Learning *to* Die *in the* Anthropocene

REFLECTIONS ON THE END OF A CIVILIZATION

Roy Scranton

"Scranton draws on his experiences in Iraq to confront the grim realities of climate change. The result is a fierce and provocative book."
—Elizabeth Kolbert, author of The Sixth Extinction

PRAISE FOR ROY SCRANTON AND
LEARNING TO DIE IN THE ANTHROPOCENE

"In *Learning to Die in the Anthropocene,* Roy Scranton draws on his experiences in Iraq to confront the grim realities of climate change. The result is a fierce and provocative book."

—Elizabeth Kolbert, 2015 Pulitzer Prize winner and author of *The Sixth Extinction: An Unnatural History*

"Roy Scranton lucidly articulates the depth of the climate crisis with an honesty that is all too rare, then calls for a reimagined humanism that will help us meet our stormy future with as much decency as we can muster. While I don't share his conclusions about the potential for social movements to drive ambitious mitigation, this is a wise and important challenge from an elegant writer and original thinker. A critical intervention."

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—McKenzie Wark, author of *Molecular Red: Theory for the Anthropocene*

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"Roy Scranton has written a howl for the Anthropocene—a book full of passion, fire, science and wisdom. It cuts deeper than anything that has yet been written on the subject."

—Dale Jamieson, author of *Reason in a Dark Time: Why the Struggle Against Climate Change Failed—and What It Means for Our Future*

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City Lights Books

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Dedicated to my brother, who taught me to remember the dead, and to Laura, who taught me to fight like hell for the living.

A free man thinks of death least of all things, and his wisdom is a meditation of life, not of death.

—Baruch Spinoza, *Ethics*, IV.67

INTRODUCTION

COMING HOME

> The knowledge of future things is, in a word, identical with that of the present.
>
> —Plotinus, *Enneads* IV. 12

Driving into Iraq in 2003 felt like driving into the future. We convoyed all day, all night, past Army checkpoints and burned-out tanks, till in the blue dawn Baghdad rose from the desert like a vision of hell: flames licked the bruised sky from the tops of refinery towers, cyclopean monuments bulged and leaned against the horizon, broken overpasses swooped and fell over ruined suburbs, bombed factories, and narrow ancient streets.

With "shock and awe," the US military had unleashed the end of the world on a city of six million —a city about the same size as Houston or Washington, D.C. Baghdad's infrastructure was totaled: water, power, traffic, markets, and security fell to anarchy and local rule. The government had collapsed, walls were going up, tribal lines were being drawn, and brutal hierarchies were being savagely established. Over the next year, the city's secular middle class would disappear, squeezed out by gangsters, profiteers, fundamentalists, and soldiers.

I was a private in the United States Army. This damaged world was my new home. If I survived.

Two and a half years later, still in the Army but safe and lazy back in Fort Sill, Oklahoma, I thought I had made it out. Then I watched on television as Hurricane Katrina hit New Orleans. This time it was the weather that inspired shock and awe, but I saw the same chaos and collapse I'd seen in Baghdad, the same failure of planning and the same tide of anarchy. The 82nd Airborne Division took over strategic points and patrolled streets now under de facto martial law. My unit was put on alert and trained for riot control operations. The grim future I'd seen in Baghdad had come home: not terrorism, not WMDs, but the machinery of civilization breaking down, unable to recuperate from shocks to its system.

That future is not going away. According to Admiral Samuel J. Locklear III, head of the US Pacific Command, global climate change is the greatest threat the United States faces, more dangerous than terrorism, Chinese hackers, and North Korean nuclear missiles.[1] Upheaval from increased temperatures, rising seas, and climatic destabilization "is probably the most likely thing that is going to happen that will cripple the security environment, probably more likely than the other scenarios we all often talk about," he said. Thomas E. Donilon said much the same thing in 2014 as National Security Advisor, arguing that the "environmental impacts of climate change present a national security challenge."[2] James Clapper, Director of National Intelligence, told the Senate in 2013 that "Extreme weather events (floods, droughts, heat waves) will increasingly disrupt food and energy markets, exacerbating state weakness, forcing human migrations, and triggering riots, civil disobedience, and vandalism."[3] President Obama's 2010 *National Security Strategy*, the Pentagon's *2014 Quadrennial Defense Review*, and the Department of Homeland Security's *2014 Quadrennial Homeland Security Review* all identify climate change as a severe and imminent danger.[4] More recently, the Pentagon's *2014 Climate Change Adaptation Roadmap* warned: "Rising global temperatures, changing precipitation patterns, climbing sea levels, and more extreme weather events

will intensify the challenges of global instability, hunger, poverty, and conflict. They will likely lead to food and water shortages, pandemic disease, disputes over refugees and resources, and destruction by natural disasters in regions across the globe."[5]

