

The Deep Dispute over "Deep Decarbonization"

It began as an academic argument over how the world could meet a goal of 90% reductions in carbon dioxide emissions by 2050, known as "deep decarbonization." Underneath the academic language is a fight among renewable energy advocates on the one hand and defenders of a role for conventional generating technologies, particularly nuclear, on the other.

Kennedy Maize

In late 2015 in Paris, most of the nations in the world, including the U.S., committed to taking measures to reduce carbon dioxide (CO₂) emissions enough to prevent a rise of global temperatures by 2 degrees Celsius (C). That meant stabilizing the atmospheric CO₂ concentration at 450 parts per million (ppm) or less.

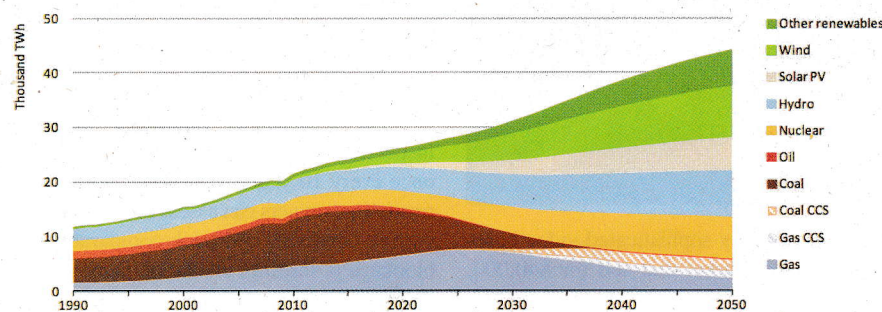
The Paris Agreement is remarkably obtuse, abstract, and difficult to parse. Its ambiguities, of course, allow the various national governments to agree to the goals without requiring countries to actually meet specific targets. The Obama administration even said it did not view its Paris commitments as a treaty, requiring Senate ratification, although it argued that the executive agreement had the strength necessary to succeed. The administration knew that a Republican-controlled Senate would not ratify the agreement as legally binding.

In the U.S., the agreement triggered a series of academic analyses aimed at figuring out how to reduce CO₂ emissions, both in the U.S. and across the globe, by 70% to 90% by 2050. That's a daunting—perhaps impossible—reach called "deep decarbonization."

Six European scientists outlined the magnitude of the task in an article published in the journal *Science* last March. Here's the heavy lifting required to hit the Paris target (Figure 1):

- Each decade, the world would have to cut CO₂ emissions from energy use in half. That may be easy from 2017 to 2020. It gets much tougher for 2020 through 2030, and even more difficult for 2040 through 2050. This requires enormous increases in energy efficiency, deployment of large-capacity and long-duration energy storage, and other energy technologies not yet known.
- Land use emissions from agriculture and

1. What will it take to make the Paris Agreement a reality? A core scenario proposed by the International Energy Agency (IEA) that would be compatible with limiting the rise in global mean temperature to 2 degrees Celsius by 2100 with a probability of 66% could require that renewables and other low-carbon technologies make up more than 80% of global installed capacity by 2050. The IEA's New Policies Scenario assumes climate pledges made as part of the Paris Agreement are fulfilled. *Courtesy: Chapter 2 of Perspectives for the energy transition—investment needs for a low-carbon energy system ©OECD/IEA 2017*



Note: TWh = terawatt-hours; CCS = carbon capture and storage.

deforestation would have to fall steadily to zero, while the world's population grows. Feeding a growing world with diminishing CO₂ emissions is a conundrum.

- Technologies to remove and store CO₂ (not including geoengineering, see sidebar), which only exist on a tiny scale today, would have to explode beyond any known growth pattern.

While the decarbonization goals ultimately may not be achievable, various hypothetical claims have emerged about how to meet them in a detailed way. The analyses of how to implement such deep cuts in CO₂ emissions have led to competing camps. On one side are advocates of 100% renewables to achieve deep CO₂ reductions. On the other are those who believe the claims of the 100% group are impractical and costly. They want to preserve technologies that are not just wind, solar, hydro, and biomass, but also nuclear, and fossil with carbon capture

and storage.

