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Climate Change Mitigation and Decarbonization

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BLANK ROME LLP SYMPOSIUM DECARBONIZATION: A NEW DIRECTION IN CLIMATE CHANGE POLICY?

CLIMATE CHANGE MITIGATION AND DECARBONIZATION

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I. INTRODUCTION

The great majority of climate policymakers and their expert advisors focus on how much annual greenhouse gas discharges (GHGs) can be curtailed by setting multi-decade emissions-reduction targets and implementing regulatory programs or market-based economic incentive systems to attain the targeted cuts. These conventional emissions-reduction programs focus on what percentage of annual GHG emissions *should be reduced slowly* over the next several decades.

In contrast, the critical issue is how much heat-trapping greenhouse gas pollution will be allowed to reach the atmosphere as a result of the conventional emissions-reduction programs' limited targets and extended timeframes. The effectiveness or ineffectiveness of emissions-reduction programs is a function of how much GHG emissions *will not be eliminated* under each regulatory approach, and instead will reach the atmosphere and combine with the already-too-high concentration of greenhouse gases in the air to exacerbate climate change dangers. The central concern is not how much annual GHG discharges can be reduced by conventional emissions-reduction programs, but how much of the remaining un-

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regulated GHGs will be allowed to contaminate the atmosphere, while the cumulatively increasing GHG concentrations cause greater climate change risks and damages.

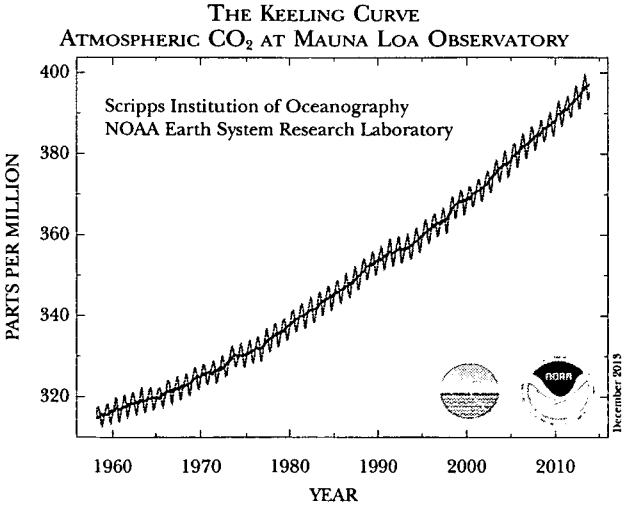
For example, on June 25, 2013, President Obama gave an inspirational speech on climate change mitigation and adaptation that proposed setting a 17 percent emissions-reduction target for GHG discharges by 2020, when compared with the 2005 baseline emissions level.[1] Several commentators called this an "ambitious" pollution-control commitment.[2] Even if this emissions-reduction target could be fully met, what about the remaining 83 percent of unregulated GHG discharges from American sources that will be allowed to pollute the air each year up to 2020 and thereafter under this regulatory proposal? What about the increasing climate change dangers that will result from consistently increasing the cumulative atmospheric GHG concentration?

Before discussing this fundamental problem in greater depth, it is important to show that climate change risks are indeed growing worse as the atmospheric GHG concentration is increasing.[3] 2012

1. President Barack Obama, Remarks at Georgetown University on Climate Change (June 25, 2013) [hereinafter *Obama's Climate Change Speech*] (transcript available at http://www.whitehouse.gov/the-press-office/2013/06/25/remarks-president-climate-change).

2. *See, e.g.*, Paul Krugman, *Invest, Divest and Prosper*, N.Y. TIMES (June 27, 2013), http://www.nytimes.com/2013/06/28/opinion/krugman-invest-divest-and-prosper.html; Mark Landler & John M. Broder, *Obama Outlines Ambitious Plan to Cut Greenhouse Gases*, N.Y. TIMES (June 25, 2013), http://www.nytimes.com/2013/06/26/us/politics/obama-plan-to-cut-greenhouse-gases.html?_r=0.

3. Dr. Peter Tans & Dr. Ralph Keeling, *Trends in Atmospheric Carbon Dioxide*, NOAA (Dec. 2013), http://www.esrl.noaa.gov/gmd/ccgg/trends/. The Keeling Curve shows that the CO_2 concentration in the atmosphere is steadily growing:



was the hottest year since the systematic recording of US temperatures began in the 1880s.[4] 2010 and 2005 were tied for the previous record,[5] and all 10 of the hottest years on record have occurred since 1998.[6] During 2012, many American states experienced the worst drought since the dustbowl years of the Great Depression,[7] leading to billions of dollars in crop losses and reduced cargo transport on the Mississippi River caused by unusually low river levels.[8] Hurricane Sandy created losses to the US people and economy of more than 50 billion dollars, at least partly as a result of higher sea levels, stronger wave surges, and greater energy absorbed from warmer ocean waters as a result of global warming.[9] Higher than normal temperatures in 2012 also induced destructive heatwaves[10] and wildfires,[11] and increased the frequency of tornados across much of the central US.[12]

Id.

4. Christopher F. Schuetze, *2012: The Year of Extreme Weather*, N.Y. TIMES (Jan. 14, 2013), http://rendezvous.blogs.nytimes.com/2013/01/14/2012-the-year-of-extreme-weather/.

5. Justin Gillis, *Figures on Global Climate Show 2010 Tied 2005 as the Hottest Year on Record*, N.Y. TIMES (Jan. 12, 2011), http://www.nytimes.com/2011/01/13/science/earth/13climate.html?_r=0.

6. *See* John M. Broder, *Past Decade Warmest Ever, NASA Data Shows*, N.Y. TIMES (Jan. 21, 2010), http://www.nytimes.com/2010/01/22/science/earth/22warming.html.

7. John Eligon, *Drought Leaves Cracks in Way of Life*, N.Y. TIMES (Oct. 3, 2012), http://www.nytimes.com/2012/10/04/us/widespread-drought-threatens-way-of-life-for-farmers.html?pagewanted-all.

