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Tracking Climate Progress:
A Guide for Policy Makers and the Informed Public

Roger Pielke Jr.*

International climate policy is incredibly complex. The field is highly technical and characterized by an esoteric jargon that is spoken by insiders who have dedicated their careers to the aim of coordinating an international response to the threats posed by the accumulation of greenhouse gases in the atmosphere. As a result, for many policy makers and the informed public, understanding climate policy can be a challenge. To help observers who may not be insiders to better understand climate policy, this essay presents a straightforward approach to tracking international (and national) progress with respect to the implementation of the Paris Agreement.

The objective of the Paris Agreement reached in December, 2015 is articulated in a single, 78-word run-on sentence that is difficult to parse.[1] The goal of the agreement is to be achieved by the implementation of "nationally determined contributions" which are expected to be built upon incrementally as steps toward the larger goal of the agreement. In the language of the agreement, each "successive nationally determined contribution will represent a progression beyond the Party's then current nationally determined contribution and reflect its highest possible ambition, reflecting its common but differentiated responsibilities and respective capabilities, in the light of different national circumstances."

This language is difficult to understand and digging even deeper in search of a precise understanding leads down a path of disaggregated national greenhouse gas targets and budgets, and for most observers, what might seem to be incomprehensible complexity. Fortunately, a detailed understanding of the mechanics of the Paris Agreement is not necessary to track how well it may be working.

A simplified approach to tracking climate progress begins with the Framework Convention on Climate Change, which came into effect in 1994 and serves as the overarching framework under which the Paris Agreement was negotiated.[2] The FCCC 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."

This objective can be thought of in terms of a bathtub. Humans are putting carbon dioxide into the atmosphere, mainly through the combustion of fossil fuels, at a rate that exceeds their removal. This is analogous to water filling a bathtub. The concern over "dangerous interference" is analogous to the level at which the water in our metaphorical bathtub overflows and floods the

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[1] The objective can be found in Article 4, paragraph 1: https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf

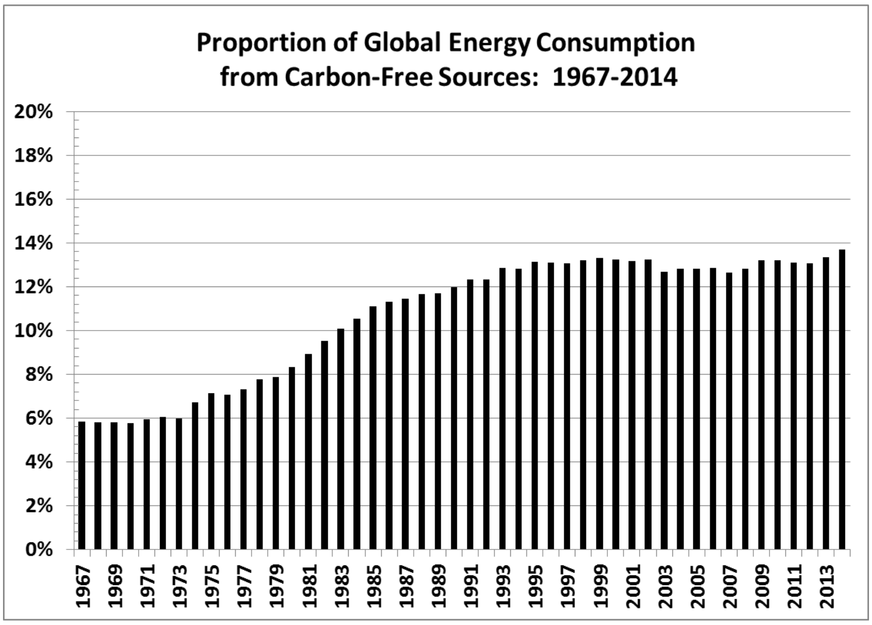
[2] http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf

house. Experts have debated where that level is, and the most commonly used thresholds are 450 parts per million (ppm) and 350 ppm carbon dioxide in the atmosphere.[3] In the language of international climate policy these concentration levels have been equated to global average temperature targets – 2 degrees C (450 ppm) and 1.5 degrees C (350 ppm).