On the civilian side, the World Bank's 2013 report, *Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience,* and their 2014 follow-up *Confronting the New Climate Normal,* offer dire prognoses for the effects of global warming, which climatologists now predict will raise global temperatures 3.6 degrees Fahrenheit above pre-industrial levels within a generation and 7.2 degrees Fahrenheit within 90 years.[6] As hotter temperatures liquefy glaciers and ice sheets from Greenland to Antarctica, all that melted ice flows into the sea: Some worst-case estimates suggest we might see seven or eight feet of sea level rise as soon as 2040.[7] The collapse of the West Antarctic ice sheet alone, already underway, will eventually raise sea levels by as much as twenty feet.[8]

As glaciers and ice sheets melt, so too will carbon and methane long frozen in seabeds and permafrost. As a greenhouse gas, methane is more than twenty times more powerful than carbon dioxide, and thousands of gigatons of the stuff lies locked under the oceans in clathrate hydrates, waiting to be released: "These solid, ice-like structures are stable only under specific conditions," writes oceanographer John Kessler, "and are estimated to contain a quantity of methane roughly equal in magnitude to the sum of all fossil fuel reservoirs on Earth."[9] Methane-rich sinkholes have appeared in Siberia and methane bubbles have been tracked leaking from the floor of the Arctic Ocean, possibly signaling the beginning of a massive planetary "belch" capable of generating catastrophic runaway greenhouse effects.[10] As geophysicist David Archer warns, "The potential for planetary devastation posed by the methane hydrate reservoir . . . seems comparable to the destructive potential from nuclear winter or from a comet or asteroid impact."[11]

We're fucked. The only questions are how soon and how badly. The Intergovernmental Panel on Climate Change's (IPCC) 2014 report on climate impacts cautions: "Without additional mitigation efforts beyond those in place today, and even with adaptation, warming by the end of the 21st century will lead to high to very high risk of severe, widespread, and irreversible impacts globally."[12] According to the World Bank, 2.7 degrees Fahrenheit of warming now appears inevitable, even if we were to stop emitting carbon dioxide (CO_2) worldwide right now.[13] Projections from researchers at the University of Hawai'i find us dealing with "historically unprecedented" climates as soon as 2047.[14] Climate scientist James Hansen, formerly with NASA, has argued that we face an "apocalyptic" future—a bleak view that is seconded by researchers worldwide.[15]

This chorus of Cassandras predicts a radically changing global climate causing widespread upheaval, and their visions of doom are backed by an overwhelming preponderance of hard data. Global warming is not the latest version of a hoary fable of annihilation. It is not hysteria. It is a fact. And we have likely already passed the point where we could have done anything about it. From the perspective of many policy experts, climate scientists, and national security officials, the concern is not whether global warming exists or how we might prevent it, but how we are going to adapt to life in the hot, volatile world we've created.

There is a name for this new world: the Anthropocene. The word comes from ancient Greek. All the epochs of the most recent geological era (the Cenozoic) end in the suffix "-cene," from *kainós,* meaning new. *Anthropos* means human. The idea behind the term "Anthropocene" is that we have

entered a new epoch in Earth's geological history, one characterized by the advent of the human species as a geological force.[16] The biologist Eugene F. Stoermer and the Nobel-winning chemist Paul Crutzen advanced the term in 2000, and it has gained acceptance as evidence has grown that the changes wrought by global warming will affect not only the world's climate and biodiversity, but its very geological structure, and not just for centuries, but for millennia.[17] In the prophetic words of William Blake, written at the dawn of the carbon era more than two hundred years ago, "The generations of men run on in the tide of Time / But leave their destin'd lineaments permanent for ever and ever."[18]

The International Commission on Stratigraphy, the geologists responsible for driving the "golden spikes" that demarcate different geological periods, have adopted the Anthropocene as a term deserving further consideration, "significant on the scale of Earth history," and are discussing what level of geological time-scale it might be and at what date we might say it began.[19] Is it an "epoch" like the Holocene, or merely an "age" like the Calabrian? Did it start with the beginning of the Industrial Revolution, around 1800, or during the Great Acceleration in the middle of the 20th century? With the dawn of agriculture, 12,000 years ago, or on July 16, 1945, with the first atomic bomb?[20]

Whenever it began, it is the world we now live in. Within a few generations we will face average temperatures 7 degrees Fahrenheit warmer than they are today, rising seas at least three to ten feet higher, and worldwide shifts in crop belts, growing seasons, and population centers. Unless we stop emitting greenhouse gases wholesale now, humans will within a couple hundred years be living in a climate the Earth hasn't seen since the Pliocene, three million years ago, when oceans were 75 feet higher. Once the methane hydrates under the oceans and permafrost begin to melt, we may soon find ourselves living in a hothouse climate closer to that of the Paleocene-Eocene Thermal Maximum, approximately 56 million years ago, when the planet was ice-free and tropical at the poles. We face the imminent collapse of the agricultural, shipping, and energy networks upon which the global economy depends, a large-scale die-off in the biosphere that's already well under way, and our own possible extinction as a species. If *Homo sapiens* survives the next millennium, it will be survival in a world unrecognizably different from the one we have known for the last 200,000 years.

