TWO

How the Most Important Fact of Global Warming Has Been Obscured

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THE SUMMER OF 2024 was the hottest on record.[1] Heat domes formed across the world like gigantic ovens, and smoke from incinerated forests covered the North American continent. Waters in the Gulf of Mexico reached jacuzzi-like temperatures, while the North Atlantic Ocean heated up as never before in human history, threatening to collapse the Atlantic meridional overturning circulation. Greenhouse gasses are higher than they have ever been in three million years, and we are sprinting toward ever-greater extremes. And almost all due to the production and consumption of fossil fuels.

Like anything, global warming is complicated in some ways and simple in others. Petro polluters and their apologists are quick to emphasize complexity, with the implication that there's always more to study before solving the problem and that no one is to blame for the slow pace of progress. But climate change isn't complicated in *every* way and is not very hard to understand. It turns out that the most important facts are also rather simple, including the most important fact of all: replacing fossil fuels is necessary—and pretty much sufficient—to solve our climate emergency.

The science of climate change—involving careful modeling with eerily exact predictions of global warming—has been understood for decades both by climate scientists outside the fossil fuel industry and by scientists and executives within the industry itself. Remarkably, by 1980, both academic and industry scientists were aware that catastrophic global warming was largely preventable and required an immediate turn away from fossil fuels. This most important fact, however, posed an existential threat to fossil fuel producers, who already in the 1980s had launched an assault on the truth through denial, distraction, and obfuscation. Their goal? To promote the idea that global warming could be solved without replacing fossil fuels. As we shall see, from the late 1980s to the early 1990s, oil producers and their allies developed three major strategies for

defeating fossil fuel controls: weaponizing scientific uncertainty, manipulating economics, and promoting false solutions. The net effect is that large segments of the population—and even many climate-science professionals—still today don't grasp the importance of replacing fossil fuels to respond properly to the emergency.

DISCOVERING THE MOST IMPORTANT FACT

The need to replace fossil fuels to fix global warming might appear trivial or obvious. At the same time, much of the history of contested climate policy can be understood as a struggle over this crucial fact's existence, interpretation, and implications. More than any other piece of knowledge, this fact has posed the greatest existential threat to the most powerful industry on the planet.

Exact knowledge of fossil fuels' dangers developed as early as the 1950s and was well established by 1980. In 1954, for example, the American Petroleum Institute (API)—the industry's most important trade association—was privately informed by scientists at the California Institute of Technology that fossil fuels were likely causing a buildup of carbon dioxide in the atmosphere.[2] Five years later, in 1959, physicist and father of the hydrogen bomb Edward Teller warned oil-industry executives that this buildup would cause serious warming by the end of the century and advocated for the replacement of fossil fuels to prevent this catastrophe.[3] And in 1965, shortly after the White House published an assessment warning of global warming, the head of API notified fossil fuel chiefs that, based on the report's findings, "an alternative nonpolluting means of powering automobiles, buses, and trucks is likely to become a national necessity."[4] Three years later, in 1968, the API received this same warning from its own private consultants, who advised that it was time to develop "air pollution technology" to bring CO_2 emissions under control.[5]

European manufacturers came to similar conclusions. In 1971, the French oil giant Total published an article titled "Atmospheric Pollution and Climate" in its magazine *Total Information*, which noted that since the 1800s, the burning of fossil fuel had resulted in the release of "enormous quantities of carbon dioxide" and that if fossil fuel use continued to grow, CO_2 concentrations would reach four hundred parts per million (ppm) around 2010 (a forecast that proved surprisingly accurate).[6] The article characterized the predicted global warming as "quite worrying" and warned of modified atmospheric circulation, melting of polar ice, and significant sea level rise, stating, "The catastrophic consequences are easy to imagine."[7]

Based on these and other warnings, policymakers and energy modelers started discussing how to shift to low-carbon energy economies in the future. In 1969, for example, Victor Erickson from the U.S. Department of Commerce

reported to the annual meeting of the American Institute of Mining, Metallurgical and Petroleum Engineers that if "we are faced with the problem of a warming of the earth from the 'hot house' effect of carbon dioxide in the upper atmosphere or with the cooling of the earth from particulates cutting out the radiation of the sun, entirely new approaches may be needed. . . . [This] will raise major economic issues and it is not too early to be thinking about them."[8] The following year, the institute's conference program included contingency planning for transitioning to a low-carbon energy economy by the year 2000.[9] And one year later, in 1971, a speaker from the U.S. Treasury Department observed that to address atmospheric pollution, "future demands may be met by systems which are not dependent on fossil fuels."[10]

By the end of the 1970s, climate science had advanced with the development of computer-based general circulation models and multiple consensus assessments, including the 1979 "Charney report" by the U.S. National Academy of Sciences, which found that a doubling of atmospheric CO_2 would cause an average warming of around three degrees Celsius.[11] This allowed researchers both within and outside the industry to predict how much warming would be produced by various fossil fuel future scenarios. In other words, by this time, many of the most important facts about global warming were well established. Scientists could describe how much warming would occur, when it would occur, and how to prevent it from getting worse.

Around this same time, a body of scientific literature began to examine how to limit the severity of global warming. The main conclusion of this work was that to avoid a climate catastrophe, fossil fuels needed to be replaced, beginning immediately. Researchers also realized, though, that the replacement of fossil fuels, even if pursued energetically, would not happen overnight. Fifty years was a common estimate for the time needed to replace one energy source with another, and this lent the climate problem a certain urgency.[12] In 1978, Stanford engineer John Laurmann noted that a few years prior, the physicist Wolf Häfele and engineer Wolfgang Sassin of the International Institute for Applied Systems Analysis (IIASA; an international research center established near Vienna, Austria, to facilitate East-West cooperation during the Cold War) had suggested that half a century would be needed to transition away from fossil fuels, leading Laurmann to warn that "the most likely date for reaching at least 2.5°C [of global warming], 2029, suggests the need for immediate remedial measures in the form of global reduction of fossil fuel use."[13]

Laurmann elaborated on this concept in 1979, writing in *Science* that because moving away from fossil fuels would likely take decades (what he called the "market penetration time concept"), climate change posed an "immediate environmental control problem."[14] Global warming, he noted, could be avoided "by switching from the present-day predominant use of coal and oil as primary

energy sources to a non-carbon-based fuel" and that the timescale for replacing fossil fuels suggested "the need for immediate action if the [climate] change is to be averted."[15] Assuming an annual global-energy-demand growth rate of 2 percent (similar to actual historical and current rates),[16] Laurmann projected that with immediate action, atmospheric CO_2 could be limited to a peak of around 403 ppm before it would start to decline. That would have been significantly lower than our current level of over 420 ppm (and steadily rising).

