Has It Come to This?

The Promises and Perils of Geoengineering on the Brink

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AND ANDREAS MALM

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A Left Defense of Carbon Dioxide Removal

The State Must Be Forced to Deploy Civilization-Saving Technology

CHRISTIAN PARENTI

Experience has shown that only princes and republics that have their own army make great progress, while mercenary armies do nothing but harm.
—Niccolo Machiavelli, *The Prince*

Note: The symbol $ refers to U.S. dollars.

If civilization was serious about saving itself, powerful and wealthy states would treat the climate crisis like a massive military emergency and do the following: euthanize the fossil fuel industry while rapidly building out a clean energy infrastructure so as to eliminate greenhouse gas (GHG) emissions[1]; and, more controversially, nationalize existing technologies for carbon dioxide removal (CDR) and immediately commence massive crash programs of publicly funded atmospheric CO_2 drawdown.[2] The state must deploy this technology as a public good and manage atmospheric CO_2 levels as a global commons because the costs of CDR are too high and its benefits too broadly distributed for private profit-seeking investment in the technology to make sense. Here the mercenary logic of the market fails.

The science on climate tipping points is clear: even if we stopped all GHG pollution, we would need to strip CO_2 from the atmosphere. At the time of writing, CO_2 concentrations are 405 ppm (parts per million) and need to be at 350 ppm or lower to avoid self-compounding climate breakdown. In other words, stopping CO_2 emissions is not enough; we also need a global program of negative emissions.

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In the following paragraphs, I argue that attempts to integrate CDR technology into competitive markets will fail; only deployment by governments, as something like a public utility, can bring CDR to scale. Orthodox economists argue that the proper response to climate change is to simply wait for the market to innovate. Alas, the real history of capitalism does not comport with the laissez-faire mythology. Innovation is not an apolitical, "merely" technical process; rather, it is a highly political process. The technological outcomes of innovation are the products of political struggle just as much as they are products of purely scientific choices.

The good news is that all the technologies necessary to achieve negative emissions already exist in proven form. And states have the power and money to undertake such a task at the necessary scale. However, we lack policies that can bring about the radical technological transformations necessary. In this, we face what Marx described as a contradiction between the forces of production and the relations of production. The social relations of capital are now holding back the full potential of some of the most promising technologies that modern science has yet invented.

We lack the necessary policies because of two ideological problems, or blockages. The first blockage is the market fundamentalism that corrupts intellectual life in the West. This even penetrates much of the left, creating a state phobia among people who, while not deluded about markets and capitalism, still cannot see the usefulness of government power. The second blockage is the deep, often unexamined, technophobia and nature fetish of many environmentalists.

As a result of these ideological blockages, most of the people who support CDR technology operate with ridiculous ideas about market-based mechanisms for the technology's mass deployment. Meanwhile, those on the left and in environmental movements who think critically about capitalism and pressure the government to craft progressive policy remain largely silent on CDR or oppose it as just sophisticated technogreenwashing.[3] Because CDR means large-scale technological intervention into the climate system, most greens reject it without further consideration. This is highly dangerous and wrongheaded.

Ultimately, the challenge of climate change requires that the human species overcome the central social divisions produced by class society and become a fully self-conscious species that can recognize its collective interdependence and embrace our role as environment makers. The existence of powerful new technologies, like CDR, that if rationally deployed could help maximize the chances of human survival should give us hope that we can rise to the challenge.

How CDR Works

An important distinction must be clarified at the outset. So-called carbon engineering or carbon capture and storage (CCS), or more simply CDR, which seeks to mechanically remove CO_2 from wastes streams and the ambient air, should not be conflated with geoengineering in the form of solar radiation management (SRM), which would attempt to artificially increase the earth's albedo, or reflectivity, by spraying reflective particles into the stratosphere in an effort to deflect infrared radiation back out into space before it heats the planet's surface.

