on past observations.

SOIL CARBON

A 2016 study concluded that a soil carbon-cycle feedback "has not been incorporated into computer models used to project future climate change, raising the possibility that such models are underestimating the amount of warming that is likely to occur".[79] The projected loss of soil carbon resulting from climate change is a potentially large but highly uncertain feedback to warming, however there is likely to be strong carbon-climate feedbacks from colder northern soils.[80]

FORESTS

At the moment about one-third of human-caused CO_2 emissions are absorbed by trees and other plants. But rapid climate warming and unusual rainfall patterns are jeopardising many of the world's trees, due to more frequent drought, pest outbreaks and fires. This is starting to have profound effects on the Earth's carbon cycle.

In 2009, researchers found that 2°C of warming could cut in half the carbon sink of tropical rainforests.[81] Some tropical forests — in the Congo, and in Southeast Asia — have already shifted to a net carbon source. The tropics are now a net carbon source, with losses owing to deforestation and reductions in carbon density within standing forests being double that of gains resulting from forest growth.[82] Other work has projected a long-term, self-reinforcing carbon feedback from mid-latitude forests to the climate system as the world warms.[83]

There has been an observed decline in the Amazon carbon sink. Negative synergies between deforestation, climate change, and widespread use of fire indicate a tipping point for the Amazon system to flip to non-forest ecosystems in eastern, southern and central Amazonia at 20–25% deforestation. Researchers say the severe droughts of 2005, 2010 and 2015-16 could well represent the first flickers of this ecological tipping point, and say the whole system is oscillating.[84]

PERMAFROST

The world's permafrost holds 1.5 trillion tons of frozen carbon, more than twice the amount of carbon in the atmosphere. On land, it covers an area of 15 million square kilometres. The Arctic is warming faster than anywhere else on Earth, and some permafrost degradation is already occurring. Large-scale tundra wildfires in 2012 added to the concern, as have localised methane outbursts.

The 2007 IPCC assessment on permafrost did not venture beyond saying: "Changes in snow, ice and frozen ground have with high confidence increased the number and size of glacial lakes, increased ground instability in mountain and other permafrost regions and led to changes in some Arctic and Antarctic ecosystems". It reported with "high confidence" that "methane emissions from tundra… and permafrost have accelerated in the past two decades, and are likely to accelerate further". It offered no projections regarding permafrost melt.

77 Proistosescu, C & Huybers, P 2017, 'Slow climate mode reconciles historical and model-based estimates of climate sensitivity', *Science Advances*, vol. 3, e1602821.

78 Bradford, A 2017, 'A leaky sink', *Nature Climate Change*, vol. 7, pp. 475-476

79 Crowther T. et al. 2016, 'Quantifying global soil carbon losses in response to warming', *Nature*, vol. 540, pp. 104-108.

80 Koven, C, Hugelius, G, Lawrence, DM & Wieder, WR 2017, 'Higher climatological temperature sensitivity of soil carbon in cold than warm climates', *Nature Climate Change*, vol. 7, pp. 817-822.

81 Murray, J 2009, 'Research warns two degree rise will halve rainforest "carbon sink"', Business Green, 3 March 2009, <http://www.businessgreen.com/business-green/news/2237656/research-warns-two-degree>.

82 Baccini, A, Walker, W, Carvalho, L, Farina, M, Sulla-Menashe, D & Houghton, RA 2017, 'Tropical forests are a net carbon source based on aboveground measurements of gain and loss', *Science*, vol. 358, pp. 230-234.

83 Melillo, JM, Frey, SD, DeAngelis, KM, Werner, WJ, Bernard, MJ, Bowles, FP, Pold, G, Knorr, MA & Grandy, AS 2017, 'Long-term pattern and magnitude of soil carbon feedback to the climate system in a warming world', *Science*, vol. 358, pp. 101-105.

84 Lovejoy, T & Nobre, C 2018, 'Amazon Tipping Point', *Science Advances*, vol. 4, eaat2340.

Yet, in 2005, Lawrence and Slater had shown that a doubling of CO_2 levels by 2100 — a path to 3°C of warming — would reduce the land permafrost area by more than half and melt much of the top three metres.[85] (In 2017, permafrost area loss was estimated to be 4 million square kilometres for each 1°C of warming.)

The 2014 *Summary for Policymakers* (*SPM)* said: "It is virtually certain that near-surface permafrost extent at high northern latitudes will be reduced as global mean surface temperature increases, with the area of permafrost near the surface (upper 3.5 meters) projected to decrease by 37% (RCP2.6) to 81% (RCP8.5) for the multi-model average (medium confidence)." That was it.

The effect of the permafrost carbon feedback has not been included in the IPCC scenarios, including the 2014 report.[86] This is despite clear evidence that "the permafrost carbon feedback will change the Arctic from a carbon sink to a source after the mid-2020s and is strong enough to cancel 42–88% of the total global land sink". In 2012, researchers found that, for the 2100 median forecasts, there would be 0.23–0.27°C of extra warming due to permafrost feedbacks. Some scientists consider that 1.5°C appears to be something of a "tipping point" for extensive permafrost thaw.[87]

A 2014 study estimated that up to 205 billion tonnes equivalent of CO_2 could be released due to melting permafrost. This would cause up to 0.5°C extra warming for the high emissions scenario, and up to 0.15°C of extra warming for a 2°C scenario. The authors say that: "Climate projections in the IPCC *Fifth Assessment Report*, and any emissions targets based on those projections, do not adequately account for emissions from thawing permafrost and the effects of the permafrost carbon feedback on global climate."[88]

But, even if human greenhouse gas emissions are stabilised, permafrost carbon loss may continue for many years and simulations suggest that 225 to 345 billion tonnes of CO_2 may eventually be released to the atmosphere for the stabilization target of 2°C.[89]

Recently attention has turned to the question of the stability of large methane hydrate stores below the ocean floor on the shallow East Siberian Arctic Shelf (ESAS). (Methane hydrates are cage-like lattices of ice within which methane molecules are trapped.)

These stores are protected from the warmer ocean temperatures above by a layer of frozen sub-sea permafrost. The concern is that warmer water could create taliks (areas of unfrozen permafrost) through which large-scale methane emissions from the hydrates could escape into the water column above, and into the atmosphere. This possibility was raised in 2013 by Whiteman, Hope and Wadhams.[90]

Prof. Peter Wadhams explained that "the loss of sea ice leads to seabed warming, which leads to offshore permafrost melt, which leads to methane release, which leads to enhanced warming, which leads to even more rapid uncovering of seabed", and this is not "a low probability event".[91]

More than a few experts derided these claims. The model estimates reported by the IPCC are that the degradation of ESAS permafrost cannot exceed several metres this century, and the formation of taliks that would allow the release of large amounts of methane will take hundreds or thousands of years. Thus the IPCC considers the potential contribution of the ESAS into the emissions of methane as insignificant.[92]

But researchers say that model is no longer correct. In August 2017, they announced that:

> " In some areas of the East Siberian Arctic Shelf the roof of the subsea permafrost had already reached the depth of hydrates' stability the destruction of which may cause massive releases of bubble methane… The results of our study ensure fundamentally new insights of the mechanism of processes responsible for the state of subsea permafrost in the East Siberian Arctic Shelf which, according to various estimates, concentrates up to 80% and more of entire subsea permafrost in the Northern Hemisphere, under which there are huge hydrocarbon reserves in the forms of hydrates, oil and free gas."[93]

A deceptively optimistic picture is painted when the potential impacts from the degradation of permafrost and methane hydrates are underplayed.

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85 Lawrence, DM & Slater, AG 2005, 'A projection of severe near-surface permafrost degradation during the 21st century', *Geophysical Research Letters*, vol. 32, L22401.

86 UNEP 2012, Policy Implications of Warming Permafrost, United Nations Environment Program, Nairobi.

87 MacDougall, A, Avis, C & Weaver, AJ 2012, 'Significant contribution to climate warming from the permafrost carbon feedback', *Nature Geoscience*, vol. 5, pp. 719–721; Schaefer, K, Zhang, T, Bruhwiler & Barrett, A 2011, 'Amount and timing of permafrost carbon release in response to climate warming', *Tellus B*, vol. 63, no. 2, pp. 165-180; Vaks, A, Gutareva, OS, Breitenbach, SF, Avirmed, E, Mason, AJ, Thomas, AL, Osinzev, AV & Henderson, GM 2013, 'Speleothems reveal 500,000-year history of Siberian permafrost', *Science*, vol. 340, no. 6129, pp. 183-186.

88 Schaefer, K, Lanuit, H, Romanovsky, V, Schuur, E & Witt, R 2014, 'The impact of the permafrost carbon feedback on global climate', *Environmental Research Letters*, vol. 9, no. 8, 085003.

89 Burke, EJ, Chadburn, SE, Huntingford, C & Jones, CD 2018, 'CO2 loss by permafrost thawing implies additional emissions reductions to limit warming to 1.5 or 2°C', *Environmental Research Letters*, vol. 13, 024024.

90 Whiteman, G, Hope, C & Wadhams, P 2013, 'Climate science: Vast costs of Arctic change", *Nature*, vol. 499, pp. 401–403.

91 Ahmed, N 2013, 'Ice-free Arctic in two years heralds methane catastrophe – scientist', *The Guardian*, 25 July 2103 .

92 Tomsk Polytechnic University 2017, Russian scientists deny climate model of IPCC', Eureka Alert, 15 August 2017, <https://www.eurekalert.org/pub_releases/2017-08/tpu-rsd081517.php>.

93 Ibid.

ARCTIC SEA ICE

In 2007, the IPCC reported: "Satellite data since 1978 show that annual average Arctic sea-ice extent has shrunk by 2.7% per decade" and "late summer sea ice is projected to disappear almost completely towards the end of the twenty-first century".

That same year, the summer retreat of Arctic sea ice wildly out-distanced all 18 IPCC computer models. One scientist exclaimed that is was melting "one hundred years ahead of schedule". Many models, including those on which the 2007 IPCC report had relied, did not fully capture the dynamics of sea-ice loss.

Prof. Michael E. Mann says sea-ice modellers had "speculated that the 2007 minimum was an aberration… a matter of random variability, noise in the system, that sea ice would recover.… that no longer looks tenable".[94]

Yet, two years earlier, Prof. Tore Furevik of the Geophysical Institute in Bergen had already demonstrated that actual Arctic sea-ice retreat had been greater than estimates in any of the Arctic models reported by the IPCC. By 2007, a wider range of scientists had presented evidence that the Arctic may be free of all summer sea-ice as early as 2030.[95] Of this, the 2007 IPCC report said nothing.

There was a similar, mind-numbing drop in Arctic sea ice in 2012 to levels unseen in millennia, with the summer minimum sea-ice volume just one-third of that just 30 years earlier, increasing the margin by which IPCC projections had been too conservative.

Yet, in an astonishing understatement, the 2014 IPCC report said: "Year-round reductions in Arctic sea ice are projected for all RCP scenarios." It said a nearly ice-free Arctic Ocean in the summer was likely for the highest emissions scenario only.

In reality, summer ice is thinning faster than every climate projection, tipping points have been crossed for sea-ice-free summer conditions, and today scientists say an ice-free summer Arctic could be just years away, not many decades.

Model limitations "are hindering our ability to predict the future state of Arctic sea ice" and the majority of general climate models "have not been able to adequately reproduce observed multi-decadal sea-ice variability and trends in the pan-Arctic region", so their trend in September Arctic sea-ice extent "is approximately 30 years behind the observed trend".[96]

The loss of sea ice reduces the planet's reflectivity and adds to warming, but this positive feedback is not fully incorporated into models in circumstances where the rate of sea-ice loss is more rapid than expected in the models, as is occurring now. To keep global temperature increase below 2°C, global CO_2 emissions would need to reach zero 5–15 years earlier and the carbon budget would need to be reduced by 20–51% to offset this additional source of warming.[97]

Because climate models are missing key real-world interactions and generally have been poor at dealing with the rate of Arctic sea-ice retreat, expert elicitations play a key role in considering whether the Arctic has passed a very significant and dangerous tipping point.[98] But the IPCC has not done this.

94 Scherer 2012a, op. cit.

95 Serreze, MC, Holland, MM & Stroeve, J 2007, 'Perspectives on the Arctic's shrinking sea ice cover', *Science*, vol. 315, no. 5818, pp. 1533-1536; Stroeve, J, Holland, MM, Meier, W, Scambos, T & Serreze, M 2007, 'Arctic sea ice decline: Faster than forecast?', *Geophysical Research Letters*, vol. 34, no. 9, L09501.

96 Maslowski, W, Kinney, JC, Higgins, M & Roberts, A 2012, 'The future of Arctic sea ice', *The Annual Review of Earth and Planetary Sciences*, vol. 20, pp. 625-654.

97 Gonzalez-Eguino, M, Neumann, MB, Arto, I, Capellán-Perez, I & Faria, SH 2017, 'Mitigation implications of an ice-free summer in the Arctic Ocean', *Earth's Future*, vol. 5, pp. 59-66.

98 Livina, VN & Lenton, TM 2013, 'A recent tipping point in the Arctic sea-ice cover: abrupt and persistent increase in the seasonal cycle since 2007', *The Cryosphere*, vol. 7, pp. 275-286; Maslowski, Kinney et al 2012., op. cit.

POLAR ICE-MASS LOSS

In 1995, the IPCC projected "little change in the extent of the Greenland and Antarctic ice sheets… over the next 50-100 years". The 2001 IPCC report suggested that neither the Greenland nor the Antarctic ice sheets would lose significant mass by 2100.

The 2007 IPCC report said there were "uncertainties… in the full effects of changes in ice sheet flow", and a suggestion that "partial loss of ice sheets on polar land could imply metres of sea-level rise… Such changes are projected to occur over millennial time scales". The reality is very different.

GREENLAND ICE SHEET

In 2007, the IPCC reported: "Contraction of the Greenland Ice Sheet is projected to continue to contribute to sea-level rise after 2100. Current models suggest virtually complete elimination of the Greenland Ice Sheet and a resulting contribution to sea-level rise of about seven metres if global average warming were sustained for millennia in excess of 1.9 to 4.6°C relative to pre-industrial values."

This was despite two 2006 studies, which found the Greenland ice cap "may be melting three times faster than indicated by previous measurements", warnings that "we are close to being committed to a collapse of the Greenland Ice Sheet" and reports that rising Arctic regional temperatures are already at "the threshold beyond which glaciologists think the [Greenland] ice sheet may be doomed".[99]

The 2007 assessment "did not take into account the potential melting of Greenland, which I think was a mistake", said Robert Watson, Chief Scientific Advisor for Britain's Department for Environmental Affairs and chairman of the IPCC's 2001 assessment.[100]

By 2014, the IPCC was reporting that "over the period 1992 to 2011, the Greenland and Antarctic ice sheets have been losing mass, likely at a larger rate over 2002 to 2011". The loss of the Greenland Ice Sheet would be a period "over a millennium or more", with a threshold between 1°C and 4°C of warming. In fact, the annual rate of loss had doubled in the period 2003 to 2010 compared with the rate throughout the 20th century.[101]

By this time, many leading cryosphere scientists were saying informally that Greenland had passed its tipping point, "is already lost", and similar sentiments. And a year before, a significant research paper had estimated the tipping point for Greenland Ice Sheet as 1.6°C (with an uncertainty range of 0.8 to 3.2°C). And there was clear satellite evidence of accelerating ice-mass loss.[102]

The loss of ice mass from Greenland is accelerating, which is drawing increasing levels of concerns from scientists. "What keeps cryosphere scientists up at night are irreversible thresholds, particularly West Antarctica and Greenland," says Pam Pearson, Director of the International Cryosphere Climate Initiative.[103]

Current-generation climate models are not yet all that helpful for predicting Greenland ice-mass loss. They have a poor understanding of the processes involved, and the acceleration, retreat and thinning of outlet glaciers are poorly or not represented.[104]

In the case of Greenland, the adverse consequences for policymaking of the IPCC's method of privileging global climate model results over observations, historical data and expert elicitations can be clearly seen. It is hard not to imagine the rate of Greenland Ice Sheet deglaciation continuing to accelerate as the climate continues to warm, reflectivity declines, and late summer ocean conditions become sea-ice free.

In 2012, then NASA climate science chief James Hansen told Bloomberg that: "Our greatest concern is that loss of Arctic sea ice creates a grave threat of passing two other tipping points – the potential instability of the Greenland Ice Sheet and methane hydrates… These latter two

99 Rignot, E & Kanagaratnam, P 2006, 'Changes in the velocity structure of the Greenland ice sheet', *Science*, vol. 311, no. 5763, pp. 986-90; Chen, JL, Wilson, CR & Tapley, BD 2006, 'Satellite gravity measurements confirm accelerated melting of Greenland ice', *Science*, vol. 313, pp. 1958–60; Young, K 2006, "Greenland ice cap may be melting at triple speed", *New Scientist*, 10 August, 2006.

100 AFP 2008, 'Climate change gathers steam, say scientists', Space Daily, 30 November 2008, <http://www.spacedaily.com/2006/081130055637.szeh21pj.html>.

101 Mooney, C, 2015, 'Greenland has lost a staggering amount of ice — and it's only getting worse', *Washington Post*, 16 December 2015.

102 Robinson, A, Calov, R & Ganopolski, A 2012, 'Multistability and critical thresholds of the Greenland ice sheet', *Nature Climate Change*, vol. 2, pp. 429–432.

103 UPFSI 2017, op cit.

104 Maslowski, Kinney et al. 2012, op cit.

tipping points would have consequences that are practically irreversible on time scales of relevance to humanity."[105]

On this very grave threat, the IPCC is mute.

ANTARCTIC ICE SHEET

The 2007 IPCC assessment proffered: "Current global model studies project that the Antarctic ice sheet will remain too cold for widespread surface melting and gain mass due to increased snowfall. However, net loss of ice mass could occur if dynamical ice discharge dominates the ice sheet mass balance." Reality and new research would soon undermine this one-sided reliance by the IPCC on models with poor cryosphere performance.

By the 2014 IPCC assessment, the story was: "Based on current understanding (from observations, physical understanding and modelling), only the collapse of marine-based sectors of the Antarctic Ice Sheet, if initiated, could cause global mean sea level to rise substantially above the likely range during the 21st century. There is medium confidence that this additional contribution would not exceed several tenths of a metre of sea-level rise during the 21st century." And: "Abrupt and irreversible ice loss from the Antarctic ice sheet is possible, but current evidence and understanding is insufficient to make a quantitative assessment." This was another blunder.

Observations of accelerating ice mass loss in West Antarctica were well established by this time.[106]

It is likely that the Amundsen Sea sector of the West Antarctic Ice Sheet has already been destabilized. Ice retreat is unstoppable for the current conditions, and no acceleration in climate change is necessary to trigger the collapse of the rest of the West Antarctic Ice Sheet, with loss of a significant fraction on a decadal-to-century time scale. 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 one 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."[107]

This was a world away from the IPCC report of the same year.

In 2016, another significant study concluded that: "Antarctica has the potential to contribute more than a metre of sea-level rise by 2100 and more than 15 metres by 2500."[108] Compare this to the IPCC report, just a year earlier, that Antarctica's contribution to rising sea levels would "not exceed several tenths of a meter… during the 21st century".

As well, partial deglaciation of the East Antarctic ice sheet is likely for the current level of atmospheric CO_2, contributing ten metres or more of sea-level rise in the longer run, and five metres in the first 200 years.[109]

The increasing rate of change in Antarctica was brought to light with the publication, in June 2018, of the most-comprehensive-yet analysis of changes to the ice sheet. The new data showed that ocean-driven melting has caused rates of ice loss from West Antarctica to triple from 53 ± 29 billion to 159 ± 26 billion tonnes per year from 1992 to 2017.[110] Forty percent of the total ice mass loss over that period has occurred in the last five years, suggesting a recent and significant acceleration in the loss rate.

Over the same period, ice-shelf collapse had increased the rate of ice loss from the Antarctic Peninsula almost five-fold from 7 ± 13 billion to 33 ± 16 billion tonnes per year. Two West Antarctic glaciers – Pine Island and Thwaites — are of particular concern, with the latter "increasingly being viewed as posing a potential planetary emergency because of its enormous size and its role as a gateway that could allow the ocean to someday access the entirety of West Antarctica, turning the marine-based ice sheet into a new sea".[111]

This is the scenario Prof. James Hansen warned about a decade ago in a paper on sea-level rise and scientific reticence: "Let us say that the ice sheet contribution is one centimetre for the decade 2005-2015 and that it doubles each decade until the West Antarctic Ice Sheet is largely depleted. That time constant yields sea-level rise of the order of five metres this century. Of course I can not prove that my choice of a ten-year doubling time for non-linear response is accurate, but I would bet $1000 to a donut that it is a far better estimate than a linear response for the ice sheet component of sea-level rise [of around 0.5 metre]."[112]

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105 Bloomberg, 2012, 'Arctic sea ice heads for record low', Bloomberg, 17 August 2012, <http://www.bloomberg.com/news/2012-08-17/arctic-sea-ice-heads-for-record-low-as-melt-exceeds-forecasts.html>.

106 Velicogna, I 2009, 'Increasing rates of ice mass loss from the Greenland and Antarctic ice sheets revealed by GRACE', *Geophysical Research Letters*, vol. 36, L19503.

107 Rignot, E, Mouginot, J, Morlighem, M, Seroussi, H & Scheuchl, B 2014, 'Widespread, rapid grounding line retreat of Pine Island, Thwaites, Smith, and Kohler glaciers, West Antarctica, from 1992 to 2011', *Geophysical Research Letters*, vol. 41, pp. 3502–3509.

108 DeConto, R & Pollard, D 2016, 'Contribution of Antarctica to past and future sea-level rise', *Nature*, vol. 531, pp. 591–597.

109 Pollard, D, DeConto, R & Alley, R 2015, 'Potential Antarctic Ice Sheet retreat driven by hydrofracturing and ice cliff failure', *Earth Planetary Science Letters*, vol. 412, pp. 112– 121.

110 The IMBIE Team 2018, "Mass balance of the Antarctic Ice Sheet from 1992 to 2017", *Nature*, vol. 558, pp. 219–222.

111 Mooney, C 2018, "Antarctic ice loss has tripled in a decade. If that continues, we are in serious trouble", *Washington Post*, 13 June 2018.

112 Hansen, J 2007, op. cit.

SEA LEVEL RISE

The fate of the world's coastlines has become a classic example of how the IPCC, when confronted with conflicting science, tends to go for the "least drama" position.

In the 2001 assessment report, the IPCC projected a sea-level rise of 2 millimetres per year. By 2007, the researchers found that the range of the 2001 predictions were lower than the actual rise. Satellite data showed that levels had risen by an average of 3.3 millimetres per year between 1993 and 2006.

The worst-case scenario in the 2007 report, which looked mostly at thermal expansion of the oceans as temperatures warmed, projected up to 0.59 metre of sea-level rise by century's end. In an extraordinary verbal contortion, it then said it did "not assess the likelihood, nor provide a best estimate or an upper bound for sea-level rise… The projections do not include uncertainties in climate–carbon cycle feedbacks nor the full effects of changes in ice sheet flow, therefore the upper values of the ranges are not to be considered upper bounds for sea-level rise. They include a contribution from increased Greenland and Antarctic ice flow at the rates observed for 1993-2003, but this could increase or decrease in the future."

Yet, in early 2007, Rahmstorf had presented a "semi-empirical relation… that connects global sea-level rise to global mean surface temperature" which resulted "in a projected sea-level rise in 2100 of 0.5 to 1.4 meters above the 1990 level".[113]

Many climate scientists received the 2007 IPCC report's suggestion of a sea-level rise of 18–59 centimetres by 2100 with dismay, because it seriously underestimated the problem. Even before the 2007 report appeared, Hansen warned of a "scientific reticence" which "in a case such as ice-sheet instability and sea-level rise (results in) a danger in excessive caution. We may rue reticence, if it serves to lock in future disasters."[114]

Within a year, a report from the US Geological Survey warned that sea-level rise will "substantially exceed" official UN projections and could top 1.5 metres by the end of the century.[115] And by 2009, various studies offered drastically higher projections than the IPCC. Australian Government reports noted: "Recent research, presented at the Copenhagen Climate Congress in March 2009, projected sea-level rise from 0.75 to 1.9 metres relative to 1990, with 1.1–1.2 metres the midrange of the projection." And: "Current estimates of sea-level rise range from 0.50 metre to over 2 metres by 2100."[116]

Yet extraordinarily, the 2014 IPCC assessment report repeated the mistake and actually produced a numerically smaller figure (0.55 metre as compared to 0.59 metre in 2007) despite mounting evidence of polar ice-mass loss: "Global mean sea-level rise will continue during the 21st century, very likely at a faster rate than observed from 1971 to 2010. For the period 2081–2100 relative to 1986–2005, the rise will likely be in the ranges of 0.26 to 0.55 metre for RCP2.6, and of 0.45 to 0.82 metre for RCP8.5." And then, having noted estimates for sea-level rise to 2100 of between 1.15 metres and 2.4 metres, the report said: "Considering this inconsistent evidence, we conclude that the probability of specific levels above the likely range cannot be reliably evaluated." If some work could not be "reliably evaluated", how could they be sure of the much lower estimates that they had quantified?

113 Rahmstorf 2007, op cit.

114 Hansen 2007, op cit.

115 Randerson, J 2008, 'Sea level could rise by 150cm, US scientists warn', *The Guardian*, 16 December 2008.

116 Australian Government, 2009, *Climate Change Risks to Australia's Coasts: A first pass national assessment*, Australian Government, Canberra; CSIRO 2009, *Science Update 2009*, no. 2, November 2009, Australian Government, Canberra.

This event shot down any shreds of IPCC credibility on sea-level rise that may have lingered after 2007.

An updated NOAA sea-level rise report, released in August 2017, recommends a revised worst-case sea-level rise scenario of 2.5 metres by 2100, 5.5 metres by 2150 and 9.7 metres by 2200. It says sea-level science has "advanced significantly over the last few years, especially (for) land-based ice sheets in Greenland and Antarctica under global warming", and hence the "correspondingly larger range of possible 21st century rise in sea level than previously thought". It points to "continued and growing evidence that both Antarctica and Greenland are losing mass at an accelerated rate", which "strengthens an argument for considering worst-case scenarios in coastal risk management".[117]

Today the discussion amongst experts is for a sea-level rise this century of at least one metre, and perhaps in excess of two metres. The US Department of Defence uses scenarios of one and two metres for risk assessments. Evidence (cited above) that Antarctica by itself has the potential to contribute more than a metre of sea-level rise by 2100, and that at 1°C of warming, West Antarctic glaciers are in "unstoppable" meltdown for one-to-four metres of sea-level rise, only add to grave concern that the IPCC reports are simply irrelevant on this matter.

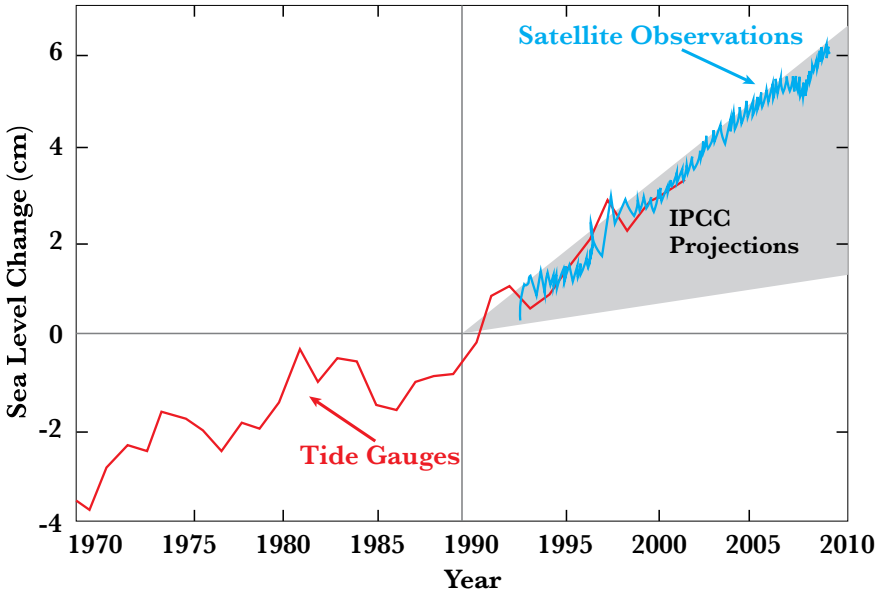

Figure 4: Observed sea-level rise 1970-2010 from tide gauge data (red) and satellite measurements (blue) compared to model projections for 1990-2010 from the IPCC (grey band). (Source: *The Copenhagen Diagnosis*, 2009)

117 NOAA 2017, *Global and regional sea-level rise scenarios for the United States*, NOAA, Silver Spring MA.

“Political reality must be grounded in physical reality or it’s completely useless.”