8. Monica Davey, *In Midwest, Drought Gives Way to Flood*, N.Y. TIMES (Apr. 25, 2013), http://www.nytimes.com/2013/04/26/us/in-midwest-drought-abruptly-gives-way-to-flood.html?partner=rss&emc=rss.

9. *See, e.g.*, WORLD BANK, TURN DOWN THE HEAT: WHY A 4° WARMER WORLD MUST BE AVOIDED, 5, 21, 27-31, 33 (Nov. 2012), *available at* https://openknowledge.worldbank.org/handle/10986/11860; *Climate Change Indicators in the United States*, ENVTL. PROT. AGENCY, 5, 21, 33 (Apr. 2010), http://www.epa.gov/climatechange/pdfs/CI-full-2010.pdf.

10. John Eligon & Marc Santora, *Unrelenting Heat Wave Bakes All in Its Reach*, N.Y. TIMES (July 7, 2012), http://www.nytimes.com/2012/07/08/us/temperatures-soar-as-heat-wave-continues.html?_r=1.

11. Barbara Marquand, *The 10 Costliest US Wildfires*, MSN MONEY, http://money.msn.com/home-insurance/the-10-costliest-us-wildfires (last visited Sept. 25, 2013); *see also* Steve Gorman, *Southern California Wildfire Forces Evacuation of Mountain Resort*, REUTERS (July 18, 2013), http://www.reuters.com/article/2013/07/18/usa-fire-california-idUSL1N0FO03O20130718; Jack Healy, *Toll of Homes Destroyed in Colorado Wildfire Rises to Hundreds; 2 Bodies Found*, N.Y. TIMES (June 13, 2013), http://www.nytimes.com/2013/06/14/us/colorado-wildfire-destroys-hundreds-of-homes.html?partner=rss&emc=rss.

12. Donald A. Brown, *Why Ethics Requires Acknowledging Links Between Tornadoes and Climate Change Despite Scientific Uncertainty*, PENN ST. U., ROCK ETHICS INST. (May 31, 2011), http://sites.psu.edu/rockblogs/2011/05/31/why-ethics-requires-acknowledging-links-between-tornadoes-and-climate-change-despite-scientific-uncertainty/.

This is only a partial list of the severe harms American society has already suffered as a result of climate change, and the recent damages in other nations may have been even greater. It is vital to emphasize that climate change is not only a future danger, but a complex combination of shifting environmental and climate conditions that are already creating a wide spectrum of dangers for human beings and nature. As Barack Obama remarked during his first presidential campaign: "We cannot afford more of the same timid politics when the future of our planet is at stake. Global warming is not a someday problem, it is now."[13]

If only the President had been able to act effectively on this comment, instead of merely stating it. During his first term in office, the Obama Administration was unable to overcome hostile partisanship on climate issues and accomplished very little in various attempts to limit climate change hazards except to require fairly significant improvements by 2025 in the fuel efficiency of new motor vehicles.[14] Yet, despite the absence of widespread political support, President Obama devoted considerable attention to climate change problems in his January 2013 Second Inaugural Address.[15] Among the President's climate concerns, he stated:

> We, the people, still believe that our obligations as Americans are not just to ourselves, but to all posterity. We will respond to the threat of climate change, knowing that the failure to do so would betray our children and future generations. Some may still deny the overwhelming judgment of science, but none can avoid the devastating impact of raging fires, and crippling drought, and more powerful storms. The path towards sustainable energy sources will be long and sometimes difficult. But America cannot resist this transition. We must lead it.[16]

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13. Barack Obama, Remarks in Portsmouth, New Hampshire: Real Leadership for a Clean Energy Future (Oct. 8, 2007), (transcript available at http://www.presidency.ucsb.edu/ws/index.php?pid=77016).

14. *See EPA and NHTSA Set Standards to Reduce Greenhouse Gases and Improve Fuel Economy for Model Years 2017-2025 Cars and Light Trucks*, ENVTL. PROT. AGENCY (Aug. 2012), http://www.epa.gov/otaq/climate/documents/420f12051.pdf [hereinafter *EPA Motor Vehicle Regs*].

15. Richard W. Stevenson & John M. Broder, *Speech Gives Climate Goals Center Stage*, N.Y. TIMES (Jan. 21, 2013), http://www.nytimes.com/2013/01/22/us/politics/climate-change-prominent-in-obamas-inaugural-address.html?_r=0.

16. Andrew C. Revkin, *Obama's Chance for a Fresh Start on a Climate-Smart Energy Quest*, N.Y. TIMES (Jan. 21, 2013), http://dotearth.blogs.nytimes.com/2013/01/21/obamas-chance-for-a-fresh-start-on-a-climate-smart-energy-quest/?partner=rss&emc=rss (quoting President Barack Obama).

A month later, in his 2013 State of the Union Address, President Obama announced in an uncharacteristically combative manner:

> I urge this Congress to get together, pursue a bipartisan, market-based solution to climate change, like the one John McCain and Joe Lieberman worked on together a few years ago. But if Congress won't act soon to protect future generations, I will. I will direct my Cabinet to come up with executive actions we can take, now and in the future, to reduce pollution, prepare our communities for the consequences of climate change, and speed the transition to more sustainable sources of energy.[17]

In the aftermath of Hurricane Sandy the Governors of New York and New Jersey, Andrew Cuomo and Chris Christie, and the Mayor of New York City, Michael Bloomberg, attributed much of the storm damage to climate change.[18] However, the fact that some prominent US political leaders are beginning to acknowledge the diverse risks from increasing climate change does not mean that these policymakers are now funding and implementing effective solutions for climate change dangers.