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Most SRM schemes contemplate spraying mass quantities of sulfate particles into the stratosphere so as to mimic the cooling effects of volcanic eruptions. The problem with this style of SRM is that the sulfate particles would likely wash out of the atmosphere as acid rain, and the SRM-induced cooling could have catastrophic impacts on precipitation patterns.[4] Nor is all CDR equal. For example, so-called ocean iron fertilization (OIF) involves adding iron dust to the sea so as to trigger carbon dioxide–sequestering algal blooms. But overabundant algae can suck up too much oxygen and cause eutrophication. The infamous "dead zone" in the Gulf of Mexico is the by-product of massive fertilizer runoff–fed algal blooms.[5]

On the other hand, mechanical CDR, or direct air capture (DAC), poses far fewer risks but requires far more investment. Instead of adding ingredients to natural systems, DAC simply removes CO_2 from the air. This sort of CDR removing CO_2 from the ambient air is not too complicated. It has been happening in submarines and spacecraft like the U.S. space shuttles for decades. In recent years, Klaus Lackner, director of the Center for Negative Carbon Emissions at Arizona State University, has developed a device similar to an artificial tree that captures CO_2 a thousand times more effectively than actual trees. The device involves strips of plastic coated with a commercially available "anionic exchange" resin; CO_2 in the air binds to the resin and is then washed off with water. Next, the CO_2 is stripped out of the water and stored as pure gas.

The problem with this approach becomes where and how to store CO_2 gas. One solution has involved pressurizing CO_2 into a liquefied form and then injecting it into underground cavities such as depleted oil and gas wells or deep saline aquifers. But such liquefied gas is buoyant and can migrate through cracks to the surface. Being invisible and odorless, leaks of pure carbon dioxide, if trapped in buildings or basements, could easily kill unsuspecting people who wander into it. A greater danger is that vast pools of stored CO_2 could escape back into the atmosphere, defeating the whole purpose of its storage. In short, underground storage of CO_2 gas remains problematic.[6]

However, in 2016, an experiment in Iceland mixed carbon dioxide and hydrogen sulfide into water and then pumped the mixture into underground basalt rock formations. Within two years, the CO_2 in the water mixture "precipitated" into a white chalky solid: a carbonate rock similar to limestone. As one report explained, "The researchers were amazed by how fast all the gas turned into a solid—just two years, compared to the hundreds or thousands of years that had been predicted." In fact, the mineralization happens so quickly that if injected too rapidly, pathways leading deeper into the basalt rocks can clog up before the dissolved CO_2 and water mixture has percolated to its intended depths. Thus along with science and engineering, the injection process (much like oil drilling) involves a bit of art and finesse.[7] Luckily, the process, which uses huge amounts of water, functions perfectly well using salt water; also, no external heat source is required, and basalt, the host rock, is one of the most common types on earth.

Though at one level miraculous, the transformation is just a radically accelerated version of a naturally occurring process. When CO_2 mixes with water, it becomes carbonic acid (H_2CO_3), and when it falls back to earth, the carbonic

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acid interacts and binds with minerals in the surfaces of rocks, primarily calcium and magnesium, to form various types of calcium carbonate rock such as ankerite, all of which are similar to limestone.

In other words, some rocks actually grow by the slow accretion of calcium carbonate rock produced by mineralization of what was once atmospheric carbon dioxide. In Oman, where carbon-capturing peridotite rock proliferates, "white carbonate minerals run through slabs of dark rock like fat marbling a steak . . . Even pooled spring water that has bubbled up through the rocks reacts with CO_2 to produce an ice-like crust of carbonate that, if broken, re-forms within days."[8] The idea of harnessing and artificially accelerating this process was only first proposed in 1995 by Lackner and a team of researchers.[9]

The current Iceland project operates as part of a large geothermal power plant—this is helpful because drilling deep into rocks and managing the flow and pressure of gases and liquids below ground is a central geothermal skill set. Called CarbFix, the project currently strips and stores five thousand metric tons of CO_2 a year. That only equals the annual emissions of about two thousand cars. Another test project, conducted by the U.S. Department of Energy's Pacific Northwest National Laboratory (PNNL), found that a mixture of mostly liquid CO_2 with only a small amount of water also mineralized within two years.[10] By some estimates, there are seventeen such CDR and mineral storage experiments around the globe.

The point is, human civilization has the technical ability to strip atmospheric CO_2 and safely store it. The stripping of ambient CO_2 and its mineral storage is not a possibility; it is an actuality, a proven technology, operating right now as you read these words.

