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The Two-Degree Delusion
The Dangers of an Unrealistic Climate Change Target
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Global carbon emissions rose again in 2017, disappointing hopes that the previous three years of near zero growth marked an inflection point in the fight against climate change. Advocates of renewable energy [1] had attributed [2] flat emissions to the falling cost of solar panels. Energy efficiency devotees had seen in the pause proof [3] that economic activity had been decoupled from energy consumption. Advocates of fossil fuel divestment had posited [4] that the carbon bubble had finally burst.

Analysts [5] who had attributed the pause to slower economic growth in a number of parts of the world, especially China [6], were closer to the truth. The underlying fundamentals of the energy economy, after all, remained mostly unchanged—there had been no step change in either the energy efficiency of the global economy or the share of energy production that clean energy accounted for. And sure enough, as growth picked up, emissions started to tick back up again as well.

Even during the pause, it was clear that the world wasn't making much progress toward avoiding significant future climate change. To significantly alter the trajectory of sea level changes or most other climate impacts in this century or the next, emissions would not just have to peak; they would have to fall precipitously. Yet what progress the world has made to cut global emissions has been, under even the most generous assumptions, incremental.

But at the latest climate talks in Bonn last fall, diplomats once again ratified a long-standing international target of limiting warming to two degrees Celsius above preindustrial levels. This despite being unable to commit to much beyond what was already agreed at the Paris meeting two years ago, when negotiators reached a nominal agreement on nonbinding Intended Nationally Determined Contributions, which would result in temperatures surpassing three degrees above preindustrial levels before the end of this century.

Forty years after it was first proposed, the two-degree target continues to maintain a talismanic hold over global efforts to address climate change, despite the fact that virtually all sober analyses conclude [7] that the target is now unobtainable. Some advocates still insist that with sufficient political will, the target can be met. Others recognize that although the goal is practically unachievable, it represents an aspiration that might motivate the world to reduce emissions further and faster than it would otherwise. For still others, the target remains within reach if everyone gets serious about removing carbon from the atmosphere or hacking the atmosphere in order to buy more time.

But it is worth considering the consequences of continuing to pursue a goal that is no longer obtainable. Some significant level of future climate impact is probably unavoidable. Sustaining the fiction that the two-degree target remains viable risks leaving the world ill prepared to mitigate or

manage the consequences.

AN ARBITRARY TARGET

My uncle, the Yale University economist William Nordhaus, is widely credited [8] with being the first person to propose [9] that climate policy should strive to limit anthropogenic global warming to two degrees above preindustrial temperatures. He didn't arrive at that conclusion through any sort of elaborate climate modeling or cost-benefit analysis. Rather, he considered the very limited evidence of long-term climate variance available at that time and concluded that a two-degree increase would take global temperatures outside the range experienced by human societies for the previous several thousand years and probably much longer. The standard was, by his own admission, arbitrary.

In the decades that followed, the international community formalized his target through a series of UN conferences, assessments, and negotiations. Climate researchers, meanwhile, have backfilled the target with science, some of it compelling. It does indeed appear that the earth is already hotter than it has been in the last several hundred thousand years, with temperatures likely to rise substantially more through this century and well beyond.

But limiting global temperatures below two degrees provides no guarantee that the world will avoid catastrophe, nor does exceeding that threshold assure it. No one knows with much precision what the relationship will be between global temperature and the impact of climate change at local and regional levels. Nor do we have a particularly good handle on the capability of human societies to adapt to those impacts.

In reality, most of the climate risks that we understand reasonably well are linear, meaning that lower emissions bring a lower global temperature increase, which in turn brings lower risk. That is the case for impacts such as sea level rise, agricultural yields, rainfall, and drought. Stabilizing emissions at 450 atmospheric parts per million brings less risk than stabilizing at 500, 500 brings less risk than 550, and so on. The world isn't saved should we limit atmospheric concentrations to 450 parts per million, nor is it lost should concentrations surpass that threshold.

