Avoiding catastrophic climate change isn't impossible yet. Just incredibly hard

There's a narrow path to safety

David Roberts, September 19, 2017

This photo taken in 2006 shows a warning sign for boats sitting on the bottom of the empty Green Hill Lake outside the small rural town of Ararat, some 170 kms west of Melbourne. (WILLIAM WEST/AFP/Getty Images)

When they signed the Paris climate agreement, the countries of the world committed to a common goal: Hold the rise in global temperatures "well below 2 degrees Celsius above pre-industrial levels" and "pursue efforts" to hold it even lower, to 1.5 degrees.

Aim for well below 2 C, hit 1.5 C if possible. That's what we all signed up for. Is that wildly ambitious goal still possible? The general feeling among scientists and analysts, especially off the record, has been that 1.5 C is impossible and 2 C unlikely. However, three new research publications offer some hope — or at least what passes for hope in climate circles these days. To wit: "well below 2 C," even as low as 1.5 C, might not be impossible yet. It might only be really, really difficult!

An actual plan to meet the Paris goal

The first two reports are related. The first is a paper in *PNAS*, by researchers Yangyang Xu and Veerabhadran Ramanathan, that lays out a concrete policy plan for stopping "well below 2 C."

The second is from the Committee to Prevent Extreme Climate Change, a group of 33 climate scientists and policy experts, who take the *PNAS* results and expand them into a broader discussion: "Well Under 2 Degrees Celsius: Fast Action Policies to Protect People and the Planet from Extreme Climate Change". Here is the plan, summarized in a graphic. There are four building blocks (the shaded colors) and three levers, involving 10 solutions, which range from technological to political to cultural.

Lever one: decarbonize the global energy system with efficiency and renewables

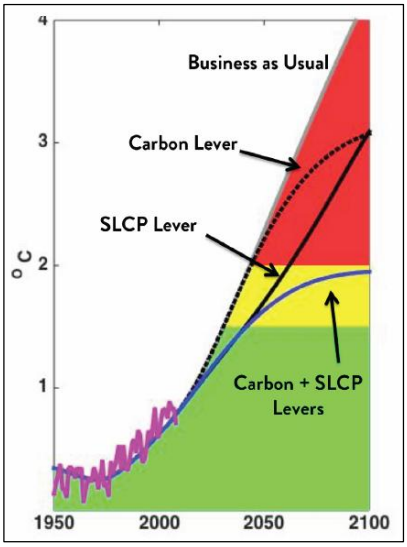
Step one is achieving 100 percent clean electricity by 2030 and 100 percent clean energy by 2050. Among other things, that will involve decarbonizing sectors that now rely on fossil fuel combustion, notably transportation and heavy industry, either by shifting them to electricity or finding zero-carbon liquid fuel alternatives (more likely the former). And in the electricity sector, it means getting rid of coal and natural gas entirely.

To date, clean sources of energy have barely managed to maintain their ratio of global energy use, even as fossil fuels grow much faster in absolute terms. Renewables are still a blip on the radar. Flipping that ratio would involve a truly heroic, large-scale, well-coordinated effort like nothing in history, a kind of global war mobilization.

Lever two: rapidly reduce short-lived climate pollutants (SLCPs) to the maximum extent possible by 2030

SLCPs — including methane, black carbon, HFCs, and tropospheric ozone — are gases that tend to have more warming effect than carbon dioxide but for a shorter duration. Reducing them can bring short-term changes in the trajectory of warming while also improving local air quality and reducing crop loss, preventing millions of deaths.

For the most part, the technology exists to make these reductions, and in many cases, legal frameworks are already in place. For instance, the Kigali Amendment to the Montreal Protocol, signed in 2016, will rapidly reduce HFCs; it *alone* could avoid 0.5 C of warming by 2100. The two levers work together to tame the rise in temperature:



Assuming both levers are maximized in the short-term — carbon emissions start falling by 2020 and hit zero by 2050 — we will have about a 50 percent chance of staying under 2 C. That's great, but it falls somewhat short of "well below 2 C." To drive the chances of exceeding 2 C down to 20 percent, the researchers had to add another lever (and a fourth building block).