The problem is how to bring CDR and mineral storage to scale? Here the limits of the first blockage—market thinking—immediately come it to focus. For example, a partner in CarbFix is a Swiss company that, although born of Swiss government funding and spun off from a large public university, now tries to operate as a profit-making venture. Its only real commercial clients seem to be a few greenhouses that use CO_2 gas to enhance plant growth and some beverage companies that use the gas in carbonation and dry ice.[11] Another carbon capture project in Canada plans to sell its by-product, magnesium carbonate, to wastewater treatment facilities and to the steel industry. Another company uses captured CO_2 in foam mattresses. In Australia, free market boosters of enhanced weathering technology push the idea of selling artificially created limestone as building material. The economics of that are patently ridiculous: Why buy expensive rock when cheaper natural rock is available?[12]

One academic paper described the quandary as follows: "At present, there is a large gap between the total cost per ton of CO_2 handled by CCS and the revenue available to operators for capturing and storing CO_2 (for example, from the price of emissions allowances in the EU ETS). For CCS to be attractive, this gap must be closed, through both a higher allowance price induced by a stricter climate policy and technological advances that lower CCS cost."[13]

The market fails because there is no way the world can "use" all potentially captured CO_2. Thus captured CO_2 cannot be disposed of by means of commodification and sale into competitive markets.

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The world economy is producing about forty billion metric tons of carbon emissions a year. At current prices—which means little, since there are no real functioning carbon markets and price estimations vary widely—my calculations indicate stripping out that amount of CO_2 could cost up to $24 trillion, a sum equal to 133 percent of the annual U.S. GDP. But to be fair, the price of CDR technology and mineral storage is dropping. The cost of all prototype technologies is astronomically high but tends to fall precipitously as production improves and costs decline. Thus let us assume that stripping and storing a year's CO_2 emissions will soon cost only $12 trillion. That is still astronomically expensive.

There is, however, a scenario that is always more expensive, no matter the cost of CDR. That is permanent global economic collapse caused by rapidly rising seas, flooded coast cities, desertification of the globe's key grain-exporting breadbaskets, colossal settlement-ravaging wildfires, proliferating disease, and attendant social breakdown. Unchecked, anthropogenic climate change threatens to become self-compounding, runaway, and stoppable. James Hansen has even forecast the possibility of what he calls "Venus syndrome," in which global warming over the course of two thousand years kills all life on earth.[14] The economic analog to Hansen's worst-case scenario, because it would "cost" everything, is therefore more expensive than the most expensive global campaign of CDR.

More optimistically, and correctly, J. W. Mason argues that thinking of climate adaptation in the zero-sum terms of cost and austerity misunderstands how the economy actually works. From a Keynesian perspective, investment creates economic growth, which in turn, creates the resources for more investment. Or as Mason puts it, "The real resources for decarbonization will not have to be withdrawn from other uses. They can come from an expansion of society's productive capabilities, thanks to the demand created by clean-energy investment itself . . . ," and, we might add, from massive investment in CDR. Mason continues, "People rightly compare the scale of the transition to clean technologies to the mobilization for World War II. Often forgotten, though, is that in countries spared the direct destruction of the fighting, like the United States, war-time mobilization did not crowd out civilian production. Instead, it led to a remarkable acceleration of employment and productivity growth. Production of a liberty ship required 1,200 man hours [sic] in 1941, only 500 by 1944. These rapid productivity gains, spurred by the high-pressure economy of the war, meant there was no overall tradeoff between more guns and more butter."[15]

Extending the military analogy, Mason says that "the degree to which all wartime economies—even the United States—were centrally planned, reinforces a lesson that economic historians such as Alexander Gerschenkron and Alice Amsden have drawn from the experience of late industrializers: however effective decentralized markets may be at allocating resources at the margin, there is a limit to the speed and scale on which they can operate. The larger and faster the redirection of production, the more it requires conscious direction . . ."[16] Indeed, economic history reveals that massive economic transitions always require state coordination and subsidy, if not outright nationalization.[17]

In other words, the state could remove and store atmospheric CO_2 the same way that it currently builds dangerous and oppressive technologies like aircraft

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carriers and surveillance satellites. Society needs the utility of CDR deployed at a colossal scale as part of a multifaceted crash course of mitigation and adaptation. All indications are that only the decommodification of CDR and its deployment as a public utility can bring it to scale.

Society, the State, and Capital

CDR technology resists commodification and does not easily fit into capitalist social relations because its costs are too high and its benefits are too diffuse. Thus it must be treated as a global technology commons and deployed by governments as a public utility. This brings us to the second blockage: state phobia or state aphasia, as in the inability to see the state and comprehend its central role in modern life.