This paper compares three different mitigation strategies intended to reduce climate change risks. The first strategy has achieved widespread consensus support among many American and international leaders and most expert advisors concerned with climate change issues. This mitigation approach relies on multi-decade GHG emissions-reduction programs to reduce annual greenhouse gas discharges gradually by some percentage and ostensibly to cut related climate change impacts. The consensus emissions-reduction programs would progressively but slowly tighten permissible GHG discharge rates, with limited cutbacks during the

17. President Barack Obama, *Remarks by the President in the State of the Union Address*, WHITE HOUSE (Feb. 12, 2013) [hereinafter *2013 State of the Union Address*] (transcript available at http://www.whitehouse.gov/the-press-office/2013/02/12/remarks-president-state-union-address).

18. *See, e.g.*, Jon Alexander, *Governor: We Must Prepare Infrastructure for Changing Climate*, POSTSTAR.COM (June 29, 2013), http://poststar.com/news/local/governor-we-must-prepare-infrastructure-for-changing-climate/article_29f0d7b8-e11c-11e2-abfe-0019bb2963f4.html; Mylique Sutton, *Mayor Bloomberg Unveils Climate Change Strategy For New York City*, CITY&STATE (June 11, 2013), http://www.cityandstateny.com/bloomberg-unveils-climate-change-strategy-for-new-york-city/; *see also* Patricia Levi, *Hurricane Sandy Climate Change: Andrew Cuomo Rightly Raises Global Warming Issue*, POLICYMIC, http://www.policymic.com/articles/17930/hurricane-sandy-climate-change-andrew-cuomo-rightly-raises-global-warming-issue (last visited July 29, 2013); Christopher Baxter, *Gov. Christie Admits Climate Change is a Real Problem, That Human Activity Plays a Role*, NJ.COM (Aug. 19, 2011), http://www.nj.com/news/index.ssf/2011/08/gov_christie_admits_climate_ch.html.

first 40 years followed by more ambitious GHG pollution-control restrictions after 2050. This conventional mitigation approach also includes various economic incentive mechanisms, such as cap-and-trade, carbon offset systems, and carbon taxes that in theory would gradually reduce the authorized number of GHG allowances, offsets, or pollutant discharges over several decades.

Examples of support for this conventional emissions-reduction approach include the specific commitments in President Obama's June 25, 2013 speech; the Obama Administration proposals at annual international conferences on climate change;[19] and a number of congressional bills during the past decade, including the McCain-Lieberman Climate Stewardship Act,[20] the Lieberman-Warner Climate Security Act,[21] the Waxman-Markey American Clean Energy and Security Act,[22] and the Kerry-Lieberman American Power Act.[23] None of these bills was able to attain sufficient congressional support to be adopted into law, but they all shared the same basic methodology of setting multi-decade GHG emissions-reduction targets to be implemented through market-based cap-and-trade and offset systems. In his 2013 State of the Union Address, as quoted above, President Obama called for a "market-based solution to climate change" and he cited the bipartisan McCain-Lieberman bill of 2003, with its cap-and-trade provisions, as a positive example.

On an international plane, the Kyoto Protocol[24] and European Union's Emissions Trading Scheme (ETS) – the world's largest carbon-based cap-and-trade system – incorporate similar multi-decade GHG emissions-reduction programs that will not impose stringent pollution control targets until several decades later. These long-term GHG emissions-reduction programs and proposals have created substantial mitigation delay on both sides of the Atlantic Ocean, which is convenient for present-day politicians who can avoid making hard choices with high regulatory costs and unpleasant social consequences; and deliberate delay is also convenient for

19. HOWARD A. LATIN, CLIMATE CHANGE POLICY FAILURES: WHY CONVENTIONAL MITIGATION APPROACHES CANNOT SUCCEED 4 (World Scientific Publishing Co. 2012) [hereinafter LATIN, CLIMATE POLICY FAILURES].

20. Climate Stewardship Act of 2003, S.139, 108th Cong. (2003).

21. Lieberman-Warner Climate Security Act of 2007, S. 2191, 110th Cong. (2007).

22. Waxman-Markey American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong. (2009).

23. The American Power Act (Discussion Draft), S. 1733, 111th Cong. (2010).

24. Kyoto Protocol to the United Nations Framework Convention on Climate Change, Mar. 16, 1998 – Mar. 15, 1999, U.N. Doc FCCC/CP/1997/7/Add.1, 37 I.L.M. 22 (1998), *available at* http://unfccc.int/kyoto_protocol/items/2830.php.

polluting businesses that can minimize costly GHG clean-up measures for years. On the other hand, the largely irreversible delay resulting from multi-decade GHG emissions-reduction programs is not convenient for the billions of human beings on Earth who are increasingly vulnerable to a broad spectrum of severe climate change dangers.

In 2012, I published a book, CLIMATE CHANGE POLICY FAILURES: WHY CONVENTIONAL MITIGATION APPROACHES CANNOT SUCCEED,[25] which challenged the multi-decade GHG emissions-reduction consensus and explained in detail why these programs could not succeed in overcoming global climate change whether the mitigation initiatives rely on regulatory mandates or on market-based programs. Part II of this paper offers a brief summary explanation of the core weaknesses of the multi-decade GHG emissions-reduction approach. The central weakness of the consensus multi-decade GHG emissions-reduction programs, whether they are adopted in the form of direct regulatory standards, cap-and-trade and carbon-offset economic incentive systems, or international treaty negotiations, is that these programs would allow vast quantities of GHGs to be discharged into the atmosphere during the next several decades.

Part II argues that all of the consensus emissions-reduction programs and proposals would allow too much GHG pollution to reach the atmosphere for too long a timeframe.[26] I have not found a single emissions-reduction program that has set a target of reducing even half of their nation's annual GHG discharges before 2050. Correspondingly, this means that all of the consensus emissions-reduction programs would allow more GHGs to reach the atmosphere than they would curtail in the next four decades. The only thing that could be said in their favor is that they might be marginally better than no GHG regulation at all. However, "better than nothing" is not good enough to attain tangible climate change progress.