There are a range of potential nonlinear tipping points that could also bring catastrophic climate impacts. Many climate scientists [10] and advocates [11] argue that the risks associated with triggering these impacts are so great that it is better to take a strict precautionary approach to dramatically cut emissions. But there are enormous uncertainties about where those tipping points actually are. The precautionary principle holds equally well at one degree of warming, a threshold that we have already surpassed; one and a half degrees, which we will soon surpass; or, for that matter, three degrees.

Such calculations are further complicated by the substantial lag between when we emit carbon and when we experience the climate impacts of doing so: because of the time lag, and because of the substantial amount of carbon already emitted (atmospheric concentrations of carbon today stand at 407 parts per million, versus 275 prior to the start of the Industrial Revolution), even an extreme precautionary approach that ended all greenhouse gas emissions immediately would not much affect the trajectory of global temperatures or climate impacts until late in this century at the earliest.

Projections of sea level rise, for instance, don't really diverge in high-emissions versus low-emissions scenarios until late in this century, and even then not by very much. It is not until modelers project into the twenty-second century that large differences begin to emerge. The same is true of most other climate impacts, at least as far as we understand them.

Many advocates for climate action suggest that we are already experiencing the impacts of anthropogenic climate change in the form of more extreme weather and natural disasters. Insofar as this is true—and the effect of climate change on present-day weather disasters is highly contested—there is not much we can do to mitigate it in the coming decades.

THE URGENCY TO ADAPT

Over the last two decades, discussions of climate risk have been strongly influenced by concerns about moral hazard. The suggestion that human societies might successfully adapt to climate change, the argument goes, risks undermining commitments to cut emissions sufficiently to avoid those risks.

But moral hazard runs the other way as well. On a planet that is almost certainly going to be much hotter even if the world cuts emissions rapidly, the continuing insistence that human societies might cut emissions rapidly enough to avoid dangerous climate change risks undermining the urgency to adapt.

Adaptation brings difficult tradeoffs that many climate advocates would prefer to ignore. Individual and societal wealth, infrastructure, mobility, and economic integration are the primary determinants of how vulnerable human societies are to climate disasters. A natural disaster of the same magnitude will generally bring dramatically greater suffering in a poor country than in a rich one. For this reason, poor nations will bear the brunt of climate impacts. But by the same token, the faster those nations develop, the more resilient they will be to climate change. Development in most parts of the world, however, still entails burning more fossil fuels—in most cases, a lot more.

Most climate advocates have accepted that some form of adaptation will be a necessity for human societies over the course of this century. But many refuse to acknowledge that much of that adjustment will need to be powered by fossil fuels. Hard infrastructure—modern housing, transportation networks, and the like—is what makes people resilient to climate and other natural disasters. That sort of infrastructure requires steel and concrete. And there are presently few economically viable ways to produce steel or concrete without fossil fuels.

The two-degree threshold, and the various carbon budgets [12] and emissions reduction targets that accompany it, has provided the justification for prohibitions at the World Bank and other international development institutions on finance for fossil fuel development. Given how much climate change is likely already built into our future owing to past emissions and how long it takes for emissions reductions to mitigate climate impacts, those sorts of policies will almost certainly increase exposure to climate hazards for many people in developing economies.

DEPLOYMENT DELUSIONS

Continued devotion to the two-degree target has also undermined carbon-cutting efforts. In theory, cutting emissions deeply enough by midcentury to limit warming to two degrees would require deploying zero-carbon energy technologies today at a historically unprecedented scale. That would seem to take important drivers of incremental decarbonization, such as the transition from coal to gas in the United States and many other parts of the world, off the table. Burning natural gas produces half the carbon per unit of energy produced as burning coal. But it can’t decarbonize the power sector fast enough to hit the two-degree target by 2050.

For this reason, most climate advocates are at best indifferent to natural gas and are more often opposed, even though the switch from coal to natural gas has been the largest source of emissions reductions in the United States for over a decade, as it was in the United Kingdom in the early 1990s.