Prof. Hans Joachim Schellnhuber, 2009


POLITICAL
UNDERSTATEMENT

POLITICISATION

Much has been written about the inadequacy of IPCC processes, and the politicisation of its decision-making.

Scientists say one reason the IPCC's work is too conservative is that unwieldy processes mean reports do not take the most recent research into account. The cutoff point for science to be considered in a report is so far in advance of publication that the reports are out of date upon release. This is a crucial failure in a field of research that is rapidly changing. Inez Fung at the Berkeley Institute of the Environment, California says that for her research to be considered in the 2007 IPCC report, she had to complete it by 2004. This is a typical experience that she identifies as "an awful lag in the IPCC process".[118]

IPCC *Assessment Reports* are compiled by working groups of scientists within guidelines that urge the building of consensus conclusions from evidence presented, though that evidence itself may be diverse and sometimes contradictory in nature. The general result may be described as middle-of-the-road reporting. Propositions supported by the greater quantity of research papers presented win out against propositions that might be outliers in terms of quantity of papers presented, though the latter may be no less scientifically significant.

The higher-impact possibilities may have less research available for consideration, but there are good risk-management reasons for giving such possibilities more prominence, even if the event probability is relatively low.

For example, the projected sea-level rise in the 2007 report was well below the subsequent observations. This occurred because scientists compiling the report could not agree on how much would be added to sea-level rise by melting polar ice sheets, and so left out the data altogether to reach "consensus". Science historian Naomi Oreskes calls this "consensus by omission".[119]

This is the consensus problem at the scientific level, but there is also a problem at the political level. In the first instance, the powerful coordinating authors for reports are selected by political representatives of the 195 member nations of the IPCC.

In the second instance, whilst the full-length IPCC *Assessment Reports* are compiled by scientists, the shorter and more widely reported SPMs require consensus from diplomats in "a painstaking, line-by-line revision by [political] representatives from more than 100 world governments — all of whom must approve the final summary document".[120]

As early as the IPCC's first report in 1990, the United States, Saudi Arabian and Russian delegations acted in "watering down the sense of the alarm in the wording, beefing up the aura of uncertainty".[121] Prof. Martin Parry of the UK Met Office, co-chairman of an IPCC working group at the time, exposed the arguments between scientists and political officials over the 2007 IPCC *SPM*: "Governments don't like numbers, so some numbers were brushed out of it."[122]

In 2014, *The Guardian* reported increasing evidence that "the policy summaries on climate impacts and mitigation by the IPCC were significantly 'diluted' under political pressure from some of the world's biggest greenhouse gas emitters, including Saudi Arabia, China, Brazil and the United States".[123]

118 Barras, C 2007, 'Rocketing CO2 prompts criticisms of IPCC', *New Scientist*, 24 October 2007.

119 Scherer 2012a, op cit.

120 Ibid.

121 Leggett, J 1999, *The Carbon War: Global warming and the end of the oil era*, Routledge, New York.

122 Adam, D 2007, 'How climate change will affect the world', *The Guardian*, 20 September 2007.

123 Ahmed, N 2014, 'IPCC reports 'diluted' under 'political pressure' to protect fossil fuel interests', *The Guardian*, 15 May 2014.

One of the 2014 report's more powerful sections was deleted during last minute negotiations over the text. The section tried to specify other measures that would indicate whether we are entering a danger zone of profound climate impact, and just how dramatic emissions cuts will have to be in order to avoid crossing that threshold. Prof. Michael Oppenheimer, an eminent climate scientist at Princeton University who was also part of the core writing team, suggests that politics got in the way.[124]

Oliver Gedden, head of the EU Research Division at the German Institute for International and Security Affairs in Berlin, says climate scientists and economists who counsel policymakers are being pressured to extend their models and options for delivering mitigation later, which has "introduced dubious concepts, such as repaying 'carbon debt' through 'negative emissions' to offset delayed mitigation — in theory".[125] He says that climate researchers who advise policymakers feel that they have two options, to be pragmatic or be ignored: "Many advisers are choosing pragmatism… Each year, mitigation scenarios that explore policy options for transforming the global economy are more optimistic — and less plausible… The scientific community must defend its independence from outside interference."[126]

"It may seem impossible to imagine that a technologically advanced society could choose, in essence, to destroy itself, but that is what we are now in the process of doing."

Elizabeth Kolbert, Field Notes from a Catastrophe, 2006

124 Leggett, J 2014, 'Why two crucial pages were left out of the latest UN climate report', Jeremy Leggett, 4 November 2014, <http://www.jeremyleggett.net/2014/11/why-two-crucial-pages-were-left-out-of-the-latest-u-n-climate-report/>.

125 Geden, O 2015, 'Climate advisers must maintain integrity', *Nature*, vol. 52, pp. 27-28.

126 ibid.

GOALS ABANDONED

The IPCC and the UNFCCC are the twin climate science and policy development organisations of the UN.

Conferences of the Parties (COPs) under the UNFCCC are political fora, populated by professional representatives of national governments, and subject to the diplomatic processes of negotiation, trade-offs and deals. In this sense, the COPs are similar in process to that of the IPCC by which the *SPM* are agreed by diplomats. The decision-making is inclusive (by consensus), making outcomes hostage to national interests and lowest-common-denominator politics.

The COP 21 *Paris Agreement*[127] is almost devoid of substantive language on the cause of human-induced climate change and contains no reference to "coal", "oil", "fracking", "shale oil", "fossil fuel" or "carbon dioxide", nor to the words "zero", "ban", "prohibit" or "stop". By way of comparison, the term "adaptation" occurs more than eighty times in 31 pages, though responsibility for forcing others to adapt is not mentioned, and both liability and compensation are explicitly excluded. The *Agreement* has a goal but no firm action plan, and bureaucratic jargon abounds, including the terms "enhance" and "capacity" appearing more than fifty times each.

The proposed emission cuts by individual nations under the *Paris Agreement* are voluntary (unilateral), without an enforceable compliance mechanism. In this sense, the *Agreement* cannot be considered "binding" on signatories. The voluntary national emission reduction commitments are not critically analysed in the *Agreement*, but noted to be inadequate for limiting warming to 2°C.

The Paris voluntary national commitments would result in emissions in 2030 being higher than in 2015 and are consistent with a 3.4°C warming path, and significantly higher if the warming impacts of carbon-cycle feedbacks are considered. Unless dramatically improved upon, the present commitments exclude the attainment of either the 1.5°C or 2°C targets this century without wholly unrealistic assumptions about negative-emission technologies.

The UNFCCC primary goal is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system".[128] But what is "dangerous"? Traditionally, policymakers have focused on the 2°C target, but the *Paris Agreement* emphasises "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C".

With the experience of global warming impacts so far, scientists have distinguished between "dangerous" (1-2°C band) and "extremely dangerous" (above 2°C) climate warming.[129]

But we now have evidence that significant tipping points — for example, summer sea-ice-free Arctic conditions, the loss of West Antarctic glaciers and a multi-metre sea-level rise — have very likely been passed at less than 1°C of warming.[130] As well, evidence is accumulating that around the current level of warming more elements of the system may be heading towards tipping points or experiencing qualitative change. These include the slowing of the Thermohaline Circulation (the Atlantic conveyor), likely as a result of climate change; accelerating ice-mass loss from Greenland and Antarctica; declining carbon efficiency of the Amazon forests and other sinks; and the vulnerability of Arctic permafrost stores. Warming of 1.5°C would set sea-level rises in train sufficient to challenge significant components of human civilisation, besides reducing the world's coral ecosystems to remnant structures.

127 UN 2015, *Paris Agreement*, United Nations, New York, <http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf>.

128 UNFCCC n.d., 'First steps to a safer future: Introducing The United Nations Framework Convention on Climate Change', United Nations, <http://unfccc.int/essential_background/convention/items/6036.php>.

129 Anderson, K & Bows, A 2011 'Beyond 'dangerous' climate change: emission scenarios for a new world', *Philosophical Transactions of the Royal Society A vol.* 369, pp. 20–44.

130 Livina & Lenton 2013, op. cit.; Rignot, Mouginot et al. 2014, op. cit.; DeConto & Pollard 2016, op. cit.

In other words, climate change is already dangerous, but the UNFCCC processes have not acknowledged this reality, proposing higher warming targets as policy goals. Nor has the IPCC process, with the lags in its publication process, and a "burning embers" representation of the risks that again looks too conservative.[131]

An expert panel recently concluded that warming would need to be limited to 1.2°C to save the Great Barrier Reef.[132] That is probably too optimistic, but with a current warming trend of about 1.1°C and 2016 global average warming above 1.2°C, it also demonstrates that climate change is already dangerous.

The question as to what would be safe for the protection of people and other species is not addressed by policymakers.

If climate change is already dangerous, then by setting the 1.5°C and 2°C targets, the UNFCCC process has abandoned the goal of preventing "dangerous anthropogenic influence with the climate system" for this century.

The UNFCCC key goals "to ensure that food production is not threatened" and achieving "a time-frame sufficient to allow ecosystems to adapt naturally to climate change" have been discarded for all practical purposes. Food production is already threatened by rising sea levels and inundation, shifting rainfall patterns and desertification, and extreme heatwave and wildfire episodes. Such events became a driver of the Arab Spring and a threat multiplier in the Syrian conflict and in Darfur.[133]

Ecosystems, including coral reefs, mangroves and kelp forests in Australia, are degrading fast as the world's sixth mass extinction gathers pace. Major ecosystems are now severely degraded and climate policymakers have no realistic agreement to save or restore them, from the Arctic to the Amazon, from the Great Barrier Reef to the Sahel.

The *Paris Agreement* recognised the "fundamental priority of safeguarding food security" (note the change from the original goal to "ensure" food production is not threatened). It made no reference to earlier commitments to act within time-frames sufficient to allow ecosystems to adapt naturally to climate change, suggesting this goal has been (literally) dropped.

131 O'Neill, B, Oppenheimer, M, Warren, R, Hallegatte, S, Kopp, RE, Portner, HO, Scholes, R, Birkmann, J, Foden, W, Mach, K, Marbaix, P, Mastrandrea, M, Price, J, Takahashi, K, van Ypersele, JP & Yohe, G 2017, 'IPCC reasons for concern regarding climate change risks', *Nature Climate Change*, vol. 7, pp. 28–37.

132 Hannam, P 2017, 'Warming limit of 1.2 degrees needed to save Great Barrier Reef: expert panel', *The Age*, 2 August 2017.

133 Werrell, CE & Femia, F 2013, *The Arab Spring and Climate Change*, edn., Centre for American Progress/Stimson/The Center for Climate and Security, Washington.

A FAILURE OF IMAGINATION

At the London School of Economics in 2008, Queen Elizabeth questioned: "Why did no one foresee the timing, extent and severity of the Global Financial Crisis?" The British Academy answered a year later: "A psychology of denial gripped the financial and corporate world… [it was] the failure of the collective imagination of many bright people… to understand the risks to the system as a whole."[134]

A "failure of imagination" has also been identified as one of the reasons for the breakdown in US intelligence around the 9/11 attacks in 2001.

Prof. Max Bazerman of Harvard University has asked why societies fail to implement wise strategies to prevent "predictable surprises", a term he coined to describe events that catch organisations and nations off-guard, despite necessary information being available to anticipate the event. Bazerman identifies five psychological patterns that help to explain the failure to act on climate:

> " … positive illusions lead us to conclude that a problem doesn't exist or is not severe enough to merit action… we interpret events in an egocentric, or self-serving, manner… we overly discount the future, despite our contentions that we want to leave the world in good condition for future generations… we try desperately to maintain the status quo and refuse to accept any harm, even when the harm would bring about a greater good [and] we don't want to invest in preventing a problem that we have not personally experienced or witnessed through vivid data."[135]

Bazerman suggests that many political leaders will not want to act until great, demonstrable harm has already occurred.

This problem is widespread at senior levels of government and global corporations. A 2016 report, *Thinking the Unthinkable* (see page 9), based on interviews with top leaders around the world, found that: "A proliferation of 'unthinkable' events… has revealed a new fragility at the highest levels of corporate and public service leaderships. Their ability to spot, identify and handle unexpected, non-normative events is… perilously inadequate at critical moments… Remarkably, there remains a deep reluctance, or what might be called 'executive myopia', to see and contemplate even the possibility that 'unthinkables' might happen, let alone how to handle them."[136]

Such failures are manifested in two ways in climate policy. At the political, bureaucratic and business levels in the underplaying of the high-end risks and in failing to recognise that the existential risks of climate change are totally different from other risk categories. And, at the research level, as embodied in IPCC reports, in underestimating climate change impacts, along with an under-emphasis on, and poor communication of, the high-end risks. The IPCC reports have not provided a sufficient evidentiary base to answer a key question for normative policymaking: what would be safe? As noted previously, IPCC processes paid little attention to less than 2°C scenarios until prompted to do so by the political sector.

Climate policymaking at all levels of government uses the reports of the IPCC as the primary physical science basis. The failure of the IPCC to report in a balanced manner on the full range of risks and to fully account for high-end outcomes leaves policymakers ill-informed. This undermines the capacity of governments and communities to make the correct decisions to protect their well-being, or indeed to protect human civilisation as a whole, in the face of existential risks.

134 Stewart, H 2009, 'This is how we let the credit crunch happen, Ma'am …', *The Guardian*, 26 July.

135 Bazerman, M 2006, 'Climate change as a predictable surprise', *Climatic Change*, vol. 77, pp. 179–193.

136 Gowing, N & Langdon, C 2016, op cit.

ADDRESSING EXISTENTIAL CLIMATE RISK

This report demonstrates the risk that both the speed and extent of future human-induced climate change impacts has been badly underestimated. At the social level lies the massive inertia of global leaders, who still have great reluctance in accepting that their approach must fundamentally change if humanity, and nature, are to have sustainable futures.

The UNFCCC formally aims for climate policies which "enable economic development to proceed in a sustainable manner". In practice, priority is given to short-term economic considerations. Thus the emphasis has been on ensuring that the emissions-reduction paths developed for policymakers are not economically disruptive.

For example, in 2006 and 2008 respectively, both Sir Nicholas Stern and Prof. Ross Garnaut, in their initial reports to the UK and Australian governments, canvassed the 450 ppm and the 550 ppm atmospheric CO_2 targets. Whilst both concluded that 450 ppm would inflict significantly less damage, they nevertheless advocated starting with the 550 ppm figure because they considered the lower goal would be too economically disruptive. (550 ppm is roughly equivalent to 3°C of warming before carbon cycle feedbacks are considered, and truly devastating for people and nature). They have since acknowledged that evidence of accelerating climate impacts has rendered this approach dangerously complacent.

Rapid reduction of carbon emissions is still excluded from consideration by policymakers because it is deemed to be too economically dislocating. The fact that the present political path of 3°C or more of warming would result in a world overwhelmed by extreme climate impacts, leading to outright chaos, is avoided. The dominant neo-liberal framing of progress, through globalisation and deregulation, suppresses regulatory action which would address the real climate challenge because it undermines the prevailing political–economic orthodoxy.

Discussion around policy choices gives primary emphasis to the role of markets. The commodification of carbon pollution for the purposes of market trading, and the virtue of carbon pricing, are emphasised by policymakers as the most desirable method for achieving decarbonisation. However, these discussions have become unrealistic. They accept the continuing expansion of fossil fuels in the first half of the 21st century, eventually counteracted by massive expansion of negative emission technologies, such as carbon capture and storage and BECCS — which do not even exist at scale — in the second half of the century to draw down excess carbon from the atmosphere. But, by that time it will be too late to prevent irreversible, catastrophic climate impacts.

In so doing, policymakers are complicit today in destroying the very conditions which make human life possible. There is no greater crime against humanity.

After three decades of global inaction, climate change is now an existential risk to humanity. It implies large negative consequences, which will be irreversible, resulting in major reductions in global and national population, mass species extinction, economic disruption and social chaos, unless carbon emissions are rapidly reduced. The risk is immediate, in that it is being locked in today by our insistence on expanding and sustaining the use of fossil fuels when the carbon budget to stay below sensible temperature increase limits is already exhausted.

As one of the countries most exposed to climate impacts, and in the top half dozen carbon polluters worldwide when exports are included, this should be a major concern to Australia. Instead, it is ignored, with many parliamentarians refusing to even accept that human-induced climate change is happening.

In signing and ratifying the 2015 *Paris Agreement*, the global community, Australia included, committed to the objectives of limiting global average temperature increase to "well below 2°C above pre-industrial levels and to pursue efforts to limit the increase to 1.5°C", and "to reach global peaking of greenhouse gas emissions as soon as possible, in accordance with best available science", recognising that "climate change represents an urgent and potentially irreversible threat to human societies and the planet". To meet those objectives, climate action must be reframed around two principles:

- Human-induced climate change represents an immediate and existential threat to humanity; and
- An emergency response is essential if that threat is to be properly addressed.

Such a response should seek to normatively achieve these clearly defined objectives.

SUMMARY

Human-induced climate change is an existential risk to human civilisation: an adverse outcome that will either annihilate intelligent life or permanently and drastically curtail its potential, unless carbon emissions are rapidly reduced.

Special precautions that go well beyond conventional risk management practice are required if the increased likelihood of very large climate impacts — known as "fat tails" — are to be adequately dealt with. The potential consequences of these lower-probability, but higher-impact, events would be devastating for human societies.

The bulk of climate research has tended to underplay these risks, and exhibited a preference for conservative projections and scholarly reticence, although increasing numbers of scientists have spoken out in recent years on the dangers of such an approach.

Climate policymaking and the public narrative are significantly informed by the important work of the IPCC. However, IPCC reports also tend toward reticence and caution, erring on the side of "least drama", and downplaying the more extreme and more damaging outcomes.

Whilst this has been understandable historically, given the pressure exerted upon the IPCC by political and vested interests, it is now becoming dangerously misleading with the acceleration of climate impacts globally. What were lower-probability, higher-impact events are now becoming more likely.

This is a particular concern with potential climatic tipping points — passing critical thresholds which result in step changes in the climate system — such as the polar ice sheets (and hence sea levels), and permafrost and other carbon stores, where the impacts of global warming are non-linear and difficult to model with current scientific knowledge.

However the extreme risks to humanity, which these tipping points represent, justify strong precautionary management. Under-reporting on these issues is irresponsible, contributing to the failure of imagination that is occurring today in our understanding of, and response to, climate change.

If climate policymaking is to be soundly based, a reframing of scientific research within an existential risk-management framework is now urgently required. This must be taken up not just in the work of the IPCC, but also in the UNFCCC negotiations if we are to address the real climate challenge.

Current processes will not deliver either the speed or the scale of change required.

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Climate Action Tracker

Climate crisis demands more government action as emissions rise

Climate Action Tracker

UPDATE

June 2019

NEW CLIMATE INSTITUTE

CLIMATE ANALYTICS

Summary

Global progress is stalling

- Emissions are growing. In 2018, emissions grew at the fastest rate since 2011
- Fossil fuels are expanding. Coal growth is back and natural gas is booming
- Installation of renewable energy is slowing

Public concern is growing as impacts bite

- Climate impacts are becoming clear to a larger number of people
- Public awareness is growing, protests expanding
- Climate change is becoming a political priority

Climate crisis demands bold action

- Time is running out. The IPCC special report on 1.5°C made it clear: incremental steps will not be sufficient. Significant, bold and immediate action is necessary.

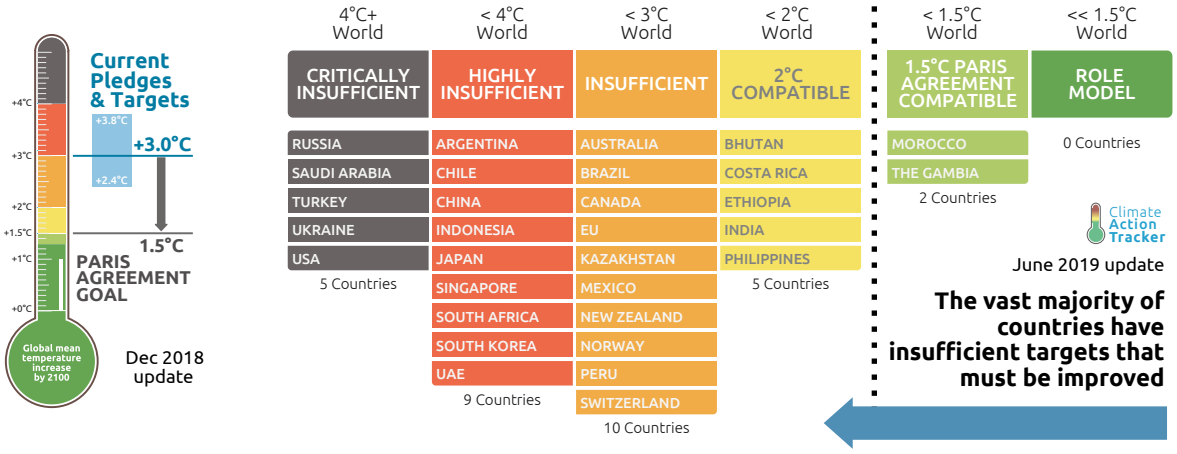
Governments must strengthen Paris targets

- Governments are scheduled to update their Paris Agreement targets (NDCs) by 2020 and must be ambitious. To keep the 1.5°C goal alive, they need to take radical steps and halve global emissions by 2030.

The last year has seen growing public concern and the formation of global movements pushing governments for serious action in the face of rising emissions and escalating climate impacts.

2018 saw energy-related emissions reach yet another historic high after significant net greenhouse gas increases, 85% of which came from the US, India and China. Coal reversed its recent decline and was responsible for over a third of CO_2 emissions. At the same time there was a huge 4.6% surge in natural gas CO_2 emissions and an associated rise in atmospheric methane. This, plus a stagnation in the number of renewable energy installations, make it clear that governments must do a lot more to address the climate crisis.

In previous assessments, the Climate Action Tracker has identified that the vast majority of countries have targets that are woefully inadequate and, collectively, have no chance of meeting the 1.5°C temperature goal of the Paris Agreement.



This is a call for governments all over to step up their game. In particular focus are those governments that have previously presented inadequate NDCs. The CAT-rated "critically insufficient" examples are Russia, Saudi Arabia, Turkey, Ukraine and the USA.

Equally, there are a number of governments that are likely to meet - or bring their emissions close to - their NDC without implementing any more national policies, a strong indication they have not yet reached their "highest possible ambition" as stated in the Paris Agreement and could do well to increase their targets; examples are India, EU and China.

2020 will see an opportunity for governments to update their targets. Up to 80 may announce new targets later this year at the UN Secretary General's Summit in September. A number of countries are beginning to discuss net zero targets, mostly by the year 2050, but most governments are nowhere near taking the radical steps required, especially given that global emissions need to halve by 2030 in order to keep the goal of 1.5°C alive.

There have been many developments at a national and sub-national level. For this update, the CAT has assessed 24 of the 32 countries we cover. Below is a selection of highlights (see page 8 for more details on each country):

Australia – Re-election of coalition government makes progress unlikely
The government has effectively turned its back on any serious attempts of action and is instead relying on "carrying over" surplus emissions units from the Kyoto Protocol as emissions continue to rise.

Brazil – President Bolsonaro continues reversal of environmental policies
Deforestation has begun a rapid rise after the progress made since 2005 and the new administration has already taken steps to weaken key environmental policies and institutions.

Canada – Upcoming October election will determine Canada's direction
The Federal government, playing catch-up on climate, is attempting to implement a number of policies in the face of pushback from some provinces, especially on the mandatory carbon pricing system.

Chile – Plans to phase out coal by 2040 and achieve carbon neutrality by 2050
Chile, hosts of the upcoming COP25, announced plans to close 8 of its 28 coal power plants by 2024, equivalent to 20% of its current coal electricity capacity. This could bring it close to a 1.5˚C pathway.

China – Second year of emissions growth as coal power plant construction ban lifted
China's policies have a huge global impact. It is discouraging that China is continuing to increase its huge coal power plant fleet by 235 GW and is involved in another 102 GW of construction overseas.

Costa Rica – Freshly announced National Decarbonisation Plan 2018-2050
Costa Rica's new decarbonisation goal by 2050 includes a plan with specific policies in the most polluting sectors, bringing its policies very close to a CAT 1.5˚C Paris Agreement-compatible rating.

European Union – Discussing long-term goal while revitalising its Emissions Trading Scheme
A number of new pieces of legislation have been adopted, including new emissions reduction goals for vehicles and discussion on long-term strategy has revealed a shift in dynamics between member states.

Germany – At a crossroads, with plans to adopt overarching climate law by end of 2019
The government has already acknowledged that it will not meet its 40% target for 2020 but intends to adopt a national climate law and coal phase out.

India – On track to become a global renewable energy leader
The ramp up of renewables has continued after the third straight year of RE investment topping fossil fuels. Uncertainty over the future of coal and transport remains. NDC could be much stronger.

Indonesia – Fossil fuel exporter ponders its future
Indonesia is currently developing both its next five-year plan and its long-term vision and much hinges on where it invests. Plans to expand its coal power plant fleet remain despite overcapacity.

New Zealand – Zero Carbon Bill to deliver net-zero emissions by 2050
The newly-introduced bill proposes achieving net zero emissions by 2050 is a big step, but it excludes methane emissions from agriculture and waste, which are the subject of a separate 2050 target.

South Africa – Coal dominant country plans a shift towards renewables
The government's Integrated Resource Plan includes a shift away from coal, halting nuclear expansion and increased adoption of renewables and gas. But will the new energy minister adopt it?

UK – Draft legislation for net-zero goal by 2050
The UK Parliament has declared a Climate Emergency, and PM May has placed draft legislation in front of parliament to achieve net zero emissions by 2050, making it the first G20 economy to do so.

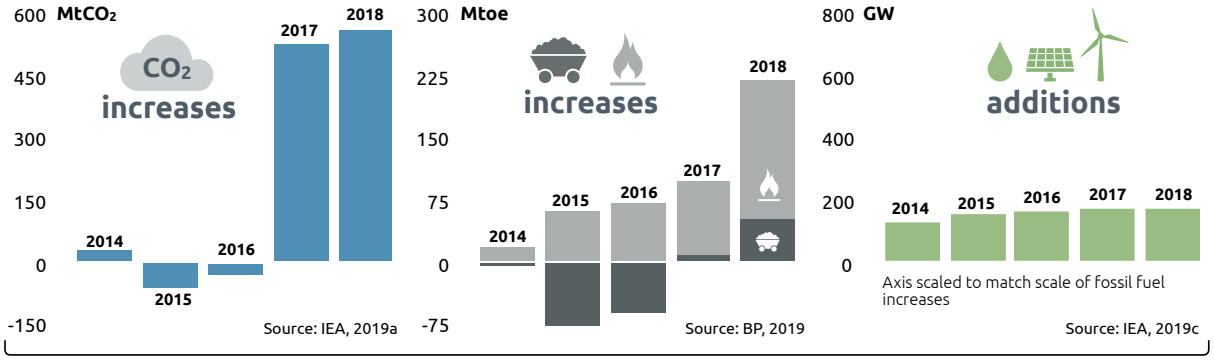
USA – Trump Administration continues rollback of policy amid Green New Deal debate
Calls for net zero emissions through a "Green New Deal" spark debate while oil & gas production records largest ever increase by any country and weakened federal policies potentially cancel state gains.