In order for us to adapt to this strange new world, we're going to need more than scientific reports and military policy. We're going to need new ideas. We're going to need new myths and new stories, a new conceptual understanding of reality, and a new relationship to the deep polyglot traditions of human culture that carbon-based capitalism has vitiated through commodification and assimilation. Over and against capitalism, we will need a new way of thinking our collective existence. We need a new vision of who "we" are. We need a new humanism—a newly philosophical humanism, undergirded by renewed attention to the humanities.

Admittedly, ocean acidification, social upheaval, and species extinction are problems that humanities scholars, with their taste for fine-grained philological analysis, esoteric debates, and archival marginalia, might seem remarkably ill-suited to address. After all, how will thinking about Kant or Frantz Fanon help us trap carbon dioxide? Can arguments between object-oriented ontology and historical materialism protect honeybees from colony collapse disorder? Are ancient Greek philosophers, medieval poets, and contemporary metaphysicians going to save Bangladesh from being inundated by the Indian Ocean?

Perhaps not. But the conceptual and existential problems that the Anthropocene poses are precisely those that have always been at the heart of humanistic inquiry: What does it mean to be human? What does it mean to live? What is truth? What is good? In the world of the Anthropocene, the question of

individual mortality—What does my life mean in the face of death?—is universalized and framed in scales that boggle the imagination.[21] As environmental philosopher Dale Jamieson puts it, "The Anthropocene presents novel challenges for living a meaningful life."[22] Historian and theorist Dipesh Chakrabarty has claimed that global warming "calls us to visions of the human that neither rights talk nor the critique of the subject ever contemplated."[23] Whether we are talking about ethics or politics, ontology or epistemology, confronting the end of the world as we know it dramatically challenges our learned perspectives and ingrained priorities. What does consumer choice mean compared against 100,000 years of ecological catastrophe? What does one life mean in the face of mass death or the collapse of global civilization? How do we make meaningful decisions in the shadow of our inevitable end?

These questions have no logical or empirical answers. They cannot be graphed or quantified. They are philosophical problems *par excellence.* If, as Montaigne asserted, "To philosophize is to learn how to die," then we have entered humanity's most philosophical age, for this is precisely the problem of the Anthropocene.[24] The rub now is that we have to learn to die not as individuals, but as a civilization.

Learning to die isn't easy. In Iraq, at the beginning, I was terrified by the idea. Baghdad seemed crazily dangerous, even though statistically I was relatively safe. We got shot at, mortared, and blown up by IEDs, but we wore high-tech ballistic armor, we had great medics, and we were part of the most powerful military the world had ever seen.[25] The odds were good that I would come home, maybe wounded, but probably alive. Yet every day I drove out past the wire on mission, I looked in my Humvee's mirror and saw a dark, empty hole.

"For the soldier death is the future, the future his profession assigns him," wrote Simone Weil in her 1939 meditation on war, *The Iliad, or the Poem of Force.* "Yet the idea of man's having death for a future is abhorrent to nature. Once the experience of war makes visible the possibility of death that lies locked up in each moment, our thoughts cannot travel from one day to the next without meeting death's face."[26] I recognized that face in the dark of my Humvee's mirror. Its gaze almost paralyzed me.

I found my way forward through an old book: Yamamoto Tsunetomo's 18th-century Samurai manual, the *Hagakure*, which advised: "Meditation on inevitable death should be performed daily."[27] I took that advice to heart, and instead of fearing my end, I practiced owning it. Every morning, after doing maintenance on my Humvee, I would imagine getting blown up, shot, lit on fire, run over by a tank, torn apart by dogs, captured and beheaded. Then, before we rolled out through the wire, I'd tell myself that I didn't need to worry anymore because I was already dead. The only thing that mattered was that I did my best to make sure everyone else came back alive.

To survive as a soldier, I had to learn to accept the inevitability of my own death. For humanity to survive in the Anthropocene, we need to learn to live with and through the end of our current civilization. Change, risk, conflict, strife, and death are the very processes of life, and we cannot avoid them. We must learn to accept and adapt.

The human psyche naturally rebels against the idea of its end. Likewise, civilizations have throughout history marched blindly toward disaster, because humans are wired to believe that tomorrow will be much like today. It is hard work for us to remember that this way of life, this present moment, this order of things is not stable and permanent. Across the world today, our actions testify to our belief that we can go on like we are forever: burning oil, poisoning the seas, killing off

other species, pumping carbon into the air, ignoring the ominous silence of our coalmine canaries in favor of the unending robotic tweets of our new digital imaginarium. Yet the reality of global climate change is going to keep intruding on our collective fantasies of perpetual growth, constant innovation, and endless energy, just as the reality of individual mortality shocks our casual faith in permanence.