Pushing the "all-renewables" case is Stanford professor Mark Jacobson (Figure 2) and his "The Solutions Project," which says on its website (www.thesolutionsproject.org), "The world can transition to 100% clean, renewable energy." The project is funded by a range of renewable energy enthusiasts including the foundations of actor Leonardo DiCaprio and entrepreneur Elon Musk.

The Solutions Project "accelerates the transition to 100% clean, renewable energy for all people and purposes," according to its website. "To achieve this mission, we engage the public, celebrate and convene leaders, and advance partnerships and policies to make strides on the road to 100%. We implement this integrated model at the state level. To maintain our national reach, we develop inspired content, amplify stories and media, and create opportunities to celebrate and activate leadership across the country."

Is Geoengineering the Answer?

The competing scenarios of how to reach near-zero carbon dioxide (CO₂) emissions by 2050 all explicitly exclude geoengineering (see "Geoengineering: A Practical Climate Work-Around or Just Plain Crazy?" in the July 2014 issue of *POWER*). Many experts in the field dealing with how to respond to climate change view geoengineering with considerable skepticism.

The daunting task of reducing CO₂ emissions to near zero may require chemical and physical approaches that tackle the mechanisms that produce global warming, not just ways to reduce emissions in the first place. These include measures to prevent sunlight from hitting the planet, either blocking it or reflecting it back into space. A recent BBC broadcast said the world might need a "Plan B" for responding to global warming.

David Keith of Harvard's School of Engineering and Applied Sciences, a geoengineering guru, in a 2013-published book *A Case for Climate Engineering* (MIT Press, 2013), says: "Geoengineering complements emissions reductions. Cutting emissions reduces the long run risk by stopping the accumulation of carbon, while geoengineering—if it works as expected—will reduce risks in the short run (in the slow moving world of carbon and climate short run means the next half century)."

Keith was a speaker at a March 2017 "Forum on U.S. Geoengineering Research" at Washington's Carnegie Endowment for International Peace. Harvard's Solar Geoengineering Research Program and the Emmett Center on Climate Change and the Environment

at the University of California, Los Angeles, hosted the event. The Alfred P. Sloan Foundation funded it.

Among those suggesting a role for geoengineering as a decarbonization backstop is Jesse Jenkins, a doctoral candidate in engineering at the Massachusetts Institute of Technology who is affiliated with the Breakthrough Institute. "Whether we can reverse the atmospheric concentration or warming will depend on whether we can develop cost effective negative carbon technologies, carbon capture and storage and biomass, or even geoengineering to directly address warming," Jenkins said.

Geoengineering research also has deep-pockets backing it, including Microsoft founder Bill Gates, British billionaire Richard Branson, and Skype founder Niklas Zennstrom.

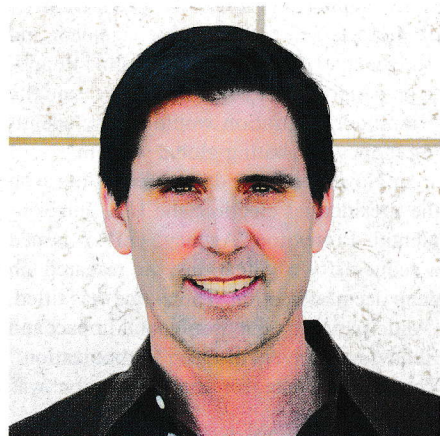
Many environmentalists oppose geoengineering technology as too risky. They argue that fooling around with the way the atmosphere responds to sunlight could change rainfall patterns and other weather features. They also say engineered approaches to fixing the climate could undercut emissions reductions programs. A 2010 United Nations resolution called for a moratorium on all but very small-scale geoengineering experiments.

Nevertheless, the daunting task of deep decarbonization could lead to climate engineering if the world definitively determines that a 2-degree-Celsius rise in global temperatures is an existential threat to the planet.

2. A renewables optimist. Mark Jacobson, a professor of civil and environmental engineering at the Stanford Woods Institute for the Environment, has developed roadmaps to transition states and countries to 100% renewable energy. *Courtesy: Stanford University*

"While many modelled scenarios have been published claiming to show that a 100% renewable electricity system is achievable, there is no empirical or historical evidence that such systems are in fact feasible."