Other researchers also emphasized the importance of this market-penetration-time concept. A 1979 study in the *Journal of Geophysical Research* by F. Niehaus and J. Williams obtained results similar to Laurmann's, projecting that with immediate action, CO_2 emissions could peak around the year 2000 with concentrations limited to around four hundred ppm (fig. 2.1) and that continued reliance on fossil fuels could lead us to a catastrophic one thousand ppm by the year 2100.[17] Niehaus and Williams's projections were adopted in 1981 by the IIASA in its own analysis of the fossil fuel climate problem.[18]

This is important to grasp. By 1980, the market-penetration-time concept was widely acknowledged and indicated a need for immediate action to avoid disastrous levels of global warming. Multiple peer-reviewed studies projected that with immediate action, atmospheric CO_2 in the twenty-first century could be limited to around four hundred ppm, corresponding to warming of only about 1 degree Celsius. In reality, CO_2 concentrations might have been limited to even less than four hundred ppm with a faster transition to renewables. The key lesson of these studies from over forty years ago is that catastrophic global warming was understood to be largely preventable and required prompt efforts to replace fossil fuels.

A related concept developed around this time was something called the "action-initiation time," which referred to the date by which actions to reduce fossil fuel emissions would begin to have an effect. Researchers found that the later the action-initiation time (i.e., the longer fossil fuel controls were delayed), the more abrupt the replacement of fossil fuels would have to be to achieve a given CO_2 limit. A 1982 study in the journal *Energy* by A. M. Perry and colleagues, for example, examined future CO_2 buildup as a function of the action-initiation time, explaining that the energy transition would be required "sooner or later" and that "the longer the transition is delayed, the more abrupt and difficult" it would be.[19] "The possibility of limiting CO_2," they found, "will depend strongly on energy use patterns established and decisions taken in the relatively near future"; they also warned against any "delay in promoting restraint in the growth of fossil fuel use."[20]

In his 1979 study, Laurmann also modeled how *delaying* efforts to replace fossil fuels could lock the world into a climate catastrophe, estimating that one, two, or three decades of delay would lead to an additional 70, 140, or 250 ppm

FIGURE 2.1. **Two different scenarios for energy and climate, published by Niehaus and Williams in the *Journal of Geophysical Research* in 1979. In the first chart (fig. 10), immediate dedication to nonfossil energy sources allows emissions to peak around the year 2000, CO_2 concentrations peak at 400 ppm, and global warming peaks at 0.8°C (assuming a climate sensitivity of 2°C per doubling of CO_2; a climate sensitivity of 3°C, closer to current estimates, would yield global warming of around 1.2°C). In the second chart (fig. 12), continued reliance on fossil fuels leads to 1,000 ppm CO_2 and 6°C warming by the end of the twenty-first century.**

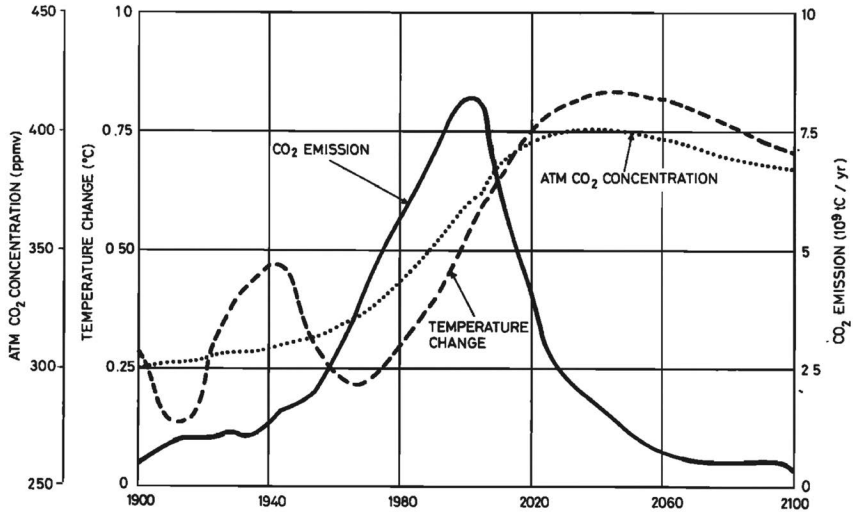


Fig. 10. CO_2 impact of 30-TW solar and nuclear strategy.

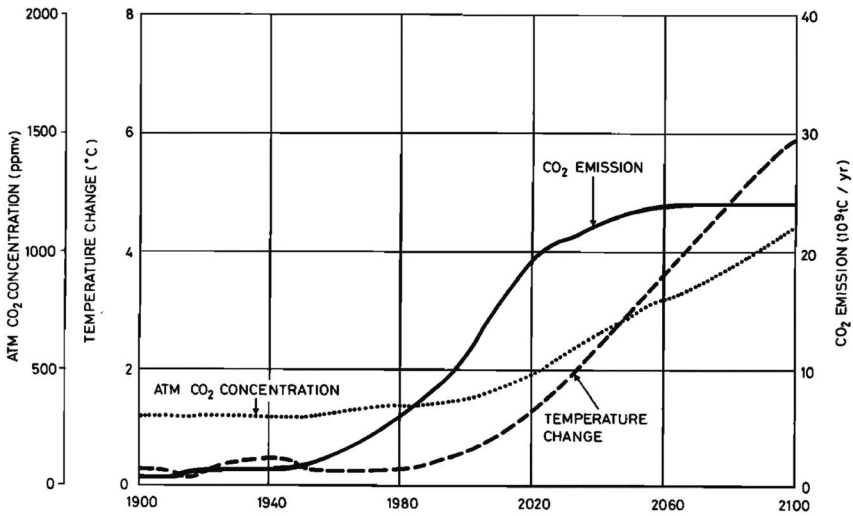


Fig. 12. CO_2 impact of 30-TW fossil fuel strategy.