The greatest challenge the Anthropocene poses isn't how the Department of Defense should plan for resource wars, whether we should put up sea walls to protect Manhattan, or when we should abandon Miami. It won't be addressed by buying a Prius, turning off the air conditioning, or signing a treaty. The greatest challenge we face is a philosophical one: understanding that this civilization is already dead. The sooner we confront our situation and realize that there is nothing we can do to save ourselves, the sooner we can get down to the difficult task of adapting, with mortal humility, to our new reality.

Carbon-fueled capitalism is a zombie system, voracious but sterile. This aggressive human monoculture has proven astoundingly virulent but also toxic, cannibalistic, and self-destructive. It is unsustainable, both in itself and as a response to catastrophic climate change. Thankfully, carbon-fueled capitalism is not the only way humans can organize their lives together. Again and again throughout our history, we have shown ourselves to be capable of shedding maladaptive systems of meaning and economic distribution, developing resilient social technologies in response to precarity and threat, and transforming obsolete social practices into novel forms of life. Humanity's survival through the collapse of carbon-fueled capitalism and into the new world of the Anthropocene will hinge on our ability to let our old way of life die while protecting, sustaining, and reworking our collective stores of cultural technology. After all, our capacities to innovate and adapt depend on our being able to draw from our immense heritage of intellectual production, living and dead, exotic and close at hand: from the Iñupiat and from Islam, from Heraclitus and Zhuangzi, from the Torah and from the Buddha, from the *Federalist Papers* and from the *Communist Manifesto.* Carbon-fueled capitalism has given rise to a truly marvelous liberal multiculturalism, but if we are to survive its death throes, tolerance must mature into conservation and synthesis, grounded in a faith in human community existing beyond any parochial identity, local time, or single place.

The argument of this book is that we have failed to prevent unmanageable global warming and that global capitalist civilization as we know it is already over, but that humanity can survive and adapt to the new world of the Anthropocene if we accept human limits and transience as fundamental truths, and work to nurture the variety and richness of our collective cultural heritage. Learning to die as an individual means letting go of our predispositions and fear. Learning to die as a civilization means letting go of this particular way of life and its ideas of identity, freedom, success, and progress. These two ways of learning to die come together in the role of the humanist thinker: the one who is willing to stop and ask troublesome questions, the one who is willing to interrupt, the one who resonates on other channels and with slower, deeper rhythms.

The form this book takes is that of a story, but not a story about a person. Climate change is too big to be reduced to a single narrative, and the problems it presents us with demand that we transcend visually representative "picture-thinking" and work instead to create a sense of collective humanity that exists beyond any one place, life, or time. The story this book tells is of the human soul coming to know itself in its mortality. It begins in the deepest origins of our primal relationship with the Earth's climate, in Chapter 1: Human Ecologies, which traces that relationship up through our current moment and our contemporary predicament. In Chapter 2: A Wicked Problem, we consider that predicament. Carbon-fueled capitalism and its techno-utopian ideologues have promised infinite

growth and infinite innovation, yet they have proven incapable of saving us from the disaster they have made. Various "solutions" to climate change have been offered, from carbon taxes to geoengineering, but none of them are likely to work. This chapter takes a look at the reasons why.

The global failure to address climate change is fundamentally a collective action problem, meaning it is a political problem. In Chapter 3: Carbon Politics, we consider how our collective failure to respond to climate change is an effect of the very structures of our political systems and the way that they are built around decentralized flows of oil and gas. The systems that structure our political desires and constrain our political will have a material history. As the human animal developed increasingly complex social technologies for producing power, from hunting bands tracking migrating herds of giant elk and mastodons to agricultural empires harvesting grain to fossil-fuel-burning global capitalism, we also developed increasingly complex technologies of collective life. As our technologies of producing power changed, so did our technologies for distributing and controlling it. Today, global power is in the hands of a tiny minority, and the system they preside over threatens to destroy us all. With this in mind, we turn back to the collective danger that carbon-fueled climate change poses, this time considered in terms of our primal human responses to existential threat: fight or flight. Facing the fear of death and the inevitability of conflict in the Anthropocene is the task of Chapter 4: The Compulsion of Strife. Progressivist belief in the infinite perfectibility of the human animal depends significantly on carbon-fueled capitalism's promises of infinite economic growth. Accepting our limits means coming to terms with our innate violence and our inescapable mortality.

By learning to die, though, we can connect with and open up new possibilities for the human future, as I argue in Chapter 5: A New Enlightenment. Through interrupting social circuits of fear and reaction, looking deep into the face of death, and cultivating our rich stocks of human cultural technology, from the *Epic of Gilgamesh* and the *Bhagavad-Gita* to imagined Anthropocene futures, we open up a human relationship to the universe in which we might live not as parasitic consumers, but as co-creators—a relationship in which we might learn to live as the very light from which all our power ultimately flows.