—B.P. Heard, et. al. in *Renewable and Sustainable Energy Reviews*
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Jacobson's aggressive renewables agenda has sparked opposition. Opponents claim his analysis understates the problems of widespread reliance on intermittent and undispachable resources, and the need for widespread transmission construction. It also ducks the issue of how to provide ancillary grid services. The renewables-only strategy, the critics charge, requires massive

over-building of renewables in order to accommodate their low capacity factors.

"There are two branches of research on how to get deep decarbonization," Massachusetts Institute of Technology researcher Jesse Jenkins told Utility Dive. "One looks at how to get high renewables penetrations. The other looks at how to reduce [greenhouse gas emissions (GHGs)] in the power sector." The second group foresees diverse resources, not just renewables.

Jenkins is coauthor of a study with Samuel Thornstrom for the Energy Innovation Reform Project, which looks at the current literature on deep decarbonization. They conclude, "While it is theoretically possible to rely primarily (or even entirely) on variable renewable energy resources such

as wind and solar, it would be significantly more challenging and costly than pathways that employ a diverse portfolio of resources. In particular, including dispatchable low-carbon resources in the portfolio, such as nuclear energy or fossil energy with carbon capture and storage (CCS), would significantly reduce the cost and technical challenges of deep decarbonization."

So far, Jacobson's all-renewables argument is not making much progress beyond the activist community. In an article in the *Renewable and Sustainable Energy Reviews* journal, a group of four Australian scientists probed the deep decarbonization literature. They found, "While many modelled scenarios have been published claiming to show that a 100% renewable electricity system

is achievable, there is no empirical or historical evidence that such systems are in fact feasible."

The Roots of Deep Decarbonization

The United Nations Framework Convention on Climate Change (UNFCCC)—adopted in 1994 as a result of the 1992 "Earth Summit" in Rio de Janeiro, Brazil—started the world on the path to the 2015 Paris Agreement. Climate policy analyst Roger Pielke Jr. observed that the UNFCCC "serves as the overarching framework under which the Paris Agreement was negotiated. The UNFCCC has as its ultimate objective the 'stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.'"

Pielke offers the metaphor of a bathtub, with water flowing in faster than it flows out. He says the danger is that the water in the "metaphorical bathtub overflows and floods the house." When will that occur with regard to CO₂? Most experts target about 450 ppm, which could lead to a 2 degree C increase in global temperatures. Current National Oceanic and Atmospheric Administration estimates put the current level of CO₂ at about 400 ppm.

To prevent this concentration, global emissions (not just from the U.S.) must fall to close to zero. "Reducing global emissions by 20% or 40% or even 60% is not enough," Pielke writes, "just as reducing the rate at which water is flowing into a bathtub by those amounts would not end the risk of the tub overflowing. It would just delay the inevitable."

The UNFCCC, which won unanimous U.S. senate approval and the signature of President George H.W. Bush, led to interna-

tional negotiations in Japan in 1997, spearheaded by former Vice President Al Gore. The Kyoto Protocol, where developed countries pledged to meet legally binding emissions reductions, was the result. It was never ratified by the U.S. and was acknowledged as a worldwide failure, as was a 2009 conference in Copenhagen, Denmark, aimed at developing a more inclusive agreement. That led to the Paris conference in 2015. The Paris deal abandoned the legally binding policy illusion, calling on nations to make nonbinding, and in many cases hortatory, commitments to do something to prevent a 2-degree-C temperature increase. Specificity would come later.

That commitment ultimately requires the 90% global reduction of CO₂ emissions. "The world stands very far away from this level," writes Pielke. "According to the BP Statistical Review of World Energy, in 2014 more than 86% of the world's energy consumption came from fossil fuels.... From 1994 to 2014—a period under which the [UNFCCC] was in effect—the world's total energy consumption increased by 50%, but the proportion of that consumption from carbon-free sources increased only from 12.8% to 13.7%. At that rate, it will take about 1,700 more years for the world's energy supply to become more than 90% carbon free."