Source: F. Niehaus and J. Williams, "Studies of Different Energy Strategies in Terms of Their Effects on the Atmospheric CO_2 Concentration," *Journal of Geophysical Research* 84, no. C6 (June 1979): 3127, 3129.

CO_2 in the atmosphere, respectively. Given his calculation that CO_2 concentrations could be limited to about 400 ppm with immediate action, Laurmann's analysis implied that one, two, or three decades of delay beyond 1979 would result in minimum CO_2 concentrations of 470, 540, or 650 ppm, corresponding to warming of 2.3, 2.9, or 3.7°C.[21] In other words, every year of delay would result in more unavoidable warming and more enormous, permanent damage to human life and planetary ecosystems.

To sum up, by 1980, the scientific literature showed not only that catastrophic global warming was preventable but also that every year of delay in replacing fossil fuels would come at the cost of greater climate damage. Table 2.1 summarizes this literature from the late 1970s and early 1980s.

Recently discovered internal documents from Exxon and other companies demonstrate that oil manufacturers were also aware of the necessity of replacing fossil fuels. In July 1977, for example, James Black from Exxon Research and Engineering met with the company's Management Committee to discuss climate forecasts, informing his supervisors of the "general scientific agreement that the most likely manner in which mankind is influencing the global climate is through carbon dioxide release from the burning of fossil fuels" and that the best available models predicted that "a doubling of the CO_2 concentration in the atmosphere would produce a mean temperature increase of about 2C to 3C over most of the earth," with two to three times more warming near the poles.[22]

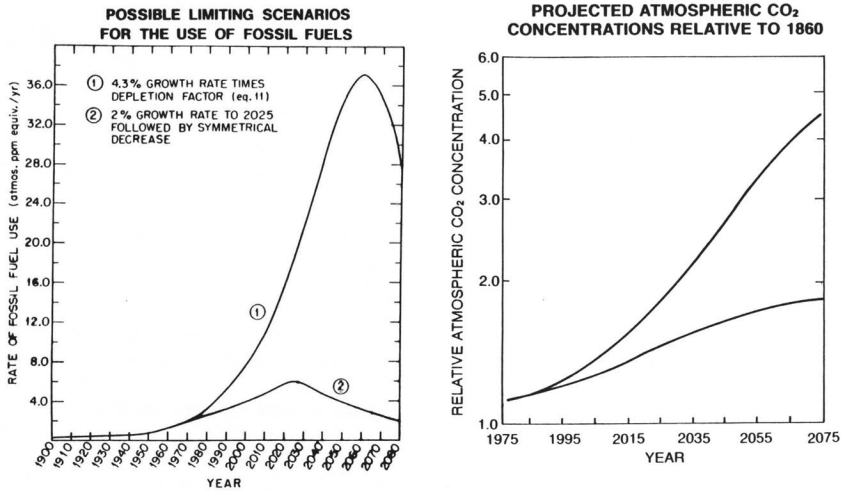
To limit warming, Black presented the Exxon board with two scenarios: one in which fossil fuel production would grow until around 2060 and decline thereafter and another in which production would begin to decline in 2025.[23] These scenarios, shown in figure 2.2, would yield CO_2 concentrations five and two times above preindustrial concentrations, respectively. In other words, even the safer scenario was expected to cause global warming of around three degrees Celsius with devastating consequences. Despite his prediction of catastrophic warming, Black's central insight was that stopping it would require replacing fossil fuels and that the sooner they were replaced, the less severe would be the resulting warming.

This same conclusion was reached in another internal study conducted by Exxon in 1979, marked "proprietary" and titled *Controlling the CO_2 Concentration in the Atmosphere*. The report, authored by Steve Knisely in the company's Planning Engineering Division, found that uncontrolled fossil fuel use would lead to "dramatic climate changes" within the next seventy-five years and that preventing such an outcome would require "dramatic changes in patterns of energy use," including leaving most fossil fuel reserves in the ground.[24] Knisely calculated that "only about 20% of the recoverable fossil fuel could be used before doubling the atmospheric CO_2 content"; he also predicted that a doubling of atmospheric CO_2 would cause increased rainfall, four feet of sea

TABLE 2.1. Overview of CO_2-control research, 1977–1983.

Year	Publication	Minimum achievable CO_2 concentration (ppm)
1977	William D. Nordhaus, "Strategies for the Control of Carbon Dioxide" (Cowles Foundation Discussion Paper 443, Yale University, New Haven, CT)	417
1978	John A. Laurmann, "Fossil Fuel Utilization Policy Assessment and CO_2 Induced Climate Change," in *Carbon Dioxide, Climate and Society*, ed. Jill Williams, IIASA Proceedings Series: Environment 1 (Laxenburg: IIASA), 253–62	No estimate but calls for immediate action due to market-penetration time
1979	F. Niehaus and J. Williams, "Studies of Different Energy Strategies in Terms of Their Effects on the Atmospheric CO_2 Concentration," *Journal of Geophysical Research* 84, no. C6 (June): 3123–29	400
1979	John A. Laurmann, "Market Penetration Characteristics for Energy Production and Atmospheric Carbon Dioxide Growth," *Science* 205, no. 4409: 896–98	403
1979	Steve Knisely, "Controlling the CO_2 Concentration in the Atmosphere," Exxon internal document, Oct. 16, 1979, ID no. mqwl0228, Climate Investigations Center Collection, University of California, San Francisco, https://www.industrydocuments.ucsf.edu/fossilfuel/docs/#id=mqwl0228	440 (420 by 2050)
1981	Jeanne Anderer, Alan McDonald, and Nebojsa Nakicenovic, *Energy in a Finite World: Paths to a Sustainable Future* (Cambridge, MA: Ballinger)	400 (adopting Niehaus and Williams, "Different Energy Strategies")
1982	A. M. Perry et al., "Energy Supply and Demand Implications of CO_2," *Energy* 7, no. 12: 991–1004	460 (note: funded by the petrochemical company Union Carbide)
1983	David J. Rose, Marvin M. Miller, and Carson E. Agnew, *Global Energy Futures and CO_2-Induced Climate Change* (Cambridge, MA: Energy Laboratory, MIT)	420 (by 2050)