Contents

Global progress, political momentum and NDC ambition

Global progress is stalling

- In 2018, emissions grew at the fastest rate since 2011
- Coal growth is back and natural gas is booming
- Installation of renewable energy is slowing



Annual changes in global energy-related CO_2 emissions, fossil fuel consumption and renewable energy installations **2014–2018**

Greenhouse gas emissions continue to increase globally. In 2018, energy related emissions reached a historic high of 33.1 $GtCO_2$, and more than a third of these emissions were from coal (IEA, 2019b). While coal remains largest source of CO_2 emissions, the fastest growing source is natural gas, which grew 4.6% from 2017 to 2018.

China, India and the US accounted for 85% of net GHG emission increase, while emissions in Germany, Japan, Mexico, France and the UK declined. Despite the fact that costs for renewable energy continue to decrease year on year, global renewable net capacity additions in 2018 stagnated after almost 20 years of strong annual growth (IEA, 2019c). On a positive note, the growth in electricity produced from renewables grew 7% from 2017 to 2018, more than twice as fast that from fossil fuel-sourced power.

At the same time other GHG emissions are increasing, notably methane. The increase in atmospheric methane concentrations has accelerated in the last few years, which appears likely to reflect in significant part increasing emissions of methane from oil and gas production, including fracking.

Methane is a much more powerful greenhouse gas than CO_2, some 28 times more powerful on mass for mass basis measure over a 100 year timeframe (Myhre et al., 2013). Urgent calls are being made from the scientific community for the need to reduce methane emissions, especially from fossil fuels (Nisbet et al., 2019).

The total greenhouse gas concentration of all the major greenhouse gases (CO_2, CH_4 and N_2O) - known as CO_2 equivalent concentration - is rising at record rates, an average rate of 3.3ppm per year over the last decade, with no sign of slowing (Loh et al., 2019). The CO_2 equivalent concentration of GHGs has recently been estimated as over 500 ppm CO_2 equivalent.

Public concern is growing as impacts start to bite

- Climate impacts are becoming clearer
- Public awareness is growing, protests expanding
- Climate change is becoming a political priority

Rising public concern is taking place against a backdrop of increasing and more devastating climate impacts, with many populations now experiencing first-hand the effects of human-induced climate warming.

The 25th anniversary edition of the WMO "State of the Global Climate" report for 2018 reports ongoing increases in sea level rise and exceptionally high land and ocean temperatures over the past four years, with the trend expected to continue (World Meteorological Organization, 2019).

Developing countries are experiencing the brunt of these impacts - Tropical Cyclone Idai, for example, caused devastating floods and loss of life in Mozambique, Zimbabwe and Malawi. The northern Indian state of Rajasthan recorded 50˚C in the heatwaves in early June 2019 at the same time as New Delhi experienced record high June temperatures - close to 48˚C (BBC News, 2019; India Today, 2019).

PEW Global Attitudes Survey finds climate change is top global threat
Global climate change is a major threat to our country
Source: PEW Research Center

There has been a marked increase in public engagement in climate action in some countries. Examples include Greta Thunberg's Fridays for Future, the Sunrise Movement in the US, and Extinction Rebellion, to name a few. A growing number of Parliaments and councils have declared a "Climate Emergency".

Recent elections indicate that climate change is increasingly becoming a priority for voters. In some countries, elections have shown that there is growing public support for ambitious policies on climate change. In the recent European Union elections, the green parties rose substantially and now holds the balance of power in the European Parliament. In Germany, the Greens carried over 20% of the votes, the second-largest party.

Even in countries where parties with most progressive climate change policies did not win, climate change was an important topic during the elections. In Australia, climate change became a major topic during the elections (The Guardian, 2019), but ultimately it was not decisive, with the incumbent government winning a larger majority, despite its lacklustre performance on climate change, against the background of rising emissions, and extreme weather events.

A Pew Research poll in February found that in 13 of the 26 countries polled, climate change was considered the top international threat (Poushter & Huang, 2019). The share of people concerned has grown since 2013 (56%) to 67%. In ten countries, the share of people who see it as a major threat grew by at least ten percentage points.

In the US, where the Democratic party has begun the process of selecting presidential candidates, climate change is shaping up to be a key issue, with the Green New Deal at the centre of it, and most candidates are producing major climate policy proposals. While the US public is still very much split along party lines in concern around climate change, with Republicans generally less concerned than Democrats, Republican millennials are by far the most motivated, according to Pew (Funk & Kennedy, 2019).

This political momentum could ultimately lead governments to take more ambitious action.

The urgency of the climate crisis demands bold and immediate action

- It has become increasingly clear that incremental steps will not be sufficient. Significant, bold action is necessary.

It was already clear in Paris in 2015 that the national climate targets, in aggregate, were not enough to be consistent with the Paris Agreement's long-term 1.5˚C temperature goal. The IPCC Special Report on 1.5°C made it clear: there is no more time to rely on incremental steps. In the face of the climate crisis, significant, bold climate action is necessary.

In the 2009 Copenhagen Accord, the world aimed to halve global emissions by 2050. Now with delayed action global emissions need to be halved in ten years to meet the 1.5°C warming limit. As we are turning from climate change to a climate crisis, bolder and bigger steps are required from decision-makers.

With climate becoming a priority in public opinion, bold government action is more likely. Recent positive examples include:

Finland – carbon neutral by 2035
Finland has announced a carbon neutral goal of 2035.

Costa Rica – decarbonised by 2050

Costa Rica's new decarbonisation goal by 2050 includes a plan with specific policies in the most polluting sectors, bringing its policies very close to a CAT 1.5˚C Paris Agreement-compatible rating.

United Kingdom – net zero by 2050

The UK Parliament has declared a Climate Emergency, and the government has put in front of parliament the recommendation of the Committee on Climate Change of net zero emissions by 2050. This would be the first G20 economy with a net zero emissions target.

New Zealand – net zero by 2050

In New Zealand, a new zero carbon bill is now before Parliament, mandating a net emissions zero by 2050 (although methane from agriculture and waste is treated separately, and issues remain with its forestry sector accounting).

Chile – reduce coal by 20% in five years, carbon neutral by 2050

Chile will shut down a fifth of its coal capacity in five years. The current share of electricity from coal is 40%. It also aims for carbon neutrality by 2050.

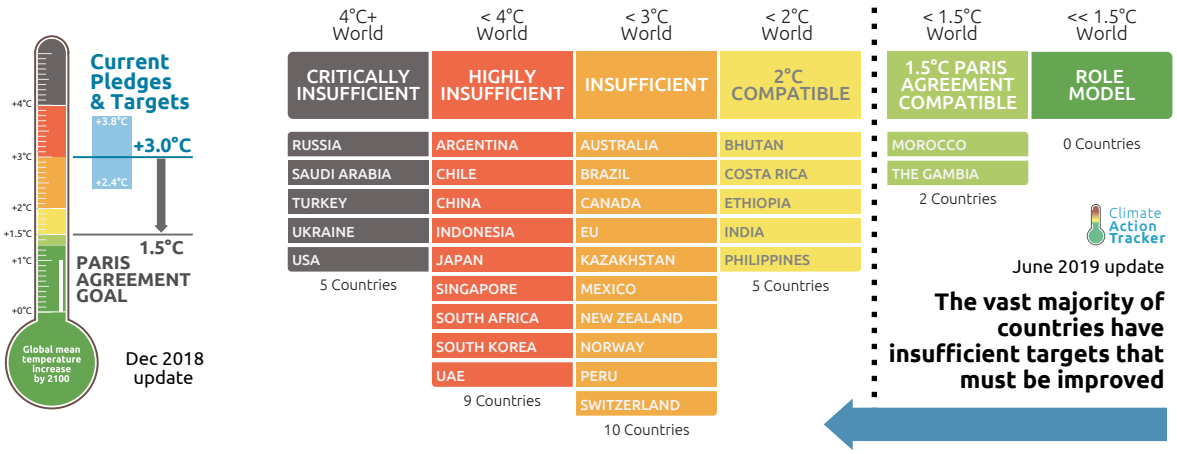
Norway – National pension fund divests

Norwegian Parliament has mandated its national pension fund to divest USD$ 13 billion away from fossil fuels .

Governments must strengthen their Paris targets

Governments are scheduled to update their Paris Agreement targets (NDCs) by 2020 and must be ambitious. To keep the 1.5°C goal alive, they need to take radical steps and halve global emissions by 2030.

Ambitious action at home is not enough. The Paris Agreement requests governments to update their NDCs by 2020 with more ambitious targets and bold actions, reflecting the highest possible ambition that would lead to achieving the Paris Agreement Goal limiting warming to 1.5˚C.



Radical steps need to happen to achieve those goals. 1.5°C means halving emissions by 2030, but right now, we calculate that temperature would continue to rise to around 3.0˚C by the end of the century even if Governments fully implemented their NDCs (Climate Action Tracker, 2018).

In particular focus are those governments that have previously presented insufficient NDCs: they should be able to come up with more ambitious targets. This particularly applies to Russia, Saudi Arabia, Turkey, Ukraine, USA, Argentina, Chile, China, Indonesia, Japan, Singapore, South Africa, South Korea, UEA, Australia, Brazil, Canada, EU, Kazakhstan, Mexico, New Zealand, Norway, Peru and Switzerland.

Equally, there are a number of governments that are likely to meet - or bring their emissions close to - their NDC without implementing any more national policies. This means they have probably not yet reached the “highest possible ambition” as stated in the Paris Agreement and could do well to enhance their NDC’s. This applies to Bhutan, China, EU, Japan, India, Indonesia, Peru, Russia, Saudi Arabia, Singapore, Switzerland, Turkey, UAE, and Ukraine.

The UN Secretary General’s Summit in September this year is a prime opportunity for governments to present an updated NDC. According to the UN, as many as 80 countries may announce enhanced NDC’s in New York (Phys.org, 2019). The Climate Action Tracker will follow the announcements.

And again, incremental steps are not sufficient. The climate crisis demands significant action by all governments.

Country-level updates and CAT ratings

Australia

Re-election of coalition government makes progress unlikely

The government has effectively turned its back on any serious attempts of action and is instead relying on "carrying over" surplus emissions units from the Kyoto Protocol as emissions continue to rise.

Australia's climate policy is further deteriorating, as it focuses on propping up the coal industry and ditches efforts to reduce emissions, ignoring the record uptake of solar PV and storage, and other climate action at state level (Australian Government, 2019; Climate Change Authority, 2017, 2019; Finkel, 2017; Murphy, 2019).

The Australian government has effectively turned its back on global climate action by dismissing the findings of the IPCC Special Report on Global Warming of 1.5°C, announcing it would no longer provide funds to the Green Climate Fund (GCF) and has approved the start of what could prove to be the biggest coal mine in the world, the Adani mine in Queensland (ABC News, 2019a, 2019b; Hannam & Latimer, 2018; Mathiesen, 2019). It will also continue to subsidise fossil fuel extraction and export, against the need to phase out fossil fuels, in particular coal, globally. There are no signs from the re-elected government that they intend to reverse their position on climate change.

Australia's emissions from fossil fuels and industry continue to rise and are now 7% above 2005 levels and increasing. Under current polices, fossil fuel and industry-related emissions are headed for an increase of 8% above 2005 levels by 2030, rather than the 14–17% decrease in these emissions required to meet Australia's Paris Agreement target. This means Australia's emissions are set to far outpace its "Insufficient" 2030 target.

Further undermining this already bad situation is the fact that the Government has stated it intends to "carry over" surplus emission units from the Kyoto Protocol towards its Paris Agreement target (Australian Department of the Environment, 2018). This would significantly lower the actual emission reductions needed to only 4.2 to 4.9% below 2005 levels by 2030 (Climate Analytics, 2019).

The so called "Climate Solutions Package" announced in February 2019 confirms that the Government is not intending to implement any serious policy efforts. Instead, it wants to mainly rely on carry over units, and continue relying on an inadequate instrument, the Emissions Reduction Fund (ERF) now to be called the "Climate Solutions Fund".

The re-elected government continues to plan to underwrite a new coal power plant - completely inconsistent with the need to phase out coal globally by 2050 and in OECD countries by 2030 (Climate Analytics, 2016). If all other countries were to follow Australia's current policy trajectory that we rate "Highly Insufficient", warming could reach over 3°C and up to 4°C.

Brazil

President Bolsonaro continues reversal of environmental policies

Deforestation emissions are up in recent years after the incredible progress made since 2005 and the new administration has already taken steps to weaken key environmental policies and institutions.

In just over 100 days in office, Brazil's new President, Jair Bolsonaro, has moved his country further away from climate action and from fulfilling its commitments under the Paris Agreement. Brazil's remarkable progress in forestry emissions mitigation observed since 2005 has stopped, and deforestation and resulting emissions increases have picked up speed again in recent years (Instituto Homem e Meio Ambiente da Amazônia (Imazon), 2019; PRODES, 2019; Weisse and Goldman, 2019)

Brazil's previous administration had already begun reverting key environmental policies (budget cuts to the environmental authorities, and reversal of LULUCF policies already in place) (Climate Home, 2017a, 2017b; Estado de São Paulo, 2017). Bolsonaro's administration, supported by "ruralist" legislators, has continued with the reversal of key environmental policies and the weakening of environmental institutions.

The government has passed legislation that weakens the institutional and legal framework that helps fight deforestation and other environmental offenses, as well as reforms that substantially weaken the participation of civil society, including pro-environment groups, in policymaking and in the oversight of policy implementation (NBC news, 2019; Observatório do Clima, 2019a, 2019b; The New York Times, 2019).

The changes include eliminating 95% of the Ministry of Environment's budget for climate change related activities (Jornal O Globo, 2019); transferring the body responsible for certifying Indigenous territory from the National Indian Foundation to the Ministry of Agriculture (The New York Times, 2019); easing the rules for converting environmental fines into alternative compensations (Climate Policy Initiative, 2019b; Observatório do Clima, 2019a); changes in the Forest code to extend deadlines for enforcement measures (Climate Policy Initiative, 2019a); and the abolition of most committees and commissions for civil participation and social control in the Federal Government (Observatório do Clima, 2019b).

While it's hard to predict the effect these regulatory changes will have on emissions, most of them have the potential to drive up illegal deforestation and other environmental offenses. Given the key role of the Land Use and Forestry sector in Brazil's NDC and the huge global importance of its forests for environmental services, biodiversity, and carbon sequestration, the Brazilian government urgently needs to strengthen mitigation action in this sector—instead of weakening it.

In addition, since our last assessment, the current administration has not implemented any new policies to halt emissions growth in other sectors. The current situation is so critical that, for the first time in Brazilian history, a number of former Environment Ministers from different political parties have released a joint declaration encouraging civil society and the official institutions to pay close attention to the government's detrimental decisions on the environment (IEA USP, 2019). This should raise concern.

Bolsonaro's agenda on environment is at odds with the urgent need for climate action in Brazil.

Upcoming October election will determine Canada's direction

The Federal government, playing catch-up on climate, is attempting to implement a number of policies in the face of pushback from some provinces, especially on the mandatory carbon pricing system.

Canada continues with the incremental implementation of its Pan-Canadian Framework on Clean Growth and Climate, its overarching strategy for reducing emissions, adopted in 2016 (Government of Canada, 2016); often in the face of provincial pushback.

The Government is implementing its coal-fired power plant phase-out, but it clearly needs to take more climate action, as emissions are still projected to be above 1990 levels beyond 2030, far from its Paris Agreement target and nowhere near a 1.5˚C-compatible pathway.

The Federal government had been facing strong headwinds against climate action at the provincial level, with four provinces (Saskatchewan, Manitoba, Ontario, and New Brunswick) challenging the constitutionality of its mandatory federal carbon pricing system (Perkel, 2019; Reuters, 2019a; The Canadian Press, 2019). These provinces have no - or insufficient - climate plans and the carbon pricing system applies to them while these court challenges proceed. The first of the cases was recently decided in favour of the federal government and will now be appealed to the highest court in the country, the Supreme Court (Hunter, 2019; Reuters, 2019a).

The headwinds reached gale force in April with the election of a conservative government in Alberta (Bakx, 2019). The new government has already begun rolling back the province's climate policy,

while the federal government has stated that it will apply the federal carbon pricing 'backstop' to Alberta as well (Government of Alberta, 2019; Vigliotti, 2019).

Canadians will head to the polls this October to elect their next federal government. It is possible that climate change will be a ballot box issue. There are a number of key pieces of legislation working their way through Parliament to regulate or ban oil and gas industry activity that the current government hopes to pass into law before the summer, all of which may have some bearing on the future of the country's emissions and fossil fuel exports (Government of Canada, 2019a, 2019b).

Canada, a member of the Powering Past Coal Alliance, adopted performance standards on coal and natural gas-fired power stations in December 2018, which will ensure it meets its 2030 coal phase-out date (Government of Canada, 2018b, 2018a). However, it is expected that many of the coal-fired plants will be replaced by new natural gas plants or coal-to-gas conversions, all of which run the risk of being stranded assets, given that gas has a limited role to play as a bridging fuel (Climate Action Tracker, 2017; Government of Canada, 2018a).

There have been some positive developments in Canada in the transport sector; though more work is needed. Canada has adopted sales targets for zero-emissions passenger vehicles of 10% by 2025, 30% by 2030 and 100% by 2040 (Transport Canada, 2019). To reach full decarbonisation of the road transport sector worldwide, the last fossil fuel car should be sold before 2035. In the 2019 Federal Budget, the Canadian government allocated $300 million CAD to support consumers and businesses purchase zero-emissions vehicles (Transport Canada, 2019). The Advisory Council on Climate Action has recommended that the government follow up on these initiatives by imposing supply commitments on car manufacturers (Vrooman & Guilbeault, 2019).

Canada is also vying for a seat on the UN Security Council for 2021-22 and has stated that climate change would be a key focus of its tenure (von Scheel, 2019). The UN Secretary General will host a summit to accelerate action on climate change in September. This is a key opportunity for Canada to demonstrate to the world what leadership on climate change would look like by enhancing its NDC.

In past assessments, the CAT has rated the Canadian NDC as 'Highly insufficient' due to the uncertainty around the extent to which it would rely on its forestry sector sink to meet its target. In its latest 2030 projections, Canada has quantified the extent of that contribution for the first time (Environment and Climate Change Canada, 2018). It is estimated that the forestry sector (LULUCF) will contribute a 7-46 $MtCO_2e$ reduction towards meeting its 2030 target. With this greater clarity, the CAT has changed Canada's rating to 'Insufficient'.

Plans to phase out coal by 2040 and achieve carbon neutrality by 2050

Chile, hosts of the upcoming COP25, announced plans to close 8 of its 28 coal power plants by 2024, equivalent to 20% of its current coal electricity capacity. This could bring it close to a 1.5˚C pathway.

As the host of the upcoming UNFCCC COP25, Chile has a unique opportunity to demonstrate its leadership on ambitious actions to reduce carbon emissions.

In June 2019, Chile announced its plan to completely phase-out coal by 2040 and aim towards carbon-neutrality by 2050 (Ministerio de Energía, 2019). The coal phase-out plan is divided into two stages. By 2024, Chile will close eight of its oldest coal-fired power plants—equivalent to 20% of its current coal electricity capacity.

This is a remarkable step for a country with a 40% coal share in their electricity mix and an example of the type of short-term actions needed to limit temperature increase to 1.5°C as required by the Paris Agreement (Climate Analytics, 2016). Chile will also phase-out its remaining 20 coal plants by 2040, but has not yet specified a detailed phase-out schedule.

In its 2050 Energy Strategy of 2015, Chile had announced renewable energy targets of at least 60% by 2035 and 70% by 2050 for electricity generation (Ministerio de Energía, 2015). Notably, most

recent energy sector planning documents—the Mitigation Plan for the Energy Sector, and the Electromobility Strategy—are aligned with these goals (Ministerio de Energía, 2017b, 2017c).

The Chilean electromobility strategy sets out an action plan to achieve a 40% share of the private vehicle fleet—and 100% of public urban transport—being electric by 2050 (Ministerio de Energía, 2017a). Chile has already made some steps in the right direction: as of January 2019, Chile had the second-largest electric urban public bus fleet in the world (after China), making Chile a pioneer for electric buses in Latin America.

Our analysis which, in comparison to previous assessments, now takes into account emissions reductions from the Electromobility Strategy and the retirement of the first eight coal-fired power plants—suggests that Chile will overachieve its 2020 pledge, and meet its unconditional and conditional Nationally Determined Contribution (NDC) Paris Agreement targets with currently implemented policies.

Additionally, we have estimated the impact of a complete coal phase-out by 2040 under a planned policies scenario. Under this scenario Chile would get to our 2°C compatible range. We have also estimated a range for Chile's net-zero carbon target for 2050. While this highly depends on the size of their forestry sinks, we estimate that the lower end of the range would be consistent with the CAT rating category of 1.5°C Paris Agreement compatible for Chile.

The Climate Action Tracker rates countries based on their NDC targets – the current Chilean 2030 pledge is rated "Highly insufficient." If Chile were to enhance their NDC to reflect their new national targets of phasing out coal by 2040 and achieving carbon-neutrality in 2050, we would upgrade their CAT rating.

Second year of emissions growth as coal power plant construction ban lifted

China's policies have a huge global impact. It is discouraging that China is continuing to increase its huge coal power plant fleet by 235 GW and is involved in another 102 GW of construction overseas.

China is the world's largest greenhouse gas emitter, and its actions both at home and abroad have an enormous impact on global greenhouse gas emissions. Discouragingly, increased fossil-fuel consumption drove an estimated 2.3% increase in Chinese CO_2 emissions in 2018 (Korsbakken, Andrew, & Peters, 2019), a second year of growth after emissions had appeared to level out between 2014 and 2016.

China is simultaneously, and almost paradoxically, the world's largest consumer of coal and the largest solar technology manufacturer, and the choice it makes between the technology of the past versus the future will have a lasting effect on the world's ability to limit warming to 1.5°C.

The IPCC Special Report on 1.5°C found that coal needs to exit the power sector by 2050 globally if warming is to be limited to this level, and efforts by China to reduce coal in the next few years will be critical to this. In global cost-optimal, Paris Agreement-consistent pathways, China phases out coal by 2040 (Climate Analytics, 2016).

China's emissions, like the rest of the world's, need to peak imminently, and then decline rapidly (IPCC, 2018). Discouragingly, China started construction of 28 GW of new coal-fired power capacity in 2018 after a previous construction ban was lifted, bringing its total coal capacity under construction to 235 GW (Shearer, Mathew-Shah, Myllyvirta, Yu, & Nace, 2019).

With current policies, China's greenhouse gas emissions are projected to rise until at least 2030. Under optimistic renewables growth assumptions, energy-related CO_2 emissions could level off over the next few years, but these emissions continue to grow in our upper-bound scenario.

China's actions abroad will also have an important impact on future global greenhouse gas emissions, and China is financing and building both fossil-fuel and renewables infrastructure worldwide. Of all coal plants under development outside of China, one quarter, or 102 GW of capacity, have committed or proposed funding from Chinese financial institutions and companies (Shearer, Brown, & Buckley, 2019). That's roughly double Germany's current coal capacity.

China is on track to meet or overachieve its 2030 Nationally Determined Contribution (NDC), which the CAT rates "Highly insufficient." China's NDC is not ambitious enough to limit warming to below 2°C, let alone to 1.5°C as required under the Paris Agreement, unless other countries make much deeper reductions at comparably greater effort.

Under current policies, China is also likely to achieve its 2020 pledge. Given that China is on track to achieve or overachieve its climate targets, its next step could be to set an example by submitting a strengthened NDC to the Paris Agreement by 2020. China has indicated that it is working on updating its NDC (Darby, 2019).

Freshly-announced National Decarbonisation Plan 2018-2050

Costa Rica's new decarbonisation goal by 2050 includes a plan with specific policies in the most polluting sectors, bringing its policies very close to a CAT 1.5˚C Paris Agreement-compatible rating.

In February 2019, Costa Rica outlined its pathway towards net-zero emissions by 2050 in a new plan: the National Decarbonisation Plan 2018-2050 (Gobierno de Costa Rica, 2019).

The Plan includes strategies for all sectors of the economy, which, if implemented, will lead to further emissions reductions, and get very close to our 1.5°C compatible range. The strategies include electrifying the public transport system, energy efficiency measures in industry, transport (incl. freight), and buildings sectors, and improved farming practices and measures in the waste and agriculture sectors.

The National Decarbonisation Plan is more ambitious than Costa Rica's Paris Agreement targets for 2030 and 2050. The government plans to present an updated Nationally Determined Contribution (NDC) in 2020, which is expected to be informed by this plan, as well as other climate policy planning documents, including the National Strategic 2050 plan.

Costa Rica is close to achieving its 2030 NDC emissions reduction target due to new policies that support the electrification of its transport sector, the country's largest source of greenhouse gas emissions (Gobierno de Costa Rica, MINAE, & MOPT, 2019; Ministerio de Ambiente y Energía, 2015a). This includes the 9518 law on the promotion and incentive of transport electrification - all from renewable energy, and made it a national priority to use renewable energy in all modes of transportation including trains, freight, buses, and taxis (Asamblea Legislativa de la República de Costa Rica, 2018).

The new National Plan for Electric Transportation, published in early 2019, contains a set of strategic actions, the plan for implementation (Gobierno de Costa Rica et al., 2019). It establishes that the bus fleet should be replaced by electric buses every two years by at least 5%, and at least 10% of new taxis concessions are given to electric vehicles, between other measures. Successful implementation of this policy would lead to a 2030 emissions reduction equivalent to 19% of GHG reductions compared to a pathway without this policy.

Costa Rica has also launched multiple initiatives to facilitate the implementation of its NDC. Its climate-related policies and programmes include the second phase of its National Programme for Carbon Neutrality—a carbon neutral certification scheme for businesses and municipalities, Nationally Appropriate Mitigation Actions in the agricultural sector, and the National Energy Plan (Ministerio de Ambiente y Energía - Gobierno de Costa Rica, 2017; Ministerio de Ambiente y Energía, 2015a, 2015b; NAMA Database, 2011). In February 2019 Costa Rica extended its moratorium on oil extraction and exploitation from 2021 until the end of 2050 (Ministerio de Ambiente y Energía - Gobierno de Costa Rica, 2017).

Costa Rica's electricity generation already runs on a very high share of renewable sources, and aims to be 100% renewable by 2021 (Ministerio de Ambiente y Energía, 2015b). In 2018 the country beat its own record by generating 98% of electricity from renewable sources - for the fourth consecutive year (Canelo, 2018).

Discussing long-term goal while revitalising its Emissions Trading Scheme

A number of new pieces of legislation have been adopted, including new emissions reduction goals for vehicles and discussion on long-term strategy has revealed a shift in dynamics between member states.

The last two years witnessed a flurry of climate policy developments at the European level. The implementation of the numerous proposals presented by the European Commission in its Winter Package "Clean Energy For All Europeans" from November 2016 led to the adoption of eight new pieces of legislation.

In some cases, the adopted legislation was more ambitious than the proposals suggested by the Commission. That was especially the case for the share of renewable energy goal at 32% and improving energy efficiency by 32.5% - both by 2030. In both cases the Commission suggested 27%. Achieving both targets would allow the EU to reduce emissions by at least 48%. Yet its NDC target is only "at least 40%", so it's clear the EU could strengthen that target.

The flagship EU climate policy instrument, the Emissions trading scheme, has been revitalised: With the entry into force of the Market Stability Reserve in January 2019, in the coming months almost 400 million allowances will be taken off the market, contributing to reducing their oversupply (European Commission, 2019). This has already been reflected in the price of emissions allowances, which remained above €20 since the beginning of 2019 and even reached €27 in April 2019 (EEX, 2019).

Significant legislative progress has also taken place in the case of emissions from transport sector with the next round of passenger and light commercial vehicle standards agreed as well as, for the first time in the EU, standards for heat duty vehicles (The ICCT, 2019). In 2019, the EU finalised the adoption of a range of new emissions reduction goals for vehicles.

The EU has also started discussing its long-time strategy based on the proposal tabled by the Commission in November 2018, with a focus on reaching emissions neutrality by the middle of the century (European Commission, 2018). While the presentation of the strategy was a step in the right direction, the emissions reduction pathways postpone a large share of the emissions reduction effort to post 2030. This will not only have negative impact on the climate by using up a large portion of the remaining carbon budget in the 2020s, but this way the EU will also forego the opportunity to develop new low carbon industries, especially with climate action accelerating in some other countries.