Let us begin by drawing a distinction between capital and capitalism. In classical Marxist terms, capital is a social relation. As Marx put it, "A cotton-spinning machine is a machine for spinning cotton. Only under certain conditions does it become capital. Torn away from these conditions, it is as little capital as gold is itself money, or sugar is the price of sugar."[18] In other words, "capital also is a social relation of production. It is a bourgeois relation of production, a relation of production of bourgeois society."[19] Only when the means of subsistence and the means of production are privately owned and used to command labor power in the goal of producing evermore exchange value are use values also capital.

Capitalism, on the other hand, is the whole ensemble of institutions that make up global society. Though dominated by capital, capitalism (or capitalist society) is not reducible only to the logic of capital. Throughout *Capital* vol. 1, Marx refers only to "the bourgeoisie" and "capital," never to "capitalism."[20] Society as a whole includes important countervailing forces, such as the state and public sector, social movements, precapitalist social formations and norms such as religions, and the whole noncommodified sphere of work referred to as "reproduction" or the love and care of families. In fact, capital (the social relationship of commodification and labor power exploitation) requires precapitalist and noncapitalist practices, institutions, and social formations to sustain it. Capital always depends on an "outside," as it were.[21]

Here, Karl Polanyi is essential. Polanyi showed that while all societies have embedded within them material processes that we would call "economic activity" and many include markets, no society, not even our own, has been totally governed by the rules of the market. As Polanyi put it in *The Great Transformation*, "The idea of a self-adjusting market implied a stark Utopia. Such an institution could not exist for any length of time without annihilating the human and natural substance of society; it would have physically destroyed man and transformed his surroundings into a wilderness."[22] To update that for the climate crisis, replace "wilderness" with "toxic wasteland of flooded coastal cities and desiccated agrarian interior."

For Polanyi, there

> was nothing natural about laissez-faire; free markets could never have come into being merely by allowing things to take their course. Just as cotton

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> manufactures—the leading free trade industry—were created by the help of protective tariffs, export bounties, and indirect wage subsidies, laissez-faire itself was enforced by the state. . . . The road to the free market was opened and kept open by an enormous increase in continuous, centrally organized and controlled interventionism. . . . The introduction of free markets, far from doing away with the need for control, regulation, and intervention, enormously increased their range.[23]

Polanyi argued that the transition to capitalism was so brutal and socially destabilizing that mitigating counteractions started immediately and organically—and came from reactionary forces as often as it did from progressive sectors like trade unions and socialist parties. Thus he wrote that while the "laissez-faire economy was the product of deliberate State action, subsequent restrictions on laissez-faire started in a spontaneous way. Laissez-faire was planned; planning was not."[24]

Polanyi correctly inverts the relationship between the state and capital. In Polanyi, we see that the state is always already deeply bound up with "the economy." It is in fact a crucial part of capital's life-support system. Thus while capital—the private sector on its own—cannot solve the climate problem, other elements within society acting through the state can, and must, take immediate steps to deploy the use value of CDR without waiting on social relations that are hostage to exchange values. In short, CDR must be treated like a modern commons or "public utility."

From the beginning of modern economics, even the most ardent advocates of laissez-faire have had to concede that certain goods and services cannot be managed by the market. Adam Smith hinted at this when groping toward the idea of "natural monopoly." Then in 1815, Malthus coined the term *natural and necessary monopolies*. Soon, many other writers were using *natural monopoly* to refer to "geographically fixed economic advantages in general."[25] In the middle of the nineteenth century, John Stuart Mill described natural monopolies as "those which are created by circumstances, and not by law."[26] For Mill, the risk associated with these natural monopolies was that they facilitated rent-seeking: "It is at once evident that rent is the effect of a monopoly."[27]

As Mill put it, "In the case of water-supply, there is virtually no competition. Even the possibility of it is limited to a very small number of individuals or companies, whose interest prompts them, except during occasional short periods, not to compete but to combine. In such a case, the system of private supply loses all that, in other cases, forms its recommendation."[28]