FIGURE 2.2. **Future scenarios describing fossil fuel production (*left*) and the resultant increase in global atmospheric CO_2 concentrations (*right*), presented to Exxon's Management Committee by company scientist James Black in July 1977. Even the relatively safe scenario presented by Black would allow CO_2 levels to nearly double and global warming to rise nearly 3°C.**



Source: J. F. Black to F. G. Turpin, letter and report (describing the presentation "The Greenhouse Effect," July 1977), Exxon internal documents, June 6, 1978, ID no. xqwl0228, Climate Investigations Center Collection, University of California, San Francisco (hereafter UCSF), https://www.industrydocuments.ucsf.edu/fossilfuel/docs/#id=xqwl0228, vu-graphs 3, 4.

level rise, and melting of the polar ice caps—potentially triggering "major increases in earthquakes and volcanic activity resulting in even more atmospheric CO_2 and violent storms" as well as an ice-free Arctic that would produce "major shifts in weather patterns in the northern hemisphere."[25]

Knisely also warned that unless limits were placed on emissions, "noticeable temperature changes would occur around 2010 as the concentration reaches 400 ppm" and that "significant climatic changes [will] occur around 2035 when the concentration approaches 500 ppm." Knisely predicted dire impacts in the United States at five hundred ppm: the Southwest would be hotter and drier and suffer water shortages, glaciers would melt in the Rockies and Pacific Northwest, snowpack would decline, and marine life would be "markedly changed." Without controls on fossil fuel production, preindustrial CO_2 would double by 2050, causing "dramatic climatic changes in the world's environment."[26] Knisely's predictions were remarkably accurate: CO_2 concentrations passed four hundred ppm in 2013, postdating his prediction by only three years.[27]

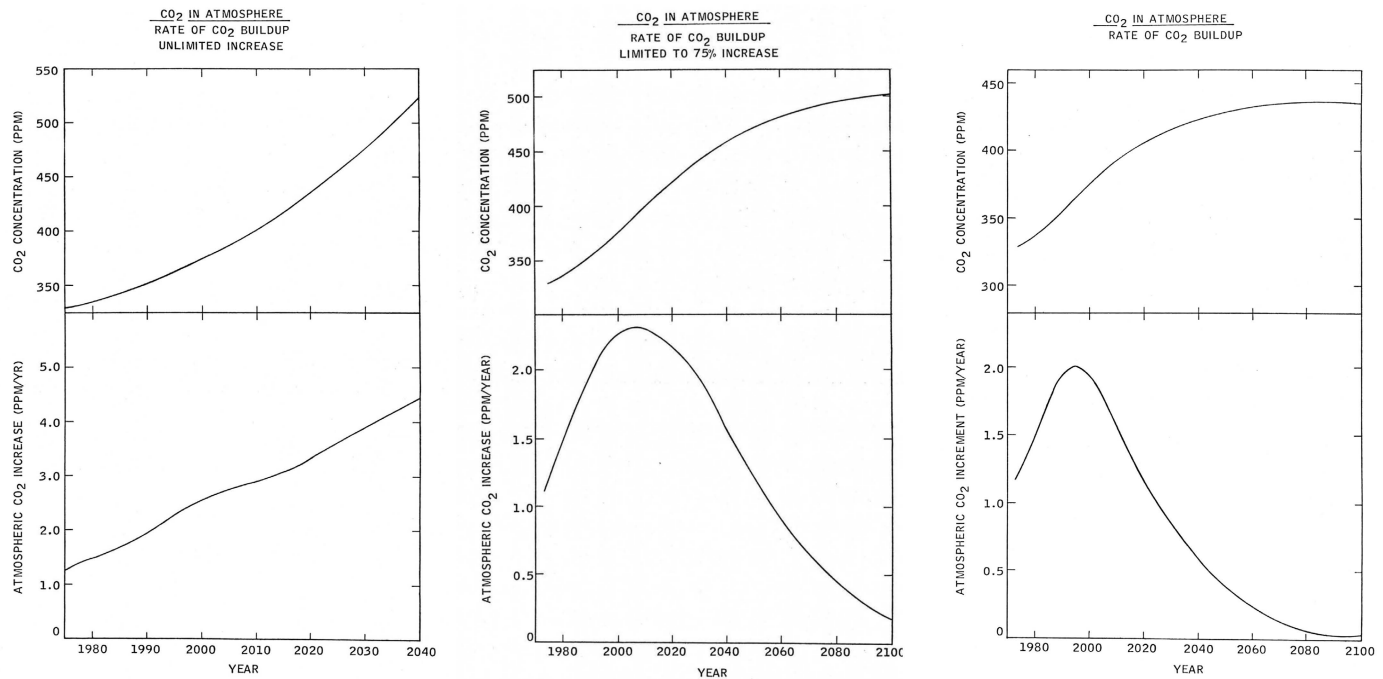
Could these outcomes be avoided? Knisely considered three future scenarios: one in which fossil fuels remained *uncontrolled*, a second in which the CO_2 buildup was limited to *510 ppm*, and a third in which CO_2 was limited to *440 ppm* (see fig. 2.3), which Knisely assumed to be "a relatively safe level for the environment." Knisely found that to achieve this last-mentioned safe concentration, non–fossil fuels would need to be substituted for coal in the 1990s and supply 50 percent of the world's energy by 2010. Neither shale oil nor coal (nor, by extension, tar sands) could remain or be developed as major energy sources. Carbon dioxide emissions would have to peak in the mid-1990s and decline thereafter, and most fossil fuel reserves would have to remain in the ground.[28]