The negotiations concerning the different pieces of legislation saw some clear new dynamics among the EU member states. While Germany suspended its climate leadership it has, in some cases, worked jointly with Poland as the major objector of an ambitious climate action, but appears to have recently changed its mind. Spain, France, the Netherlands and recently Finland with its carbon neutrality by 2035, with some other countries, held the ground (Finnish Government, 2019). In general, however, the Council representing the EU member states, was much less ambitious than the European Parliament.

Despite a significant legislative effort, the EU still needs to do more to regain its climate action leadership. Formal adoption of the net-zero emissions goal by at the latest 2050, still opposed by some member states, would send a clear signal allowing the industry to adapt and accelerate development of low carbon solutions. Increasing the level of ambition of EU's NDC is essential to achieving the goal of the Paris Agreement goal.

Germany

Paris target rating — NO RATING

At a crossroads, with plans to adopt overarching climate law by end of 2019

The government has already acknowledged that it will not meet its 40% target for 2020 but intends to adopt a national climate law and coal phase out.

Germany is at the crossroads of climate policy. The government plans by the end of 2019 to put the agreement of a stakeholder commission into law and adopt an overarching climate law. In addition it is discussing implementing an additional carbon price. Due to the currently unstable coalition, it remains to be seen how much of these plans it implements by the end of 2019.

A multi-stakeholder commission developed a compromise for ending coal-fired power plants in Germany (Kommission „Wachstum Strukturwandel und Beschäftigung", 2019). Of the 43 GW currently installed coal capacity, the commission proposed to shut down 13 GW by 2022, an additional 13 GW by 2030 and phase out all production by 2038, with the option of bringing this date forward to 2035. The compromise was found only by compensating the affected regions (€40 billion Euro) and the affected companies operating the coal power plants (up to additional €40 bln Euro). The compromise now needs to be enshrined in law.

The positive aspect of this is that the compromise was reached with broad societal consensus. However, the schedule is not fast enough to be compatible with 1.5°C which would require a coal phase-out by 2030 (Climate Analytics, 2018). The compensation is also very high.

In its coalition contract, the current government decided to adopt a national climate law, which would include the national climate targets. The government has already acknowledged that it will not meet its 40% target for 2020. Current projections are at 32%. The failure to meet the 2020 target and making up for by 2030 would result in cumulatively 1 $GtCO_2e$ of additional emissions compared to the original target path (Höhne, Emmrich, Fekete, & Kuramochi, 2019a).

A draft climate law was rejected as it intended to distribute the 55% reduction target by 2030 to sectors and to give responsibility to sector ministries to implement it (Bundesministerium für Umwelt Naturschutz und nukleare Sicherheit (BMU) [Hrsg.], 2019). The building and transport ministries would also be responsible to pay the fines to the EU Commission, if these targets were not met. Such compensation is required by the EU regulation and could be in the order of €60 bln Euro for Germany if no additional measures are implemented (Agora Energiewende & Agora Verkehrswende, 2018; Höhne & Fekete, 2019). An intense debate on a carbon price for the building and transport sectors has started and makes it more likely that such an instrument is adopted (tagesschau.de, 2019).

In addition, the 55% reduction 2030 target (agreed ten years ago) would need to be strengthened to be compatible with the Paris Agreement (Höhne, Emmrich, Fekete, & Kuramochi, 2019b). Implementing this insufficient target would risk locking Germany into stranded assets, if it were to later increase that target. Germany's current goal for 2050 is to be "largely climate neutral". Germany did not participate in an initiative of the President of France, Emanuel Macron, to move the EU to adopt a target of climate neutrality by 2050 (France et al., 2019). The government is considering how such a target could be reached if it were adopted. Media report that Germany now backs an EU-wide net-zero emissions target (Financial Times, 2019).

India

CAT **Paris commitment rating** — 2°C COMPATIBLE

Will policies **meet that target?** — YES

On track to become a global renewable energy leader

The ramp up of renewables has continued after the third straight year of RE investment topping fossil fuels. Uncertainty over the future of coal and transport remains. NDC could be much stronger.

India is on track to becoming a global leader in the field of renewables. While India's NDC is currently rated "2°C compatible" by the CAT, an updated NDC which reflects the lower end of India's current policy projections would be rated "1.5°C Paris Agreement compatible". For this to be

feasible, the incoming government should continue to signal its strong commitment to renewable energy deployment and enshrine similar commitments in other sectors such as the transport sector.

The ramp-up of renewables in India can provide access to affordable power at scale, and quickly. For three consecutive years, renewable energy investment topped that of fossil fuel-related power investments and in 2018, solar investments exceeded those in coal (McKenna, 2019). Moreover, India is likely to achieve the more ambitious part of its NDC goals—a 40% non-fossil-based power capacity by 2030 more than a decade earlier than targeted.

Despite the fact that current policies in place will lead to an overachievement of targets laid out in India's NDC, there is significant uncertainty over the future of coal power capacity in India. The NEP foresees coal-fired power capacity additions of 46 GW between 2022 and 2027 (CEA, 2018), and these risk becoming stranded assets. This expansion is not only inconsistent with the goals of the Paris Agreement, but also inconsistent with demand projections from independent studies (Shearer, Fofrich, & Davis, 2017). Addressing concerns over the grid integration of renewables and cancelling the planned coal expansion plans are pivotal steps in the short term for India to meet the goals of the Paris Agreement.

While interventions in the electricity sector have largely been driven by strong policy commitments, action in the transport sector is governed by uncertainty. The Indian Government set up the National Electricity Mission Mobility Plan (NEMMP), with an aim to provide incentives for the adoption and manufacturing of electric vehicles. This plan operates in an atmosphere of uncertainty over a broader transport strategy, with the government no longer pursuing its initial commitment to a 100% share of electric vehicles in new sales by 2030. This commitment would have been consistent with global benchmarks to reach full decarbonisation.

Fossil fuel exporter ponders its future

Indonesia is currently developing both its next five-year plan and its long-term vision and much hinges on where it invests. Plans to expand its coal power plant fleet remain despite overcapacity.

Indonesia is one of the most populous countries in the world, with substantial emissions from the forestry sector, and a massive coal-fired power generation pipeline. Indonesia is currently developing both its next five-year plan and its long-term vision. Only one of the long-term scenarios under consideration would see absolute emissions decrease by 2045 (Ministry of National Development Planning (BAPPENAS), 2019). Shifting the investments planned for the next five years towards zero-carbon solutions is crucial to putting Indonesia on a development pathway compatible with the Paris Agreement.

Indonesia is a fossil fuel exporter: coal, oil, and gas were responsible for about half the country's non-tax revenue in 2018. However, fossil fuel net exports have been declining since 2013 and international market prices for both coal and oil finished 2018 at lower levels than they began the year (Ministry of Energy and Mining Resources, 2019).

To reduce Indonesia's dependency on international fossil fuel demand, the Government is incentivising domestic coal utilisation for industry and power generation to maximise coal extraction profits. Besides the damage to the climate from continued coal use, this support is not without risk. Indonesia has consistently overbuilt capacity that, combined with inflated energy demand projections, is likely to result in high shares of idle capacities (Republic of Indonesia, 2018, 2019; The Jakata Post, 2018). Yet it is still planning to install over 6 GW of coal-fired power generation by 2020 and about 27 GW by 2028, which is estimated to lead to an obligation to pay over USD 16 billion for idle capacity by 2026 (IEEFA, 2017).

Questions remain as to whether Indonesia will achieve its 2025 renewable energy (RE) target. The government has implemented some policies to support reaching this target, e.g. by regulating the installation of rooftop solar. However, various design elements of these policies and the general investment environment still favour large-scale fossil-fuelled power and prevent a swift and large-scale expansion of renewables (Institute for Essential Services Reform, 2018).

Based on current policies projections, Indonesia is very likely going to overachieve its Paris Agreement targets excluding the forestry sector. However, the CAT rates the Indonesian NDC target (excluding forestry) as "Highly insufficient". This overachievement puts Indonesia in a position to significantly increase the ambition of its NDC. Including the 2025 renewable energy target in the target is the first step, though further action would be needed to become 1.5°C compatible.

Zero Carbon Bill to deliver net-zero emissions by 2050

The newly-introduced bill proposes achieving net zero emissions by 2050 is a big step, but it excludes methane emissions from agriculture and waste, which are the subject of a separate 2050 target.

Prime Minister Jacinda Ardern's government introduced its Zero Carbon Bill into Parliament in May 2019, proposing to achieve net zero emissions of all greenhouse gases, except for methane emissions from agriculture and waste, by 2050 (Government of New Zealand, 2019). Methane emissions from these sectors – about 40% of emissions today - would be reduced by at least 24-47% below 2017 levels by 2050, with an interim target of 10% by 2030.

While the introduction of the Bill is a significant step forward, excluding such a substantial share of emissions from the net zero goal lowers its ambition. During the consultation process for the Bill, an overwhelming majority (91%) of the 15,000 submitters supported achieving net zero emissions for *all* greenhouse gases (Ministry for the Environment, 2018). Previous analysis found that a net zero target for all domestic GHG emissions in 2050 could be consistent with the Paris Agreement (Hare, Schleussner, Schaeffer, & Nauels, 2018).

The Zero Carbon Bill will also establish an independent Climate Commission to oversee a five-year carbon budgeting process to drive the required emission reductions. The Commission will also advise on future revisions of the 2050 target, the use of international credits and the extent to which emissions may be banked or borrowed from one budget to the next. The comparable climate advisory body in the UK unequivocally advised its government in February not to bank emissions from its second carbon budget (UK Committee on Climate Change, 2019a). New Zealand's Climate Change Minister has called the practice "dodgy accounting" (Doherty, 2018).

The Bill does not introduce any policies to actually cut emissions: New Zealand has very few policies to implement this bill.

The CAT rates New Zealand's 2030 emissions reductions target as "Insufficient", and its current policy projections do not put it on track to meet this target.

Prime Minister Jacinda Ardern has vowed to make New Zealand a climate leader. According to our analysis, this would mean: 1) implementing strong policies to reduce emissions quickly, 2) updating the Paris Agreement 2030 emissions reductions targets, including abstaining from carry-overs and other creative accounting rules, and 3) strengthening the long-term target.

We would expect to see PM Ardern taking a leading role at the UNSG Climate Summit in September.

Coal dominant country plans a shift towards renewables

The government's Integrated Resource Plan includes a shift away from coal, halting nuclear expansion and increased adoption of renewables and gas. But will the new energy minister adopt it?

The South African government under recently re-elected President Cyril Ramaphosa released the long-awaited draft of its Integrated Resource Plan (IRP 2018) in August 2018 (Department of Energy, 2018), setting out a new direction in energy sector planning.

The plan includes a shift away from coal, increased adoption of renewables and gas, and an end to the expansion of nuclear power. Directly after the election in May 2019, then Energy Minister Jeff Radebe announced that the IRP updated will be concluded 'very shortly' and be approved by the Cabinet (Cloete, 2019). However, initial remarks by newly appointed Minister Gwede Mantashe of the now combined Department of Minerals and Energy indicate that he will review the current renewable-focused draft IRP of his predecessor and might consider a larger role of other technologies such as coal and nuclear going forward (Heiberg, 2019; Seccombe, 2019).

The revised plan, if adopted in the upcoming weeks as originally proposed under previous Energy Minister Jeff Radebe, would mark a major shift in energy policy, which is remarkable for a coal-dominated country like South Africa. It aims to decommission a total of 35 GW (of 42 GW currently operating) of coal-fired power capacity from state-owned coal and utility giant Eskom by 2050, starting with 12 GW by 2030, 16 GW by 2040 and a further 7 GW by 2050.

Costly coal capacity currently under construction (5.7 GW) would still be completed and another 1 GW of new coal capacity would be commissioned by 2030. The plan also proposes a significant increase in renewables-based generation from wind and solar as well as gas-based generation capacity by 2030 (additional 8.1 GW for wind, 5.7 GW for solar and 8.1 GW for gas by 2030) and beyond, with no further new nuclear capacity being procured.

Implementing the IRP update of 2018 could bring South Africa close to meeting the upper range of its 2030 NDC target. The implementation of the IRP update of 2018 would constitute significant progress in the transformation of the South African energy sector. However, we rate South Africa's NDC target as "Highly Insufficient". To be in line with the Paris Agreement goals for mitigation, South Africa would still need to adopt more ambitious actions by 2050 such as expanding renewable energy capacity beyond 2030, fully phasing out coal-fired power generation by mid-century, and substantially limiting unabated natural gas use.

The South African Parliament also finally approved a carbon tax in February 2019 after two years of consultations (Climate Home News, 2019; Reuters, 2019b), although its immediate impact will likely be limited given tax exemptions for up to 95% of emissions during the first phase until 2022 (KPMG, 2019).

Draft legislation for net-zero goal by 2050

The UK Parliament has declared a Climate Emergency, and PM May has placed draft legislation in front of parliament to achieve net zero emissions by 2050, making it the first G20 economy to do so.

On 12 June, Theresa May's government tabled draft legislation in Parliament to strengthen the country's 2050 target to net-zero emissions of greenhouse gases (UK Government, 2019b, 2019a). This is seen as a legacy issue for May, who will leave office at the end of July (Evans, 2019; Walker, Mason, & Carrington, 2019). Once passed, it will make the UK the first G20 country to adopt such a target.

The new net-zero target was a recommendation from the UK's advisory body, the Committee on Climate Change (CCC), in May, that pointed out that replication of this target across the world, coupled with ambitious near-term emissions reduction would deliver a greater than 50% chance of limiting the increase in global temperature to 1.5°C (UK Committee on Climate Change, 2019b). The Committee also stressed that such a target represented the "highest possible" level of ambition called for by Article 4 of the Paris Agreement. The new legislation will strengthen the previous target of 80% emissions reduction adopted in 2008 (UK Government, 2008). The CCC also recommended targets for Scotland and Wales of net zero in 2045 and 95% reduction below 1990 levels by 2050, respectively.

The Committee stressed the need to strengthen and acceleration policy implementation in a number of areas in order to be able to meet this target. It highlighted that current plans to phase-out combustion cars by 2040 are too late. As achieving this goal would still lead to many of such cars being utilised around the middle of the century, this phase-out date must be moved forward to 2035 - even 2030 if feasible.

The new target is a step in the right direction. However, the expectation that the hydrogen will be most cost-effectively produced with CCS ("blue hydrogen") underestimates the potential of the "green hydrogen" generated in the process of electrolysis utilising renewables sources of energy. It also largely ignores the fact - already stated in the CCC 2018 report that hydrogen from natural gas with CCS is "not a zero-carbon process" (UK Committee on Climate Change, 2018).

Between 1990 and 2018, the UK's emissions have already decreased by 44% whereas its economy has grown by 75% (UK Committee on Climate Change, 2019b). The adoption of the five-year carbon budgets allows its industry to plan in advance and invest in low carbon technologies, knowing these will be needed as the carbon budget decreases.

The 80% emissions reduction target adopted in 2008 resulted in an emissions reduction pathway with the intermediate target of reducing emissions by 57% in 2030 - way more than the EU's "at least 40%" emissions reduction target and more than the German 55% target adopted in its Climate Protection Plan 2050 (European Commission, n.d.; German Federal Ministry for the Environment Nature Conservation and Nuclear Safety, n.d.). The adoption of the net zero target should result in corresponding changes to the periodical carbon budgets and a more ambitious emissions reduction target in 2030.

Trump Administration continues rollback of policy amid Green New Deal debate

Calls for net zero emissions through a "Green New Deal" spark debate while oil & gas production records largest ever increase by any country and weakened federal policies potentially cancel state gains.

The Trump Administration has continued with its campaign to systematically walk back US federal climate policy. If it successfully implements all the proposed actions, greenhouse gas emissions projections for the year 2030 could increase by up to 400 $MtCO_2e$ over what was projected when President Trump first took office. That's almost as much as the entire state of California emitted in 2016.

The Trump Administration rollbacks include:

- Put forward a weak replacement for the Clean Power Plan called the Affordable Clean Energy Rule (U.S. Environmental Protection Agency, 2018a)
- Raised emissions standards for coal-fired power plants (U.S. Environmental Protection Agency, 2018c)
- Proposed freezing vehicle efficiency standards after 2020 under the Safer Affordable Fuel-Efficient Vehicles (SAFE) rule, instead of requiring more stringent standards over time (U.S. Environmental Protection Agency, Administration, & U.S. National Highway Safety Administration, 2018)
- Will not enforce regulations to limit highly potent HFC emissions (U.S. Environmental Protection Agency, 2018d)

- Will also allow methane leaks from oil and gas production to continue for longer before they are found and fixed (U.S. Environmental Protection Agency, 2018b).

The administration has also instructed government agencies to change their climate science methodology.

In 2018, the US overtook Russia and Saudi Arabia to become the world's largest producer of crude oil (U.S. Energy Information Administration, 2018a). It is also the world's largest producer of natural gas (U.S. Energy Information Administration, 2018b), and increased LNG exports by 53% in 2018 (Lester, 2019).

Against this background, climate action has forcefully entered the political debate in the United States following the introduction of the "Green New Deal" legislation in Congress. The resolution, which did not pass the Republican-controlled Senate, calls for economy-wide action to "achieve net-zero greenhouse gas emissions through a fair and just transition" (Ocasio-Cortez, 2019). This would be a major step in the right direction. As the run-up to the 2020 presidential election begins, some Democratic candidates are also putting forward their own climate plans.

Based on the Trump Administration's intent to withdraw from the Paris Agreement, we rate the US "Critically insufficient." In May 2019, the US House of Representatives passed a resolution to keep the US in the Paris Agreement, the first major legislation on climate change in nearly ten years to win congressional approval. Although symbolically important, such a resolution is, however, unlikely to get the necessary approval of the Senate. The existing US target under the Paris Agreement would be rated "Insufficient", as it is not stringent enough to limit warming to 2°C, let alone 1.5˚C.

At the subnational level, some cities, states, businesses, and other organisations are taking action. Recent analysis suggests that recorded and quantified non-state and subnational targets, if fully implemented, could come within striking distance of the US Paris Agreement commitment, resulting in emissions that are 17–24% below 2005 levels in 2025 (incl. LULUCF) (America's Pledge, 2018; Data Driven Yale, NewClimate Institute, & PBL, 2018). 22 states, 550 cities, and 900 companies with operations in the US have made climate commitments, and all 50 states have some type of policy that could bring about emissions reductions (America's Pledge, 2017).

Even with the Trump Administration's steps to rollback federal climate policy, the CAT's June 2019 emissions projections for 2030 are 2–3% lower than they were in 2018, mainly because the projected gas and renewables share in electricity generation has increased, and the projected coal share has decreased. The US is within striking distance of the upper end of its 2020 target, with emissions projections for 2020 only 1–2% higher than the target.

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The Climate Action Tracker (CAT) is an independent scientific analysis produced by two research organisations tracking climate action since 2009. We track progress towards the globally agreed aim of holding warming well below 2°C, and pursuing efforts to limit warming to 1.5°C.

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NewClimate Institute is a non-profit institute established in 2014. NewClimate Institute supports research and implementation of action against climate change around the globe, covering the topics international climate negotiations, tracking climate action, climate and development, climate finance and carbon market mechanisms. NewClimate Institute aims at connecting up-to-date research with the real world decision making processes.

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The EU's NDC after the Talanoa Dialogue

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1 Introduction

Nationally Determined Contributions (NDCs) represent the efforts of Parties to the Paris Agreement to reach the Paris Agreement's long-term goal of limiting warming to well below 2°C, with efforts to limit temperature increase to 1.5°C above pre-industrial levels. Parties are requested to communicate their first NDC, or update their Intended Nationally Determined Contributions, by 2020.[2]

After 2020, the Paris Agreement's five-yearly stocktaking cycle will provide a regular cycle for increasing ambition. The first stocktaking cycle will start in 2023. Every five years the NDCs must be updated, with each successive NDC representing a progression in ambition beyond the previous one.

This so-called ratchet-up mechanism seeks to, over time, bridge the gap between the current combined mitigation commitments from countries and the emissions reductions that are necessary to reach the temperature goals of the Paris Agreement. This timeframe allows Parties to consider scientific, technological and legislative developments and, therefore, make the new NDCs more ambitious than the previous ones.

The European Union (EU) was one of the Parties under the Paris Agreement calling for the inclusion of the ratchet-up mechanism for ambition. Therefore, failing to enhance the EU NDC could lead to a loss of credibility and weaken the EU's influence in climate negotiations under the auspices of the UNFCCC. The EU can lead by example by issuing a more ambition NDC. This enhanced NDC would play a critical role creating momentum on the international level and motivating other Parties to further enhance the ambition of their NDCs.

This paper explores a number of major options that the EU could consider if the decision is made to enhance the EU NDC. It shows that the options are varied, with significant differences in terms of additional mitigation effort, political will and environmental impacts.

These options have been discussed through workshops with stakeholders and policy makers3 and an online survey. The survey asked participants to rate the political and social acceptability, as well as competitive, international and environmental impacts of 9 options for enhancing the EU NDC set out in this paper. The results of these efforts to gather input and foster discussion are analysed at the end of the paper.

[2] Out of 169 NDC that have been communicated by countries, 15 differ from their earlier INDC.

[3] Workshops have been held in six cities during the Autumn of 2018: Brussels, Florence, Prague, Bratislava, Bucharest and Warsaw

2 Current EU's current NDC

The EU's current NDC[4] pledges to achieve a domestic reduction in greenhouse gas (GHG) emissions of at least 40% compared to 1990 levels by 2030:

"The EU and its Member States are committed to **a binding target of an at least 40% domestic reduction in greenhouse gas emissions by 2030 compared to 1990**, to be fulfilled jointly, as set out in the conclusions by the European Council of October 2014" [5]

The EU NDC is set out in a short three-page table summarising its climate and energy targets for 2030: an economy-wide absolute, single year reduction target compared to base year emissions (1990).

The EU NDC comprises all greenhouse gases (GHG) not controlled by the Montreal Protocol (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3), covering 100% of emissions. The EU aims to achieve its target through domestic efforts only: there is no international component to the NDC.

3 Recent developments in EU legislation

The EU's NDC built on the European Council conclusions of 23/24 October 2014[6], which set out the 2030 climate and energy framework. The NDC overall target of at least 40% domestic emission reduction by 2030 was divided in two sub targets (that were not communicated in the NDC): 43% emissions reductions in the EU Emission Trading Scheme (EU ETS) sectors, and 30% in the sectors covered by the Effort Sharing Regulation (ESR – also called non-ETS) sectors (from 2005 levels). Moreover, the EU committed itself to have at least a 27% share of renewable energy in its energy production, and to improve energy efficiency by at least 27% (compared to BAU).

In the last 3 years, negotiations have taken place to implement the legislation necessary to reach these targets. The ETS and ESR kept their above-mentioned targets unchanged. The June 2018 EU Clean Energy Package, however, contained higher renewable energy and

[4] A country's INDC is converted to a Nationally Determined Contribution (NDC) when it formally joins the Paris Agreement by submitting an instrument of ratification, acceptance, approval or accession, unless a country decides otherwise

[5] EU (2015) Intended Nationally Determined Contribution of the EU and its Member States, available at: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/European%20Union%20First/LV-03-06-EU%20INDC.pdf

[6] European Council (2014), European Council (23 and 24 October 2017) – Conclusions, available at: http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/ec/145397.pdf

energy efficiency targets for 2030, raised to at least 32% and at least 32.5% respectively, both with an upward revision clause by 2023.

The upward revision of these targets, including the effects of other legislation recently adopted such as the Energy Performance of Buildings Directive and the LULUCF regulation with its no-debit rule, means that the EU is now set to go well beyond the 2030 target set out in its NDC. In fact, the new renewable energy and energy efficiency targets alone would *de facto* cut emissions by 'slightly over 45%' by 2030, according to European Commissioner Cañete.[7]

It is important to note that clarity is needed in terms of knowing where the EU is going before we can make concrete commitments in terms of where we want to end up. An internal stocktaking exercise is necessary to determine and quantify:

- The impacts of new EU legislation;
- The cumulative effect of current Member State level climate policies;
- The projected GHG emission reductions resulting from the upcoming National Climate and Energy Plans.

The European Commission's ongoing exercise on redefining the EU long-term climate strategy should provide much of the necessary clarity and allow for these policy processes to be taken into account for the enhanced EU NDC.

4 Why enhance the ambition of the EU NDC by 2020?

The Paris Agreement contains provisions to raise ambition over time through the "ratchet-up" or ambition mechanism, by which every consecutive NDC must present a progression in ambition. This mechanism is a key element of the Paris Agreement, and presents an *opportunity* to Parties that have submitted their NDC, such as the EU, to enhance their ambition upwards until 2020.

The first argument for a more ambitious EU NDC is the potential impact it could have in the international arena. As mentioned before, the EU was one of the main proponents of this ambition mechanism, and failing to enhance the ambition of its NDC could not only lead to a loss of credibility and weaken the EU's influential role in climate negotiations, but also undermine the international Paris Agreement process.

[7] European Commission (2018), Opening remarks by Climate Action and Energy Commissioner Miguel Arias Cañete at the Second Ministerial on Climate Action (MoCA) by the EU, China and Canada, available at: http://europa.eu/rapid/press-release_SPEECH-18-4236_en.htm

Of course, the EU cannot close the global ambition gap on its own, but a strong EU commitment could provide motivation and momentum for other Parties to follow suit. The Talanoa Dialogue and its Call for Action could create a framework to promote collective action and help strengthen the argument for an ambitious update to the EU's NDC. Ambitious global emission reduction pathways do need cooperation between Parties – if the EU leads, other must move with us. Climate clubs are an example of a mechanism to keep countries moving together and incentivize others to follow suit.

The second argument is that the EU should go further in the reduction of domestic emission. A new and ambitious international climate change commitment could force the EU into taking domestic climate action, and set the direction of current and future policy makers on the direction the EU economy and society will take. This would also send a strong signal to businesses, investors and citizens, and provides a valuable tool for the EU and its Member States for strategy setting.

On the eve of COP24, the European Commission presented its long-term vision for a climate neutral Europe by 2050,[8] and is currently working on the EUs long-term climate strategy to be submitted by early 2020 to the UNFCCC, as reflected in the Paris Agreement, which will include a vision on the relationship between the – current – 2030 target and longer-term goals.

In addition, as mentioned above, the EU has updated its legislation and agreed to more ambitious domestic targets since the adoption of the Paris Agreement. However, analysis by IC4E and Enerdata[9] indicates that the EU's current policies and commitments are currently not sufficient to reach the EU's current long-term targets for 2050.

The EU still has work to do, but some important steps have been taken towards increasing its climate ambition such as the review of the EU's long-term climate vision which explicitly investigates pathways to reach net-zero emissions in the EU. The European Council is due to provide 'overall direction and political priorities' on the EUs long-term strategy during the first semester of 2019.[10] These elements could be communicated in the new EU NDC.

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[8] European Commission Communication COM (2018) 773 final, "A Clean Planet for all – A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy", Brussels, 28.11.2018

[9] I4CE and Enerdata (2018). Mind the gap: Aligning the 2030 EU climate and energy policy framework to meet long-term climate goals, available at: https://www.i4ce.org/download/full-report-mind-the-gap-aligning-the-2030-climate-and-energy-policy-framework-to-meet-long-term-climate-goals/

[10] European Council conclusions, 13-14 December 2018. Available at: https://www.consilium.europa.eu/en/press/press-releases/2018/12/14/european-council-conclusions-13-14-december-2018/

Finally, the scientific consensus is increasingly clear in that current global commitments are insufficient to adequately tackle climate change. The IPCC's 1.5C special report summary for policy makers[11] concludes that the world needs to reach net-zero emissions by the second half of the century to have a reasonable chance at limiting global warming to 1.5°C.

The UNEP Emissions Gap Report 2017 highlighted that the current commitments made in NDCs cover only approximately one third of the GHG emission reductions that are necessary to be on a least-cost pathway to reaching the Paris Agreement goals of keeping temperature rise "well below 2°C". The available global carbon budget to reach 1.5°C will be depleted by 2030 under current NDCs [12].