The Paris Agreement nations met in Marrakech, Morocco, in November 2016, just as U.S. voters elected climate skeptic Donald Trump as president. A group of Obama administration environmental staffers presented the Obama plan for implementing the Paris Agreement, even though it was clear that the election could derail the proposal. It was titled "United States Mid-Century Strategy for Deep Decarbonization."

The stillborn Obama plan said the U.S.

would reduce CO₂ emissions by 80% by 2050. Renewables would make up 55% of the energy supply, and nuclear 17%. The remaining 28% would be fossil-fueled energy, with 20% of that cohort using CCS. A "carbon price" with an unspecified mechanism to collect it would incentivize the U.S. private sector to cut its carbon dioxide emissions. Many skeptics viewed the outgoing administration's plan as impractical and costly.

Even then, the Obama plan said, the measures it proposed wouldn't be enough to achieve deep decarbonization, so the plan called for reforestation on a massive scale to suck CO₂ out of the air, more efficient use of cropland, and bioenergy with CCS. The price tag for the U.S. would be in the trillions of dollars by many estimates.

Decarbonization in the Trump Era

That Obama decarbonization plan was then. Donald Trump is now. What will a Trump administration mean for plans to slash U.S. (and worldwide) CO₂ emissions to the bone, at the expense of fossil fuels?

It doesn't look promising for those who want to see deep decarbonization, and particularly for those who want to see a 100% renewables future. While Trump has not rejected the Paris deal, he has made it clear he does not view global warming as a national or international problem.

During his campaign, Trump claimed, hyperbolically, that global warming is a hoax, invented by the Chinese to damage the U.S. economy. He also said his administration would revitalize the coal industry, while supporting domestic production of oil and gas. His Office of Management and Budget chief, former South Carolina Republican congressman Mick Mulvaney, said the Trump administration would not be spending money combating global warming.

In November, just days after Trump won the presidential election, the U.S. Environmental Protection Agency (EPA) issued a request for applications for research on deep decarbonization. The notice was titled, "Anticipating the Environmental Impact and Behavioral Drivers of Deep Carbonization." The closing date for the solicitation was February 10.

In typical bureaucratic verbosity, EPA said it "is seeking applications proposing research that will contribute to an improved ability to understand and anticipate the public health and environmental impacts and behavioral drivers of significant changes in energy production and consumption in the United States, particularly those changes associated with advancing toward the deep decarbonization necessary to achieve national

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—Roger Pielke Jr., climate policy analyst

and international climate change mitigation objectives and avoid the most significant health, environmental, and economic impacts of climate change.”

POWER requests to the EPA to comment

obtained by the E&E news site, from acting Chief Financial Officer David Bloom, said, “To provide additional clarity on priorities, as well as deliberation on options and impacts, I am asking you to provide details

the development of the budget request.”

The White House doesn’t determine the EPA’s budget. That’s a matter for Congress to determine. It’s unlikely that the draconian cuts that the Trump administration has signaled in its preliminary budget plan will persevere. But it is likely that a Republican legislature will cut the EPA budget significantly, and that the agency’s climate programs will be a major target.

Many experts say that U.S. CO₂ emissions will continue their recent steady decline, despite the intentions of the Trump administration to boost fossil fuels. That’s a function of bottom-up market forces, trumping any top-down initiatives from Washington. But the decreases won’t come close to the targets set in the Paris Agreement.

And that means deep decarbonization doesn’t have a realistic chance of implementation, at least not in the U.S. and probably not anywhere else. Those policies were a long shot before the Trump election. Since Trump’s ascent to the White House, deep decarbonization may have become a dead end. ■

—Kennedy Maize is a long-time energy journalist and frequent contributor to POWER.

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on the status of this project have not received a response. But it doesn’t look good for the future of the EPA initiative, given the Trump administration’s view of global warming and its desire to cut deeply into the EPA’s budget. An internal EPA memo,

on those activities that will be supported, reduced and eliminated at this level of funding relative to [fiscal year] 2016 activities. These responses will be provided to leadership for review and concurrence or follow on discussions, as appropriate, to support

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