Part III of this essay criticizes current and proposed Environmental Protection Agency (EPA) greenhouse gas pollution-control standards and other EPA regulatory policies that are intended to curtail annual GHG discharges by rigidly following the procedural and structural requirements of the Clean Air Act of 1970 (CAA).[27] In 2007, the US Supreme Court held in *Massachusetts v. EPA*[28] that

25. *See* LATIN, CLIMATE POLICY FAILURES, *supra* note 19, at 19-53.
26. *See id.*
27. Clean Air Act, 42 U.S.C. §§ 7401-7642 (2012).
28. 549 U.S. 497 (2007).

the CAA requires EPA to regulate greenhouse gases if they endanger human health or welfare. The EPA did issue a "finding of endangerment" two years later[29] under the newly-elected Obama Administration, and as a result the Agency became obligated to develop GHG regulations that would confront and eventually overcome this "endangerment." Since then, regrettably, EPA has not even come close to creating strong GHG regulations that would actually lessen growing climate change dangers, and there are no suitably ambitious and promising EPA mitigation initiatives on the horizon.

Regulatory mitigation measures that might have a realistic chance of reducing worldwide or nationwide GHG discharges and resulting climate change dangers must be different from the pollution-control standards and ambient air quality standards imposed on other kinds of air pollution discharges under the CAA. EPA's attempts to rely almost entirely on previous CAA regulatory precedents to impose equivalent GHG emissions-reduction requirements will not be able to limit the critical accumulation of greenhouse gases in the atmosphere. It is hard to overstate the mistakes and confusions arising from EPA's plan to apply various CAA provisions reflexively in the extremely different greenhouse gas context.

Part IV of the paper focuses on the mitigation strategy of "decarbonization" recommended in my recent climate change book. This term has been used by some commentators to describe any emissions-reduction method that would sharply reduce GHG discharges in any way; but I have narrowed the meaning of the term to an approach that would shift the primary mitigation initiatives and investments from a multi-decade GHG emissions-reduction strategy to a *"clean" GHG-free replacement-technology* strategy. The best, and probably only, way to reduce GHG discharges *enough* to avoid increasing cumulative atmospheric GHG levels with growing climate change risks is to eliminate the major sources of greenhouse gas pollution as rapidly as feasible by replacing them with GHG-free or very-low-GHG technologies, processes, and methods.

Rather than retaining "dirty" fossil fuel technologies that discharge large amounts of GHGs each year, and trying to control climate change hazards by making the GHG sources a little "more efficient" or a little "less harmful" over a long period of time, we should put our foremost mitigation efforts and investment dollars

29. EPA, Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 18,886, 18,895 (proposed Apr. 24, 2009).

into creating clean GHG-free replacement technologies and practices capable of maintaining or improving current standards of living without continuing to degrade the Earth's climate. This form of decarbonization is not a perfect solution – there are none – but it aims to maintain or improve economic welfare while reducing the climate change vulnerability of countless people in developing and developed countries. I believe this approach can function reasonably effectively, not perfectly, without requiring unrealistic lifestyle modifications or unwelcome economic sacrifices by billions of people endangered by global climate change risks.

A central point emphasized throughout this paper, and especially in the criticisms of the EPA proposed regulations, is that we cannot afford to waste large-scale administrative resources and trillions of investment dollars on developing multi-decade mitigation programs that are only a "little better than nothing," and are not strong enough to produce substantial climate change benefits. We must not adopt ineffectual interim, provisional, or counter-productive mitigation measures at high costs under the illusion that we will always be able to change course in the future. If we do not choose effective and affordable GHG-free replacement technologies in the next couple of decades, the cumulatively increasing GHGs in the atmosphere and the high persistence of the most common greenhouse gas, carbon dioxide (CO_2), will almost certainly ensure a disastrous future that cannot be avoided, undone, or remedied for many centuries or millennia to come.

Most people concerned with these issues recognize that "time is of the essence" for viable climate change solutions. We will not be able to turn back the clock if we choose to rely on ineffectual multi-decade GHG emissions-reduction programs or other regulatory mitigation programs that cannot succeed in overcoming climate change problems within a relatively short timeframe. By "overcoming climate change," I do not mean eliminating all greenhouse gas emissions, which would be impossible. Rather, what is required is cutting *enough* GHG emissions in *enough* ways to reach the point at which the natural sinks – the oceans, forests, and other vegetative matter – can absorb a sufficient volume of the remaining GHGs to return to a lower GHG concentration in the atmosphere that does not create disastrous climate change risks. More than wasted money and futile regulatory efforts are at stake now because the economic and social welfare, and possibly the survival, of a significant proportion of the human race will be at risk as a consequence of the on-going accumulation of heat-trapping greenhouse

gases in the atmosphere if we fail to implement an effective climate change mitigation solution.

II. GHG STOCKS AND FLOWS

In May 2013, several scientific organizations announced that the growing concentration of carbon dioxide in the atmosphere, the leading cause of global warming and climate change, rose above 400 parts of CO_2 per million parts of air[30] for the first time in millions of years.[31] The Club of Rome recently cited scientific predictions: "that even limiting global warming to 2° C could eventually produce sea level rises of up to 6 to 7 meters (23 feet), wiping out coastal cities like New York, London, Shanghai and Tokyo" and they warned: "if we continue with current policies, temperatures could rise 4°C or more, leading to sea level rises of up to 70 meters (230 feet)."[32] Even if these particular predictions prove somewhat excessive, the world's developed nations and large developing states continue to expand their GHG discharges,[33] which scientists have predicted may reach irreversible "tipping points" leading to disastrous human and environmental damages for centuries or longer.[34]

The basic straightforward explanation for the crucial greenhouse effect, global warming, and climate change is that they are caused by the retention of excess heat-trapping gases in the atmosphere.[35] These heat-trapping greenhouse gases are mainly discharged into the air by human activities, particularly by fossil fuel-burning energy generation, transportation sectors using fossil fuel-

30. Press Release, United Nations Climate Change Secretariat, Statement by UNFCCC Executive Secretary on Crossing of 400 ppm CO2 Threshold (May 13, 2013), http://unfccc.int/files/press/news_room/press_releases_and_advisories/application/pdf/400_ppm_media_alert_13052013.pdf.