In the United States, Progressive Era economist Richard T. Ely first linked the idea of "natural monopoly" with the notion of "public utility." In his 1888 book *Problems of To-Day*, Ely listed key natural monopolies as "gas supply, street-car service, highways and streets, electric lighting, all railways, canals, bridges, lighthouses, ferries, docks, harbors, natural navigations, postal service, telegraphs and telephones."[29] Ely's contention was that "the regulation of these natural monopolies must be different from the regulation of commerce, agriculture, and manufactures" because "a natural monopoly . . . is excluded from the steady, constant pressure of competition."[30]

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In other words, natural monopolies lead themselves to predatory rent-seeking. Ely argued that this situation left only two alternatives: "public control of private corporations, and public ownership with the public control which naturally springs from ownership." Ultimately, much crucial infrastructure was subject to considerable governmental control. Canals and railroads were built with vast public subsidies. Then during World War I, the federal government nationalized and reorganized the private railroad industry. Many cities built electrical grids or municipalized competing private grids.[31]

Even today, after forty-plus years of neoliberalism, there is no such thing as the free market. Unregulated capitalism is a myth; it has never actually existed. Nor could it. Capital is always bound up with the capitalist state. As Mariana Mazzucato has shown in her book *The Entrepreneurial State*, the modern capitalist state plays a central, guiding role in shaping technological innovation and deployment.[32]

In short, state economic action is not exotic and untested, as even many leftists and environmentalists believe; rather, it is ubiquitous yet veiled and denied. Step one in bringing CDR technology to scale is being realistic and honest about the dependence of capital upon the state.

Environment Making and Technology

Sorting out our relationship to CDR might require some clarification on the relationship between *Homo sapiens* and technology and a more historically informed understanding of the truly massive scale of our environment making. Lurking behind the specifics of CDR are larger questions about our role as a species. Should we attempt to restore a central feature of the global climate system? Is that not the height of hubris and bound for calamitous failure? Perhaps. But consider this: we have always used technology and have always been an environment-making species. Indeed, every species is. What we call "nature" or "the environment" is ultimately just the sum total of layer upon layer of organism-environment interactions. Every organism interacts with and impacts its environment. At the same time, every organism is always also part of the external environment of all other organisms. Environment making is what life-forms do. Beavers need beaver ponds, but the creatures do not find their niche habitat; they make it by their prodigious and compulsive dam building.[33]

Or as Engels put it in the unfairly maligned and overlooked *Dialectics of Nature*: "Animals, as has already been pointed out, change the environment by their activities in the same way, even if not to the same extent, as man does, and these changes, as we have seen, in turn react upon and change those who made them. In nature nothing takes place in isolation. Everything affects and is affected by every other thing . . ."[34]

As a species, *Homo sapiens* are, Engels argued, the product of their own labor and technology of tools and fire: "The practical discovery of the conversion of mechanical motion into heat is so very ancient that it can betaken as dating from the beginning of human history . . . the making of fire by friction was the first instance of men pressing a non-living force of nature into their service."[35]

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Further on, Engels noted how fire led to cooking, which led to profound physical transformations in the human body: "A meat diet contains in an almost ready state the most essential ingredients required by the organism for its metabolism. . . . The most essential effect, however, of a flesh diet was on the brain, which now received a far richer flow of the materials necessary for its nourishment and development, and which therefore could become more rapidly and perfectly developed from generation to generation. . . . With all respect to the vegetarians, it has to be recognised that man did not come into existence without a flesh diet" because cooked meat "further shortened the digestive process, as it provided the mouth with food already as it were semi-digested." And just "as man learned to consume everything edible, he learned [thanks to the warmth of fire] also to live in any climate. He spread over the whole of the habitable world, being the only animal that by its very nature had the power to do so."[36]

Modern environmental history has confirmed the importance and ubiquity of the human-fire relationship. As Stephen J. Pyne, the dean of fire studies, put it in one of the culminating books in his series on world fire culture, "there are no known peoples," except some Inuit and Yupik of the icebound far north, "who do not burn routinely" parts of their landscapes. All over the world foragers have

> recognized that berries, mushrooms, bracken, edible tubers like camas, and wild grasses flourished best on burned ground, that a light fire exposed acorns and chestnuts, that smoke deadened bees into a stupor that made honey accessible. Fishers recognized that torches attracted fish at night, when they could be easily speared or netted. Hunters saw that evening torches froze deer and geese, that flames could drive ungulates, that the fresh growth sprouting on old burns drew grazers, that fires flushed both elusive prey and dangerous predators from thickets . . . Regular burning, moreover, retained the desired habitat indefinitely. . . . Surely it is no accident that Artemis, the ancient goddess of the hunt—with an ancestry predating the Greeks—held a bow in one hand and a torch in the other.[37]