The crisis of global climate change, the crisis of capitalism, and the crisis of the humanities in the university today are all aspects of the same crisis, which is the suicidal burnout of our carbon-fueled global capitalist civilization. The odds of that civilization surviving are negligible. The odds of our species surviving are slim. The trouble we find ourselves in will likely prove too intractable for us to manage well, if we can manage it at all. Yet as German philosopher Peter Sloterdijk observes: "It is characteristic of being human that human beings are presented with tasks that are too difficult for them, without having the option of avoiding them because of their difficulty."[28] We cannot escape our fate. Our future will depend on our ability to confront it not with panic, outrage, or denial, but with patience, reflection, and love.

Our choice is a clear one. We can continue acting as if tomorrow will be just like yesterday, growing less and less prepared for each new disaster as it comes, and more and more desperately invested in a life we can't sustain. Or we can learn to see each day as the death of what came before, freeing ourselves to deal with whatever problems the present offers without attachment or fear.

If we want to learn to live in the Anthropocene, we must first learn how to die.

TWO

A WICKED PROBLEM

I have seen this swan and
I have seen you; I have seen ambition without understanding in a variety of forms.

—Marianne Moore, “Critics and Connoisseurs”

In Iraq today, as in Uruk four thousand years ago, human beings live at the mercy of a changing climate. Decreased rainfall and diminished snowpack in the mountains mean that the Tigris and Euphrates are drying up, a problem exacerbated by new dams, increased water use, and water diversion in Turkey, Iran, and Syria. Drought, Saddam Hussein’s draining of the Mesopotamian Marshes, and the devastation and abandonment of farmland due to years of war, neglect, and neoliberal economic policies favoring foreign imports over local produce have increased desertification, which in turn is unleashing punishing dust storms on Iraq’s cities and crops.[41]

There are, of course, many differences between Uruk’s distant collapse and Iraq’s ongoing crisis. One of the most important is that Iraq’s situation is man-made, while Uruk’s was not. Another is that in 2200 BCE, the only things that beleaguered Sumerians could do in response to a changing climate were ration their grain and pray. Today, national, regional, and local governments worldwide, in cooperation with international bodies such as the IPCC, the United Nations Framework Convention on Climate Change (UNFCCC), the World Bank, the International Energy Agency (IEA), and the World Trade Organization (WTO), confront the problem of global warming with tremendous resources, the knowledge of thousands of highly trained scientists and engineers, and the support of hundreds of thousands of dedicated activists and concerned citizens. Yet for all that, we seem no more capable than were the people of Uruk when it comes to rescuing ourselves from imminent catastrophe.

The scientific study of climate change goes back to the early nineteenth century, when geologists and naturalists struggled to make sense of evidence suggesting that much of the Earth had once been covered in glaciers, and the science developed as physicists and chemists sought to understand the composition and mechanics of the Earth’s atmosphere. The Swedish scientist Svante Arrhenius demonstrated the close relation between carbon dioxide levels and atmopheric temperature in 1895, theorizing what we now understand as the greenhouse effect and suggesting that widespread coal burning might increase global temperatures.[42] By the 1950s and 1960s, the effects of industrial pollution on the global climate were being studied by many scientists, among them Charles David Keeling, whose graph measuring carbon dioxide at the Mauna Loa Observatory in Hawai‘i, the now-famous “Keeling Curve,” showed clearly that atmospheric CO_2 was increasing. Over the next thirty years, evidence for man-made global warming grew, and by the late 1980s a scientific consensus had been established.

In 1988, James Hansen, then director of the National Air and Space Administration’s Insitute for Space Studies, testified before the US Senate that the Earth was definitely warming, and “that it was 99 percent certain that the warming trend was not a natural variation but was caused by a buildup of carbon dioxide and other artificial gases in the atmosphere.”[43] The Intergovernmental Panel on

Climate Change was founded that same year to report and advise the United Nations on the problem of climate change, and the United Nations Framework Convention on Climate Change was established in 1992, committing its signatories to stabilizing global greenhouse gas emissions at a safe level. Every member nation of the UN signed the UNFCCC treaty in 1992 and most had ratified it by 1995, but the commitments they made came with no clear objectives, no viable mechanism for monitoring whether objectives were achieved, and no binding authority to enforce compliance.

In the decades since, while the almost two hundred nations committed to the UNFCCC have worked out individual emissions targets, they have not come to any agreement on monitoring or enforcement. Conference after conference has sunk under its own weight as a lack of accountability, intransigence from the US, China, and India, outsized goals set with no realistic plan for achieving them, bickering, and global power politics have led to failure after failure. Meanwhile, global greenhouse gas emissions have increased 35 percent since 1990, driven primarily by waste carbon dioxide from expanding energy consumption in North America and Asia.[44]

The only sure way to keep global warming from accelerating out of control would be to stop dumping waste carbon dioxide immediately. In the stern words of the IPCC: "Climate change can only be mitigated and global temperature be stabilized when the total amount of CO_2 is limited and emissions eventually approach zero."[45] With just the CO_2 in the atmosphere and oceans today, we are already set for at least 2 to 3 degrees Fahrenheit warming above pre-industrial levels, and it might be more like 5 or 6 degrees Fahrenheit. Any more CO_2 we put in from now on (by starting a car, for instance, or charging a phone) is only going to amplify that. So even if we banned dumping CO_2 right now, this very instant, we would still be facing serious climate impacts for centuries. Unfortunately for us, given the realities of global politics, a comprehensive, enforceable, worldwide ban on CO_2 is sheerest fantasy.