31. *See Carbon Dioxide at Mauna Loa Observatory Reaches New Milestone: Tops 400 ppm*, SCRIPPS INST. OF OCEANOGRAPHY (May 10, 2013), https://scripps.ucsd.edu/news/7992; Josep G. Canadell et al., *Contributions to Accelerating Atmospheric CO_2 Growth from Economic Activity, Carbon Intensity, and Efficiency of Natural Sinks*, 104 PNAS 18866, 18866-70 (2007), *available at* http://www.pnas.org/content/104/47/18866.long.

32. *See Crisis of Global Sustainability*, CLUB OF ROME (Apr. 28, 2013), http://www.clubofrome.org/?p=5984.

33. *See Climate Change: A Scientific Assessment for the GEF*, SCIENTIFIC & TECHNICAL ADVISORY PANEL (Nov. 2012), http://www.thegef.org/gef/sites/thegef.org/files/publication/Climate%20Change-A%20Scientific%20Assessment%20for%20the%20GEF_2.pdf; *America's Climate Choices*, NATIONAL RESEARCH COUNSEL (2011).

34. *See* LATIN, CLIMATE POLICY FAILURES, *supra* note 19, at 99, 139, 160, 197.

35. BERT METZ, CONTROLLING CLIMATE CHANGE 1–9 (Cambridge: Cambridge Univ. Press 2010); INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE CLIMATE CHANGE, SUMMARY FOR POLICYMAKERS *in* CLIMATE CHANGE 2007: THE PHYSICAL SCIENCE BASIS 129-34 (Susan Solomon et al. eds., 2007); KERRY EMANUEL, WHAT WE KNOW ABOUT CLIMATE CHANGE (MIT Press 2d ed. 2013).

combustion engines, and land-use changes such as deforestation producing CO_2 emissions. Increasing the cumulative amount of GHGs in the air will worsen the greenhouse effect by trapping more heat, which means that the concentration of greenhouse gases in the atmosphere is the most fundamental factor determining the extent of climate change dangers.[36]

A critical flaw underlying the conventional multi-decade GHG emissions-reduction programs is that their proponents presume reducing annual GHG discharges will comparably limit the growth of global warming and climate change. A sensible climate change policy could and should focus on the aggregate concentration of GHGs in the atmosphere and how to stabilize and then reduce this cumulative pollution level. Yet, nearly all consensus mitigation plans around the world put their foremost emphasis on reducing current or projected annual GHG discharges by designated percentage rates applied over the next several decades, while ignoring the crucial impacts of the remaining unregulated GHG discharges on the cumulative atmospheric GHG concentration.[37]

I am indebted to Professor John D. Sterman of MIT for explaining the "stocks and flows" characteristics of the greenhouse gas problem. The *stock* in this context is the amount of CO_2 and other greenhouse gases that is *already* in the atmosphere. The *flow* is the amount of new GHGs discharged annually and *added to* the existing atmospheric concentration. The magnitude of climate change risks results from the combination of the existing stock of GHGs in the air with the new GHG emissions flows that will increase the present stock. The critical factor is the *cumulative* amount of existing and new heat-trapping gases in the air that are causing the earth's atmosphere, surface, and ocean waters to become progressively warmer.

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36. Canadell, *supra* note 31, at 18866-70; *see generally Climate Change Science: State of Knowledge*, ENVTL. PROT. AGENCY (Sept. 9, 2013), http://www.epa.gov/climatechange/science/stateofknowledge.html; ENVIRONMENT CANADA, THE SCIENCE OF CLIMATE CHANGE-PART I: INTRODUCTION/GHG/RADIATIVE FORCING (2007); Andrew C. Revkin, *Climate Panel Reaches Consensus on the Need to Reduce Harmful Emissions*, N.Y. TIMES (May 4, 2007), http://www.nytimes.com/2007/05/04/science/04climate.html?_r=0.

37. *See* LATIN, CLIMATE POLICY FAILURES, *supra* note 19, at 19-37; David M. Driesen, *Climate Disruption: An Economic Dynamic Approach*, 42 ENVTL. L. REPORTER 10,639, 10,648 (2012), *available at* http://www.law.syr.edu/faculty/pdfs/Driesen_ClimateDisruption.pdf.

Professor Sterman emphasized the analogy of a bathtub overflow[38] that has since become well-known in the literature on climate change perils. As long as the in-coming flow of water combined with the amount of water already in the bathtub (the stock) exceeds the capacity of the drain to remove the cumulative stock and flows, the water level in the bathtub will keep rising until a flood occurs. Even if the flow from the faucet is reduced by a significant amount, the cumulative water level in the bathtub will continue to rise as long as the combined stock and flows of water in the bathtub exceed the ability of the drain to remove sufficient water.

Dr. Sterman concluded this analogy by estimating that the annual volume of worldwide GHG discharges (the flows) added to the current atmospheric concentration (the stock) is about twice the level of the GHGs that can be removed by natural sinks, such as the oceans, forests, and other vegetation able to absorb carbon dioxide. This imbalance means that the aggregate level of GHGs in the atmosphere will continue "overflowing," in the sense that the cumulative stock and flows of GHGs in the air will increasingly retain more heat, which will lead to the growth of global warming and climate change with associated damages.

This "stocks and flows" analysis is more important for climate change than it may at first seem because virtually all concerned climate-policy leaders, including President Obama, and their expert advisors have focused on periodic reductions in GHG discharges (flows) without considering the cumulative effects of the remaining GHG pollution flows on the future atmospheric concentration (the stock). The unregulated or allowable GHG pollution that will still reach the atmosphere after an emissions-reduction target is met will be described here as "residual" GHG discharges, which means the GHG pollution (new flows) that will reach the atmosphere despite the conventional multi-decade regulatory measures imposed.