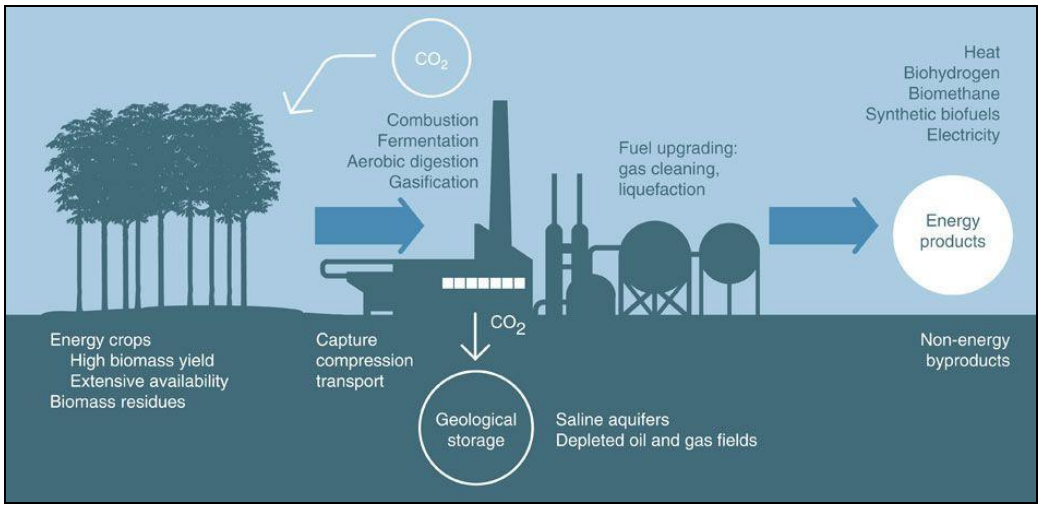
Lever three: negative emissions

Even rapidly bringing our net greenhouse gas emissions down to zero probably won't be enough to ensure that temperatures peak and begin falling before 2 C. To ensure that, we need to start sucking carbon back out of the atmosphere. We need to go carbon negative. (I wrote about that more in this post.)

There are several options for negative carbon. The researchers list "afforestation (including urban forestry), capturing, utilizing, and storing CO2, bioenergy combined with carbon capture and sequestration (BECCS), soil organic carbon management, biochar, direct air capture, enhanced weathering and ocean liming, and ocean fertilization with iron."

All of those technologies have been demonstrated, but none of them is even close to sufficient scale. Still, we need that negative-carbon building block, badly. It can be thought of as serving two roles. In the best cast scenario for the other levers, lever three becomes a way of getting from "likely under 2 C" to "close to 1.5" — from maybe safe to probably safe. But if things go wrong with the other levers — policy rollbacks, high technology costs, social resistance, more-sensitive-than-expected climate response, whatever — negative emissions can be thought of as *insurance*. They are, in theory, a dial we can turn to compensate for failures in other mitigation efforts. They enable us, in theory, to blow past our target, but then ratchet our way back down ("overshoot" scenarios).

If SLCPs and carbon both begin declining by 2020 and the world achieves carbon neutrality by 2050, then the amount of carbon that will need to be removed from the atmosphere is modest. If, instead, we follow the trajectory of the existing Paris commitments and carbon emissions don't peak until 2030, we will need to remove a *trillion* tons of carbon from the atmosphere by the end of the century. Trillion, with a T. That is about half the total carbon that humans have contributed to the atmosphere to date. It is an industrial project of almost unfathomable scale.



(Sanchez 2015)

Anyway, that's the plan for staying "well under 2 C": strengthen all the treaties and sign some new ones, empower sub-national actors, decarbonize the entire global energy system in just over three decades, radically reduce SLCPs within 10 years, and research and develop negative-emissions technologies that can scale toward the end of the century.