Therefore, the scientific evidence shows that current global commitments are not sufficient to achieve the Paris goals. The Council of the European Union recognizes this in the October 2018 Council Conclusions and reconfirms the EU's commitment to leading in the UNFCCC negotiations. The Council conclusions add that the EU will continue to create positive momentum to enhance global climate ambition, and is ready to update its NDC by 2020 – dependent on efforts undertaken by other Parties.[13] This readiness was reiterated at COP 24 in a statement by the High Ambition Coalition, announcing that its members (including the EU) are determined to step up their ambition by 2020.

Enhancing the ambition of the NDCs could therefore show leadership, and while the EU cannot compensate the shortfall in global ambition on its own – other countries also need to urgently review their NDCs – the EU can provide momentum for other Parties to contribute more. UN Secretary-General Antonio Guterres will host heads of states and governments in New York at the UN 2019 Climate Summit to push for more climate ambition. The EU could provide momentum to that meeting by having its new and more ambitious NDC ready.

Note that there are also non-climate related events in the EU that also call for revisiting the EU NDC, Brexit is just the most high-profile example.

5 Options for enhancing the EU's NDC for 2030

[11] IPCC (2018), Global Warming of 1,5°C – An IPCC Special Report on the impacts of global warming of 1,5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Summary for policy makers available at http://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf

[12] UNEP (2017), The Emissions Gap Report 2017 - A UN Environment Synthesis Report, available at https://wedocs.unep.org/bitstream/handle/20.500.11822/22070/EGR_2017.pdf?isAllowed=y&sequence=1

[13] Council of the EU (2018), Council Conclusions for October 9 session. Available at: https://www.consilium.europa.eu/media/36619/st12901-en18.pdf

There are many potential options to enhance the EU NDC, and these can be combined to generate a potentially extensive list of concrete 'recipes'. This paper examines a limited number of options – which can be combined in many ways. They fall under three major approaches. These major approaches and nine options that will be discussed are:

I. Change the NDC's domestic headline target, and adjust the main climate legislation
   - **Option 1**: Enhance the headline target and adjust EU climate legislation
   - **Option 2**: Adopt a carbon budget
   - **Option 3**: Widen the scope of the EU NDC

II. Increase the ambition of climate policies, but without adjusting the EU NDC's headline target
   - **Option 4**: Raise ambition through the ESR
   - **Option 5**: Raise ambition through the EU ETS
   - **Option 6**: Include efforts in other areas in the EU NDC

III. Use international cooperative mechanisms in addition to the existing domestic headline target.
   - **Option 7**: Use international carbon markets
   - **Option 8**: Increase climate finance commitments
   - **Option 9**: Increase support for innovation, technology transfer and capacity building

Beyond these three major approaches, there is also the issue of usefulness of the NDC as a communication tool. The EU NDC has two main roles: decreasing GHG emissions and supporting the Paris process. By improving its quality as a tool for communication, the EU's GHG reduction commitments can more strongly support the Paris process, even if that does not significantly directly impact the climate ambition and environmental delivery of the EU's international climate commitments.

Communication should be in line with transparency, clarity and understanding as per COP decision 1/CP.21. A clear and more transparent NDC would provide a more accurate picture of what the EU is actually doing, and planning to do, to combat climate change. It could also serve as an example for other Parties to the Paris Agreement to clarify their own NDCs and proposed climate measures. Understanding how each Party plans to reach its commitments can provide much needed trust amongst negotiators.

The quality as a tool for communication of the NDC could be upgraded in several ways.

First, the Paris Agreement (Article 4.16) requires Parties, including regional economic integration organizations, to report on internal effort sharing agreements. This element is currently missing from the EU NDC and needs to be added. The EU should therefore report on its internal effort sharing decisions, including how the emissions target (currently at least

40% domestic reduction) is split between ETS and ESR, and how the ESR efforts are divided between Member States.

Second, the EU could add details and clarifications on the tools and policies it is using to reduce its emissions, and discuss relevant governance aspects, as well as opportunities and challenges. It should also detail the monitoring, reporting and verification tools that the EU has put in place to ensure compliance with climate change targets. It could also describe the EU's use clear policy review cycles and calendars and how it could be used to support the Paris Agreement's ambition mechanism.

Third, the NDC could be updated to reflect ongoing climate action and changes to the Energy and Climate Framework agreed since the publication of the EU's INDC, such as the increased targets for Renewable Energy and Energy Efficiency and the implementation of the 2030 Framework and the Energy Union into legal texts. These developments could now be included in the enhanced NDC.

Finally, as already observed, the EU is currently undertaking a process to review its Long-Term Climate Strategy, with the European Commission recently publishing their Communication 'A Clean Planet for all'[14]. The conclusions of that process could be introduced in the NDC. This will clarify the EU's envisaged long-term pathway beyond 2030, to 2050 or even beyond, and might serve as an example to other Parties working on their own long-term decarbonisation strategies.

It is important to note that only enhancing the NDC through improving its value as a communication tool will limit both the domestic and international perception of the enhanced NDC, and its climate impacts. The EU NDC would not be perceived as significantly more ambitious and 'enhanced' if it does not include additional emission reduction commitments. This would be detrimental for the EU's position in the UNFCCC process, undermine the Paris Agreement's global ambition cycle that the EU championed, as well as mobilise opposition to the new NDC from actors such as civil society organisations, business representatives seeking a clear framework for future investment planning and other Parties to the Paris Agreement.

Therefore, improving the NDC by making it more explicit should be seen as no-regret option, to be considered alongside the options for enhancing the EU NDC outlined in the following sections. The current EU NDC could be elaborated on, and in any case needs to include a discussion on the internal effort sharing agreements required under Article 4.16 of the Paris Agreement. Though enhancing the NDC along these lines may provide limited environmental

[14] European Commission Communication COM (2018) 773 final, "A Clean Planet for all – A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy", Brussels, 28.11.2018

benefits, it could serve as an example for other Parties and help the NDC fulfil its function as a communication tool.

5.1 Change the NDC's domestic headline target, and adjust the main climate legislation

In this approach, enhancing the EU NDC would entail changing the NDCs headline target, and aligning the relevant EU legislation to the new target. All options under this approach are options for the EU as a whole – they cannot be used by individual or groups of Member States (no 'fragmentation' of EU climate policy).

Adopting a more ambitious domestic headline target would increase the credibility of the EU, allow it to maintain a central role in climate negotiations and hopefully lead to other Parties boosting their commitments as well. This approach is considered the most visible option and strongest signal from an international perspective. It would also provide the most support for the Paris Agreement ratchet-up process from all the options considered in this paper. In addition, it also provides the most clarity for investment decisions, as it minimizes the fragmentation of policies, and the single market, in the EU.

This approach implies adjusting relevant domestic EU legislation to comply with the changed headline target, and possibly a new effort sharing exercise among Member States and/or sectors. This could involve going through the full ordinary legislative procedure – involving the European Commission, Council of the EU and the European Parliament in the decision-making process. Such a procedure could take several years to finalise, especially if several pieces of legislation need to be adjusted in parallel, and if it necessitates revisiting current burden sharing arrangements.

However, the timing, and order of work, could be kept more flexible. The current NDC and its targets were agreed internally and communicated externally before the process to amend key underpinning legislation (EU ETS Phase 4 and ESR) was initiated.

Announcing a new target, and using the predetermined review processes and calendars to amend existing legislation could enable the issuance of the enhanced NDC without necessitating a long legislative process. Many stakeholders and policy makers would welcome not having to reopen ETS and/or ESR discussions so soon after they have been finalised.

Note that current announced measures in the Energy Union are already projected by the European Commission to overachieve the 40% reduction target. The headline target could therefore also be updated to more accurately reflect currently agreed upon policies without revisiting domestic EU climate policies.

There are three main options for revisiting the headline target and aligning domestic legislation to the new target:

Option 1: Enhance the headline target and adjust EU climate legislation
Option 2: Adopt a carbon budget
Option 3: Widen the scope of the EU NDC

Option 1: Enhance the headline target and adjust EU climate legislation

Option 1 could be considered the most visible and, for many stakeholders, the most logical way of enhancing the EU NDC.

The EU can increase the headline target and then adjust relevant EU legislation. The most likely and relevant candidates among EU legislation for adaptation are the EU ETS, the ESR, the LULUCF regulation, the renewable energy target and the energy efficiency target. Increased climate change efforts could be translated in higher emission reductions targets for any or all of these mechanisms, and the following examples could be implemented:

- Member States' ESR target could be increased. This could be done across the board by the same percentage, or with individual or groups Member States having differentiated additional commitments.

- Existing flexibility mechanisms in the MSR could be limited, either in terms of size, which Member States can use them, the timeframe for their use, or through the abolition of (a) flexibility mechanism(s).

- Increasing the linear reduction factor could be considered the most plausible mechanism for adapting the EU ETS. This would lead to a steeper decline in the annual emission cap for covered sectors.

- Revision of the market stability reserve (MSR). With the current rules, the MSR is expected to remove a considerable number of allowances from the market (more than 3 billion allowances, including the back loaded and unallocated allowances), and to cancel about 2.6 billion of these allowances over Phase 4.[15] Revisions of the MSR are scheduled for 2021 and 2026. During these revision processes the rules could be tweaked to increase the take-in of allowances in the MSR (without them flowing back into the market before 2030) and/or cancellation of allowances in the MSR.

[15] ICTSD, I4CE, EcoAct, Nomisma Energia and the Wegener Centre for Climate Change (2018), 2018 State of the EU ETS report.

- The implementation of a price floor in the EU ETS could also be used to raise ambition in the EU ETS. For example, the California cap-and-trade uses a minimum price at auctions. The climate mitigation impacts of a floor price would need to be examined in detail before it could be used credibly to support a more ambitious NDC.

- Increase the share of allowances that are auctioned under the EU ETS to increase the pressure on industrial sectors to decarbonize. Attention should, however, continue to be given to possible carbon leakage risks.

- A revision of the renewable energy and energy efficiency targets was already concluded earlier in 2018. However, the current energy efficiency targets are not considered legally-binding.

- Increased climate commitments in the LULUCF regulation, for instance replacing the 'no debit' rule with clear Member State targets for enlarging sinks and carbon stocks in the LULUCF sector.

Besides these paths for increasing ambition in any of the main climate-related EU and Energy Union policies, there are many others measures that could be implemented at the EU level. Examples to raise climate change ambition in other climate related fields include:

- Greening the Multiannual Financial Framework.
- Climate-related public procurement rules for EU investments.
- Sector-specific emission reduction targets for sectors covered by either ETS or ESR. Examples include an additional target for phasing out coal and/or other fossil fuels in the electricity generation sector, phasing out of fossil fuelled vehicles or more stringent GHG emission standards in the transportation sector.

If any of these EU-wide tracks are used to enhance the EU NDCs ambition, it would need to be accompanied by an assessment on how it does not undermine the functioning of the EU ETS or the ESR and actually adds ambition to the EU's climate change efforts. For example, phasing out coal in the power sector could have waterbed effects for other sectors covered by the ETS if the emission reductions in the power sector are not compensated, for example by the corresponding cancellation of allowances.

Option 2: Adopt a carbon budget

A carbon budget for the EU would require the EU to define the total amount of GHG emissions to be emitted between the starting year and the end year of the enhanced NDC. This would provide clarity, and put pressure on other Parties to follow suit. From an environmental and scientific perspective, global emissions in 2030 are far less relevant than cumulative global emissions till the end of the century, and resulting GHG concentrations in the atmosphere. It

represents an increase in ambition as a limit is placed on cumulative EU GHG emissions – in contrast to the current single-year approach.

The current single-year target is reached if the emissions in 2030 are at least 40% lower than those in 1990. However, the emissions profile over time is flexible (both before and after 2030), and environmental consequences uncertain. As a somewhat extreme and unlikely example, emissions could be at 1990 levels until 2029, and then be drastically reduced the following year through stringent policies, only for those policies to be relaxed again in 2031.

While the risk of the EU engaging in this type of behaviour is very limited, a carbon budget could be combined with a point year target to rule it out and send a signal. This would ensure that emission trends are decreasing over the period. Without a point year target that is not necessarily the case: lower emissions in earlier years could lead to a surplus that is used in later years of the period.

This is, *de facto*, closely related to the current EU system. The current target is a single-year target, but the main policies implementing the target have prominent budgetary aspects. The EU ETS uses annual caps to determine how many allowances are auctioned and allocated and the 2030 ESR targets for Member States are determined using a linear reduction trajectory defining annual emission reductions for the covered period (2021-2030). However, due to the inclusion of flexibility mechanisms in these policies and the functioning of the MSR, neither the ETS nor the ESR can be considered 'pure' carbon budgets.

If a budgetary approach is to be implemented, an additional discussion will need to be had on defining the budget and how it is set:

- Through the introduction of a linear reduction factor, ending at -40% in 2030 and adopting long-term targets such as climate neutrality;
- Through the adoption of specific targets for every individual year until 2030 (which do not necessarily have to decrease in a linear fashion);
- As a sum of the current ETS and ESR targets, with a consideration of the flexibilities under the ESR, the functioning of the MSR, and clarity on post-2030 ambition;
- Through the calculation of the total budget of GHG emissions allowed to be emitted until 2030 without adopting specific yearly targets.

This discussion could also include the selection of a starting year for the budget. There are three logical options for the starting point:

- 1990 which has been used as the base year for all of the EU's international climate commitments,
- the most recent data possible (for ETS that is 2017, but for ESR that is currently 2016), or,

- 2021, which is the starting year of the next trading periods of both the ETS and the ESR.

The discussion on the starting point of the budget could be central to its design. The selection of the starting point of the ESR was one of the most important elements of its design. Using the 2020 targets of the ESD as the starting point for the 2021-2030 ESR period would have ignored the expected overachievement of the 2020 targets by many Member States (estimated in 2016 by the European Commission at around 1,7 billion tonnes of CO2). The selection of the 2020 target (as opposed to real emissions) for the start of the ESR would therefore have seriously undermined the functioning and environmental delivery of the ESR by 2030. A similar and extensive assessment will need to be made with regards to the starting point of the budget to ensure its functioning.

The end year of the budget could also be a difficult issue to resolve. Does the EU stick with 2030? Or build upon the long-term climate strategy? Or does it define the total carbon budget for the EU till the end of the century or beyond? Is it combined with a point year target?

From an environmental and scientific perspective, an earlier starting point and a later end year may seem more logical. Pragmatically, defining the carbon budget till 2100 seems politically unrealistic, same for a budget covering 1990-2030 as nearly 75% of the period had already passed.

From a communication perspective, a carbon budget has advantages and disadvantages. It would set the emissions the EU allows itself the coming years in stone, especially if it was linked strongly to the EU's long-term climate strategy and proposed emissions pathways to 2050 and beyond. However, the EU's headline target climate target has been a percentage reduction since the start of the Kyoto Protocol. Some would argue that a percentage is more visible for many and that adopting a carbon budget is unnecessarily throwing the communication baby away with the environmental bathwater.

At the international level, there are also possible benefits and pitfalls. A budget could prove divisive at UNFCCC negotiations in light of equity and historic responsibilities for current levels of GHGs in the atmosphere. On the other hand, if it motivates other Parties to adopt carbon budgets it could strengthen the environmental integrity of the Paris Agreement process and NDCs.

Option 3: Widen the scope of the EU NDC

The scope of the EU NDC is economy-wide according to UNFCCC definitions. However, this definition does not accurately reflect the real world. There are several sources of emissions that are not accounted in this approach: emissions from international transport (maritime or aviation) and embedded carbon in goods and services imported into the EU.

Emissions from international maritime and aviation activities are left outside the scope of the UNFCCC negotiations and discussed in the respective UN bodies (the International Maritime Organisation - IMO and the International Civil Aviation Organisation - ICAO). Climate change is currently under discussion in both those bodies. IMO adopted an initial strategy on GHG emission reductions in April 2018, but is yet to implement specific measures to ensure it fulfils the emission reductions envisaged in its initial strategy. ICAO announced the creation of the CORSIA scheme in 2016, and is currently working on the rulebook of this offsetting mechanism for international aviation.

Notwithstanding these deliberations, the EU could add either, or both, sectors to its NDC. Emissions from both these sources will need to be tackled or further tackled at some point, and the EU could show leadership here.

The EU also imports embedded carbon in imported goods. An analysis by CarbonBrief[16] estimated total imports of carbon into the EU at 770 million tonnes in 2014, which is over 17% of emissions from within the EU (not counting GHG embedded in imports) for that same year[17]. Note that this is still not a complete picture of total emissions by EU consumers as it does not take services into account.

Under the UNFCCC, emissions are supposed to be tackled in the source country. However, discussions on an EU border carbon adjustment (BCA) or border carbon tax have been held throughout EU Member States for decades. BCA could have two uses: (1) as a climate policy pushing producers of goods outside the EU to decarbonize and (2) as a carbon leakage protection instrument for industry within the EU. However, imposing climate-related tariffs on imported goods is likely to be met with international resistance and challenges within the WTO's dispute settlement process, as well as considering an explosive political issue at a time when multilateral trade agreements are under stress.

There are also strong international concerns and potential repercussions with regards to unilaterally tackling emissions from international transportation, which severely limits the political feasibility of expanding the scope of the EU NDC to include international aviation and maritime transportation. In 2012, the EU's attempt to bring aviation into the scope of the EU ETS had to be limited to only intra-EU flights due to strong pressure, both from international partners and the aviation industry. This led to the "stop the clock" mechanism that gave ICAO

[16] CarbonBrief (2017), Mapped: the world's largest CO2 importers and exporters, available at: https://www.carbonbrief.org/mapped-worlds-largest-co2-importers-exporters

[17] EEA (2017), Environmental indicator report 2017, available at: https://www.eea.europa.eu/airs/2017/resource-efficiency-and-low-carbon-economy/greenhouse-gas-emission

time to implement a global mechanism to tackle emissions from aviation, which was considered a positive outcome.

The “stop the clock” mechanism allowed the EU to maintain pressure on ICAO and the international community to ensure that the negotiations end up with strong policy that can tackle aviation emissions. If negotiations result in a toothless policy with low environmental integrity, the idea was that the EU could “start the clock” and international aviation to and from the EU would be covered by the EU ETS.

The EU could expand the scope of the NDC to include international transportation in order to add pressure, and create a “stop the clock” mechanism that covers both aviation and maritime transportation. However, this approach is very likely to be strongly opposed by other Parties, and risks undermining progress made and hamper current efforts within ICAO and IMO on climate change.

Time is another dimension along which the scope of the EU NDC could be expanded. The current NDC aims at 2030, with no discussion on what happens after. An enhanced NDC could include targets further in the future, and build upon the EU long-term climate strategy to give a clear signal to international partners, citizens and investors on how the EUs emissions will evolve in the longer term.

Challenges for changing the domestic headline target and adjusting the main climate legislation

Increasing the EUs climate commitments and sharing the additional effort among economic sectors and Member States is challenging at best, and the EU has just closed of a period of long negotiations on different legislative proposals. These proposals were at the core of the EU’s energy and climate framework and set different climate and energy targets up to 2030. It is unlikely that Member States would be willing to revisit and restart in-depth negotiations to discuss a new increase in targets, and how to transpose those targets into the recently finalized legislation.

The legislative process to increase the headline target and adjust domestic legislation will likely involve fulfilling one or more (potentially parallel) full cycles of the ordinary legislative procedure. This could be very time consuming, the legislative procedure for the Phase 4 revision of the EU ETS took 2.5 years to complete and the outcome of such a process is uncertain at best due to political challenges.

However, amending legislation to increase its ambition could arguably be a less profound and intensive process than the recently finished – more technical – negotiations on the EU ETS and the ESR. There are two potential solutions to avoid a full renegotiation of the EU ETS and the ESR:

- Limit the discussion to redefining the NDC headline target, and use the review process for the EU ETS and ESR to align those policies with the new target. However, following the review calendar could present missed opportunities for increasing EU ambition in the future: the first global stocktake under the Paris Agreement rachet-up cycle is to begin in 2023, while the ESR for example is only due to be reviewed for the first time in 2024.
- Limit the scope of the renegotiation by only revisiting the key provisions underpinning the level of ambition of these policies. In the ESR, for example, reopening the entire directive could be avoided by either reviewing the criteria for effort sharing, the Member State targets and/or the use of flexibility mechanisms. The EU ETS discussions could be limited to the Linear Reduction Factor or the cancellation of allowances from the MSR.

These elements are, arguably, less technical and more political in nature and could allow for a more focused revision of the legislation.

Currently the EU is set to overachieve its 2020 target[18]. Raising the target for the EU ETS and/or ESR policies could therefore be done without requiring extra action. However, translating current overachievement into a new target might not be perceived as a true enhancement of the EU NDC – both domestically and internationally.

With regards to adopting a carbon budget in the EU NDC, difficult negotiations will be necessary to define key elements of the carbon budget, such as: start year, end year, whether or not to combine with a point year target etc. On the international level, it could be welcomed and give momentum to a wider movement towards carbon budgets, but it could also restart very difficult discussions on historic responsibilities.

The main challenge for expanding the scope of the NDC to include international aviation, maritime transportation and/or carbon embedded in imports and exports is the political reality that on the international level significant opposition and repercussions are very likely. Including these emissions in the scope of the EU NDC could impact efforts to tackle these emissions at the respective UN bodies, negatively impact the functioning of the WTO and trade negotiations and even affect negotiations in the UNFCCC.

[18] The European Environment Agency estimated in its 2017 Environmental indicator report that 2015 that GHG emissions for the EU will be 26% lower by 2020, compared with 1990. The target for 2020 is 20% lower than 1990, and was reached already in 2014. However, EEA projections do indicate that the current decarbonisation trend will not be sufficient to reach the 2030 target of -40% compared to 1990. Report available at: https://www.eea.europa.eu/airs/2017/resource-efficiency-and-low-carbon-economy/greenhouse-gas-emission

5.2 Increase the ambition of climate policies, but without adjusting the EU NDC's headline target

Domestic action in the EU can also be upgraded without adjusting the headline target of the NDC. Options under this approach include action taken by the EU, but also by coalitions of Member States or a single Member State. In addition, commitments and actions from actors beyond the EU institutions and Member States governments could be included in the NDC. Such actors could include sub-national levels of government (provinces, cities, autonomous regions), economic sectors or even individual civil society organisations and companies.

In practice, it would mean that ambition is *de facto* increased without a *de jure* adjustment of the headline target. The EU NDC's headline target is not changed, but additional domestic commitments are summed up and are added 'below' the headline target.

Three options are envisaged for enhancing the EU NDC without revisiting the headline target:

Option 4: Raise ambition through the ESR
Option 5: Raise ambition through the EU ETS
Option 6: Include efforts in other areas in the EU NDC

The main advantages of this approach are that it does not need to follow EU legislative processes, or involve new negotiations between all Member States in the European Council on an updated target. It allows Member States to take unilateral action – alone or through a coalition of more ambitious Member States. Ambitious Member States could go further than EU legislation for their own reasons: their economy and international competitive position in the short and/or long term could benefit, their international prestige could increase, or climate action is firmly on the political agenda and voters demand ambitious climate action.

However, by allowing more ambitious Member States to forge ahead with more ambitious unilateral action, other Member States can free-ride and risk falling behind in terms of decarbonization trends and investments. Any climate action that is not coordinated at the EU level risks increasing the level of dangerous policy fragmentation. This could affect the competitive landscape within the EU over the short and the long term.

In the short term it is unlikely that more ambitious Member States will ignore carbon leakage risks, which could even put pressure on the EU's internal market. In the longer term, more ambitious Member States could have a competitive advantage in the green economy, with less ambitious Member States struggling to catch up. These elements hamper the convergence of EU countries in terms of income equality and economic performance.

Option 4: Raise the ambition of the ESR

Member States are responsible for national policies to limit emissions from the sectors covered by the ESR legislation – agriculture, transportation, building, non-ETS industry and waste among others. The ESR covers almost 60% of EU emissions, and has an emissions target of -30% by 2030 compared to 2005.

The ESR legislation sets emission reduction targets for individual Member States and includes a number of 'flexibility mechanisms' that Member States can use while implementing national policies to reach their target.

There are many potential options that individual or groups of Member States can use to increase the ambition of the ESR sectors. These options include:

- Unilateral overachievement of existing ESR targets by individual Member States or a coalition thereof. Either by publicly communicating a new, more ambitious, Member State ESR target, or through a commitment to cancel ESR credits (AEAs).
- Cooperation between a coalition of Member States to increase ambition together in a specific sector. Countries could cooperate to implement a cross-border mechanisms in a sector covered by the ESR sector, such as charging infrastructure for electric vehicles.
- Member States can limit their use of the available ESR flexibility mechanisms. Commitments could include, for example, promises not to use any credits from the LULUCF sector or the EU ETS to achieve their ESR target, or commit to not bank or borrow AEAs.

Option 5: Raise the ambition of the EU ETS

Mechanisms to increase the ambition of the EU ETS at the EU level were already listed in a previous section, and include: increasing the LRF, revising the functioning of the MSR, increasing the auction share of allowances and implementing a price floor in the EU ETS.

Individual or groups of Member States - could, in addition, make a commitment to voluntarily cancel allowances from the EU ETS auctioning calendar. Voluntarily cancelling units permanently removes these units from the emissions trading system, thus decreasing the EU's cap on emissions.

The EU ETS Directive does explicitly allow for Member States to cancel allowances to compensate for national policies, for instance the closure of electricity generation capacity due to additional national measures (such as a coal phase out in the power sector). The cancellation of allowances should be done in a transparent and predictable manner to minimize market distortions and ensure that market actors can understand the implications of the cancellation and can act accordingly.

Note that voluntary cancellation by a Member State means that the number of allowances to be auctioned by or on behalf of that Member State is reduced. This means that the Member State itself foregoes the financial benefit of auctioning those allowances.

Option 6: Include efforts in other areas in the EU NDC

Commitments can be made in other areas and through other policies than the EU's main climate change policies. Any policy with a direct, or indirect, climate change mitigation impact could be included in the NDC. These policies could affect sectors already covered by the EU ETS and/or the ESR, but would function beyond those policies at a lower level of climate governance.

Potential fields in which commitments could be made include climate standards for goods and services (for example vehicles), trade policy, fossil fuel subsidies, investment policy, renewable energy, energy efficiency, green mobility, investments in greening the housing stock, af- and reforestation, green procurement etc.

Climate actions in these fields could be undertaken by a wide range of actors: the EU as a whole, individual Member States or a coalition of more ambitious Member States, cities or regions. But they could also take the form of voluntary commitments by economic sectors, companies, financial institutions or citizen associations. The Japanese NDC for example contains commitments taken from action plans from industrial associations, such as the chemical and iron and steel industries.

The enhanced EU NDC could contain an exhaustive list or table of climate commitments made by a wide variety of actors. Examples of such measures are legion, and include:

- Member States phasing out the use of specific or all fossil fuels in the power sector.
- Member States reforming fossil fuel subsidies and tax incentives for green mobility.
- Cities acting to limit their climate impacts, for example through the greening of urban mobility and their building stock.
- Sectors committing more funds to the research and development of CO2 neutral, low-carbon technologies or adaptation technologies. Potentially even promising 'open sourcing' any results to ensure new climate-friendly technologies can be picked up widely as fast as possible.
- Funding from a wide variety of sources for afforestation and reforestation projects in the EU.
- Ambitious renewable energy targets for investments by investment funds or economic sectors. Many large retail and telecom companies have already announced their own renewable energy targets.

Some of these examples could have significant climate change mitigation effects, also beyond the borders of the EU. The EU is an important producer of, and market for, vehicles. If the EU

car industry makes a commitment to phase out the production of fossil fuelled vehicles, this would have significant spill over effects.

Note that any commitments formulated in the NDC should be quantitative and clearly defined. Communicating vague and qualitative efforts in the enhanced NDC could be counter-productive for the EU's role in the UNFCCC negotiations, and for the example the EU NDC should set for other Parties to the Paris Agreement.

Challenges for increasing the ambition of climate policies, but without adjusting the EU NDC's headline target

The main challenge for the EU-wide options under this approach is the need for potentially long and costly negotiations. But there are also significant challenges to adding commitments from other actors than the EU-level to the EU NDC: (1) fragmentation of EU climate policy, and (2) how an NDC that is less harmonised at the EU level would be perceived by domestic actors and international partners.