But what about other solutions? What about mitigation? What about decarbonizing our economy, replacing coal and oil with renewable energy or nuclear power? What about a carbon tax? What about cap-and-trade, carbon capture and sequestration, carbon extraction, and geoengineering? Might these strategies help us end, reduce, or at least mitigate our CO_2 emissions before we hit a tipping point and it's too late?

Ending our reliance on carbon-based fossil fuels—decarbonizing the global economy—would be the most reliable path to limit and eventually stop dumping waste CO_2. The problem is that global decarbonization is effectively irreconcilable with global capitalism. Capitalism needs to produce profit in order to spur investment. Profit requires growth. Global economic growth, even basic economic stability, depends on cheap, efficient energy.

Decarbonizing the global economy without a replacement energy source would mean turning off approximately 80 percent of our power, causing a worldwide economic meltdown that would make the Great Depression look like a sluggish sales season. While not nearly as dire, worldwide decarbonization *with* replacement energy still looks pretty unpalatable. The most reliable studies suggest that even stabilizing CO_2 at a relatively low but still unsafe level would require long-term economic austerity. According to the Potsdam Institute for Climate Impact Research, stabilizing carbon dioxide levels at 450–500 ppm (which is 100–200 ppm *over* the upper limit for keeping warming anywhere near 3.6 degrees Fahrenheit [2 degrees Celsius]) calls for slowing and probably even contracting the global economy indefinitely, basically extending the Great Recession into the indefinite future.[46] No population on the planet today is going to willingly trade economic growth for lower carbon emissions, especially since economic power remains the key index of global status.[47]

The political paroxysms of forced austerity rocking countries across Europe today are only a taste of what we would have to look forward to under a carbon-austerity regime.

Offering a glimmer of hope, the IPCC's 2014 report on mitigation argues that we can avoid the worst of global warming with what would be only a slight decrease in global economic growth—about .06 percent.[48] The report claims that shifting investment from oil and coal production to research and development of renewable energies, nuclear power, and carbon capture and sequestration could make it possible to decarbonize within thirty or forty years with only a slight cost to global gross domestic product. The report may be right, but the IPCC's numbers are speculative, not predictive: The renewable energy and carbon capture technologies the report's numbers depend on are still emerging, and we don't know yet whether they can work on a large enough scale to make a difference, or how much more they might cost than carbon fuels do now. As well, critics have pointed out a variety of problems with the IPCC's numbers on decarbonization, ranging from excessive political influence affecting data to biases in models underestimating economic impacts.[49]

Adding to our troubles, it's no simple thing to completely renovate worldwide energy infrastructure that has taken many years to build. Vaclav Smil, one of the world's leading energy analysts, observes: "There are five major reasons that the transition from fossil to nonfossil supply will be much more difficult than is commonly realized: scale of the shift; lower energy density of replacement fuels; substantially lower power density of the renewable energy extractions; intermittence of renewable flows; and uneven distribution of renewable energy resources."[50] It would take decades to develop and implement new systems of carbon-free or carbon-minimal energy infrastructure, if it's even possible, and we don't have decades.[51] Even 2035, a mere twenty years from now, will be too late. It's very likely already too late now.

Another major problem we face in decarbonizing and rebuilding global energy infrastructure is that the prime candidates for clean renewable power, solar and wind, are in themselves not reliable enough to supply the baseline energy we need to keep our lights burning, our EKGs and medical respirators beeping and pumping, and our servers crunching data. "The central and deeply intractable fact about electricity," writes journalist and historian Gwynne Dyer, "is that it must be generated at the very moment it is used. This poses a major problem for those in charge of supplying a society with electricity, since . . . the demand can vary as much as threefold from a mild weekend day in summertime to a cold midwinter evening."[52] The debilitating issue with solar and wind power is that they add to the problem of variable demand the problem of variable supply: they depend on the weather, which changes dramatically from day to day and hour to hour. Dyer writes:

> The managers of the big grids, who already have to cope with wildly fluctuating levels of demand, are now being asked to deal with uncontrollably fluctuating levels of supply as well, and they can only go so far. It hasn't come up much in public yet, because only Germany and Denmark have approached even 20 percent renewables in their electricity-generation mix [recently as much as 27 percent], but most grid managers are very unhappy about going beyond that level of renewables in the system.[53] With better programmes for predicting short-term wind fluctuations they might be persuaded eventually to go up to 50 percent, but beyond that . . . you simply cannot go unless you are prepared to accept periodic collapses of the entire grid when the wind drops.[54]