The physics of a bathtub are simple. In order for the water to stop rising – to stabilize – and thus to eliminate the risk of the tub overflowing, the water entering the tub must stop flowing in. The physics of stabilizing carbon dioxide concentrations are essentially the same. In order for carbon dioxide concentrations to stabilize in the atmosphere at any level, the emissions of carbon dioxide from fossil fuels must fall to essentially zero.[4] The time that it takes for emissions to reach that low level will determine the ultimate stabilization level, such as 450 ppm.

The fact that emissions of carbon dioxide from the burning of fossil fuels must go to near zero helps to explain why the Paris Agreement focuses on the "ratcheting" of emissions reductions pledges. Reducing global emissions by 20% or 40% or even 60% is not enough, just as reducing the rate at which water is flowing into a bathtub by these amounts would not end the risk of the tub overflowing. It would just delay the inevitable.

The emissions of carbon dioxide from fossil fuels comes from three primary sources: coal, natural gas and petroleum. Since we know that emissions from these fuel sources must be reduced close to zero if the ultimate goal of the FCCC is to be achieved, this gives us a readily apprehensible way to evaluate progress with respect to the implementation of the Paris Agreement. In order for carbon dioxide concentrations to be stabilized in the atmosphere, the world will need to



[3] Sometimes these levels are expressed only in terms of carbon dioxide and at other times with other greenhouse gases added in. Here I focus on carbon dioxide, not because the other greenhouse gases do not matter, but because dealing with carbon dioxide is a necessary condition for international climate policy to succeed.

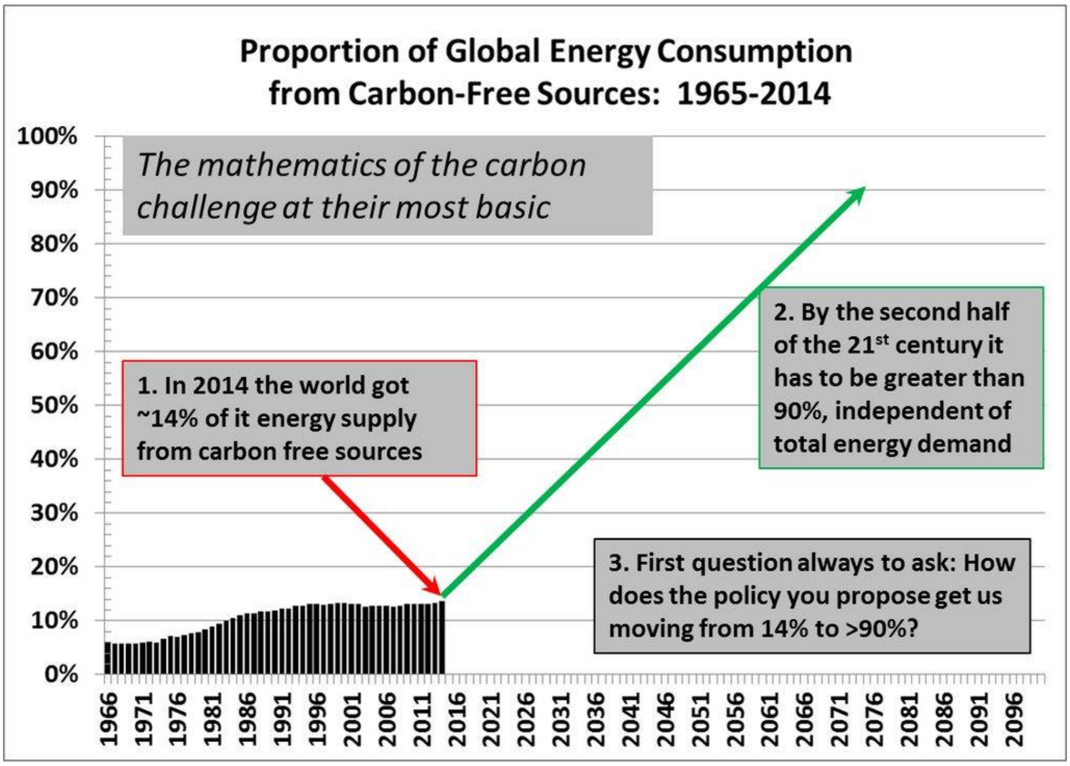
[4] I say "essentially" here because there are some complexities associated with the uptake of atmospheric carbon dioxide by plants, soils and the oceans. But these complexities don't change the bottom line conclusion that emissions must be reduced close to zero to achieve stabilization. For more details see Pielke, R. (2011). ***The climate fix: what scientists and politicians won't tell you about global warming***. Basic books.

secure more than 90% of its energy consumption from sources that do not emit carbon dioxide.