Focusing on *reducing* the annual volume of GHG pollution rather than restricting the *cumulative increases* in the atmospheric GHG concentration is a serious climate-policy mistake that will destroy the effectiveness of all consensus multi-decade emissions-reduction programs. It is vital to understand that the current GHG concentration in the atmosphere is already manifestly dangerous; thousands of people and many billions of dollars were lost in 2012 because the current cumulative level of GHGs in the air is now

38. Andrew C. Revkin, *The Greenhouse Effect and the Bathtub Effect*, N.Y. TIMES (Jan. 28, 2009), http://dotearth.blogs.nytimes.com/2009/01/28/the-greenhouse-effect-and-the-bathtub-effect/.

large enough to cause or compound a variety of severe climate-related dangers. Imagine the hazards that will arise if we continue increasing the atmospheric GHG concentration (the stock) with large amounts of residual GHG emissions (the flows) for the next several decades.

The consensus multi-decade emissions-reduction programs cannot stabilize or reduce the atmospheric greenhouse effect because the volume of residual GHG discharges that is authorized or allowed will *combine* with the GHGs already in the atmosphere to increase the harmful aggregate heat-trapping GHG concentration. This is a simple, but not simple-minded, explanation of why deferring genuinely stringent GHG pollution-control requirements for a few decades will lead to more atmospheric heating and environmental degradation despite modest annual emissions-reduction measures. Taking into account the appreciable financial and political capital, administrative resources, personnel efforts, and irreplaceable time invested in typical multi-decade GHG emissions-reduction programs or proposals, and therefore diverted from more beneficial regulatory plans, the consensus GHG emissions-reduction approach should be regarded as an unqualified climate change policy failure rather than a limited success.

Another serious flaw of the multi-decade GHG emissions-reduction strategy is that it fails to take into account the fact that the most prevalent greenhouse gas, carbon dioxide, is also the most persistent heat-trapping gas that typically will remain in the atmosphere for the longest period of time. In a 1999 study, scientists from the American Geophysical Union concluded: "it is now generally believed that a substantial fraction of the excess CO_2 in the atmosphere will remain in the atmosphere for decades to centuries, and about 15-30% will remain for thousands of years."[39] Recent climatological research found that the extent of CO_2 persistence was underestimated in previous studies, and that the atmospheric warming effects of carbon dioxide will often last for thousands of years rather than centuries.[40]

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39. Tamara S. Ledley et al., *Climate Change and Greenhouse Gases*, 80 EOS 453, 453, 458 (1999), *available at* http://www.agu.org/eos_elec/99148e.html.

40. Susan Solomon et al., *Irreversible Climate Change Due to Carbon Dioxide Emissions*, 106 PNAS 1704-09 (2009), *available at* http://www.pnas.org/content/early/2009/01/28/0812721106.full.pdf+html; Mason Inman, *Carbon is Forever*, NATURE REPORTS (Nov. 20, 2008), http://www.nature.com/climate/2008/0812/full/climate.2008.122.html; Juliet Eilperin, *Carbon Output Must Near Zero To Avert Danger, New Studies Say*, WASH. POST (Mar. 10, 2008), http://www.washingtonpost.com/wpdyn/content/article/2008/03/09/AR2008030901867.html; H. Damon Matthews & Ken Caldeira, *Stabilizing Climate Requires Near-Zero Emissions*, 35 GEO-

When viewed in this light, the consensus climate-policy choice to allow many billions of tons of residual CO_2 and other greenhouse gases to be discharged into the atmosphere before 2050 is little short of criminal irresponsibility. I have not found any multi-decade GHG emissions-reduction program that would eliminate as much as 50% of harmful annual GHG discharges before 2050, and it will take a miracle to reach the widely-cited 2050 target of an 83% pollution cutback when no conventional mitigation program requires even 50% greenhouse gas reductions up to 2049.

These criticisms may be illustrated by one concrete example: The Waxman-Markey Bill was passed in the House of Representatives in 2009 by a slim majority vote but was rejected by the Senate. Nevertheless, President Obama changed his previous emissions-reduction targets to correspond with the somewhat more lenient projected GHG pollution cuts identified in the Waxman-Markey Bill, and he has accepted these same GHG emissions-reduction targets as recently as his June 25, 2013 climate change speech.

TABLE 1. Waxman-Markey/Obama GHG Emissions-Reduction Targets[41]

Target Dates	Mandated % Cuts	Residual GHGs Allowed	Annual US Discharges
2009	0%	100%	~6.0 Billion Tons
2012	3%	97%	~5.80 Billion Tons
2020	17%	83%	~4.98 Billion Tons
2030-2050	42%	58%	~3.48 Billion Tons
After 2050	83%	17%	~1.02 Billion Tons

PHYSICAL RES. LETTERS L04705 (2008); Andreas Schmittner et al., *Future Changes in Climate, Ocean Circulation, Ecosystems, and Biogeochemical Cycling Simulated for a Business-as-Usual CO_2 Emission Scenario Until Year 4000 AD*, 22 GLOBAL BIOGEOCHEMICAL CYCLES GB1013 (2008), *available at* http://onlinelibrary.wiley.com/doi/10.1029/2007GB002953/abstract.

41. *See* Waxman-Markey American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong. (2009); *see also* Press Release, The White House Office of the Press Secretary, President to Attend Copenhagen Climate Talks (Nov. 25, 2009), http://www.whitehouse.gov/the-press-office/president-attend-copenhagen-climate-talks (discussing White House's emissions reduction targets); *President Obama Sets a Target for Cutting U.S. Greenhouse Gas Emissions*, DEPT. OF ENERGY (Dec. 2, 2009), http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=15650; LATIN, CLIMATE POLICY FAILURES, *supra* note 19, at 31.