Many critics question whether renewable energy will *ever* be a feasible alternative to carbon fuels, pointing out that its cost-to-energy ratios are simply too high. Even James Hansen, one of the most

outspoken scientists on the urgent need to address global warming, remains skeptical: "Most energy experts agree that, for the foreseeable future, renewable energies will not be a sufficient source of electric power. There is also widespread agreement that there are now just two options for nearly carbon-free large-scale base-load electric power: coal with carbon capture and storage, and nuclear power."[55]

As Hansen wrote with three other scientists in a controversial open letter in 2013, "Renewables like wind and solar and biomass will certainly play roles in a future energy economy, but those energy sources cannot scale up fast enough to deliver cheap and reliable power at the scale the global economy requires. While it may be theoretically possible to stabilize the climate without nuclear power, in the real world there is no credible path to climate stabilization that does not include a substantial role for nuclear power."[56] Nuclear fission, however, presents significant and perhaps insurmountable waste issues, and in order to reduce carbon emissions enough to keep CO_2 below 450 ppm, the world would have to build more than 12,000 nuclear power plants in the next 35 years, "about the same as one new plant coming online every day between now and 2050."[57] That seems unlikely, especially since disasters such as Three Mile Island, Chernobyl, and Fukushima remain forbidding reminders of the risks nuclear power poses.

And then there's the question of how the nations of the world would even go about implementing global decarbonization if they all agreed to do it. National carbon taxes strict enough to actually decrease carbon use have been implemented in a few countries, but even so, global emissions have continued to rise, and we have yet to solve the problem of enforcement: Who is going to make the United States, China, Russia, and India pay more for their coal and oil? There would necessarily have to be some kind of international agreement on the price of carbon, which seems unlikely, given that scientists and economists in the United States and the United Kingdom—both wealthy nations with shared economic interests and a long history of CO_2 emissions—disagree substantially, estimating the costs of carbon variously "from a few to several hundred dollars per tonne."[58] As economist Michael Grubb describes the problem:

> The holy grail of an economic cost-benefit calculation applied to climate change is to establish the "social cost of CO_2 emissions"—the damage inflicted by emitting each tonne. As shown, the calculation turns out to be just as uncertain as everything else—in fact more so. It does not provide an objective answer in a world of conflicting views, but unavoidably reflects back the assumptions and values that people bring to the table. Climate policy will have to contend with "incommensurable benefits estimates." Even the world's top economists have accepted that they cannot reach an agreement about how to tackle the problem, even on the single component of how to weight impacts over time, let alone other dimensions.[59]

Populations and countries in economic competition, with wildly unequal investments in fossil fuel reserves and facing wildly unequal impacts from the changing global climate, are highly unlikely to come to an agreement on how much a ton of CO_2 should cost, thus making it improbable that strict, universal regulatory taxes on carbon will ever be established. If this seems unduly pessimisstic, consider that neither the US, Russia, nor China—together responsible for around 48 percent of the world's carbon dioxide emissions—have a national carbon tax, and that two of those nations are fossil fuel exporters who depend on the growing energy markets of the third. Further, carbon taxes have faced intense opposition not only from fossil fuel producers, but also from voters: most notably, Australia became famous in 2014 as the first country in the world to repeal a national carbon tax.

Instead of such taxes, many people advocate decarbonization through a global "cap-and-trade" mechanism similar to the one that helped solve the problem of acid rain.[60] In a cap-and-trade scheme, emissions limits are established and gradually tightened, while emitters are allowed to trade emissions credits among themselves to minimize the costs of compliance. But Thomas Schelling, a Nobel-winning economist and strategic systems theorist, makes a strong case that carbon trading simply will not work. While he "believes in the essentiality of incentives, in clearly defined obligations, and in the virtues of trading," Schelling "cannot imagine such a regime for carbon emissions."[61] His main reasons are straightforward. First, "any serious regime would have to allocate emission rights over many decades, not just a decade at a time but cumulatively," and there is no way of reaching agreement on what emissions limits should be over the next hundred years or on deciding the costs of exceeding them. Second, "it would be almost impossible to determine, during the first half-century or so, whether a nation was on target to meet its ultimate cumulative limit." Third, enforcement would require an independent body able to punish poor and rich countries alike, and it is hard to see how such an enforcement body would function or from where it would derive its authority. As Schelling notes, "there is no historical example of any international regime that could impose penalties on a scale commensurate with the magnitude of global warming. . . . Nothing like this has ever existed and it is even hard to conceive."[62] Consider the fact that human trafficking, genocide, torture, the use of chemical weapons, and wars of aggression have all been banned by international agreements, yet such crimes keep happening and are often committed by the leading signatories of the very treaties that ban them. It seems irresponsible to expect things to be any different when it comes to dumping carbon.