There is a considerable danger of fragmentation of climate policies and efforts across the EU related to many of the options and examples described above such as a two-speed (or multiple-speed) EU ETS. In addition, the increased ambition of measures by sectors, cities, Member States etc. need to be sufficiently large, transparent and quantifiable in order to provide a credible signal and useful addition to the EU NDC.

Note that fragmenting efforts and policies below the EU level also risks undermining the efficiency and cost-effectiveness of EU's current approach to climate change mitigation. Care is necessary, for example, in terms of how Member States cancel allowances in order to minimise potential market distortions arising from voluntary cancellation. Without clear timetables, transparency and predictability provisions, significant market distortions are possible.

While there are differences between EU Member States in terms of ease to mitigate GHG emissions, such differences should be accounted for at the level of EU policies. Allowing each Member State to decide how far they can go in terms of climate action risks a race to the bottom as countries could seek to compete with regards to stringency of climate policy – undermining the EUs single market.

Changing the nature of the EU NDC from a clear pan-EU target to a list of more bottom-up commitments will also not help the overall message delivered by the EU through its NDC. Commitments made by the EU as a whole provide a stronger signal than commitments made at other levels of governance or in the private sector. There is a difference in optics between EU and Member State level commitments, and an even stronger difference when compared with efforts promised by cities or companies.

In addition, there could also be legal hurdles to adding commitments from non-state actors to the EU NDC. Who is responsible for the compliance with commitments taken below Member State level: e.g. a voluntary contribution from a sector that has activities across the EU. Can such commitments actually be included in an NDC without a Party to the Paris Agreement taking responsibility for them?

Finally, climate change is a collective action problem, and if even the EU Member States cannot coordinate their response together, it does not bode well for the Paris Agreement process where the EU wants to show leadership and push for compromise.

5.3 Use international cooperative mechanisms in addition to the existing domestic headline target

The current EU NDC specifies that the EU's target is to be reached domestically. An enhanced EU NDC could:

- add an international pillar to the domestic target, without updating the NDC's current domestic target ("at least 40% domestic reduction, plus x% through international cooperation"), or
- be included in a new headline target ("at least 40+x% reduction through domestic measures and international cooperation")

Additional international commitments could be undertaken by the EU as a whole, or by Member States or a coalition of Member States.

The advantages of adding an international pillar to the EU's NDC include potentially bypassing the need to revisit the domestic target and new related new effort sharing negotiations. Domestic policies would also not need to be amended, except to potentially allow for the use of international measures within domestic policies (for example using international credits for EU ETS or ESR compliance). At the same time, it could send a powerful signal that the EU, or its Member States, is willing to engage with other Parties to the Paris Agreement, show leadership with respect to international climate cooperation, support other Parties, and ensure they can also benefit more directly from the EU's climate commitments (beyond the global environmental benefits enjoyed by everyone).

The international pillar could include several climate measures. The main options that are discussed in this paper are:

Option 7: Use international carbon markets
Option 8: Increase climate finance commitments
Option 9: Support innovation, technology transfer and capacity building

Option 7: Use international carbon markets

The EU, individual Member States or a group of Member States could use international carbon markets to add an international layer on top of the current – domestically focused – NDC. This should proceed according to the Article 6 of the Paris Agreement rulebook, once it has been finalised. Credits could be issued in accordance with Article 6.2 and Article 6.4 mechanism under the Paris Agreement, currently under development in UNFCCC negotiations.

This would ensure that the EU remains credible in the UNFCCC negotiations on Article 6, as it would create demand for units issued and traded under the Article 6 system. However, this implies that credits under Article 6 are of the highest standard in terms of environmental integrity and additionality.

If the Article 6 negotiations do not result in a system in which EU stakeholders have the highest level of trust, the EU could put additional requirements on projects and credits (for example on vintage, technology or country of origin) beyond those set by the Paris Agreement rulebook. This would not only complicate trading of international credits through the creation of a sub-market for highest standard credits, but also undermine international negotiations on Article 6.

International carbon credits could be acquired by the EU or its Member States through a variety of ways: trading on international markets, multilateral funds or bilateral projects. The EU could also commit to a purchasing strategy that ensures higher environmental benefit, such as a 'net global mitigation strategy'. Not all credits purchased towards its NDC would be used for compliance which would increase ambition.

Lower marginal abatement costs of climate mitigation efforts in third countries means that the use of international markets could enable access to cheaper mitigation options abroad for EU stakeholders.

Option 8: Increase climate finance commitments

The EU or Member States could increase their contributions to climate finance, either through bilateral commitments or multilateral financing mechanisms. This could aid low income and/or vulnerable countries with both mitigation and adaptation, for example through climate-friendly development projects, renewable energy infrastructure, etc.

Existing mechanisms that could be used include the Green Climate Fund and the Global Environmental Facility at the global level, or the European Development Fund and the European Investment Bank at the EU level.

A report by ACT Alliance EU[19] (released in April 2018) analysed the climate financing contributions from individual EU Member States and found that in 2016 EU Member States contributed 15.5 billion euros in 2016, and that total financing from the EU has more than doubled between 2013 and 2016.

However, not only are negotiations on climate finance under the auspices of the UNFCCC relatively blocked, the EU is already considered by many developing countries as not on track to reach 2020 climate finance commitments. Will new commitments in this area be a credible signal on increased ambition from the EU?

Option 9: Increase support for innovation, technology transfer and capacity building

A third option for increasing the scope of the EU NDC to the international level relates to including commitments related to innovation, technology transfer and capacity building.

Innovation is required to 'green' technologies and address climate change, but new technologies which have been developed also need to be disseminated to maximise their impact. Therefore, technology transfer (for example through the UNFCCC's Technology Mechanism) is another area where the EU could enhance its NDC through the addition of clear commitments in this field.

Extra commitments with respect to capacity building could improve the capacity of individuals, organizations and institutions in developing countries and countries with economies in transition regarding identifying, planning and implementing ways to mitigate and adapt to climate change. Increased commitments to the UNFCCC's Capacity Building Frameworks are one example for enhancing the EU NDC with respect to capacity building.

[19] ACT Alliance EU (2018), 'An analysis of the Climate Reporting of the European Union', report accessible through: https://actalliance.eu/wp-content/uploads/2018/04/Analysis-of-the-climate-finance-reporting-of-the-EU.pdf

Challenges for using international cooperative mechanisms

The same caveats that applied to earlier ones also apply to these three international options: the trade-off between pan-EU negotiations versus fragmentation of climate policy. But the addition of an international component to the EU NDC also faces a number of additional challenges.

The use of international markets and climate finance tools have budgetary implications for Member States and/or the EU budget if public finances are utilized. Not only could this be untenable for finance ministries, but spending taxpayer money outside the EU instead of inside the EU could have political repercussions in many Member States. Using international carbon markets and/or increasing climate finance commitments would reduce funding for the climate transition in the EU, and thereby limit climate dividends linked with green growth.

In addition, a high reliance on international mechanisms, as opposed to extra domestic efforts, could be unacceptable for other Parties to the Paris Agreement and domestic stakeholders. The view that the EU should first and foremost focus on its domestic transition is widely held, as it the distrust of international carbon markets due to historic issues with environmental integrity and additionality. An Oeko Institut study from 2016 estimated that only 2% of CDM projects they reviewed had a high likelihood of being additional[20].

The Article 6 negotiations will be critical in this regard. Not only does the Article 6 system need to be operational on time, but it also needs to conclude with a result that inspires full trust among EU stakeholders, especially with regards to environmental integrity and additionality. Otherwise the EU might set additional requirements on credits, such as vintage or additionality. It is possible, for example, that if all Clean Development Mechanism (CDM) credits are transposed without limitations into the Article 6 system that the EU could set additional requirements such as:

- location of project, with a prioritization of developing and least developed countries
- vintage of credit, with older credits being banned to ensure that current and future climate efforts are incentivized
- limits on technologies, for example no credits related to coal power plants

Furthermore, will commitments in the fields of innovation, capacity building and technology transfer be perceived as strong enough for the EU NDC to be considered 'enhanced'? Innovation is considered an important element of the EU's competitiveness, making it

[20] Oeko Institut (2016), How additional is the Clean Development Mechanism? Analysis of the application of current tools and proposed alternatives. Available at: https://ec.europa.eu/clima/sites/clima/files/ets/docs/clean_dev_mechanism_en.pdf

challenging to encourage development, diffusion and deployment of new technologies to third parties.

With regards to the level of the commitments on using international cooperative mechanisms (EU-wide, individual or by groups of Member States), the issue of visibility of the signal remains an important one. An EU-wide commitment would likely provide a stronger signal and be perceived as stronger than Member State level commitments.

6 Conclusion

There is a wide range of options available to the EU, its Member States, and other actors to enhance the ambition of the EU's NDC. These options should not be seen as mutually exclusive, but rather as a list of options that can be combined into a package.

There are both opportunities and challenges related to each of the options. There is an important trade-off to be considered on how to proceed with enhancing the EU NDC: strength of the signal of the new NDC versus ease of negotiation and implementation of new commitments.

On the one hand, updating the EU's headline target, amending relevant domestic policies, expanding the scope of the NDC and additional EU commitments in the fields of climate finance and use of international markets would provide the strongest signal – both to actors in the EU and international partners.

But these options could also be the most challenging to implement as they imply a successful conclusion of EU negotiations on a difficult subject: effort sharing. Member States will have to find agreement to update the EU's headline target and the distribution of any additional emission reduction efforts, while revisiting policies could involve going through lengthy and costly legislative processes involving the European Commission, the European Parliament and the Council of the EU – with the outcome of these negotiations uncertain. The EU has recently revisited its Energy and Climate Framework, and it is unlikely that there is much appetite among the relevant institutions to restart this process.

These effort sharing negotiations could, however, be left till after the announcement of a new headline target by the EU, just as work on the Energy Union and 2030 Energy and Climate framework was still ongoing long after the EU published its INDC in 2015. Alternatively, only those provisions underpinning the level of ambition of key policies could be reopened for discussion.

On the other hand, individual Member States, groups of more ambitious Member States or other actors (cities, companies, sectors) could take on unilateral commitments and bypass the need for negotiations at the EU level.

While the contributions from these actors (especially from Member States and large sectors of the economy) could be significant in terms of emission reductions, the signalling power of these commitments - if included in the NDC - could be perceived as weaker than that of EU-wide action.

That is less relevant from an environmental and scientific point of view (a ton is a ton after all), but could undermine the EU's position of a leader in the UNFCCC process and be a weaker example to other Parties in the framework of the ratchet-up mechanism. It could also be perceived as sign of division within the EU and weaken its standing. Fragmentation of policy could also have many negative consequences in the future, not least on the functioning of the EU's main climate change policies, but also on the functioning of the single market.

While differences between Member States do exist in terms of the economic, social and/or political ability to implement additional climate actions, these differences have been taken into account during the formulation of current EU climate change policy. EU-wide ambition backing an enhanced NDC could therefore be implemented while still taking those differences into account, without the need for individual Member States to take additional unilateral action.

There are other pressing issues that could significantly impact the enhanced EU NDC and how it is perceived.

The impact of Brexit on EU climate change policies and commitments is yet to be determined, but it could make meeting the targets more demanding.

Any commitment made needs to be credible, not only in terms of environmental significance, but also in terms of plausibility. The EU must be able to deliver on its promises or international partners will not consider them credible.

Across the EU, climate change policies should be assessed with regards to Just Transition – many stakeholders argue that there is insufficient focus on social and economic policies to help manage the negative impacts of the transition to a low-carbon economy. This issue will remain key for many Member States in the future, especially during intra-EU effort sharing negotiations.

In conclusion, the case for revisiting the EU NDC is compelling, and if the decision is made to do so, there are many options for the EU to consider during the discussions on a new enhanced NDC. However, there are significant concerns related to these options and their practical implementation.

Arguably the most important concern is that the EU cannot tackle climate change in isolation. Other Parties to the Paris Agreement will need to step up as well, yet the EU can play a strong role as a leader and provide an example for what the next generation of NDCs could look like, and how ambition can be raised during each ambition cycle of the Paris Agreement.

A strong signal from the EU on increasing it climate change mitigation ambition could do much to help reach the goals of the Talanoa Dialogue and of the Paris Agreement in general. Creating momentum to reach those goals should be one of the main considerations of EU policy makers during the discussions on how and when to enhance the EU NDC.

7 Analysis of qualitative and quantitative input

7.1 Methodology

The goal of this project was not only to identify and analyse the main options for the EU to enhance its NDC, but also to gather feedback on the options. Feedback was gathered through a set of six outreach workshops held across the EU in Brussels, Florence, Prague, Bratislava, Bucharest and Warsaw.

In addition, an online survey was created to gather input from a wider range of stakeholders on the nine options introduced in the previous section. A multi-criteria framework was used in the survey to evaluate the options. The evaluation aimed at assessing their social and political acceptability and their environmental, competitive and international impacts. Practically speaking, a group of European experts was asked to evaluate the nine options according to the following five criteria:

- Political acceptability: any change to the current EU NDC needs to be politically acceptable, as the European Council will need to agree on the changes. This implies that Member States not only acknowledge that the NDC needs to be updated and enhanced, but also agree on the way forward to do so. This is especially important with regards to enhancing the NDC in a timely fashion.
- Social acceptability: this criterion is related to the way society at large, public opinion, would react and accept the social impact of an enhanced EU NDC – which includes changes in employment in economic sectors and possible behavioural changes necessary to reach the climate goals.
- Impact on competitiveness: the degree in which the enhancement of the EU NDC affects the competitiveness of the EU industry compared to other countries. The competitiveness impacts could be short-term and/or long-term.
- Environmental impact: The enhanced EU NDC environmental impacts could be identified on a number of axes. Among them, the most important impact concerns its effect on GHG emissions in the EU and global climate change mitigation. However, additional potential impacts may concern air and water pollution, land use, land use change etc…
- International impact: International impact concerns the manner in which the international community would perceive and respond to an enhanced EU NDC. It concerns the impact of the enhanced EU NDC on the international climate negotiations under the auspices of the UNFCCC, including third countries' revision of their own NDCs.

In the survey, respondents were asked to rate the nine options on a five-point scale, which range from 1 to 5, where 1 means not acceptable (or highly negative impact) and 5 means

very high acceptability (or highly positive impact). A summary of the rating system can be found in Table 1 below:

Table 1: Rating system for the criteria used in the online survey

Acceptability	**Impact**
1. Not acceptable; 2. Low acceptability; 3. Acceptable; 4. High acceptability; 5. Very high acceptability.	1. Highly negative impact; 2. Negative impact; 3. No impact; 4. Positive impact; 5. Highly positive impact.

The questionnaire was sent to approximately 450 recipients, chosen among a list of experts employed in the academia, business, think-tanks, civil society organisations, governments and in public and private research centres. Fifty-four replies were received.

Initially a draft questionnaire, which included open questions, was sent to a more select group of approximately 40 experts (18 replies were received). The draft survey was used to gather (1) feedback on the survey itself (type of questions, options selected for analysis etc.) and (2) qualitative input which fed into the outreach workshops held across the EU.

In the following analysis, a quantitative analysis is presented first, relying on a matrix summarising the scores of all different options received through the final questionnaire. After that, the options will be discussed more qualitatively one by one, using input from the draft questionnaire, the final questionnaire and the various workshops' comments.

It is important to highlight that the results, both qualitative and quantitative, have been gathered from a very small sample that cannot be considered representative of either the EU population, or experts in EU climate policy. The results should, therefore, be seen rather as indicative of how the proposed options are perceived in our small sample, although they may still be widely shared across the EU. The qualitative results do raise several very interesting concerns that should be addressed by policy makers in view of the update of the EU NDC by 2020.

7.2 Aggregate results: The matrix

The matrix below summarises aggregate results and allows for a comparison of the different options according to different criteria.

The numbers in the cells reflect the average response received for each option on the respective criteria. To ease comparisons, cells are coloured in white for value close to 'neutral' value (range of 2,8- 3,2, i.e. acceptable or no impact) and range from darker red, when values are close to one (no acceptability or high negative impact), to darker green, when values are close to five (very high acceptability or high positive impact). The use of relatively wide ranges in Table 2 is necessary to ensure a credible level of robustness, as the number of respondents is relatively small.

Table 2: Matrix with aggregate scores along five criteria

	Political acceptability	Social acceptability	Impact on competitiveness	Environmental impact	International impact
1: Enhance the headline target and adjust EU climate legislation	2,61	3,00	2,80	4,10	3,88
2: Adopt a carbon budget	2,79	3,11	3,02	3,79	3,55
3: Widen the scope of the EU NDC	2,50	3,04	2,77	3,94	3,34
4: Raise the ambition through the ESR	2,60	2,81	3,02	3,85	3,55
5: Raise the ambition through the EU ETS	2,55	3,00	2,65	3,80	3,50
6: Include efforts in other areas in the EU	3,18	3,28	3,21	3,93	3,56
7: Use international carbon markets	2,98	2,80	3,45	3,70	3,87
8: Increase climate finance	2,84	2,98	3,30	3,91	3,96
9: Increase support for innovation, technology transfer and capacity building	3,25	3,32	3,37	4,00	4,00

From a quick and visual analysis of the matrix some very general conclusions can be drawn. Reading the table in columns, it is clear that the first five options have lower political acceptability; options 6, 7 and 8 are close to the neutral value; only option 9, “Innovation, technology transfer and capacity building”, has been considered slightly politically acceptable. This indicates that the respondents of the questionnaire do not consider any of the options truly politically acceptable, nor wholly unacceptable either.

Concerning social acceptability, options 4 and 7 are the least preferred, but still fall within the ‘neutral zone’, along with options 1, 2, 3, 5 and 8. Options 6 and 9 show minor positive results.

The impact on competitiveness is generally considered positive for the last 4 options. Options 3 and 5, however, are considered to lead to slightly negative competitive impacts.

The options receive better ‘scores’ on the last two criteria. The international and, especially, the environmental impacts of all options are considered positive. There does not seem to be a trade-off among various options for what concerns the last two criteria: this means that enhancing the EU NDC through any of the nine options presented is expected to have both positive environmental and international impacts.

Looking at the table option by option however, there are some interesting differences. The options that would, arguable, involve the most political will (options 1-5) are considered the least politically acceptable. The last 4 options (which might not require extensive negotiations at the highest levels on burden sharing) are deemed less politically unacceptable, but also more positive for the EUs competitive position. The final option (“Innovation, technology transfer and capacity building”) is the only one considered by the sample to palatable on all five criteria. However, it is also arguably the option that implies the least in terms of actions and costs for the EU as a whole.

To conclude, the sample used for this analysis is relatively small, so it would be imprudent to reach any strong conclusions based on it. However, two interesting results do emerge: stakeholders seem to see an inverse relation between necessary political will and viability of an option. The more difficult options to implement – because for example the EU ETS or ESR negotiations have to be reopened – are considered the least politically acceptable ones, even if they might send a more credible political signal, use existing policies and be more effective in terms of environmental impact. This could be perceived as that respondents believe there is a lack of political will to push for stronger climate action.

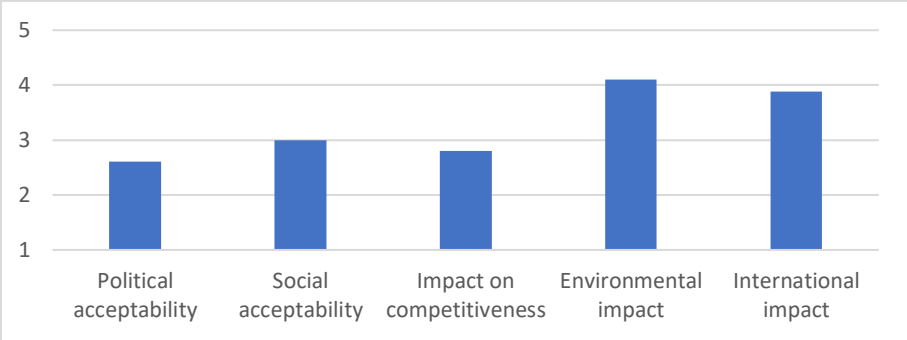
7.3 Analysis of individual options

Looking at each option separately, we can include qualitative feedback received through the draft questionnaire and the outreach workshops in the discussion. In this section, we therefore comment on each option, complementing quantitative results with qualitative insights.

Change the NDC's domestic headline target, and adjust the main climate legislation (options 1-3)

Option 1 - Enhance the headline target and adjust EU climate legislation

Graph 1: average outcome for Option 1 on each of the five criteria



The received responses indicate that political acceptability, competitiveness impacts and, especially, social acceptability are close to neutral. The environmental and international impacts of option 1 are perceived as positive.

These limited quantitative results highlight a potential trade-off with regards to option 1: despite perceived very positive environmental and international impacts, the respondents indicate relatively low political acceptability. Qualitative feedback hints at the reasons behind this perceived discrepancy.

Concerning political acceptability, respondents agree that the EU should maintain its climate leadership and strengthen its NDC, but the reopening of EU ETS and ESR negotiations is seen as problematic. Lengthy negotiations were concluded relatively recently and reopening them could lead to political stalemate, regulatory uncertainty, and necessitate convincing Member States to raise ambition.

On the other hand, there are opportunities coming up in the regulatory calendar to tweak policies to enhance ambition, without reopening the entire policy. The MSR will see its first review in 2021, where a higher surplus withdrawal rate and cancellation from the Reserve would increase ambition of the EU ETS. Revising the ESR is considered by some respondents to be more problematic, as it involves effort sharing negotiations between Member States.

Revisiting the headline target is possible, however, through changes in the energy efficiency and renewable energy targets – as was already done in 2018.

Enhancing the headline target is considered neither acceptable nor unacceptable from a social point of view by the respondents. Growing populist movements may make raising climate ambition more challenging, while costs and cost pass through can also play an important role, as was made clear by the *gilet jaunes* movement in France (which emerged after the questionnaires had been submitted). Behavioural change by consumers and energy transitions for Member States reliant on fossil fuels are additional challenges for raising ambition.

These challenges are somewhat balanced by the growing awareness of air quality concerns and the co-benefit climate action could deliver on that issue. Respondents also highlighted that positive momentum could be enforced by a strong coupling of climate action with opportunities for economic growth, innovation and jobs.

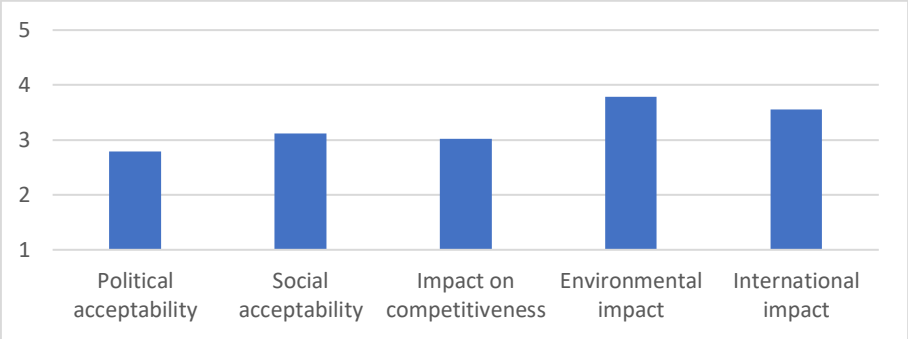
On competitiveness impacts, some respondents agree that there are potential short-term negative impacts, and medium to long-term positive impacts due to first-mover advantages. Others highlight that competitiveness impacts depends on the degree to which ambition is raised and on implementation. The negative competitive impacts are expected by some respondents to be higher in certain sectors, but on the other hand EU companies will have an opportunity to become leaders in low carbon technologies, such as electric mobility. One respondent highlighted that strengthening the EU ETS could accelerate the low carbon transition while maintaining safeguards for industry, whereas strengthening the ESR could have larger competitiveness impacts.

Option 1 is considered to lead to the best environmental impacts according to the sampled experts. The perceived positive environmental impacts are linked to more feasible decarbonization pathways towards 2050 and a more efficient transition to a zero-carbon economy if higher ambition is implemented through the EU ETS. Respondents mentioned that updating the EU NDC could have significant positive impacts by creating international momentum, increasing EU international credibility and reducing GHG emissions worldwide. Some respondents believe that environmental impacts will indeed be positive, but relatively modest due to carbon leakage protection still being too wide – shielding industry from incentives to decarbonize.

Concerning international impacts, respondents generally agree that raising ambition and increasing the ambition of the EU NDC would strengthen the EU's negotiating position in the UNFCCC and could provide momentum to other countries to also raise their ambition by 2020.

Option 2 - Adopt a carbon budget

Graph 2: average outcome for Option 2 on each of the five criteria



Option 2 is also evaluated as close to neutral on the first three criteria, while environmental and international impacts are again perceived as positive.

The qualitative interviews indicated that most respondents understand that there is already a link to a budgetary approach through the EU ETS and ESR, and that some actors, such as NGOs and MEPs, support transforming the NDC to a carbon budget. The positive impacts of a carbon budget depend on its size and timing – such as start and end year. Respondents indicate that the carbon budget should be set well in advance so that it provides certainty to investors and the private sector can adapt.

Several respondents believe that adopting a carbon budget is a zero-sum game, which would make international negotiations more difficult (for example because of the possibility of raising discussions on historic responsibility) and that, although it is important in terms of climate science, the value for EU climate policy would be limited.

With regards to social acceptability, social justice issues were raised as pivotal, while distributional impacts are perceived as negligible. Communication of the new type of targets was highlighted as another important issue to consider with respect to carbon budgets: is it easier to explain to citizens, or would it involve radically new communication strategies?

On competitiveness, translating current targets into a budget is not seen as having any competitiveness impact. However, there could be competitiveness impacts if there is some *a priori* partition of the budget among economic sectors.

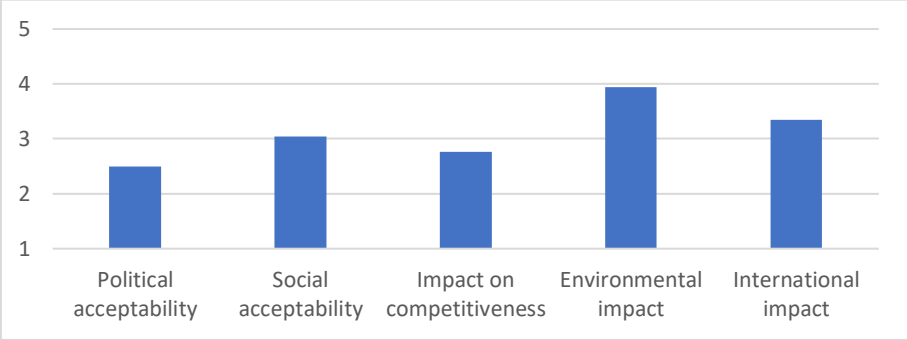
For the majority of respondents, a carbon budget would encourage early action and therefore have a positive environmental impact - this does, however, depend on the size of the budget and on its implementation.

A carbon budget would send a strong signal and strengthen EU leadership and credibility in the international arena according to the majority of experts. But the strength of this signal

depends on the size of the carbon budget. However, some respondents emphasized the risk that the budget could be contested in international negotiations, regardless of how it is set.

Option 3 - Widen the scope of the NDC

Graph 3: average outcome for Option 3 on each of the five criteria



The responses on this option are similar to the two previous cases, confirming that these options aimed at increasing the ambition of the NDC are not considered highly acceptable, despite having perceived positive environmental impacts. Increasing the scope of the NDC is expected by the respondents to have a less positive international impact, mostly due to the influence EU action on international transport would have on international partners and negotiations in those areas.

Since aviation and shipping are negotiated by international bodies such as ICAO and IMO, and are not regulated by ETS nor ESR, most respondents consider it politically unlikely that these sectors would be included in the EU NDC. Reasons are varied: individual Member States and interest groups are strongly opposed; both sectors are not fully under the jurisdiction of the EU; NDC scope should follow national inventories; and third countries are likely to protest expansion of the EU NDC's scope.

Survey respondents underline two issues related to the social acceptability of option 3: the limited social impacts (jobs) due to inelastic demand for these sectors, and the potential for distributional impact. Increasing costs for air travellers would work as a progressive taxation.

