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A Very Hot Year

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This year began with huge bushfires in southeastern Australia that drove one community after another into temporary exile, killed an estimated billion animals, and turned Canberra's air into the dirtiest on the planet. The temperatures across the continent broke records—one day, the average high was above 107 degrees, and the humidity so low that forests simply exploded into flames. The photos of the disaster were like something out of Hieronymus Bosch, with crowds gathered on beaches under blood-red skies, wading into the water as their only refuge from the flames licking nearby. But such scenes are only a chaotic reminder of what is now happening every hour of every day. This year wouldn't have begun in such a conflagration if 2019 hadn't been an extremely hot year on our planet—the second-hottest on record, and the hottest without a big El Niño event to help boost temperatures. And we can expect those numbers to be eclipsed as the decade goes on. Indeed, in mid-February the temperature at the Argentine research station on the Antarctic Peninsula hit 65 degrees Fahrenheit, crushing the old record for the entire continent.

It is far too late to stop global warming, but these next ten years seem as if they may be our last chance to limit the chaos. If there's good news, it's that 2019 was also a hot year politically, with the largest mass demonstrations about climate change taking place around the world.

We learned a great deal about the current state of the climate system in December, thanks to the annual confluence of the two most important events in the climate calendar: the UN Conference of the Parties to the Framework Convention on Climate Change, which met for the twenty-fifth time, this year in Madrid (it ended in a dispiriting semi-collapse), and the American Geophysical Union conference, which convened in San Francisco to listen to the newest data from researchers around the world. That latest news should help ground us as we enter this next, critical phase of the crisis.

The first piece of information emerged from a backward look at the accuracy of the models that scientists have been using to predict the warming of the earth. I wrote the *Review's* first article about climate change in 1988, some months after NASA scientist James Hansen testified before Congress that what we then called the “greenhouse effect” was both real and underway. Even then, the basic mechanics of the problem were indisputable: burn coal and oil and gas and you emit carbon dioxide, whose molecular structure traps heat in the atmosphere.

Human activity was also spewing other gases with the same effect (methane, most importantly); it seemed clear the temperature would go up. But how much and how fast this would occur was a bewildering problem, involving calculations of myriad interactions across land and sea; we came to fear climate change in the 1980s largely because we finally had the computing power to model it. Critics—many of them mobilized by the fossil fuel industry—attacked those models as crude approximations of nature, and insisted they'd missed some negative feedback loop (the effect of clouds was a common candidate) that would surely moderate the warming.

These climate models got their first real chance to shine in 1991, when Mount Pinatubo erupted in the Philippines, injecting known amounts of various chemicals into the atmosphere, and the models passed with flying colors, accurately predicting the short-term cooling those chemicals produced. But the critique never completely died away, and remains a staple of the shrinking band of climate deniers. In December Zeke Hausfather, a UC Berkeley climate researcher, published a paper showing that the models that guided the early years of the climate debate were surprisingly accurate. “The warming we have experienced is pretty much exactly what climate models predicted it would be as much as 30 years ago,” he said. “This really gives us more confidence that today's models are getting things largely right as well.”¹

We now know that government and university labs were not the only ones predicting the climatic future: over the last five years, great investigative reporting by, among others, the Pulitzer-winning website InsideClimate News unearthed the

large-scale investigations carried out in the 1980s by oil companies. Exxon, for instance, got the problem right: one of the graphs their researchers produced predicted with uncanny accuracy what the temperature and carbon dioxide concentration would be in 2019. That this knowledge did not stop the industry from its all-out decades-long war to prevent change is a fact to which we will return.

The rise in temperature should convince any fair-minded critic of the peril we face, and it is worth noting that in December one longtime skeptic, the libertarian writer Ronald Bailey, published a sort of mea culpa in *Reason* magazine. In 1992, at the first Earth Summit in Rio, he'd mourned that the United States government was "officially buying into the notion that 'global warming' is a serious environmental problem," even as "more and more scientific evidence accumulates showing that the threat of global warming is overblown." Over the years, Bailey had promoted many possible challenges to scientific orthodoxy—for example, the claim of MIT scientist Richard Lindzen that, as mentioned, clouds would prevent any dangerous rise in temperature—but, to his credit, in his new article he writes:

I have unhappily concluded, based on the balance of the evidence, that climate change is proceeding faster and is worse than I had earlier judged it to be.... Most of the evidence points toward a significantly warmer world by the end of the century.²

If scientists correctly judged the magnitude of the warming—about one degree Celsius, globally averaged, thus far—they were less perceptive about the magnitude of the impact. Given that this infusion of greenhouse gases into the atmosphere is a large-scale experiment never carried out before during human history, or indeed primate evolution, it's not really fair to complain, but many scientists, conservative by nature, did underestimate the rate and severity of the consequences that would come with the early stages of warming. As a result, the motto for those studying the real-world effects of the heating is probably "Faster Than Expected."