Since we're not likely to regulate our carbon dioxide emissions away, maybe we should bury them. Carbon capture and sequestration (CCS) has been proposed as a technological solution that would do just that. With CCS, you put pipes on top of smokestacks to collect waste CO_2, then bury it all somewhere. The trouble is that CCS is a new and expensive technology that stands little chance of being developed on a global scale quickly enough to make a real difference. According to the International Energy Agency, robust enough CCS development to keep global warming below 7.2 degrees Fahrenheit would take global investment of *at least* 5 to 6 billion dollars a year. As of 2013, cumulative global investment in CCS technologies has only been averaging about 2 billion dollars a year.[63] The IEA's 2009 CCS roadmap called for 100 CCS projects to be developed by 2020, but as of 2013, only four had been completed, with nine more under construction. The four functioning projects had cumulatively stored about 50 million tons of carbon, while we dumped 200 times that amount of CO_2 into the atmosphere in 2012 alone.[64] As more recent IEA reports have shown, progress on carbon capture and sequestration does not inspire confidence. The IEA explains: "Because markets do not value the public benefits of CCS demonstration and the benefits cannot be captured in full by early adopters, there is currently little commercial incentive for private entities to invest in CCS."[65] Absent government incentives and regulation, there's no reason for anyone to expect that carbon capture and sequestration will be developed or implemented on a meaningful scale, and as long as coal and oil companies remain politically powerful, there's no reason to expect robust enough government action in time for CCS to be a viable response to global warming.

Pulling carbon dioxide out of the air has also been proposed as a technological fix to address emissions, though it too would be tremendously expensive and, like capture and sequestration, has so far remained underdeveloped. As Roger Pielke Jr. points out, "Presently, there are no experimental data on the complete process of air capture, especially at scale, to demonstrate the concept, its energy use, and the engineering costs."[66] We should be researching and developing such technologies, of

course, while recognizing that they are far from being quick, easy solutions and may not ever be viable. The time for a speculative, miraculous, last-minute, long-shot techno-fix is well over. We are living *right now* in the midst of a global climate emergency and social crisis that demands immediate response and long-term adaptation. We must prepare for the coming storm—not in thirty or forty years, but today.

Some people want to believe we can hold off the storm by artificially cooling the planet with a crude process often disingenuously dignified by the term "geoengineering," otherwise known as "Solar Radiation Management."[67] The most technologically feasible plan is simple: we lay a blanket of sulfur in the stratosphere to increase the Earth's reflectivity, or albedo, thus shining back more of the Sun's light into space and thereby cooling the planet. While cheap enough that a small country or even large corporation could make it happen, this plan has serious flaws. Stratospheric sulfur aerosol cooling is dangerous, because of the toxicity of the sulfur, because it could degrade the ozone layer, and because the resulting increased albedo would make us more vulnerable to fallout from volcanic eruptions. If the atmosphere were already thick with particulate sulfur, additional aerosols from an eruption like Pinatubo or Eyjafjallajökull could force a sudden massive cooling like the one that happened when Mount Tambora exploded in 1816, the so-called "Year Without a Summer." Such an event would be catastrophic for agricultural yields and likely cause widespread famine. We also don't know how such deliberate dumping of sulfur into the atmosphere would further impact climatic changes already happening because of warming: clouds darkened with sulfur may absorb more heat, and particulate sulfur drifing down onto ice and snowfields may worsen the "dark snow" effect that is helping melt glaciers in Greenland and elsewhere. Finally, and most seriously, sulfur aerosol cooling simply doesn't work over the long term. Reflecting more light back into space deals with the symptom (warming) without addressing the cause (greenhouse gases). Sulfur aerosols are heavy and would tend to settle back on the Earth's surface (and on us and our crops), so they would have to be continually dumped into the upper atmosphere, a situation that sets us up for sudden runaway heating if we should ever stop pumping up the sulfur—if there were another world war, for instance.

Global warming is what is called a "wicked problem":[68] it doesn't offer any clear solutions, only better and worse responses. One of the most difficult aspects to deal with is that it is a collective-action problem of the highest order. One city, one country, even one continent cannot solve it alone. Any politician who honestly and frankly worked to detach her nation's economy from oil and coal would not survive in any kind of democratic or oligarchic government, because the rigorous austerity necessary to such an effort would mean either economic depression and poverty for most of her constituency, a massive redistribution of wealth, or both. Moreover, any leader who forced her country to accept the austerity and redistribution necessary to end its dependence on cheap carbon would also be forcing her country into a weak and isolated position politically, economically, and militarily. The entire world has to work together to solve global warming, yet carbon powers the world's political machinery and shapes our current form of collective life. It's coal and oil that we have to thank for connecting the many nations of the world into one tight, integrated economy. Without the information, energy, and transportation infrastructures built and sustained with carbon, there wouldn't be any global civilization to try to save.

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Many more books, websites, lectures, and reports were consulted in writing this book than are directly referenced. This brief bibliography, focusing on climate change and some of its philosophical and ethical impacts, names some of these works along with selected works cited. Please see the endnotes for references not listed here.

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