Assuming that carbon dioxide discharges from the US were about 6 billion tons in 2005,[42] which probably understates the actual amount of GHGs released then,[43] the last column in Table 1 shows the approximately 184 billion tons of residual GHG pollution authorized over the time-frames imposed by the GHG emissions-reduction targets set when the Waxman-Markey Bill was voted on in 2009 (3 years X 6 billion tons per year; 8 years X 5.80 billion tons per year; 10 years X 4.98 billion tons per year; and 20 years X 3.48 billion tons per year = 183.8 tons). These residual pollution figures may be slightly exaggerated because some polluters will reduce their GHG emissions before they reach the designated target dates, but on the other hand, previous air pollution control experiences suggest that there will be many laggard firms and widespread non-compliance or delay.

Despite being copied directly from the Waxman-Markey Bill, the figures in Table 1 cannot claim scientific precision, but the cumulative figures in the Table from 2009 to 2049 show that the approximate volume of residual GHG discharges authorized under this legislative and Administration initiative would have been about 184 billion tons, and most of these greenhouse gas pollutants would be highly persistent CO_2. As the discussion to this point has emphasized, the enormous amount of authorized or allowable residual GHG pollutants will *combine* with the already-too-high atmospheric GHG concentration to produce unmitigated climate change disasters. After these new discharges combine with the existing GHG stock in the atmosphere, the responsible climate-policy leaders would somehow have to attain the miraculous draconian GHG emissions cuts proposed for after 2050. And yet, the persistence of CO_2 ensures that global warming and climate change would grow consistently worse despite the improbable hypothetical post-2050 draconian reductions[44] claimed by proponents of the consensus GHG emissions-reduction approaches.

The world is already suffering many kinds of serious harms resulting from the current too-high atmospheric GHG concentration; and yet the future dangers will surely become worse if we allow approximately 184 billion tons of residual GHG emissions from the

42. Joseph E. Aldy et al., *Designing Climate Mitigation Policy*, at 6 (Resources for the Future, Discussion Paper DP 08-16, 2009), *available at* http://www.rff.org/documents/rff-dp-08-16.pdf.

43. *See* METZ, *supra* note 35, at 36.

44. JAMES HANSEN, STORMS OF MY GRANDCHILDREN: THE TRUTH ABOUT THE COMING CLIMATE CATASTROPHE AND OUR LAST CHANCE TO SAVE HUMANITY 177 (Bloomsbury USA 2009).

US, and many additional billions of tons of GHGs from other countries to reach the atmosphere in the next four decades. I believe no one could legitimately claim that the multi-decade GHG emissions-reduction programs, which are allowing huge annual flows of residual GHGs, could be successfully curtailing climate change risks. Some advocates of current emissions-reduction programs may contend that any annual reduction of GHGs is better than nothing, but this assertion is not good enough to achieve sufficient climate change progress or prevent continuing climate degradation. Moreover, large monetary and personnel expenditures on mitigation programs that are only "a little better than nothing" may be worse than nothing if the high regulatory costs and opportunity costs obscure or suppress the more ambitious mitigation measures required for appreciable climate change progress.

There are two additional points sufficiently essential that they cannot be omitted. The same GHG residual discharge criticisms that apply to direct regulatory standards would apply equally to cap-and-trade systems and carbon offset schemes. When a GHG trade is made or an offset is sold, this action normally grants the buyer the right to discharge one ton of GHG emissions for each allowance or offset purchased. If billions of cap-and-trade allowances and carbon offsets are authorized each year by climate change market-based regulations, these frequently-praised market mechanisms will result in just as much residual GHG pollution reaching the atmosphere as would a conventional multi-decade pollution-control regulatory program. Indeed, the Waxman-Markey bill was based on using a cap-and-trade system and the same is true for President Obama's proposals. Under these mitigation approaches, where would the GHG emissions authorized by the billions of annual allowances and offsets (the GHG *flows*) go, if not to combine with the existing atmospheric stock of GHGs to increase the cumulative volume of greenhouse gases in the atmosphere?

The figures in Table 1 were drawn directly from the cap-and-trade GHG emissions-reduction targets in the Waxman-Markey bill and accepted by the Obama Administration. My recent climate change book includes a similar but more detailed discussion of the cap-and-trade and carbon offset programs at the heart of the Kerry-Lieberman American Power Act of 2010.[45] As quoted above, President Obama praised the earlier bipartisan McCain-Lieberman Climate Stewardship Act, which also would have employed a cap-and-

45. LATIN, CLIMATE POLICY FAILURES, *supra* note 19, at 62-66, 74, 80-82, 153, 161.

trade system. Apparently, this is the "market-based" climate change "solution" the President called for in his 2013 State of the Union Address. Sadly, President Obama's idealistic comments in his recent speeches show that he does not truly understand climate change mitigation realities, and he is still following the ineffectual consensus multi-decade GHG emissions-reduction strategy that realistically cannot succeed in overcoming dangerous climate change conditions.

The other essential point is that the US is no longer the world's largest GHG-polluting nation; China is, and its GHG emissions have been rapidly growing. There is no plausible way the developed nations can overcome global climate change without the active cooperation of the large GHG-polluting developing nations, including China, India, Brazil, South Africa, and Indonesia, no matter how stringent future US regulatory standards may become. If the multi-decade GHG emissions-reduction plans of the US would allow the discharge of approximately 184 billion tons of residual GHGs by 2050, consider how much worse the aggregate atmospheric conditions will become when we include the GHG emissions of all the developed, emerging, and developing nations in the world.