The warmth we've added to the atmosphere—the heat equivalent, each day, of 400,000 Hiroshima-sized bombs—is already producing truly dire effects, decades or even centuries ahead of schedule. We've lost more than half the summer sea ice in the Arctic; coral reefs have begun to collapse, convincing researchers that we're likely to lose virtually all of them by mid-century; sea-level rise is accelerating; and the planet's hydrologic cycle—the way water moves around the planet—has been seriously disrupted. Warmer air increases evaporation, thus drought in arid areas and as a side effect the fires raging in places like California and Australia. The air also holds more water vapor, which tends to drop back to earth in wet places, increasing the risk of flooding: America has recently experienced the rainiest twelve months in its recorded history.

In late November a European-led team analyzed what they described as nine major tipping points—involving the Greenland and Antarctic ice sheets, the boreal forests and permafrost layer of the north, and the Amazon rainforest and corals of the tropical latitudes. What they found was that the risk of "abrupt and irreversible changes" was much higher than previous researchers had believed, and that exceeding critical points in one system increases the risk of speeding past others—for instance, melting of Arctic sea ice increases the chance of seriously slowing the ocean currents that transport heat north from the equator, which in turn disrupt monsoons. "What we're talking about is a point of no return," Will Steffen, one of the researchers, told reporters. Earth won't be the same old world "with just a bit more heat or a bit more rainfall. It's a cascading process that gets out of control."

That all of this has happened with one degree of warming makes clear that the targets set in the Paris climate accords—to try to hold temperature increases to 1.5 degrees Celsius, and no more than 2 degrees—are not "safe" in any usual sense of the word. Already, according to an Oxfam report released in December,³ people are three times more likely to be displaced from their homes by cyclones, floods, or fires than by wars. Most of those people, of course, did nothing to cause the crisis from which they suffer; the same is true for those feeling the health effects of climate change, which a December report from the World Health Organization said was "potentially the greatest health threat of the 21st century."

What's worse, we're nowhere close to meeting even those modest goals we set in Paris. Indeed, the most depressing news from December is that the world's emissions of greenhouse gases rose yet again. Coal use has declined dramatically, especially in the developed world—the US has closed hundreds of coal-burning plants since 2010 and halved the amount

of power generated by coal. But it's mostly been replaced by natural gas, which produces not only carbon dioxide but also methane, so our emissions are barely budging; in Asia, continued fast-paced economic growth is outstripping even the accelerating deployment of renewable energy.

The United Nations Environment Programme released its latest annual report on the so-called emissions gap in December, and it was remarkably dire. To meet the Paris goal of limiting temperature increases to 1.5 degrees Celsius, the world would need to cut its emissions by 7.6 percent annually for the next decade.⁴ Stop and read that number again—it's almost incomprehensibly large. No individual country, not to mention the planet, has ever cut emissions at that rate for a single year, much less a continuous decade. And yet that's the inexorable mathematics of climate change. Had we started cutting when scientists set off the alarm, in the mid-1990s, the necessary cuts would have been a percent or two each year. A modest tax on carbon might well have sufficed to achieve that kind of reduction. But—thanks in no small part to the obstruction of the fossil fuel industry, which, as we have seen above, knew exactly what havoc it was courting—we didn't start correcting the course of the supertanker that is our global economy. Instead, we went dead ahead: humans have released more carbon dioxide since Hansen's congressional testimony than in all of history before.

That we have any chance at all of achieving any of these targets rests on the progress made by engineers in recent years—they've cut the price of renewable energy so decisively that the basic course is pretty clear. Essentially, we need to electrify everything we do, and produce that electricity from the sun and wind, which are now the cheapest ways to produce power around the world.⁵ Happily, storage batteries for the power thus generated are also dropping quickly in cost, and electric cars grow both more useful and more popular by the month—Tesla is the brand name we know, but the Chinese are already rolling out electric cars in large numbers, and, better yet, electric buses, which could lead to dramatically cleaner and quieter cities. In his State of the City address in early February, New York mayor Bill DeBlasio announced that every vehicle in the city fleet would be electrified in the years ahead. Despite such dramatic announcements, we're adopting none of these technologies fast enough. In seventy-five years the world will probably run on sun and wind because they are so cheap, but if we wait for economics alone to do the job, it will be a broken world.