We may have slightly more room to maneuver than we thought

If the plan above seems absurdly difficult and unlikely to you, another new paper might lift your spirits. A little, anyway. To make a long story short: A group of researchers has found that humanity's "carbon budget" — the amount of carbon it can still add to the atmosphere before pushing temperatures above our targets — is somewhat larger than previously estimated, which gives us just a little extra room to work with.

The technical disputes around this are heated and longstanding, but the basic finding is pretty simple. It seems that models slightly overestimated post-2000 warming, thanks to the much-discussed "pause." If estimates and projections in carbon-budget models are updated with actual emissions and temperature changes from that period, it turns out we used less of our carbon budget than we thought, which means we have more left over than we thought. (Chris Mooney briefly covers some of the controversy around this approach.) So, the latest IPCC report, from 2014, says we have 1.7 trillion tons to burn before going over 2 C. This paper finds that, *if* SLCPs are rapidly reduced, it's more like 2.4. (Without the SLCP contribution, it's 2.0.)

The rousing conclusion? "Limiting warming to 1.5 C is not yet a geophysical impossibility." Woot! (Notably, this set of researchers also says that rapid, aggressive reductions in SLCPs are key to hitting our targets.) Basically, if this finding holds up (still a big if), we could still hit the 1.5 C target — even without overshoot — by strengthening all the 2030 Paris targets and then ramping up, well, everything after 2030, including negative emissions. The lead author, Richard Millar, writes an accompanying commentary celebrating the fact that "the window for achieving 1.5 C is still narrowly open."

But don't get too excited

I find the controversy around this paper somewhat amusing. Take a step back. The plan laid out in those first two papers is so mind-bogglingly ambitious that it's almost difficult to hold it all in your head at once. It would involve a total and immediate global U-turn on energy production and use and on infrastructure investment. It would involve an immediate, large-

scale ramp-up of R&D. It would involve the strengthening of multiple international treaties, each of which is a difficult, knotty issue on its own. It would involve the rapid development of a negative-emissions industry capable of handling quantities of CO2 vastly greater than total yearly emissions.

Each of those challenges is daunting, involving many dozens of sub-challenges. To pull them all off, simultaneously ... well, one doesn't want to be a Negative Nancy, but the likelihood seems remote. It's like we're starting a 100-mile marathon, and we've got to read a book while we're running, but we also need to build upper-body strength, so we're holding the book with one hand and lifting a barbell with the other, and by the way, we've never run farther than 10 miles.

Now, along comes this new paper that says, effectively, "Hey, the marathon is only 99 miles!" That's ... nice and all. It's great that what we need to do is not geophysically impossible, merely more difficult than anything humanity has ever done before, by multiples. But as I've said many times before, "not literally impossible" is a pretty meaningless benchmark in the real world. The social, economic, and political limitations on global, coordinated action are far more restrictive, and bite far sooner, than any physical limitations. And those are limitations science is impotent to change.

The fact is, we need to mobilize on a massive scale. Subsequent science may tell us interesting things about the total size of the challenge and the amount of time we have to complete it — the marathon may be 98 miles, it may be 102 — but it's unlikely to change the need for enormous, immediate action. We are *so far* from where we need to be that small adjustments in destination are effectively meaningless in practical terms.

There is, at this point, virtually zero real chance of us acting too fast or doing too much. In theory, there are risks on both sides; in practice, all the risks are on the side of too little action. So the basic structure of the dilemma remains the same no matter the precise size of the carbon budget.

We need to act if we can still hit 1.5 C. We need to act if we can't hit 1.5 C, but can still hit 2 C. Even if both targets become impossible, we need to act to avoid 3 C, or 4 C, or 5 C, where the risks become existential.

The imperative to act is not going to change. At this point, research emphasizing that well-established truth is less useful than research on how to overcome the social and political barriers to rapid action. Collectively, we know we need to act; we just don't know how to make ourselves do it