In 1989, Royal Dutch Shell developed its own confidential scenarios describing possible global warming futures. In one scenario, called "sustainable world," greenhouse gas emissions would peak around the year 2000 and decline rapidly thereafter, with total CO_2 in the atmosphere limited to four hundred ppm. In another scenario, dubbed "global mercantilism," emissions would continue to rise with dire outcomes, including

> more violent weather—more storms, more droughts, more deluges. Mean sea level would rise at least 30 cm. Agricultural patterns would be most dramatically changed. Something as simple as a moderate change in rainfall pattern disrupts eco-systems, and many species of trees, plants, animals, and insects would not be able to move and adapt.
>
> The changes would, however, [have the] most impact on humans. In earlier times, man was able to respond with his feet. Today, there is no place to go because people already stand there. Perhaps those in industrial countries could cope with a rise in sea level (the Dutch example) but for poor countries such defences are not possible. . . . The potential refugee problem in GLOBAL MERCANTILISM could be unprecedented. Africans would push into Europe, Chinese into the Soviet Union, Latins into the United States, Indonesians into Australia. Boundaries would count for little—overwhelmed by the numbers. Conflicts would abound. Civilization could prove a fragile thing.[29]

Thus, like Exxon, Shell predicted that preventing catastrophe would require an immediate transition away from fossil fuels. What, though, about using carbon capture to enable the continued use of fossil fuels? Interestingly, Exxon considered and rejected this possibility early on. In 1981, Exxon Research and Engineering internally distributed the twenty-page *Scoping Study on CO_2*, which considered the possibility of using carbon capture technology (which already existed) to reduce emissions but concluded the approach wasn't economically feasible. "The cost of scrubbing large quantities of CO_2 from flue gases is exorbitant," the report stated, so much so that "indirect control measures, such as energy conservation or shifting to renewable energy sources, represent the only options that might make sense."[30]

FIGURE 2.3. Three scenarios for the future of CO_2 according to Knisely at Exxon in 1979: CO_2 concentration is unlimited from lack of fossil fuel controls (*left*); CO_2 is limited to 510 ppm through some fossil fuel controls (*middle*); CO_2 concentration is limited to 440 ppm through strong fossil fuel controls (*right*). Knisely's report demonstrates that Exxon knew by 1979 how to avoid or minimize a buildup of CO_2—by rapidly developing nonfossil energy sources and leaving most such fuels in the ground—and that immediate action was necessary to avoid severe global warming. Note: For each chart, the top shows atmospheric CO_2 concentrations, and the bottom indicates annual CO_2 emissions.



Source: Knisely, *Controlling the CO_2 Concentration*, figs. 11, 9, 7.

By 1980, then, leading fossil fuel manufacturers had taken notice of the most important facts about global warming and recognized that transitioning to renewables would be necessary, and largely sufficient, to solve the problem. Alternatives to replacing fossil fuels, such as carbon capture, were rejected as economically nonviable. And researchers both inside and outside the industry understood that each year of delay would result in additional unavoidable global warming and ever-greater damage. Conceptually, the cause and the cure were pretty straightforward.

BURYING THE MOST IMPORTANT FACT

The most important fact about global warming—that preventing it would require a rapid transition away from coal, oil, and gas—poses an existential threat to fossil fuel producers who, in the 1980s, set about not only denying the climate problem but also promoting the idea that global warming could be solved *without replacing fossil fuels*. In short order, any apparent solution to climate change that left fossil fuels intact would be championed by the industry, and a resultant flurry of false and inadequate solutions quickly came to infect climate discourse, research, and policymaking at all levels.

Although fossil fuel producers have *promoted* nearly every nonviable or inadequate solution to climate change developed over the past four decades—polluting the solutions landscape—not all these strategies *originated* with the industry. In other words, Big Carbon is not the only party responsible for distracting from the necessity of replacing fossil fuels. The treatment of climate change at the IIASA in the 1970s is a disconcerting example.

As described by historian Isabell Schrickell, the issue of global warming was introduced at IIASA around 1973, largely by William Clark (later a professor at Harvard) and Crawford Stanley Holling (a pioneer of ecological economics), both of whom spent their careers defining concepts such as "sustainability" and "socioecological resilience."[31] Also in the 1970s, a group of engineers, physicists, and economists at IIASA, including the economist William Nordhaus and the physicist Wolf Häfele, started promoting the idea of removing CO_2 and other industrial pollutants through ocean sequestration or recycling. The Italian physicist Cesare Marchetti, at IIASA since 1974, coined the term "geoengineering" to describe these processes. Meanwhile Clark, Holling, and their collaborators, including the economist Thomas Schelling, promoted adaptation and management, arguing that the fundamental problem was not fossil fuels per se but rather the "resilience" of human society. This is classic catarheumatics: don't prevent, just learn to cope.

These paradigms—which sought to adapt to or clean up pollution after the fact—shared a significant blind spot: the importance of preventing pollution in

the first place. Häfele and Nordhaus claimed that replacing fossil fuels would be too disruptive to society, and rather than promote the growth of renewables (which both men saw as unrealistic), they insisted on using recycling methods that never really worked (and still don't). The adaptations promoted by Clark and Schelling also let Big Oil off the hook. Their approach called not for the prevention of global warming, but rather for a vague and complex program of global management. Clark and Schelling did not seem to realize that more direct solutions were required, and their rejection of existing nascent solutions in favor of hopeful fantasies had the effect, intended or not, of maintaining the fossil fuel status quo.

Another obstacle can be found in Nordhaus's use of economic rhetoric to normalize the climate catastrophe. While searching for a market solution befitting his economic ideology, he speculated that a doubling of atmospheric CO_2 would be a reasonable target—and then tried to devise economic models to find the "optimal" path toward that outcome. Although his analysis used a lot of math, in reality, it ignored the warnings being issued by actual climate scientists. Equally myopic was a letter to the National Academy of Sciences submitted by a group chaired by Schelling focusing on the social and political aspects of global warming.[32] Schelling asserted that the best response to warming would not be fossil fuel replacement but rather mass human migration and adaptation to a new global climate system. He also exaggerated the uncertainty of the existing science and insisted that market forces would fix the problem. On crucial matters of fact, Schelling turned out to be catastrophically wrong: market forces have not fixed global warming, and his recommendations of human migration and adaptation carried cruel and potentially unlawful implications.