The two-degree target has also hobbled support for developing better clean energy technologies. Because next-generation technologies such as advanced nuclear reactors, advanced geothermal, and carbon capture capabilities won’t be ready for large-scale commercialization for at least another decade or two, they will arrive too late to contribute much to two-degree stabilization scenarios. In turn, many prominent climate advocates have long argued [13] that the only climate action worthy of the name entails deploying zero-carbon technologies that are commercially available today.

Yet there is little reason to think that existing zero-carbon technologies are up to the job. To be sure, some models do claim that current renewable energy technologies are capable of powering the electrical grid and much beyond. But strong renewables growth in various parts of the world appears to follow a classic S-curve [14], with market share on electrical grids stalling at around 20 percent or less of total generation after a period of strong initial adoption, because the value of intermittent sources of energy such as wind and solar declines precipitously as their share of electricity production rises.

For a period of time, in the 1970s and 1980s, conventional nuclear reactors had a better track record. France decarbonized 80 percent of its electrical system with nuclear. Sweden achieved 50 percent. But conventional nuclear technology, which requires strong central governments and vertically integrated utilities that build, own, and operate plants, has been swimming against the current of economic liberalization and declining faith in technocratic institutions for decades. Outside of China and a few other Asian economies, few nations have been able to build large nuclear plants cost-effectively in recent decades.

Such limitations continue to plague power sector decarbonization efforts around the world. But the power sector accounts for only about 20 percent of global primary energy use and turns out to be relatively easy to decarbonize compared with transportation, agriculture, industry, and construction. There are currently few viable substitutes for fossil fuels in the production of steel, cement, or fertilizer or for powering aviation and heavy transportation.

Longer term, there may be better options, including advanced nuclear reactors that can provide heat for industrial processes, carbon capture technologies that can capture emissions from burning fossil fuels, and low-carbon synthetic fuels that might substitute for diesel and aviation fuels. But all are decades away from viable application. The technologies that are needed to cut emissions deeply enough to stabilize emissions at two degrees, in short, will not be ready in time to do so. As a result, continued devotion to the two-degree threshold has ended up undermining both important incremental pathways to lower emissions and long-term investment in the development and commercialization of technologies that would be necessary to deeply decarbonize the global economy.

POINT OF NO RETURN

Almost 30 years after the UN established the two-degree threshold, over 80 percent of the world's energy still comes from fossil fuels, a share that has remained largely unchanged since the early 1990s. Global emissions and atmospheric concentrations of carbon dioxide continue to rise. Climate policy, at both international and national levels, has had little impact on their trajectory.

Climate advocates have persistently blamed the failures of climate policy on the corrupting political power of the fossil fuel industry. Industry-funded "merchants of doubt [15]," as the historians Naomi Oreskes and Erik Conway originally dubbed them, together with heavy political spending, have stopped climate mitigation efforts in their tracks. But those claims are U.S.-centric. Climate skepticism and denial have not found anywhere close to the same level of political traction outside the United States. Exxon and the Koch brothers have no political franchise in the German Bundestag, the Chinese Central Committee, or most other places outside Washington. And yet those nations have had no more success cutting emissions than has the United States. To the contrary, U.S. emissions have fallen faster than those of almost any other major economy over the last decade.

The alternate explanation is rather less dramatic. Decarbonization is hard. Fossil fuels continue to bring substantial benefit to most people around the world, despite the significant environmental consequences. The alternatives have improved, but not sufficiently to displace fossil energy at scales that would be consistent with stabilizing temperatures at the two-degree threshold. The

consequences of failing to do so for human societies are too uncertain or too far off in the future to motivate either a World War II–style mobilization [16] to deploy renewable energy or a global price on carbon [17] high enough to rapidly cut emissions.