Radically speeding up that transition is the goal of the various Green New Deal policies that have emerged over the last year, beginning in the US, where the youthful Sunrise Movement recruited Representative Alexandria Ocasio-Cortez as an early supporter and used a sit-in at House Speaker Nancy Pelosi's office to draw attention to the legislation. Negotiations have been underway ever since about the exact shape of such a program, but its outlines are clear: extensive support for renewables, with an aim of making America's electricity supply carbon-neutral by 2030, and a program to make homes and buildings far more efficient, coupled with large-scale social plans like universal health care and free college tuition. At first glance, combining all these goals may seem to make the task harder, but advocates like Naomi Klein have argued persuasively that the opposite is true.

The wide scope of the proposed Green New Deal may make it sound utopian—but it may be better to think of it as anti-dystopian, an alternative to the libertarian hyper-individualism that has left us with economically insecure communities whose divisions will be easy for the powerful to exploit on a degrading planet, where the UN expects as many as a billion climate refugees by 2050. A million Syrian refugees to Europe (driven in part by the deep drought that helped spark the civil war) and a million Central American refugees to our southern border (driven in part by relentless drought in Honduras and Guatemala) have unhinged the politics of both continents; imagine multiplying that by five hundred.

On the campaign trail, the Democratic nominees have mostly embraced the Green New Deal. Its sweeping economic and social ambition fits easily with the other campaign promises of Senators Sanders and Warren, but most of the rest of the field has also backed its promises of dramatic reductions in carbon emissions. For instance, Joe Biden's climate plan says that "the Green New Deal is a crucial framework for meeting the climate challenges we face. It powerfully captures two basic truths"—first, that "the United States urgently needs to embrace greater ambition... to meet the scope of this challenge," and second, that "our environment and our economy are completely and totally connected." Biden has waffled and wavered on the practicalities, at times endorsing a continued reliance on natural gas, but it's pretty clear that, whoever the eventual nominee, the party will be at least somewhat more progressive on climate issues than in the past. And in one way the nominee will be more progressive even than the Green New Deal legislation. Sanders, Warren, Biden, Pete Buttigieg, Tom Steyer, Michael Bloomberg, and others have all called for an end to oil, gas, and coal production on public

lands—something a new president could do by executive action. Some have gone farther, calling for an end to fracking across the nation.

These so-called Keep It in the Ground policies are less popular with labor unions that want to keep building pipelines, and therefore those writing the Green New Deal legislation have not yet included them in their bill, wary of losing congressional support. But the mathematical case for such action was greatly strengthened in November with the publication of the first production gap report, intended as a counterpart to the emissions gap research I described above. For almost thirty years, global warming efforts have focused on controlling and reducing the *use* of fossil fuel—which is hard, because there are billions of users. But in recent years activists and academics have looked harder at trying to regulate the *production* of coal, gas, and oil in the first place, reasoning that if it stayed beneath the soil, it would ipso facto not be warming the planet.

The first edition of this new report, issued by a consortium of researchers led by the Stockholm Environment Institute and the UN Environment Programme, makes for startling reading: between now and 2030 the world's nations plan on producing 120 percent more coal, gas, and oil than would be consistent with limiting warming to 1.5 degrees Celsius and 50 percent more than would let us meet even the 2 degree goal.⁶ That's more coal and oil and gas than the world's nations have told the UN they plan to burn: "As a consequence, the production gap is wider than the emissions gap." "Indeed," the authors write, "though many governments plan to decrease their emissions, they are signalling the opposite when it comes to fossil fuel production, with plans and projections for expansion." Another way to look at it, as the *Financial Times* calculated in February, is that to meet the 1.5 degree target, the fossil fuel industry would have to leave 84 percent of its known reserves in the ground, writing off their value.

You would think that, compared with the billions of users, it would be easier to take on the handful of petro-states and oil companies that produce fossil fuel; after all, more than half of global emissions since 1988 "can be traced to just 25 corporate and state-owned entities," according to the Climate Accountability Institute. By definition, those are among the most powerful players in our economic and political systems, and so far they've been able to escape any effective regulation. At the very top of the list is the United States, which, according to a December report from the Global Gas and Oil Network, is on track to produce four-fifths of the new supply of oil and gas over the next half decade.

Partly, this is the result of President Trump's fanatical effort to eliminate any obstacles to new oil and gas production, including recently opening the Arctic National Wildlife Refuge in Alaska—the nation's largest wildlife preserve—to drilling. But there's a fairly long lag time in building the necessary infrastructure—the fracking boom really had its roots in the Obama administration, as the former president boasted in a 2018 speech at Rice University in Texas. "I know we're in oil country," he told the cheering crowd. "You wouldn't always know it, but [production] went up every year I was president. That whole, suddenly, America's, like, the biggest oil producer and the biggest gas...that was me, people," he said. "Just say thank you please."