In 1983, the National Academy released a follow-up to the 1979 Charney report, which had issued strong warnings about global warming and implied the necessity of replacing fossil fuels.[33] The new report was chaired by William Nierenberg (then director of the Scripps Institution of Oceanography and later an outspoken climate sceptic) and included perspectives from Schelling and Nordhaus. Schelling insisted that "it would be wrong to commit ourselves to the principle that if fossil fuels and carbon dioxide are where the problem arises, that must also be where the solution lies." Nordhaus, for his part, wrote that while carbon emissions could be reduced by taxing fuels, the strategies suggested by Schelling, notably climate modification and adaptation, were "likely to be more economical ways of adjusting."[34] Yet neither economist presented evidence for those conclusions. As described by historians Naomi Oreskes and Erik Conway, a nuclear physicist who reviewed the report, Alvin Weinberg, at the time called it "seriously flawed in its underlying analysis and in its conclusions" and asked, presciently, "Does the Committee really believe that the

United States or Western Europe or Canada would accept the huge influx of refugees from poor countries that have suffered a drastic shift in rainfall pattern?" Yet these and other critiques were ignored, and the report was used by the Reagan White House to ignore calls by the U.S. Environmental Protection Agency to reduce coal use.[35]

This history shows that although, by 1980, multiple peer-reviewed studies—and Big Oil's own in-house research—pointed to the clear need to replace fossil fuels, this conclusion was muddied by complacent economists and others who insisted, with little evidence, that such replacement would not be necessary. And this muddying of the waters was successfully weaponized to keep the fossil fuel train hurtling forward.

Additionally, in a few short years, the global fossil fuel industry and its allies had developed a full suite of false solutions to keep fossil fuel controls at bay. Much of the strategic coordination within the industry was conducted through the International Petroleum Industry Environmental Conservation Association (IPIECA), a gassy giant created in the 1970s to help carbon producers interface with the UN Environment Programme (UNEP). In 1988, for example, at a meeting held at Total's headquarters in Paris, the IPIECA created the Ad Hoc Group on the Greenhouse Effect, soon renamed the Working Group on Global Climate Change. The working group was chaired by Duane LeVine, Exxon's manager for science and strategy development, with members including Bernard Tramier from the French oil giant Elf, Brian Flannery from Exxon, Leonard Bernstein from Mobil, Terry Yosie from API, and other representatives from BP, Shell, Texaco (now Chevron), and Saudi Aramco. The group had three goals: first, "to draw up the state of the science of climate change induced by the possible accentuation of the greenhouse effect, including the main areas of uncertainty"; second, to develop "no-regrets" response strategies that would keep fossil fuels intact; and, third, to examine "efficiency" and fossil gas as industry-friendly responses to global warming.[36]

In 1990, the IPIECA's working group sent materials on climate change to its dozens of member oil companies all around the world, including a strategy document created by Exxon's Duane LeVine. LeVine warned that international policymakers would soon seek to control fossil fuels the way they had recently controlled ozone-depleting chemicals and outlined a plan to ensure that any such effort would fail. To defeat policies that could shift "the energy resource mix" away from fossil fuels, LeVine explained that the industry should emphasize uncertainties in climate science while simultaneously calling for further research. Additional strategies were to portray the costs of climate controls as prohibitive and to promote industry-friendly solutions that would keep the oil and gas business intact. Using LeVine's strategy, the industry ensured that

the pollution-control approach used to solve the problem of ozone depletion—culminating in the Montreal Protocol in 1987—would stall when it came to climate and fossil fuels.

A key revelation from Exxon's strategy document is that by 1989, the promotion of false solutions had joined denial, the weaponization of uncertainty, and economic rhetoric as foundational strategies for prolonging the reign of fossil fuels. The first two false solutions identified by the industry were to promote efficiency and "natural gas" (fossil gas). And here we need to appreciate two fundamental realities of climate physics: (1) no amount of efficiency can solve the climate problem so long as the economy is based on fossil fuels, and (2) "natural gas" is just another fossil fuel—and just as carbon intensive as oil or coal when methane emissions are taken into account.

Reforestation would soon be added as a third industry-supported false solution. Shell's internal climate-scenarios report from 1989, for example, contains one of the earliest known proposals to use reforestation "offsets" to justify continued fossil fuel expansion. Near the end of that report, a boxed section urges "Don't Just Stand There. Plant A Tree," explaining that Applied Energy Services (a power company) was paying to plant some fifty-two million trees in Guatemala to justify building a new coal-fired power plant in Connecticut.[37] Shell even hoped to make money from this scheme, noting optimistically in an internal report from 1988 that if reforestation were adopted as a solution to global warming, "there would be some call on companies, including Shell, with experience in tropical forestry."[38]

The truth, however, is that much like efficiency, reforestation can never be adequate to counteract fossil fuel pollution. Trees only temporarily store carbon, which means that reforestation cannot counteract the long-term, quasi-permanent (on a human scale) climate contamination from fossil fuels. Reforestation cannot compensate for fossil-carbon pollution.

What we have to appreciate, then, is that by 1980, the most important fact about global warming—that preventing it would require a concerted replacement of fossil fuels—was well established. Crucial also to appreciate, however, is that ten years later, Big Carbon producers had successfully managed to obscure that fact by promoting three false and distracting solutions: fossil gas, reforestation, and efficiency. Contributing to the obfuscation were a number of prominent economists who had started (intentionally or not) protecting fossil fuel interests by insisting that adaptation, geoengineering, or trusting in price signals would be preferable to a focused development of non-fossil-energy systems. The success of this agnogenesis is reflected in the fact that in the text of the United Nations Framework Convention on Climate Change adopted in 1992, fossil fuels are mentioned only four times—each time, astonishingly, in order to *protect* their continued use.[39]

The industry's delay tactics since this time are familiar.[40] From 1989 to 1998, the carbon majors leaned heavily on denial, creating front groups, like the Global Climate Coalition, to dispute the scientific basis for global warming.[41] Oil producers also began hiring economic consultants as part of a strategy to exaggerate the costs of replacing fossil fuels and downplay the costs of global warming.[42] Around 1998 (when Big Tobacco faced hundreds of billions of dollars in legal liability for its own deceptions), however, we start to see an important shift in the carbon majors' public positioning on climate change. From that time forward, rather than disputing the scientific basis for warming, the companies began presenting themselves as partners in trying to solve the problem. As such, the promotion of false solutions took on heightened importance.