The world stands very far away from this level. According to the BP Statistical Review of World Energy, in 2014 more than 86% of the world's energy consumption came from fossil fuels. The amount of the world's total energy consumption that came from carbon-free sources from 1967 to 2014 can be seen in the figure above.

From 1994 to 2014 – a period under which the FCCC 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.

For the Paris Agreement to lead to progress toward the ultimate objective of the FCCC will require a pace of replacement of carbon intensive fuel consumption with that which is carbon free far in excess of that which has been observed over the past 20 years. The figure below provides simple summary of the implementation challenge.



The rate of change in carbon-free energy implied by a goal of achieving more than 90% of global energy consumption from carbon-free sources by 2100 is significant. In quantitative, linear terms the rate is an absolute increase in carbon-free energy of just under 1% per year. What does this mean in more readily accessible terms?

In 2014 the world consumed about 15,000 x 1.5 gigawatt power plants worth of energy, to use round numbers and a readily understandable energy metric. A 1.5 GW power plant is about the size of a modern nuclear power plant or alternatively 2,000 x 2.5 megawatt wind turbines operating at 30% efficiency. Of total global energy consumption, about 12,900 power plants-worth (i.e., 86%)

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was from fossil fuels. About 11,600 of these 12,900 will have to be replaced by 2100 if the total proportion of energy consumption from carbon-free sources is to exceed 90%.[5] That implies a linear rate of replacement of about 140 power plants per year worth of carbon-intensive energy consumption, every year until 2100.[6]

But the world is adding energy supply as well. From 2013 to 2014 the world added the equivalent of about 20 x 1.5 gigawatt power plants worth of carbon-free energy consumption.[7] This addition moved the overall percentage of carbon-free energy consumption from 13.3% to 13.7%. From 2013 to 2014 the world also added the equivalent of about 40 x 1.5 gigawatt power plants worth of fossil fuel consumption.[8] The implication here is that – at the 2014-2015 rate of growth in energy consumption – the world needs to deploy more than 50 x 1.5 gigawatt power plants worth of carbon-free energy every year from now until 2100, in order to achieve greater than 90% carbon-free energy by the end of the century.[9]

Adding the replacement and new build numbers together, the bottom line is that the world needs to deploy about 190 x 1.5 gigawatt power plants worth of carbon-free energy every year from now until 2100, or the equivalent of one nuclear power plant or 200 wind turbines being deployed somewhere in the world every-other day.[10] Progress in such deployment can be tracked by simply looking at the global proportion of carbon-free energy consumption as represented in the figure above. Assumptions can easily be varied, but the conclusion will be qualitatively similar regardless.

The proportion of global energy consumption from carbon-free sources provides a readily understandable and easily tracked metric with respect to progress in the implementation of the Paris Agreement on climate change. Today, that percentage is less than 14%. By the end of the century it needs to be greater than 90% if the ultimate objective of the FCCC is to be achieved. Such an approach to tracking progress can be readily applied at national levels as well. The scale of the challenge is incredibly daunting, but the first step in confronting a policy challenge is to know what success requires and how progress is to be measured.

Writer's Profile

Roger Pielke Jr.

He served as Director of the Center for Science and Technology Policy Research at the University of Colorado Boulder from 2001 to 2007 and from 2013 to 2016. He was a visiting scholar at Oxford University's Saïd Business School in the 2007-2008 academic year. His interests include understanding the politicization of science; decision making under uncertainty; policy education for scientists in areas such as climate change, disaster mitigation, and world trade; and professional sports. In 2011 began to write and research on the governance of sports organizations, including FIFA and the NCAA, and today directs a newly established Sports Governance Center in the University's Athletics Department.

5 Math: 12,900 * 90% = 11,610

6 Math: 11,600 / 84 = ~138

7 According to BP the net addition of carbon-free consumption was 66.6 million tonnes of oil equivalent, which equates to about 2.6 quads, which equates to about 20 x 1.5 gigawatt power plants. See The Climate Fix for more details.

8 According to BP the total increase in consumption was 247.2 million tonnes of oil equivalent.

9 Math: 2014-2015 consumption increase of 20 + 40 = 60, and 60 * 90% = 54

10 In The Climate Fix I concluded that a nuclear power plant was needed every day, that is because I used 750 MW nuclear power plants as my measuring stick in that analysis.

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