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# Two Degrees of Freedom

## The world can still avoid dangerous global warming if it acts fast

*By Michael E. Mann*

**It is a steep hill** to climb if the world is to avoid warming the earth's surface by no more than two degrees Celsius (3.6 degrees Fahrenheit), the limit beyond which we will seriously harm the planet. That number is driving the commitments many nations will make at the 2015 United Nations climate change conference in Paris (COP21) to reduce their greenhouse gas emissions.

Yet some critics have declared that the so-called 2° C target is impossible, saying we cannot deploy the technologies needed to decarbonize the economy in time. But we can. The obstacle is not a physical one—it is one of political and societal will.

Nobody has said it will be easy. More than 70 climate experts who advised the U.N. Framework Convention on Climate Change said limiting global warming to below 2° C "necessitates a radical transition … not merely a fine tuning of current trends."

We can emit only 300 billion more tons (270 billion more metric tons) of carbon into the atmosphere and keep warming below 2° C. At the current emissions rate of more than 10 billion tons a year, we will burn through this "carbon budget" in just three decades. According to one recent analysis, staying below 2° C would require that a third of all proved reserves of oil, half of all natural gas and 80 percent of coal remain in the ground.

That's a big ask. It means we have to phase out coal now and walk away from most if not all the Canadian tar sands (good-bye, Keystone XL pipeline). It also means that we cannot burn increasing amounts of natural gas as a "bridge" to a cleaner climate future powered by renewable energy sources.

The 2° C threshold is often equated with keeping the atmospheric concentration of carbon dioxide below 450 parts per million (ppm). The challenge is made tougher as we use less coal. When it burns, coal releases sulfate aerosol particulates into the atmosphere that reflect some of the sun's incoming energy back into space. For a 2014 *Scientific American* article, "False Hope," I calculated that to compensate for the drop to zero sulfur emissions by the end of the century, we have to meet a $CO_2$ target of about 405 ppm—just slightly above current levels.

Can we do it? Climate scientist James E. Hansen has made a compelling case that we could pull 100 billion tons of carbon from the air by massive reforestation—limiting land use enough to allow forests to grow back to their extent before human deforestation. That, along with reducing carbon emissions by several percent a year, which is challenging but doable, could meet the 2° C stabilization target.

History is replete with preemptive declarations of infeasibility that proved misguided. As Joe Romm of the Center for American Progress said in response to climate critics, "Thank goodness these pundits weren't around when we had to do something *really* difficult, like suffer millions of casualties and remake our entire economy almost overnight to win World War II." An inspired agreement at the COP21 climate summit in Paris this month could kick-start an ambitious but entirely feasible effort.

The key factor is that there are technological innovations and economies of scale that emerge only in the course of actually *doing* something. The price of solar cells globally, for example, has dropped by more than 50 percent over the past several years as China has ramped up production. Those who say "no we can't" are engaging in self-fulfilling prophecy. The U.S. has never been a nation of no-we-canters.

Even with innovation and scaling up, we may at some point have to deploy "direct-air capture" technology, which pulls carbon dioxide out of the atmosphere. That would be expensive, but Klaus Lackner, an engineering professor at Arizona State University, is confident that the cost could be brought down to $30 a ton with volume manufacturing.

The cost of taking action is only half as much as the cost of inaction. This is not the conclusion of the Intergovernmental Panel on Climate Change. It comes from ExxonMobil, which has pegged the true cost of carbon to society at $60 a ton. Other estimates are even higher. Can we afford to stabilize planetary warming below two degrees C? We can't afford *not* to. SA

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