In the new millennium, more pseudo-solutions were added to the list, including carbon capture (not economically viable), hydrogen fuel (mostly made from fossil gas and itself an indirect greenhouse gas), biofuels (expensive, not scalable, and mostly composed of fossil fuel), solar geoengineering (potentially very risky), and a fixation on individual consumer habits (inadequate). These quickly became the subjects of industry-sponsored academic centers, advertising campaigns, and policy platforms, consuming years of public attention and delaying the deployment of demonstrably viable solutions, such as electrification (including of transport) and renewable power generation (mainly solar and wind).

Describing the full extent of Big Carbon's greenwashing and promotion of false solutions is beyond the scope of this chapter, but the industry's inroads into academia deserve special mention.[43] An internal plan formulated in 1998 by representatives from across the trade, including Exxon and Chevron, called for the support of industry-friendly scientists around the country—not crude climate deniers but rather mainstream academics aligned with Big Oil's delay-oriented positions, including the stalling-tactic that more research was needed before fossil fuel replacement could begin.[44] From that point on, Big Oil used its new ostensibly solutions-oriented position on climate change, together with the promise of corporate philanthropy, to gain sway over the scientific community (and, indirectly, the Intergovernmental Panel on Climate Change) and turn potential opponents into allies.[45] In 2000, for example, BP and the Ford Motor Company created the Carbon Mitigation Initiative at Princeton—now the university's "largest and most long-term industry-university partnership"—to study "carbon management" (not fossil fuel replacement).[46] Researchers from the new center helped develop an "all-of-the-above" climate policy that was promoted throughout the 2000s and 2010s to frame fossil fuels as part of the solution to global warming.[47]

Stanford University also became a major recipient of fossil fuel money. In 2002, Exxon founded the university's Global Climate and Energy Project, a multidecade $200 million–plus center that gave its funders (the majority of which

were corporate fossil fuel interests and all of which were chosen by Exxon) legal control over research projects. The project was directed first by petroleum engineer Lynn Orr and then by "ground fluids" engineer Sally Benson and spent much of its funding researching carbon capture and other industry-friendly responses to global warming.[48] Two years later, forestry and fossil fuel executive Ward Woods endowed Stanford's Woods Institute for the Environment, which would focus much of its attention on "natural climate solutions" (i.e., trying to engineer ecosystems to absorb CO_2) rather than fossil fuel replacement.[49]

In 2007, Chevron, BP, Total, and other fossil fuel companies founded the Massachusetts Institute of Technology (MIT) Energy Initiative, which subsumed much of the climate-related work at the institute and openly gave its funders significant influence over research directions. ExxonMobil, Saudi Aramco, Shell, and many other fossil fuel producers would soon join as sponsors of MIT's initiative, which was first directed by natural gas proponent Ernest Moniz and later by MIT's Chevron professor of chemical engineering Robert Armstrong. That same year (2007), BP created the Energy Biosciences Institute at the University of California, Berkeley, to promote biofuels as a solution to global warming under the direction of enhanced-oil-recovery microbiologist John Coates. And oil and gas executive Jay Precourt created the Precourt Center for Energy Efficiency at Stanford, directed by the Exxon-financed economist James Sweeney, which promoted fuel efficiency as the solution to climate change.

The trend would continue. In 2015, for example, a range of oil and gas companies established the Natural Gas Initiative at Stanford under the direction of industry-friendly economist Frank Wolak to promote fossil gas as a climate solution. And in 2018, ExxonMobil, Shell, and Total established Stanford's Strategic Energy Alliance, a continuation of the industry-funded Global Climate and Energy Project. Big Oil's patronage would also come to dominate many already-existing university research centers, including Stanford's Energy Modeling Forum, MIT's Earth Resources Laboratory and its Center for Energy and Environmental Policy Research, Princeton's Andlinger Center for Energy and the Environment, Columbia's Center on Global Energy Policy, and Harvard's Project on Climate Agreements. Harvard's Consortium for Energy Policy Research was similarly co-opted, as was its Environmental Economics Program, directed by the oil-friendly economists Robert Stavins and William Hogan.

Much like Big Tobacco's widespread funding of cancer research, which focused on causes *other* than cigarettes,[50] Big Oil has tended to fund work that keeps researchers busy without threatening the industry's bottom line. Much of that research has focused on promoting "solutions" that keep fossil profits flowing, including research into fossil gas, carbon capture, energy efficiency, hydrogen fuel, biofuels, "natural climate solutions" (such as reforestation), and "management" of or adaptation to a warming planet.

Emboldened by the credibility given it by funded academics, Big Oil has also promoted its pseudo-solutions through advertising. In the early 2000s, for example, the company once known as British Petroleum spent $100 million to rebrand itself as Beyond Petroleum, creating a green image for itself while continuing to funnel nearly all its investments into fossil fuels.[51] The company also popularized one of the most devious climate concepts of all time: the personal carbon footprint. Mirroring junk food producers blaming consumers for obesity, in 2006, the carbon giant proclaimed on its website that it was "time to go on a low-carbon diet" and encouraged consumers to use its "carbon footprint calculator."[52] The concept was brilliantly deceptive, deflecting blame onto consumers with scientific precision while simultaneously giving the company an aura of virtue—and guilt-tripping us all into an unwinnable quest to avoid poisoning the earth through personal choices.[53]