The one cheerful development of the past year has been the continuing rise of a global climate movement, exemplified by the young activists who brought seven million people into the streets for global climate strikes in September. (Greta Thunberg is the best known, and rightly celebrated for her poise, but fortunately there are thousands of Gretas across the planet offering provocative challenges to their local officials.) The question is where to aim all that activism. The natural impulse is to direct it at our political leaders, because in a rational world they would be the ones making decisions and shaping change. This is part of the answer—it's crucial that this year's election in the US has the climate crisis at its center, and thanks to the Green New Deal that's a real possibility.

But political change is uncertain—despite the remarkable activism of Extinction Rebellion across the UK, December's elections there seemed little affected by the issue—and even when it comes it is slow. A new president and a new Senate would still mean a Washington rusted by influence and inertia. And winning this battle one national capitol at a time is a daunting challenge given the short time physics is allowing us.

A small but growing number of activists are also looking at a second set of targets—not Washington, but Wall Street. Over the past few years a mammoth divestment campaign has persuaded endowments and portfolios worth \$12 trillion to sell

their stocks in coal, oil, or gas companies, and now that effort is expanding to include the financial institutions (mostly banks, asset managers, and insurance companies) that provide the money that keeps those companies growing. A handful of American banks—Chase, Citi, Wells Fargo, and Bank of America—are the biggest culprits, and incredibly they have increased their lending to fossil fuel companies in the years since the Paris accords. Take Chase Bank, which is the champion in this respect: in the last three years it has provided \$196 billion to the fossil fuel industry. If Exxon is a carbon heavy, in other words, Chase is too (and in many ways they're joined at the hip; Standard Oil heir David Rockefeller led Chase to its current prominence, and former Exxon CEO Lee Raymond is its lead independent director).

This financing—which has included supporting the most extreme oil and gas projects, like the huge pipelines planned in Canada's uniquely filthy tar sands complex—is perhaps the single least defensible part of the fossil fuel enterprise. You can almost understand the refusal of oil companies to shift their business plans: they really only know how to do one thing. But banks can lend their money in a thousand different directions; they don't *need* to fund the apocalypse. Given the trouble banks have already caused, it's no wonder that environmentalists have begun using the phrase “Make Them Pay”—or at the very least make them invest in the renewables and conservation measures desperately needed to get us on the right track. My colleague at the grassroots campaign 350.org Tamara Toles O'Laughlin has compared this kind of funding to nineteenth-century support by financial institutions of slavery—it's not the same crime, of course, but “the same instinct to abuse and extract, deplete, discard, and disavow holds.” It's no surprise that the same demand for reparations—compensation for all those whose lives and communities are being wrecked—is being raised.

There's no question that taking on one of the biggest parts of the planet's economy is a daunting task. It's possible that the Chases of the world can go on lending money to their friends in the oil industry without suffering any consequences. On the other hand, in the same way that the electoral map favors Republicans, the money map favors those who care about the climate. Chase branches, for instance, are concentrated in those small pockets of blue around our big cities (I was arrested in a protest in one of them, in Washington, D.C., in early January). And perhaps these institutions are beginning to bend: in mid-January the world's largest financial firm, BlackRock, announced that it was taking broad, if still tentative, steps to include climate change in its analyses of potential investments. “Awareness is rapidly changing, and I believe we are on the edge of a fundamental reshaping of finance,” its CEO, Larry Fink, wrote in a letter to CEOs of the world's largest corporations. That's perhaps the most encouraging news about climate change since the signing of the Paris climate accords, because if these pillars of global capital could somehow be persuaded to act, that action could conceivably be both swift and global.

Anything is worth a try at this point, because we're very nearly out of time.

1 Zeke Hausfather et al., “Evaluating the Performance of Past Climate Model Projections,” *Geophysical Research Letters*, December 4, 2019. ↵

2 Ronald Bailey, “Climate Change: How Lucky Do You Feel?,” *Reason*, January 2020. ↵

3 Oxfam International, “Forced from Home: Climate-Fuelled Displacement,” December 2, 2019. ↵

4 *WHO Health and Climate Change Survey Report*, 2019. ↵

5 We'd probably be well advised to keep current nuclear power plants operating where it's relatively safe to do so until they can be replaced with renewables instead of natural gas—though at the moment new nuclear power is ruinously expensive in most places, existing plants are an important part of the low-carbon power supply. A good summary of the problem came in 2018 from the Union of Concerned Scientists. We definitely need to avoid not only natural gas, which as I have explained previously in these pages is not the “bridge fuel” its proponents contended, but also the burning of trees to generate electricity—the latest science is showing this so-called biomass energy to be more of a problem than a solution, and that by contrast letting mature trees continue to grow allows them to soak up large amounts of carbon. ↵

6 Stockholm Environment Institute et al., *The Production Gap*, 2019. ↵