Very often this so-called broadcast burning creates quite fecund ecologies. Geoff Cunfer offers an impressive example in *Bison and People on the Northern Great Plains*: "On the northern plains, Village Indians developed a spring and fall burning cycle designed, in part, to manage bison . . . acre by acre, over several hundred years, Indians reworked the plains landscape" to enlarge the grassland, "converting millions of acres of forest to prairie." And by this environment making, "they increased bison populations to all-time highs, estimated at twenty-nine million by 1700."[38]

The larger point is this: we cannot retreat from our role as environment makers. Humans have always been remaking the planet. Unfortunately, under industrial capitalism, we do so as reckless, marauding somnambulants. We will destroy ourselves as a result, or we will become self-conscious, deliberate, life-producing, and life-enhancing environment makers.

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Limits and Cynicism

A state-led crash program of CDR would only be meaningful within the context of a broader program of radical mitigation involving euthanizing the fossil fuel industry, a massive clean energy build-out, and robust adaptation efforts like coastal defense.

Pursued in isolation, CDR would do little to stabilize the climate system and could be used to justify inaction on the emissions reduction front. As it is, the promise of CDR is central to the myth of "clean coal." One could imagine the fossil energy sectors line if CDR were brought to scale: "No need to stop burning fossil fuel; we are stripping out so much CO_2!" Most current CCS is used by the oil industry.

Even if we could stabilize atmospheric CO_2 levels, there is still the problem of ocean acidification and spreading anoxia, both of which might bring down the human species. Despite potential problems with CDR, movements must demand that states embrace it and drive its mass adaptation. As Lackner put it, "Throwing a life-preserver to a drowning victim may not assure a successful rescue, but it is not a high-stakes gamble. Offering the life-preserver is preferable to withholding it, even though it might reduce the victim's incentive for learning how to swim."[39]

That sort of desperate optimism has much to recommend it. For one thing, it can help roll back the debilitating pessimism that comes with actually understanding climate science. Indeed, a major though largely unacknowledged problem among environmentalists is cynicism.[40] Anyone who comprehends the basic implications of climate science is forced to realize that climate change is unfolding in a nonlinear fashion in which the causes build while the effects lag. When the effects do begin to kick in, they will most likely do so with rapidly mounting intensity. Worse yet, half of all anthropogenic GHG emissions have occurred since 1990. Despite recent years of slowed emissions growth, the causes continue to build in exponential fashion. We are headed toward an extremely dangerous future. Knowing this, it is hard not to lapse into cynicism. Why struggle when the situation is so clearly hopeless? But if we do not struggle, then all is surely lost. In a book of conversations with international intellectuals, Fidel Castro addressed this problem: "If you knew that the world is going to last for ten years only, it is your duty to struggle and do something in those ten years. If somebody tells you, 'You can be certain that the planet is going to disappear and this thinking species is going to be extinct,' what would you do? Sit down and cry? I think we must struggle, and that's what we have always done. . . . that is what I suggest that we do, and not let ourselves be overtaken by pessimism."[41]

The failure of environmentalists to propose plans that credibly stand up to scrutiny in the face of climate science produces a lack of confidence, despair, and cynicism. Outright rejection of big technology feeds cynicism. For example, in an article rejecting CDR, an organizer with the (generally very worthy) Leap Manifesto wrote, "I myself have a very simple mantra: If Exxon is involved with something, it can't be good for our planet." ExxonMobil studies geology, but we don't reject geology just because they misuse it. Nor do we reject railroads simply because the Nazis used railroads. Similarly with CDR, the misuse of it by

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fossil fuel corporations is not a legitimate basis upon which to reject it. A radical approach to technology requires neither embrace nor rejection but rather thinking through the contradictions.

As I have said elsewhere, "Our mission as a species is not to retreat from, or to preserve, something called 'nature,' but rather to become fully conscious environment makers. Extreme technology under public ownership will be central to a socialist project of civilizational rescue, or civilization will not last."[42]

Notes

1 As suggested by Delina, this volume, chap. 8.

2 This technology is also referred to as carbon capture, usage, and storage (CCUS); it is also referred to as Carbon Capture and Sequestration (CCS).

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