At some point over the next 20 years or so, atmospheric concentrations of carbon will almost certainly surpass 450 parts per million, the emissions proxy for avoiding long-term temperature increases of greater than two degrees. At that point, the only certain path to stay under the target will be either to pull carbon out of the atmosphere at almost unimaginable scales or to alter the chemistry of the atmosphere such that rising greenhouse gas concentrations do not lead to higher temperatures. Functionally, that moment has already arrived. Virtually all scenarios consistent with stabilizing global temperatures at plus two degrees, according to the Intergovernmental Panel on Climate Change, explicitly require so-called negative emissions in the latter half of this century.

In recent years, the moral hazard argument used against adaptation has also been used against geoengineering and carbon removal technologies. The suggestion that it might be possible to pull sufficient carbon out of the atmosphere to lower global temperatures or, short of that, change the chemical composition of the atmosphere or the oceans such that large temperature increases might be forestalled, the logic goes, risks distracting [18] us from the central task of rapidly decarbonizing the global economy. Yet no one is seriously proposing embarking on large-scale carbon removal or geoengineering today. We haven't really figured out how to do the former, and the latter brings a range of potential risks that we don't yet fully understand. Still, such emergency measures may be necessary in the future even with a steep cut in emissions. As in the case of adaptation, however, the twin fictions that the two-degree limit remains a plausible goal and that dangerous climate change can be avoided should we achieve it allow the moral hazard argument to be marshaled against even sensible calls for serious public research.

A PRACTICAL PATH FORWARD

At this point, if there is a moral hazard argument to be made, it is against the two-degree threshold, not for it. Humans are going to live on a significantly hotter planet for many centuries. The notion that two degrees remains an achievable target risks diverting attention from steps we might take today to better weather the changes that are coming. Once the world lets go of the unrealistic two-degree target, a range of practical policies comes much more clearly into focus.

We should do all that we can to speed up decarbonization. Accelerating the coal-to-gas transition and continuing the deployment of today's renewable energy technologies would incrementally reduce climate risk even if neither is capable of decarbonizing economies at rates consistent with achieving the two-degree target. At the same time, it is important to support those efforts in ways that don't lock out technologies that will be necessary to achieve deeper emissions cuts over the longer term. Continuing subsidies for low-efficiency solar panels, for instance, have shut higher-efficiency solar technologies out of the renewables market. Cheap gas has rendered many nuclear power plants, which don't get the same privileged access to electrical grids or direct production subsidies as do wind and solar energy, uneconomical. At relatively low overall shares of electricity generation, variable sources of power such as wind and solar risk crowding out other zero-carbon options that will be necessary to fully decarbonize power grids. And if deep decarbonization is the objective, much greater public investment will be needed to develop and commercialize clean energy technologies, even though those technologies are unlikely to contribute much to emissions-cutting efforts over the next several decades.

Meanwhile, we need to stop trying to balance the increasingly parsimonious carbon emissions budgets entailed by a two-degree target on the backs of the global poor. There is no moral justification for denying those populations the benefits of fossil-fuel-driven development. Lower-emissions levels associated with curtailed development will not provide any meaningful amelioration of climate extremes for many decades to come, whereas the benefits that come with development will make those populations substantially more resilient to climate extremes right now.

Finally, the world must get serious about researching carbon removal and geoengineering and developing the international institutions and governance frameworks necessary to use them, not out of the certainty that we will eventually need them but through an abundance of caution that we might.

From its earliest days, climate policy and advocacy has always been predicated, sometimes explicitly and always implicitly, on the idea that climate change was a problem that could be solved. The two-degree threshold is a reflection of that impulse. In reality, climate change is now a permanent condition of the human present and future, one that we will manage more or less successfully but that we will never solve. Liberating international climate policy efforts from the various constraints that the two-degree threshold imposes can't eliminate all of the risks that climate change will bring. But doing so might allow us to manage them better.

Links
[1] https://www.foreignaffairs.com/articles/2012-04-20/tough-love-renewable-energy
[2] http://energypost.eu/chinas-electricity-mix-changing-fast-co2-emissions-may-peaked/
[3] https://cleantechnica.com/2014/08/26/chinas-coal-consumption-finally-decreased/
[4] https://www.ecowatch.com/divest-fossil-fuels-2278331163.html
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