In 2007, Chevron launched its own advertising campaign, titled Will You Join Us?, depicting the company as an environmental leader and blaming global warming on individual consumer behavior. The company claimed that saving energy was equivalent to developing new sources of renewable energy; consumers were also encouraged to start "driving slower," with this upbeat admonition: "We've got a huge source of alternative energy all around us. It's called conservation. . . . Clearly, saving energy is like finding it. We've taken some of the steps needed to get started but we need your help to get the rest of the way." Ads such as these encouraged consumers to "join" Chevron in addressing climate change by making minor changes in their personal energy consumption. Everyday Americans were shown making promises, including, "I will use less energy," "I will leave the car at home more," "I will take my golf clubs out of the trunk and save gas," and "I will consider buying a hybrid."[54]

Three years later, in 2010, Chevron launched another ad campaign called We Agree, promoting fossil gas as a clean-energy source. One television ad, titled "Shale Gas Needs to Be Good for Everyone," featured a concerned citizen-farmer and a Chevron employee, where the farmer opens with, "We're sitting on a bunch of shale gas. . . . It's a game changer." Meanwhile a placard implores, "Let's do the right thing on shale gas." The farmer then says, "It means cleaner, cheaper, American-made energy." The farmer and the employee both tout the economic benefits of shale gas, and the employee then chirps, "At Chevron, if we can't do it right, we won't do it at all." Both then close by saying in unison, "We've got to think long term." In yet another Chevron ad, which aired in Australia in 2013, an older confident male "Chevron natural gas advisor" announces that Chevron is building "one of the biggest natural gas projects in the world. Enough power for a city the size of Singapore for fifty years." A young concerned female "web designer" then asks, "What's it going to do to the planet?" The Chevron rep patronizingly reassures her that fossil

gas "is the cleanest conventional fuel there is" and "the smart way to go" while both nod in agreement.[55]

In 2016, Shell launched its own campaign, called Make the Future, developed by the public relations giant Edelman. The campaign targeted "Energy-Engaged Millennials" (EEMs in Shell's internal documents), featuring pop icons, such as Jennifer Hudson, portraying the oil giant as a clean-energy leader. A leaked copy of one of the campaign's strategy documents shows that it sought to divert attention away from fossil fuels and place blame for global warming on all of society. Shell's campaign included "advertorials" (presented to look like news stories) in the *Washington Post* and *New York Times*, designed by those papers' in-house advertising companies, which touted liquified natural gas (LNG) as "sustainable," a "lower-carbon fuel, " and "part of a mosaic of alternative energy sources."[56]

ExxonMobil also joined the greenwashing party, placing misleading advertorials in the *New York Times*, many of which focused on the company's promotion of algae biofuels.[57] Exxon's ads didn't mention that most commercialized biofuels are, in reality, still mostly composed of fossil fuels with only a small amount of biological material blended in or the fact that from 2010 to 2018, the company spent only 0.2 percent of its capital investments in biofuels and other low-carbon energy systems (with the remaining 99.8 percent going to fossil fuels).[58] In 2023, Exxon ended its fourteen-year-old algae biofuels advertising campaign—seen by millions—without ever making an algae biofuel product.[59]

OBSTRUCTION AND OBFUSCATION

For the past quarter of a century, oil producers have falsely promoted themselves as leading the way in fixing global warming while normalizing fossil fuel expansion and steadily growing greenhouse gas emissions. The false solutions promoted by the industry—fossil gas, hydrogen, biofuels, carbon capture, carbon offsets, efficiency, and consumer choices—leave fossil fuel dominance intact. Some of the biggest names in public relations and print media, including Edelman and the *New York Times*, continue to help the industry with its deceptive advertising. Half a century after Big Oil could and should have begun moving toward clean-energy sources, fossil fuel expansion continues—under the cover of false solutions.

This is remarkable given that by 1980 the most important facts about global warming were understood, including what to do about it. Burning fossil fuels was understood as the main cause, and leaving them in the ground and replacing them with renewables was known to be the solution. Big Oil's response was to create a three-prong plan to defeat that process: weaponizing complexity

and scientific uncertainty, manipulating economics, and promoting false solutions. The industry largely abandoned overt climate denial in the late 1990s but dramatically expanded its promotion of pseudo-solutions, adding carbon capture, hydrogen fuel, biofuels, and consumer habits to its older promotion of efficiency, fossil gas, and carbon offsets. These distractions have helped occlude the fact that stopping global warming necessitates replacing fossil fuels.

Today, we remain awash in pseudo-solutions after decades of industry advertising and the infiltration of academia to legitimize them. Especially diabolical is that many of these false solutions seem to fit with traditional goals of environmentalists, such as protecting forests, reducing waste, and promoting personal responsibility. Yet none is adequate or viable as a solution to global warming. Indeed, these false paths have likely been supported by the industry precisely *because* they leave fossil fuel dominance intact. They are destined to fail while simultaneously portraying fossil fuel producers as responsible corporate citizens.

Arguably, false solutions have become even more important than climate denial as an obstacle to solving the climate crisis. The comparison with tobacco is closer than one might imagine given that, for decades, cigarette makers promoted false solutions to the cigarette catastrophe: first "toasting" and later menthols, filters, low tars, lights, and ultralights and then cigarettes advertised as "natural," organic, or additive-free. Cigarette makers sometimes even funded cancer research, with the idea being that curing cancer would allow the cigarette makers to keep on causing it. The cigarette denial campaign was really "a holding strategy,"[60] recognizing that every year of delaying the end of cigarettes would mean billions in profits for their makers. For Big Oil, too, the promotion of false solutions has replaced outright denial as its chief survival strategy. Sadly, this strategy of delay has often been aided by subservient academics and politicians and even some myopic environmental groups.

Counteracting this universe of false solutions will require scrutiny and perhaps even legal action. Vague promises of future progress in biofuels, hydrogen, carbon capture, and other technical fixes are inadequate and even dangerous insofar as they result in wasted time. Viable, proven solutions for replacing fossil fuels already exist, including solar and wind energy, electrification and electrical storage, and laws and economic incentives that can help us transition more rapidly toward those solutions. More than forty years after the most important fact about global warming was understood, we must stop looking for hope in all the wrong places and meet the fossil fuel disaster head-on.