International shipping and aviation are globally competitive industries, leading to potentially negative impacts on competitiveness. However, two respondents disagreed as any measures would apply equally to EU and international operators. Moreover, there is a potential for cost pass through to consumers and downstream businesses.

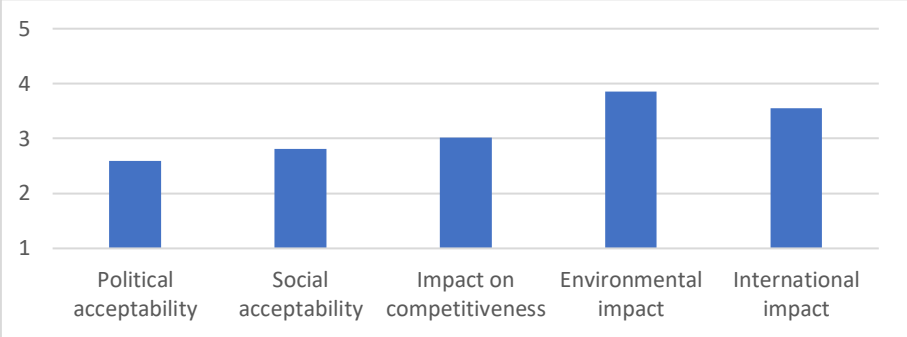
The environmental impact is considered relatively high as the aviation and shipping sectors are large and growing emitters. The size of the environmental impact depends for most of the respondents on whether the two sectors are included in the EU ETS. In that case, there would be higher demand for EUAs with potential stronger incentives for other sectors as well to decarbonize.

Most of the surveyed experts agree that tackling emissions from international transport could strengthen EU leadership. Since it is currently not well established who is responsible for emissions from international aviation and shipping, the need for international coordination is noted as fundamental to avoid tensions with international partners.

Increase the ambition of climate policies, but without adjusting the EU NDC's headline target (options 4-6)

Option 4 – Raise ambition through the ESR

Graph 4: average outcome for Option 4 on each of the five criteria



Option 4, "Raising the ambition through the ESR" is also not considered politically acceptable, even if its potential environmental and international impacts are expected to be positive. Most qualitative respondents agree on low political acceptability for unilateral action by individual Member States - EU-wide action is considered more suitable as all countries would contribute to the increased ambition and it would limit intra-EU fragmentation. However, since ESR negotiations have been among the most difficult within the EU 2030 framework, it is unlikely for many respondents that these would be reopened.

Social acceptability is impacted by the burden of abating emissions in ESR sectors (transport, buildings, waste, agriculture) falling on households.

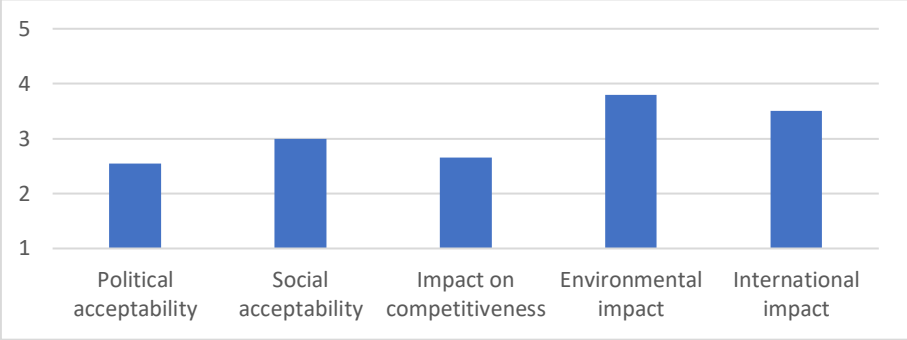
The impact on competitiveness is considered limited by some respondents since many ESR sectors are not internationally tradable. However, Member States that already have high targets could see competitive impacts in the agricultural sector. According to some respondents, fragmented EU action could lead to a less even playing field and might give rise to intra-EU competitiveness concerns for more ambitious Member States.

The environmental impact is again seen as positive; however, respondents agree that this impact depends on implementation. Increased action by individual Member States, although considered more likely than EU-wide action, is perceived as having a lower environmental impact.

Increased ambition is identified as having positive international impacts for all 9 options, as it creates momentum for third parties and increases the EU's position as a climate leader. However, for option 4 this is mitigated by the perceived undermining of the EU signal by unilateral Member State action Therefore, a more limited impact is expected on the other Parties under the UNFCCC.

Option 5 – Raise ambition through the EU ETS

Graph 5: average outcome for Option 5 on each of the five criteria



Option 5 has also received mixed scores from surveyed experts. Its political acceptability and the impact on competitiveness are perceived negatively, while potential environmental and international impact are identified as positive.

For some respondents in the qualitative analysis, the low political acceptability is linked to implementation and Member State energy mixes, with voluntary action unlikely for those Member States with high reliance on fossil fuels. Many respondents seem to agree on the need for a higher carbon price to foster innovation and investment.

Social acceptability is country and sector specific. Member States that still rely heavily on fossil fuels could be impacted more heavily by increased EU ETS ambition and a likely increased carbon price. Higher costs for utilities might be transferred through to households.

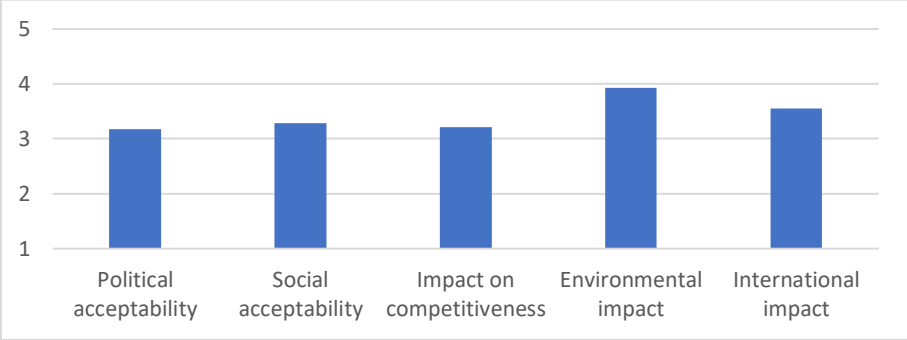
With regards to competitiveness, respondents disagree on the impacts of Option 5. Increased EUA prices may have negative competitiveness effects, especially in specific sectors such as coal and lignite. Others highlight that carbon leakage protection tools are already in place in the EU ETS. Intra-EU competitiveness concerns are considered low because the nature of the EU ETS as an EU-wide instrument. Most concerns relate to international competitiveness.

Most respondents agree on a positive environmental impact, but argue that its size depends on implementation. Unilateral action is expected to have a less strong environmental impact than action in the EU ETS at the EU level.

On international impacts, EUA price increases due to action in the EU ETS could send a signal that the carbon pricing approach is successful in the EU.

Option 6 – Include efforts in other areas in the EU NDC

Graph 6: average outcome for Option 6 on each of the five criteria



This option scores close to 'neutral' on the acceptability criteria (though on the positive side). Political and social acceptability are above average. Competitiveness impacts fall within the 'neutral 'range. The environmental and international impacts are considered to be relatively positive.

A flexible approach on what to include in the NDC is expected to be politically viable (even called a no-regrets option by one respondent) although having limited environmental effectiveness for several respondents. Several surveyed experts mention that EU level action would be more effective.

Social acceptability very much depends on the actual measures in place and how they are implemented.

Not adapting the headline target is considered by one respondent as being too flexible and therefore ineffective. Therefore, expected impact on international competitiveness is limited.

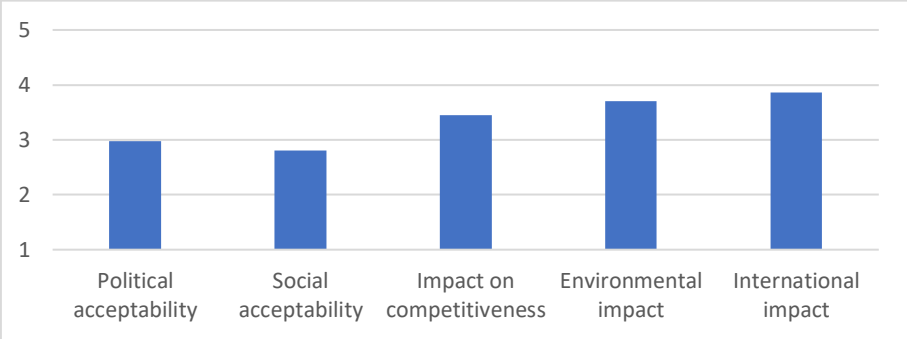
The environmental impact is considered positive. The need for clarity, concrete actions beyond targets, and lock-in of commitments is emphasized by respondents.

This option is not considered as visible or as easy to verify as other options, and its international impact is therefore relatively limited for several respondents.

Use international cooperative mechanisms in addition to the existing domestic headline target (options 7-9)

Option 7 - Use international markets

Graph 7: average outcome for Option 7 on each of the five criteria



Option 7 is expected to have a positive impact according to all impact criteria, including competitiveness. Political and social acceptability, on the contrary, are close to, but below the 'neutral' value.

In the qualitative questionnaire, political acceptability for option 7 is often considered low, mainly due to the negative experience with past KP instruments (CDM/JI) and issues of additionality and environmental integrity. Other concerns are linked to difficulty of increasing international spending in a time of budget constraints, and because there has already been a public commitment to not use international offsets post-2020.

Social acceptability, as perceived by the surveyed experts, is also hampered due the bad reputation of international offsets, i.e. they are considered as "cheating" towards domestic reduction targets. One respondent highlighted that domestic action could be more socially acceptable due to co-benefits of climate action (jobs, innovation, air quality etc).

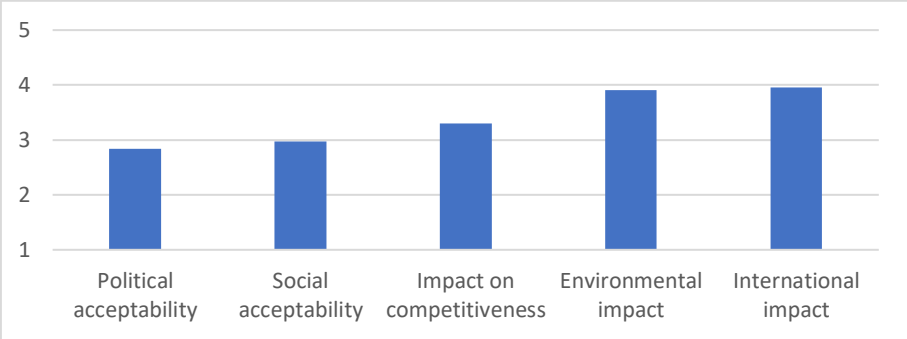
Respondents expect a positive competitiveness impact, due to higher abatements costs in the EU compared to third countries. For a number of respondents, using public finances to tap international carbon markets could lead to reduced public spending in other areas, such as innovation.

Environmental impacts are perceived as positive, but highly dependent on the environmental integrity of the units - additionality and MRV are considered crucial to limit environmental risks.

International impacts are regarded more positively, as the EU could give a strong impetus towards the development of international carbon markets. Buying units abroad would benefit host countries and help foster global climate action.

Option 8 – Increase climate finance commitments

Graph 8: average outcome for Option 8 on each of the five criteria



Results for international climate finance indicate 'neutral' acceptability, but positive impacts on competitiveness, the environment and the international arena.

The qualitative analysis suggests that political acceptability is undermined by public budgetary constraints.

The socially acceptability is limited due to potential opposition to increased investment abroad, while resources could be used domestically as well.

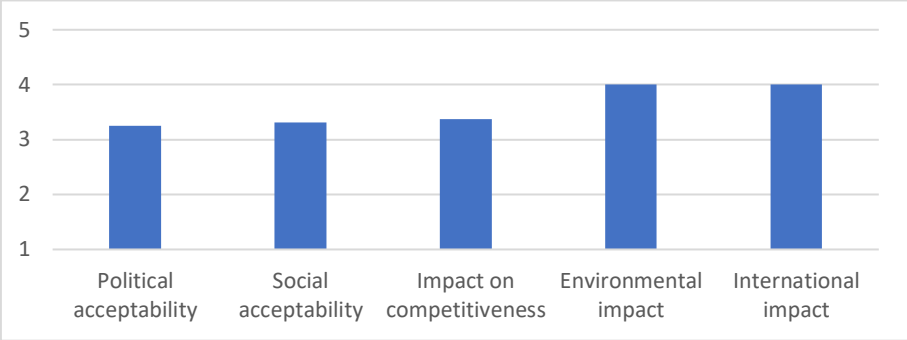
Additional climate finance has, according to most of the respondents, a positive impact on competitiveness. While respondents did not elaborate why they see a positive impact, we expect that it is considered to have a better competitive impact than other options as burdens for intra-EU industry are not increased through this option.

The environmental impact is deemed to be relatively high at the global level, but respondents highlight that there would not be a positive environmental impact in the EU.

The international impact is expected to be high. Additional climate finance is considered key to securing buy-in for the Paris Agreement and there are expectations for the EU to increase climate finance. On the other hand, if only this option is used, it could provoke international opposition as the EU should also push for domestic mitigation actions.

Option 9 - Increase support for innovation, technology transfer and capacity building

Graph 9: average outcome for Option 9 on each of the five criteria



Option 9 is considered acceptable on both acceptability criteria and is expected to have positive impacts on the three surveyed issues.

The qualitative responses on this option are mixed. The EU is seen to have the opportunity to play a key incubator role for green innovation and this option is seen as being able to deliver easily scalable climate solutions. On the other hand, respondents indicate that if this is not coupled to climate finance it is unclear how it would be implemented.

Social acceptability is burgeoned by the perceived role of climate leader and innovator this option entails. However, respondents also highlight that only using this option is unlikely to be socially acceptable to EU citizens and NGOs as it is a less ambitious option than others covered in this paper.

The diffusion of low carbon technologies worldwide could either increase the competitiveness of EU companies, or reduce it due to imitation. One respondent mentioned that by enlarging the market for climate technologies, technology transfer and innovation could decrease global costs for these technologies.

Respondents indicated that the environmental impacts might diver in the short and long run. In the short term, it is unlikely to lead to significant GHG emissions globally, but in the longer run it might become crucial to closing the emissions gap through the faster spread of efficient technologies.

Most respondents agree on that the international impact will be positive, but qualitative respondents highlight that it is unlikely to lead to significant additional technology transfers to third countries.

FEEDING THE PROBLEM

THE DANGEROUS INTENSIFICATION OF ANIMAL FARMING IN EUROPE

GREENPEACE

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Executive summary

Industrial production and excessive consumption of meat and dairy products have grave impacts on our climate, our environment and our health. An ever-increasing body of scientific evidence makes the need to reduce our production and consumption of animal products clearer and more urgent than ever.

Europe's consumption habits and production levels have widely exceeded any health, environmental and climate limits that science has defined. In the European Union the average per capita consumption of meat is twice the global average.

In light of the scientific evidence on the impact of industrial livestock production and of high consumption of animal products, Greenpeace commissioned an evaluation of how public funds delivered via the EU's common agricultural policy (CAP) are currently used. The report analyses trends in the European livestock sector, and compiles information on the use of agricultural land in Europe.

The research shows that the major trend in the European livestock sector is an ever-increasing concentration of meat and dairy production in fewer and larger farms. Data shows that over 71 % of all the EU agricultural land (land used to grow crops – arable land – as well as grassland for grazing or fodder production) is dedicated to feeding livestock. When excluding grasslands, and only taking into account land used for growing crops, we see that over 63 % of arable land is used to produce animal feed instead of food for people.

Taking into account CAP payments based on farm size, as well as payments that support production of livestock directly, between € 28.5 billion and € 32.6 billion go to livestock farms or farms producing fodder for livestock – between 18 % and 20 % of the EU's total annual budget.

This report concludes that the CAP must respond to the massive impacts the livestock sector has on nature, the climate and public health, and to reverse the current trend of farming intensification that it helped create.

1. The problem with industrial livestock farming

A new report by some of the world's leading scientists and health experts,[1] published in The Lancet in January 2019, stresses the dissonance between the way we currently eat and the healthy, sustainable food systems we need to protect nature, the climate and public health. The report estimates that the necessary dietary shift "*requires a dramatic reduction of consumption of unhealthy foods, such as red meat, by at least 50 % with variations in the change required according to region" and, simultaneously, "an overall increase in consumption of more than 100 % is needed for legumes, nuts, fruit, and vegetables.*"[2]

The Lancet report is just the most recent in the mounting scientific evidence of the substantial health, environmental and climate impacts of the livestock sector. Animal agriculture accounted for 12 - 17 % of the EU's greenhouse gas emissions in 2013.[3] Of these, 27 % were methane and 23 % were nitrous oxide.[4] Recent studies show that halving the EU's consumption of meat, dairy and eggs could cut EU agricultural greenhouse gas emissions by 25 - 40 %.[5] Globally, going a step further and adopting a vegetarian or vegan diet would cut agricultural greenhouse gas emissions by 63 % and 70 %, respectively.[6] This is echoed by the UN's Intergovernmental Panel on Climate Change which concluded that "*the potential to reduce [greenhouse gas] emissions through changes in consumption was found to be substantially higher than that of technical mitigation measures [such as improved cropland or livestock management]*".[7]

Industrial livestock production also contributes heavily to both water and air pollution, with over 80 % of EU agricultural ammonia emissions to air and nitrogen emissions to water linked to livestock.[8] According to the European Nitrogen Report,[9] nitrogen pollution costs the European Union up to € 320 billion a year. Nitrogen pollution of water potentially exposes an estimated 18 million people to drinking water with nitrate concentrations above recommended levels.[10] Factory farms also contribute to air pollution, which authorities consider the single largest environmental health risk in Europe,[11] causing over 400,000 premature deaths per year.[12] Livestock production accounts for the largest share of air pollutants created by agriculture, specifically ammonia, particulate matter and non-methane volatile organic compounds.[13]

The skyrocketing production and consumption of livestock products is also behind a latent global health crisis. High red meat consumption has been linked to cancer,[14] heart disease,[15] obesity and diabetes.[16] Industrial livestock is strongly associated with antimicrobial resistance (resistance to antibiotics), which the World Health Organization recently declared a "global health emergency".[17] The joint report by the European Centre for Disease Prevention and Control, the European Food Safety Authority and the European Medicines Agency, published in 2017, showed that in 2014 the use of antibiotics for animals in the EU-28 was more than double the use for human medicine.[18] In the EU, 33,000 people die annually due to infections caused by resistant bacteria,[19] which translates into € 1.5 billion in extra health care costs and productivity losses every year.[20] Additionally, intensive livestock factory farms, with their high densities of confined animals, have been shown to increase the transmission of diseases from animals to humans.[21] [22]

1 Willet et al. 2019. Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems.The Lancet Commissions, 393(10170):447-492.
2 Ibid.
3 Bellarby J. et al. 2013. Livestock greenhouse gas emissions and mitigation potential in Europe. Global Change Biology, 19(1):3-18
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17 World Health Organization, http://www.who.int/mediacentre/news/releases/2017/running-out-antibiotics/en/
18 ECDC, EFSA, EMA, 2017. ECDC/EFSA/EMA second joint report on the integrated analysis of the consumption of antimicrobial agents and occurrence of antimicrobial resistance in bacteria from humans and food-producing animals https://efsa.onlinelibrary.wiley.com/doi/epdf/10.2903/j.efsa.2017.4872
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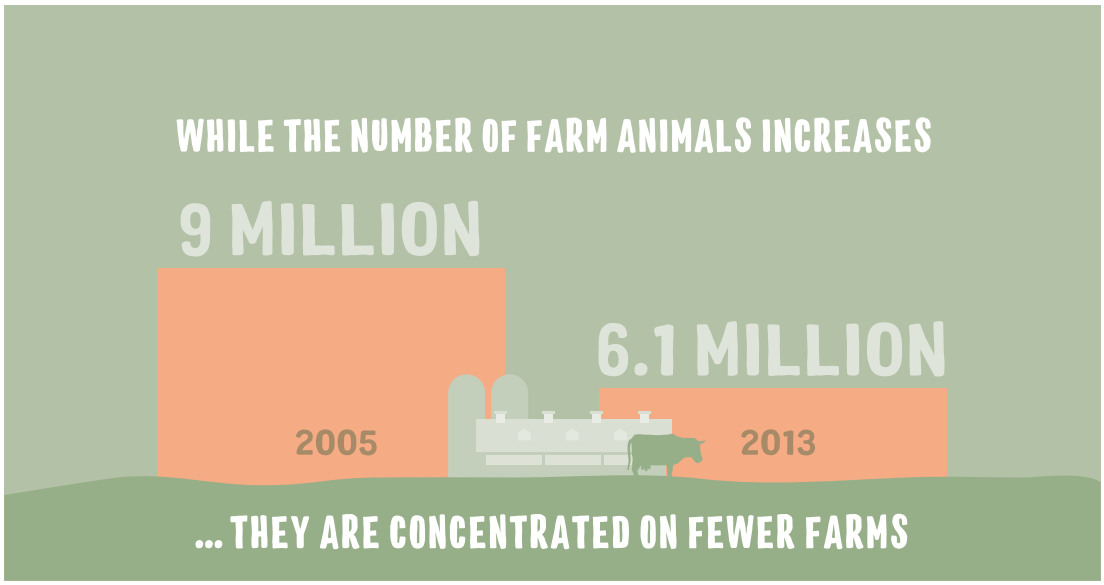
Trends in granivore and dairy farms

2.

Together with international market dynamics and favourable trade policies, the EU's common agricultural policy, via its subsidies and market interventions, exerts considerable influence over the development of the EU farming sector, and the livestock sector in particular. This is why carefully looking at the official EU data collected over the years is crucial not only to obtain an accurate picture of the situation in the farming sector, but also to indicate the direction of travel that current EU policies are setting, and investigate whether reform is needed.

Europe is losing its farms. Between 2005 and 2013, 3.7 million farms ceased to exist, a drop of 26 %, (from 14.4 million to 10.7 million).[23] The proportional loss of livestock farms was even more pronounced, falling by 32 %, from 9 million to 6.1 million, in the same timeframe.[24]



While the number of farms is decreasing, their size follows the opposite trend. Worryingly, official data collected by Eurostat shows livestock being increasingly reared on very large farms.[25] The total number of livestock units[26] reared on very large farms rose by almost 10 million in the span of just 8 years between 2005 and 2013, when it reached 94 million units.[27] As a result, almost three quarters of the livestock units (72.2 %) in the EU-28 were reared on very large farms in 2013.[28] During the same period, the numbers of units reared on farms of all other sizes visibly decreased,[29] with the number of livestock units in very small farms more than halving (to just over 1 million).[30]

Alongside an increase in size, many of the largest farms in the EU have also increased their livestock density, which, according to Eurostat, suggests that "*they were making use of more intensive farming practices.*"[31] The production is also regionally concentrated, as only four countries hold the majority of livestock units in the EU-28 (Germany, France, Spain and the UK together produce 54 % of the cattle, 50 % of the pigs and 54 % of the sheep and goats).[32]

23 Eurostat. Agri-environmental indicator – Livestock Patterns, data from March 2017.
Available at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Agri-environmental_indicator_-_livestock_patterns

24 Ibid.

25 One of the ways farms are classified is by economic size. In the EU this is done through their standard output – the average monetary value of the agricultural output at the farm gate per hectare or per head of livestock. Summing all the standard output per head of livestock in a farm is a measure of its economic size. Very small farms have standard annual output of less than €2,000, small farms have €2,000-€8,000, medium sized €8,000-€25,000, large €25,000-€100,000 and very large farms over €100,000. https://ec.europa.eu/eurostat/web/agriculture/so-coefficients

26 Livestock unit is a reference unit that helps aggregation of livestock of different species and age by using specific coefficient established on the basis of nutritional feed requirement of different animals. The reference for calculation of a livestock unit is the grazing equivalent of one adult dairy cow producing 3000 kg of milk a year, which is equivalent to two sows, or 10 sheep and so on. https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Livestock_unit_(LSU) . (Eurostat)

27 Eurostat, Archive:Small and large farms in the EU – statistics from the farm structure survey, data from October 2016. Available at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Archive:Small_and_large_farms_in_the_EU_-_statistics_from_the_farm_structure_survey&direction=next&oldid=406560

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29 Eurostat. File:Share of livestock units, by economic size of farm, EU-28, 2005-2013 (%of total).png. Available at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=-File:Share_of_livestock_units,_by_economic_size_of_farm,_EU-28,_2005%E2%80%932013_(%25_of_total).png

30 Eurostat. Share of livestock units, by economic size of farm, EU-28, 2005–2013. Available at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Share_of_livestock_units,_by_economic_size_of_farm,_EU-28,_2005%E2%80%932013_(%25_of_total).png

31 Eurostat, Archive:Small and large farms in the EU – statistics from the farm structure survey, data from October 2016. Available at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Archive:Small_and_large_farms_in_the_EU_-_statistics_from_the_farm_structure_survey&direction=next&oldid=406560

32 Buckwell, A. and Nadeu, E. 2018. What is the Safe Operating Space for EU Livestock? RISE Foundation, Brussels.
Available at http://www.risefoundation.eu/images/files/2018/2018_RISE_LIVESTOCK_FULL.pdf

Livestock products constituted 40.9 % of the total agricultural output of the EU in 2017.[33] In terms of output, the volume of animal production keeps increasing, despite the falling number of farms. Based on the data from the European Commission,[34] the total gross production of meat in the EU-28 rose by 12.7 % between 2000 and 2017, from 41,956,000 tonnes to 47,273,000 tonnes. While not finalised, predictions from 2018 data indicate a further rise to 48,064,000 tonnes. Sectorally, the increase occurred mainly in poultry and pork production. In the beef and veal sector, production decreased until 2013, after which it started to increase again.

Pig meat production represents 9.1 % of the total agricultural output of the EU and is concentrated in just a handful of countries (notably Denmark, Germany, Spain, France and Poland).[35] The gross production of pig meat in the EU rose by 8.4 % between 2000 and 2017, from 21,683,000 to 23,668,000 tonnes. The forecast for the 2018 data predicts that production of pig meat continued to rise to 24,031,000 tonnes.[36]

The most pronounced growth can be observed in the poultry sector, where total poultry meat production increased by almost 40 % from 10,422,000 tonnes in 2000 to 14,576,000 tonnes in 2017. The forecast for 2018 shows a further increase to 14,896,000 tonnes.[37] Poultry represents 5 % of the total agricultural output of the EU and the majority of the production (69 %) is concentrated in just five countries – Poland, Germany, France, Spain and the United Kingdom.[38]

The beef and veal sector represents 7.8 % of the EU's agricultural output.[39] The gross production of beef and veal decreased between 2000 and 2013 by 13 % from 8,612,000 to 7,486,000 tonnes. However, as of 2014, the production started to increase reaching 8,108,000 tonnes in 2017. The forecast for 2018 predicts a further increase to 8,236,000 tonnes.[40] Almost half of EU beef production came from France, Germany and the United Kingdom and two thirds of veal was produced by Spain, Netherlands and France.

The dairy sector, which until 2015 operated under the milk quotas system, saw the production of cow milk increasing by 10.4 % from 150 million tonnes in 2000 to 165.6 million tonnes in 2017. The production is expected to have reached 166.6 million tonnes in 2018.[41] Milk represents 13.8 % of all agricultural output of the EU-28, with Germany, France, Poland, the United Kingdom, the Netherlands and Italy accounting for about 70 % of EU milk production.[42] The end of milk quotas led to some of the smallest farms abandoning dairy production activities while, in contrast, the largest farms significantly expanded their dairy herd between 2014 and 2015.[43]

33 Eurostat. 2018. Agriculture, forestry and fishery statistics, 2018 edition. Available at https://ec.europa.eu/eurostat/documents/3217494/9455154/KS-FK-18-001-EN-N.pdf/a9ddd7db-c40c-48c9-8ed5-a8a90f4faa3f
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36 European Commission. 2018. EU balance sheet and production details by Member State. Autumn 2018. Available at https://ec.europa.eu/agriculture/sites/agriculture/files/markets-and-prices/short-term-outlook/xls/agri-short-term-outlook-balance-sheets_en.xlsx
37 Ibid.
38 Eurostat. 2018. Agriculture, forestry and fishery statistics, 2018 edition. Available at https://ec.europa.eu/eurostat/documents/3217494/9455154/KS-FK-18-001-EN-N.pdf/a9ddd7db-c40c-48c9-8ed5-a8a90f4faa3f
39 Ibid.
40 European Commission, EU balance sheet and production details by Member State. Autumn 2018 Available at https://ec.europa.eu/agriculture/sites/agriculture/files/markets-and-prices/short-term-outlook/xls/agri-short-term-outlook-balance-sheets_en.xlsx
41 Ibid.
42 Eurostat. 2018. Agriculture, forestry and fishery statistics, 2018 edition. Available at https://ec.europa.eu/eurostat/documents/3217494/9455154/KS-FK-18-001-EN-N.pdf/a9ddd7db-c40c-48c9-8ed5-a8a90f4faa3f
43 Eurostat. Agricultural Production - Animals, data from September 2017. Available at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Agricultural_production_-_animals

The decrease in the overall number of farms and the increase in farm size significantly impacts the diversity of the farming sector. It results in the increasing concentration of larger shares of agricultural production on fewer farms.

Sectoral trends in production on large farms

Using the Farm Accountancy Data Network[44] we estimated the share of production in the pig, poultry and dairy market held by the largest farms (with a standard output of € 500,000 or more) in eight European countries: Belgium, Denmark, France, Germany, Italy, the Netherlands, Poland and Spain.

The Farm Accountancy Data Network provides the only microeconomic dataset on farms that is harmonised across Europe. As it is based on surveys of a representative sample of European farms, the country-level data may not be as precise as different individual datasets compiled by national authorities. However, the data are accurate enough to identify the major trends in the farming sector.

PORK

The largest farms (over € 500,000) increased their share of pig meat production in the eight countries selected between 2004 and 2016. In 2016, these very large farms accounted for virtually the entire pig meat production in Denmark and Italy, and for over half of the production in Belgium, France, the Netherlands and Spain.

The table below shows the concentration of pig meat production in the biggest farms (with an economic output of € 500,000 or more) in the years 2004 and 2016.

Share of pig meat reared on the largest farms in:	2004	2016	% Variation (2004-2016)
Belgium	29%	70%	⬆ 41
Denmark	68%	94%	⬆ 26
France	31%	64%	⬆ 33
Germany	28%	52%	⬆ 24
Italy	90%	94%	⬆ 4
Netherlands	47%	82%	⬆ 35
Poland	7%	24%	⬆ 17
Spain	45%	64%	⬆ 19

POULTRY

The largest farms (over € 500,000) have increased their share of the production in the poultry sector as well, with the exception of Italy, where the trend seems to have reversed. Although the concentration of poultry on the second-largest category of farm in Italy (with an output of between € 100,000 and € 500,000) rose from 5% to 41% over the same period, keeping the share in the two largest farm categories stable at around 95%. The largest farms account for the majority of the production in Belgium, Germany, Italy and Spain and for approximately 96% and 100% of the production in Denmark and the Netherlands respectively.

44 The Farm Accountancy Data Network is an instrument for evaluating income of agricultural holdings and the impact of the common agricultural policy. It collects annual surveys carried out by the member states of the European Union and it is the only source of microeconomic data that is harmonised. The annual sample covers approximately 80,000 holdings, which represent a population of about 5,000,000 farms in the EU covering about 90% of the utilised agricultural area. It aims to provide representative data along three dimensions: region, economic size and type of farming. http://ec.europa.eu/agriculture/rica/

The table shows the concentration of poultry meat production in the biggest farms (with an economic output of € 500,000 or more) in the years 2004 and 2016.

Share of poultry reared on the largest farms in:	2004	2016	% Variation (2004 - 2016)
Belgium	27 %	72 %	⬆ 45
Denmark	71 %	96 %	⬆ 25
France	11 %	28 %	⬆ 17
Germany	61 %	69 %	⬆ 8
Italy	91 %	55 %	⬇ 36
Netherlands	88 %	100 %	⬆ 12
Poland	23 %	30 %	⬆ 7
Spain	24 %	59 %	⬆ 35

MILK & MILK PRODUCTS

Production in the largest farms (over € 500,000) has also generally increased for milk and other dairy products, although not as significantly as in the pig and poultry meat sectors. This is in part due to the milk quotas, which ended in 2015, that had exerted significant pressure on the milk market for over two decades. In any case, while the largest milk farms currently do not cover the majority of the production as in other sectors, they still registered a noticeable increase in all eight countries between 2004 to 2016, and in particular in Belgium (from 3 % to 25 %), Denmark (from 27 % to 83 %), the Netherlands (from 9 % to 32 %) and Spain (from 3 % to 28 %).

The table shows the concentration of the production of milk and milk products in the biggest farms (with an economic output of € 500,000 or more) in the years 2004 and 2016.

Share of milk and milk products produced on the largest farms in:	2004	2016	% Variation (2004 - 2016)
Belgium	3 %	25 %	⬆ 22
Denmark	27 %	83 %	⬆ 56
France	2 %	8 %	⬆ 6
Germany	25 %	33 %	⬆ 8
Italy	23 %	29 %	⬆ 6
Netherlands	9 %	32 %	⬆ 23
Poland	4 %	13 %	⬆ 9
Spain	3 %	28 %	⬆ 25

The trend in the concentration of production in the hands of fewer and larger players correlates with Europe's agricultural system becoming less and less diversified. As smaller farms disappear, so does a more sustainable farming model rooted in diversity – a model that incorporates a variety of practices and genetic diversity of crops and animals (e.g. mixed crops and livestock) instead of relying on one uniform way of farming.[45] Nowadays, a staggering 82 % of livestock comes from specialised[46] large farms and only 16 % from mixed farming systems.[47]

45 Eurostat,. Archive:Small and large farms in the EU – statistics from the farm structure survey, data from October 2016. Available at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Archive:Small_and_large_farms_in_the_EU_-_statistics_from_the_farm_structure_survey&direction=next&oldid=406560#Land_use_and_farming_specialisation

46 Farm specialisation describes the trend towards a single dominant activity in farm income: an agricultural holding is said to be specialised when a particular activity provides at least two thirds of the production or the business size of an agricultural holding. https://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Farm_specialisation

47 Eurostat. Agri-environmental indicator – Specialisation, data from June 2016.
Available at https://ec.europa.eu/eurostat/statistics-explained/index.php/Agri-environmental_indicator_-_specialisation

EU financial support for the livestock sector – current and future policy options

3.

Given the essential role the CAP plays in shaping European agriculture, it is critical to investigate how this public money is being spent. It is of particular interest to assess whether the CAP has created the necessary policy instruments to address the massive growth of the industrial livestock sector, and its consequent impacts, and to encourage the urgently needed reduction in both consumption and production of animal products. This is even more relevant when considering that the increasing industrialisation and specialisation of farming, particularly evident in the livestock sector, has underpinned an ever increasing consumption of animal products.

The consumption of animal protein in Europe has increased by 80 % since the 1960s. Although population growth may account for some of this increase, the main driver has been a substantial per-capita increase in consumption of animal products, which in 2011 was already 50 % higher than in the 1960s and has since increased even further.[48] Policy analysts at the RISE foundation stressed that *"the doubling of livestock product consumption in the EU since the mid-20th century was made possible by the corresponding increase in EU production. The increase in livestock numbers and production during this period was enabled by significant technological and structural change in livestock farming systems encouraged by supportive agricultural and protective trade policy."*[49]

To get a better understanding of the role the CAP played in the expansion of industrialised livestock production, Greenpeace asked Nils Mulvad[50] an investigative journalist, data specialist and co-founder of FarmSubsidy.org – a project aimed at facilitating access to information on CAP subsidies – to gather data on the amount of public funding the CAP delivers to the sector. The researcher approached the European Commission directorate-general for agriculture and rural development (DG AGRI) and Eurostat requesting information about the amount of CAP funding going to livestock production, but neither institution was in possession of these calculations. Greenpeace then asked the researcher to collect necessary data on what the EU agricultural land is used for.

A) RESEARCH METHODS

Data on the amount of agricultural land present in each EU member state and on the specific use of that land have been sourced from the European Commission's directorate-general for agriculture and rural development (DG AGRI) and Eurostat. These institutions also provided data on the proportions of crops for human consumption, the livestock sector and industry. These data allowed us to calculate the amount of agricultural land in each country dedicated to feeding livestock.

Data on the 'utilised agricultural area' for each EU member state were downloaded from Eurostat.[51] Eurostat divides utilised agricultural area into four categories: 1. arable land, 2. permanent grassland, 3. permanent crops and 4. kitchen gardens. Calculations were then made as to what percentage of utilised agricultural area in each of the four categories is used for the production of fodder for livestock.

Permanent grasslands are considered as fully dedicated to animal fodder while **permanent crops** and **kitchen gardens** are regarded as producing no animal feed.

The percentage of **arable land** dedicated to animal feed had to be calculated using data on cereals, oilseeds and sugar beet production. These data were provided by the European Commission via email on 14 December 2018.[52] These data are part of the report EU Agricultural outlook for markets and income 2018 - 2030[53] and the latest Short-term outlook for EU agricultural markets.[54] This information was then used to calculate the percentage of each product destined for animal feed.

48 Westhoek, H. et al. 2011. The Protein Puzzle. The Hague: PBL Netherlands Environmental Assessment Agency. pg 69
Available at http://www.pbl.nl/sites/default/files/cms/publicaties/Protein_Puzzle_web_1.pdf

49 Buckwell, A. and Nadeu, E. 2018. What is the Safe Operating Space for EU Livestock? RISE Foundation, Brussels.
Available at http://www.risefoundation.eu/images/files/2018/2018_RISE_LIVESTOCK_FULL.pdf

50 https://www.kaasogmulvad.dk/en/

51 Eurostat, Utilised agricultural area by categories. Available at https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tag00025

52 All the data are available here: https://ec.europa.eu/agriculture/sites/agriculture/files/markets-and-prices/short-term-outlook/xls/agri-short-term-outlook-balance-sheets_en.xlsx

53 European Commission. 2018. EU Agricultural outlook for markets and income 2018-2030. Available at https://ec.europa.eu/agriculture/markets-and-prices/medium-term-outlook_en

54 European Commission. 2018. Short-term outlook for EU agricultural markets, autumn 2018. Available at https://ec.europa.eu/agriculture/markets-and-prices/short-term-outlook_en

The calculation of the percentage of cereals dedicated to animal feed is based on the data provided by the European Commission on their different commercial use (human consumption, animal feed or industrial use). For oil seeds the European Commission did not provide detailed information. The percentage of oilseeds dedicated to animal feed was calculated by using the following percentages:[55]

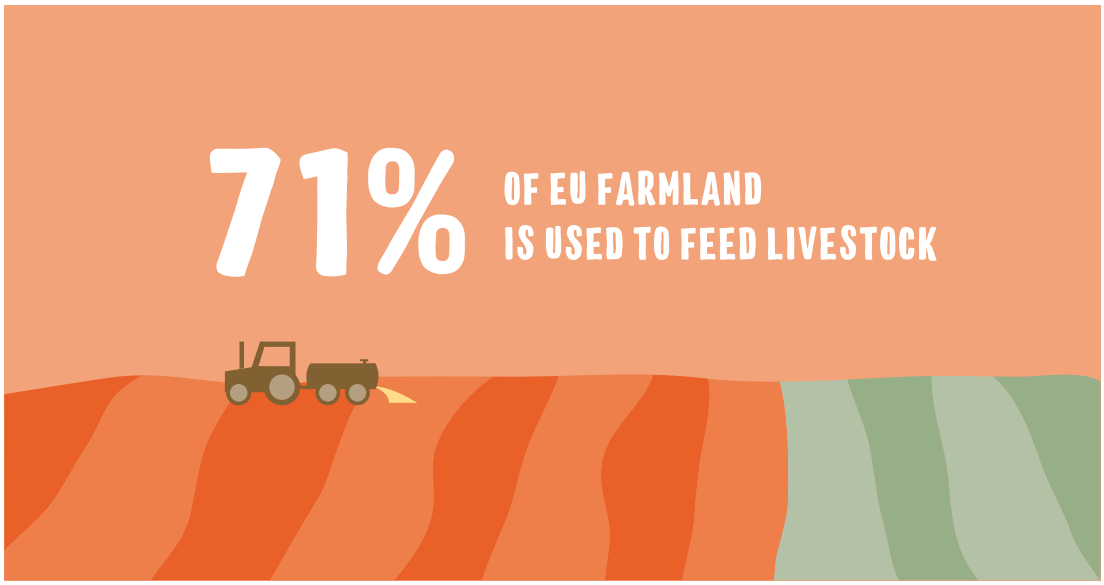
Rapeseed and turnip: **57 %**
Soya bean: **79 %**
Sunflower: **55 %**

For sugarbeet almost nothing is regarded as going to animal feed.

The heading 'rest' refers mainly to farmland used for grassland in rotation, silage, legumes and root vegetables for feed.

B) RESEARCH FINDINGS

The research found that 71.2 % of European farmland in 2017 was used for the production of fodder for the livestock sector. This percentage, encompassing both cropland and grassland, has been stable since 2007, varying slightly between 70 % and 72 %.

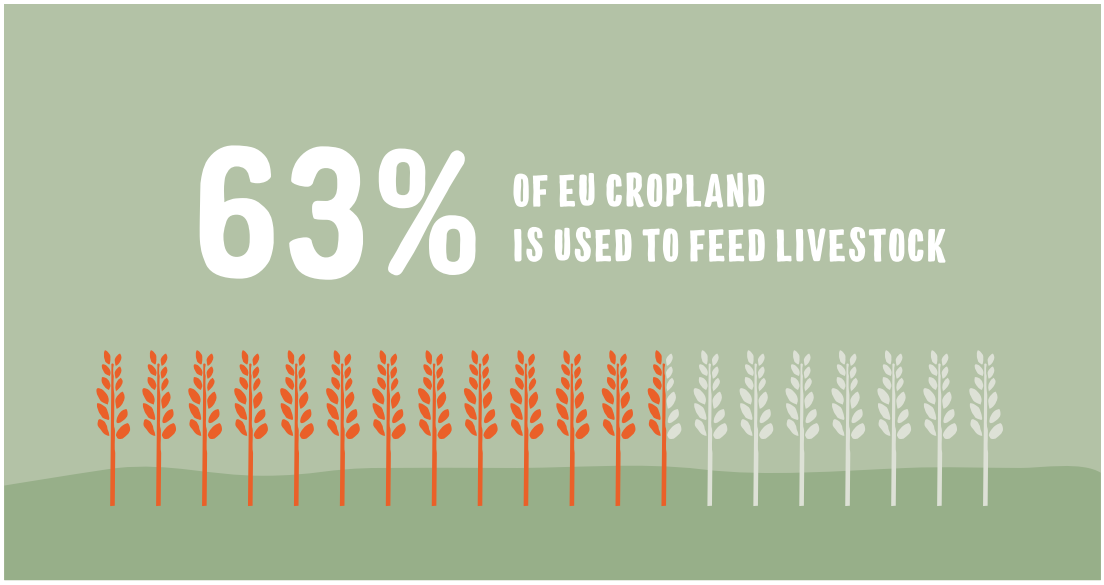


	Total agricultural land (thousand hectares)	Area dedicated to fodder production (thousand hectares)	% of total agricultural land dedicated to fodder production
Total agricultural area	178,740	127,260	71.2 %
- Permanent grassland	60,488	60,488	100 %
- Permanent crops	11,905	-	-
- Kitchen gardens	860	-	-
- Arable land	105,487	66,772	63 %
Cereals	55,478	34,410	62 %
Oil seed	11,873	6,892	58 %
Sugar beet	1,750	0	0 %
Rest	36,386	25,470	70 %

55 These percentages are based on the data and methodology provided to Mr. Mulvad by the European Commision, where the various oilseeds are divided into 'oil' (used for human consumption and biodiesel) and 'meal' (used for animal feed). The details can be found here: https://ec.europa.eu/info/sites/info/files/food-farming-fisheries/farming/documents/sto-2018-autumn-methodology.pdf

The fact that a third of the total EU agricultural area is dedicated to grassland does not itself raise concerns. Grasslands play an important role in the maintenance and enhancement of biodiversity and are an important carbon sink. While permanent grasslands with high nature value can bring these environmental benefits, temporary grasslands that are grown on crop land are less beneficial.

Estimates show that only a limited amount of livestock animals are fed with fodder coming from grasslands with high nature value, 20 % in the case of beef production and 4 % in the case of dairy production.[56] A relevant part of European grasslands are intensively farmed, with regular fertiliser application. However, given the positive contribution that grasslands make, particularly permanent grasslands of high nature value, it is crucial to defend farmland like this and encourage extensive livestock systems that contribute to rural livelihood, while providing benefits to biodiversity and the climate.



On the contrary, the most striking figure concerns feed crops. The research concludes that an astonishing 63 % of arable land in Europe is dedicated to the production of crops for animal feed. Such a large amount of land, often intensively cultivated with the application of synthetic fertilisers and pesticides – with all the associated health, environmental and climate impacts – could be dedicated for the most part to the production of food for people. A reduction in the consumption of animal products should match a parallel reduction in livestock production and an increase in alternatives to meat and dairy, grown on farmland once used to grow feed crops for animals. Using land to grow feed for livestock is also a highly inefficient use of natural resources, whether in Europe or elsewhere. Animals are able to convert only between 10 - 30 % of the feed they consume into food for people,[57] with significant consequences for the amount of land needed.

C) CAP PAYMENTS LINKED TO THE LIVESTOCK SECTOR

The main factors driving the increased specialisation and industrialisation of the livestock sector, aside from an increase in demand for animal products, are international market forces as well as trade policies and agricultural policies. The EU's trade policies and agricultural policies have ensured the availability of cheap feed, maintained prices of animal products competitive in the international market, via export subsidies and import tariffs, and regulated the market through production quotas and buying excess agricultural products if prices are in danger of falling.

A number of CAP reforms, to address market distortions, transformed subsidies into income support mechanisms. In the 1990s, payments were still coupled to production, compensating farmers for lower market prices. After 2003, the majority of CAP funds (around 90 %) became increasingly decoupled from production, linked only to the amount of land farmed. The fact that the majority of payments is not linked to any specific production prevents precise calculations on the exact number of hectares dedicated to the different farming sectors. Another element that makes precise calculations even more challenging is that not all farmers in the EU are beneficiaries of CAP payments. There is a significant number of small and very small farmers who do not, or cannot, apply for CAP payments. According to Commission's figures, CAP subsidies reach nearly 7 million farms, covering 90 % of total European farmland.[58]

56 Westhoek, H. et al. 2011. The Protein Puzzle, The Hague: PBL Netherlands Environmental Assessment Agency, page 23. Available at http://www.pbl.nl/sites/default/files/cms/publicaties/Protein_Puzzle_web_1.pdf

57 Ibid.

58 European Commission. 2017. CAP Explained - Direct Payments for Farmers 2015 - 2020. Available at https://ec.europa.eu/agriculture/sites/agriculture/files/direct-support/direct-payments/docs/direct-payments-schemes_en.pdf

Under these circumstances it is not possible to precisely match the 71.2 % of EU farmland dedicated to the production of fodder for livestock with CAP direct payments. However, the conclusion that a substantial proportion of CAP direct payments is linked to the animal farming sector, reaching land producing feed crops and grasslands, remains valid. Since direct payments are tied to the acreage of land farmed, it is possible to formulate solid estimations substantiating these conclusions.

An element that needs to be considered is that EU member states can dedicate up to 13 % of their direct payments budget to support specific production sectors, via a mechanism known as 'voluntary coupled support'. An analysis by the European Commission of the sectors currently covered by coupled payments in the various member states shows that 73 % of these payments specifically benefit the livestock sector. About 41 % of voluntary coupled support goes to the beef and veal sector, 20 % to milk and milk products and about 12 % to the sheep and goat meat sector. If one considers that 10.6 % of coupled payments are dedicated to protein crops, and at least half of which are used as feed for livestock, the amount of coupled payments devoted to livestock increases to about 78 %. € 4.2 billion per year is used by member states as voluntary coupled support.[59]

A few small adjustments could influence the overall calculation of the amount of the direct payment reaching the livestock sector:

1. Redistributive payments: EU member states are allowed to set higher payments for the first hectares (30 ha or the national average farm size if more than 30 ha). However, this redistribution remains connected to the land area, not production.
2. Young farmers and small farmers can benefit from extra payment.
3. Cross-compliance and other financial discipline mechanisms, which can impose fines on CAP beneficiaries violating public health, environmental and animal welfare.

However, these adjustments are considered to cause only marginal variations to the calculations, and are therefore not taken into account in this analysis.

D) CALCULATING TOTAL CAP DIRECT PAYMENTS LINKED TO THE LIVESTOCK SECTOR

Considering all the above-mentioned information, it is therefore possible to conclude that between 69 % (€ 28.5 billion) and 79 % (€ 32.6 billion) of the CAP direct payments is directed to producers of fodder for animals, or goes directly to livestock producers as coupled support. That's between 18 % and 20 % of the EU's € 157.86 billion budget in 2017.

59 European Commission. 2017. Voluntary coupled support – Notification of the revised decisions taken by Member States by 1 August 2016. Available at https://ec.europa.eu/agriculture/sites/agriculture/files/direct-support/direct-payments/docs/voluntary-coupled-support-note-revised_en.pdf

- **€ 41,551,156,000 is the total CAP direct payments for the year 2017**
- **Approximately € 4.2 billion of this is voluntary coupled support, 73 % of which goes directly to the livestock sector, so € 3.066 billion**
- **This leaves € 37,351,156,000 of direct payments based on acreage**
- **71.2 % of all agricultural land is used to feed livestock**
- **10 % of all agricultural land does not receive CAP payments, 90 % does**
- **Assuming that all of that 10 % of land is dedicated to livestock fodder would mean that all such land should be subtracted from the calculations, so: (71.2 - 10) / 90 = 68 % of direct payments based on acreage, so € 25,398,786,080**
- **Assuming that none of that 10 % of land is dedicated to livestock fodder, then calculations would not consider it so: 71.2 / 90 = 79.1 % of direct payments based on acreage, so € 29,544,764,396**
- **Adding the € 3.066 billion of coupled support for livestock gives us a range between approximately € 28.5 billion and € 32.6 billion of taxpayers' money spent annually on supporting the livestock sector – 18 % to 20 % of the EU's budget.**

Due to the lack of detailed information on direct payments, it is not possible to single out how much CAP money goes to extensive animal farms compared to industrial livestock farms.

Direct payments are not the only CAP subsidies reaching the livestock sector. Market measures and rural development measures also convey public funds to agricultural activities.

Market measures are public interventions that respond to market failures. When a particular sector is hit by a sudden crisis or market prices fall below certain levels, the European Commission can intervene and activate market support measures, providing finance to a sector in difficulty or buying produce from the market to ensure higher prices. In the case of livestock the biggest amount of money recently spent for market measures reached the milk sector, although other animal farming sectors have been supported as well.

The researcher found it particularly difficult to gather, from the European and national institutions contacted, detailed information on the distribution of rural development funds. Considering the critical role played in the intensification of the livestock sector by rural development policies and subsidies, particularly in the case of investments for the construction or modernisation of stables, these funds should be the subject of a dedicated investigation. For these reasons, only CAP direct payments are included in the present calculations, so the amount of total CAP funding supporting the livestock sector is higher than these estimates.

How the current CAP plan would affect trends in European farming

4.

In June 2018 the European Commission presented its proposal for the CAP post 2021. The Commission claims that the new CAP proposal introduces a new plan for direct payments that is better targeted, fairer and greener. However, despite criticism by a wide range of stakeholders on direct payments, the proposed plan leaves them untouched. The EU budgetary watchdog, the Court of Auditors, recently highlighted that "*the proposal continues to impose on Member States the use of direct payments based on given amount of hectares of land owned or used. This instrument is not appropriate for addressing many environmental and climate concerns, nor is it the most efficient way of supporting viable farm income.*"[60]

The Commission presents its proposal as aimed at increasing the environmental and climate ambition of the CAP. Even though three of the nine objectives that member states are supposed to meet by the end of the policy term are explicitly related to environmental and climate protection, the CAP proposal does not provide any clear mechanism to make sure governments achieve these objectives. The new proposed framework is set up in a way that drives member states into a race to the bottom. Governments will be under pressure to introduce requirements as weak as those set by other EU governments, so as not to put their own farmers at a competitive disadvantage.

The plan sets generic objectives and loose indicators for progress towards them, fails to set strict control mechanisms, and substantially broadens member states' discretionary spending power. The Commission proposal thereby provides EU governments with a blank cheque, allowing them to maintain unaltered the current CAP payments, benefiting the most powerful agricultural players and underpinning an unsustainable farming sector. The EU Court of Auditors confirms this by stating: "*Despite the Commission's ambitions and calls for a greener CAP, the proposal does not reflect a clear increase in environmental and climate ambition … It is unclear how the Commission would check these [required member state farming] plans to ensure environmental and climate ambition.*"

Despite the claim of aiming for a greener CAP, the Commission has shied away from even mentioning as an objective of the CAP addressing the problems that mounting scientific evidence keeps highlighting: the current excess of production and consumption of animal products in the EU.

60 European Court of Auditors. 2018. Briefing Paper, Future of the CAP, March 2018.
Available at https://www.eca.europa.eu/Lists/ECADocuments/Briefing_paper_CAP/Briefing_paper_CAP_EN.pdf

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Conclusion – what can be done?

5.

This investigation reveals a constant, worrying trend. Smaller farms are disappearing at an alarming rate, particularly in the livestock sector. Larger farms are getting bigger and bigger, to the extent that, in just a few years, the vast majority of animal products on the European market is now produced in 'very large' specialised farms. The impact of this kind of farming on public and animal health, on the environment and on the climate is well documented. In addition, the loss of smaller farms can have profound socio-economic consequences as these holdings can play a significant role in providing additional income and food in rural communities.[61]

Along with international market pressure and favourable trade policies, CAP subsidies have driven this intensive farming system, encouraging, when not forcing, livestock farmers to further intensify. The mere fact that considerably more than half of the total CAP budget is linked to the livestock sector runs counter to the urgent warning by scientists to substantially reduce consumption and production of livestock products.

So far, the CAP has failed to effectively promote extensive livestock systems beneficial to our environment, climate, health and vibrant rural communities. These systems rely on grasslands, crop residues and by-products rather than on protein-rich, concentrated feed designed for large number of animals confined to concrete stables. This more sustainable farming system would free up much of the land used for livestock fodder to instead grow crops to feed people.

Public CAP money must be spent to support a transition away from intensive farming. This money should support extensive livestock farmers raising animals via ecologically responsible methods, and encourage healthy and sustainable, predominantly plant-based diets. The funds should be spent in a way that reduces the overall number of animals produced, increasing quality, preserving natural grasslands, and ensuring the livelihood of rural communities, not just of a few isolated industrial players.

THE REFORMED COMMON AGRICULTURAL POLICY MUST:

1. **Dedicate** 50 % of the overall CAP budget to support two streams of ecological farming methods:
   a) 50 % of direct payments to mandatory eco-schemes delivering environmental and climate benefits, encouraging farmers to produce less and better livestock, as well as more fruit and vegetables,
   b) 50 % of the rural development budget to agri-environmental and climate measures.

2. **Strengthen** the requirements of the proposed 'enhanced conditionality', which all farmers receiving CAP subsidies must comply with, and in particular establish a maximum number of farm animals per unit area of farmland, beyond which CAP payments cannot be delivered. Farm holdings exceeding the number of animals producing over 170 kg/ha of nitrogen, as set by Directive 91/676/EEC, should not receive public money.

3. **Provide** coupled payments only to sectors and systems delivering clear and measurable environmental benefits.

4. **Prevent** any CAP spending aimed at or leading to encouraging the production and consumption of animal products, including via market measures and promotion measures.

61 Eurostat. 2018. Agriculture, forestry and fishery statistics, 2018 edition.
Available at https://ec.europa.eu/eurostat/documents/3217494/9455154/KS-FK-18-001-EN-N.pdf/a9ddd7db-c40c-48c9-8ed5-a8a90f4faa3f

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