Although the developed countries continue to seek mitigation support from the large GHG-polluting developing states, the multi-decade emissions-reduction process would likely be an unacceptable barrier to further economic growth in nearly all developing nations. These states typically regard improving economic and social welfare as their highest priority, and they have thus far refused to participate in the kind of long-term GHG emissions-reduction programs with progressively more stringent pollution-control targets advocated by the US and EU.[46]

A more comprehensive discussion of international climate commitments and negotiations is outside the scope of this paper,[47] but I intend to argue that the "decarbonization" strategy emphasizing clean GHG-free alternative technologies would be more compatible with the goals of developing countries than the conventional GHG emissions-reduction approach could ever be. Effective climate change mitigation policies must meet the requirements of *both* developed and developing nations, and the decarbonization approach that can promote "clean development" is much more likely to be acceptable to developing countries than the multi-decade GHG emissions-reduction approach that would typically be

46. *Id.* at 109-49.

47. *See generally id.*

perceived as imposing barriers to further growth in developing nations.

The only arguable benefit of the conventional "too little, too late" multi-decade GHG emissions-reduction programs is that climate change might eventually become even worse if we do nothing at all to restrict GHG pollution. But accepting a bad mitigation program at high costs for a long irreversible period of time because it is "better than nothing" is not a sensible climate policy. In choosing a baseline for evaluating climate change mitigation policies, a "better than nothing" baseline would apply to virtually every mitigation action or plan ever proposed, no matter how expensive and how ineffective it may prove to be. In comparison, a mitigation baseline of 2005 (or any other selected year including the present year) contrasted against the scientifically predicted growth of the GHG concentration in the atmosphere during the next several decades, causing greater climate change harms, is a much more reasonable basis for assessing the effectiveness of competing climate change mitigation policies.

We cannot tolerate GHG emissions-reduction programs that allow so much residual GHG pollution that they regularly will compound cumulative atmospheric GHG levels and worsen global warming for centuries or millennia to come. The conventional GHG emissions-reduction programs are little better than the "business as usual" do-nothing paradigm that consistently allows too much heat-trapping greenhouse gas pollution to contaminate the air, and therefore cannot succeed in limiting climate change dangers. Despite impassioned warnings by countless thousands of scientists and environmentalists, the climate-policy mistakes and unnecessary delays the world's leaders and their expert advisors have been making or tolerating are bound to produce irreversible climate change mitigation failures with terrible consequences.

III. EPA REGULATORY POLICIES

Under the Bush Administration, the EPA rejected various petitions and lawsuits urging the Agency to limit greenhouse gas discharges and to develop regulatory policies for mitigating climate change. In 2007, the US Supreme Court held in *Massachusetts v. EPA*[48] that the EPA did have the authority to regulate GHGs under the Clean Air Act, and that the Agency must regulate these air pollutants if greenhouse gases would endanger people's health or wel-

48. 549 U.S. 497 (2007).

fare. Despite this Supreme Court decision, the Bush Administration refused to issue a "statement of endangerment" or to promulgate any significant pollution control standards applicable to GHGs.

In 2009, the new Obama Administration EPA issued a finding "under CAA section 202(a) that atmospheric concentrations of the six greenhouse gases taken in combination may reasonably be anticipated to endanger both the public health and the public welfare of current and future generations."[49] Before we can evaluate the specific proposed rules and mitigation plans developed by EPA, we need a baseline or standard of comparison to determine whether the projected EPA standards would respond adequately to the primary causes of "endangerment" under present and future climate conditions.

In October 2013, Working Group I of the Intergovernmental Panel on Climate Change (IPCC) published a "Summary for Policymakers" of the physical science basis for findings on climate effects, which will be included in the IPCC's forthcoming Fifth Assessment Report on Climate Change.[50] This summary report stated:

> Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased.[51]

A 2013 report by the International Energy Agency, a highly-regarded non-governmental organization (NGO), stated that: "Fossil fuels still account for most – over 80% – of the world energy supply" and "[s]ince 1870, CO_2 emissions from fuel combustion have risen exponentially."[52] The World Meteorological Organization reported in 2013: "Carbon dioxide is the single most important

49. EPA, Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 18,886 (proposed Apr. 24, 2009) (to be codified at 40 C.F.R. ch. 1); *see also EPA's Endangerment Finding: Frequently Asked Questions*, ENVTL. PROT. AGENCY, *available at* http://www.epa.gov/climatechange/Downloads/endangerment/EndangermentFinding_FAQs.pdf (last visited Oct. 7, 2013).

50. *CLIMATE CHANGE 2013: The Physical Science Basis: Summary for Policymakers*, IPCC (2013), *available at* http://www.climatechange2013.org/images/uploads/WGI_AR5_SPM_brochure.pdf.

51. *Id.* at 2.

52. *CO_2 Emissions from Fuel Combustion: Highlights 2013*, INT'L ENERGY AGENCY, 8 (2013), *available at* http://www.iea.org/publications/freepublications/publication/CO2EmissionsFromFuelCombustionHighlights2013.pdf.

anthropogenic greenhouse gas in the atmosphere . . . . [and has] reached 141% of the pre-industrial level in 2012, primarily because of emissions from combustion of fossil fuels."[53] The US National Climate Assessment and Development Advisory Committee (NCADAC), with representatives from a dozen federal agencies and many other scientific experts, reported in 2013 that most climate change effects "are detrimental, largely because society and its infrastructure were designed for the climate of the past, not for the rapidly changing climate of the present or the future."[54] This report also noted:

> Long-term, independent records from weather stations, satellites, ocean buoys, tide gauges, and many other data sources all confirm the fact that our nation, like the rest of the world, is warming, precipitation patterns are changing, sea level is rising, and some types of extreme weather events are increasing. These and other observed climatic changes are having wide-ranging impacts in every region of our country and most sectors of our economy.[55]

These and many other recent scientific assessments have found that the concentration of greenhouse gases in the atmosphere has been steadily increasing, the harmful impacts of climate change correspondingly have been growing at an alarming pace, and the harmful consequences are primarily the result of human activities, especially the combustion of fossil fuels. These recent scientific findings make clear that climate change has adversely affected current human and natural conditions, and diverse climate-related hazards are virtually certain to grow worse in the near and distant future.

The US is now the world's second largest GHG polluter after China, as well as discharging the highest volume of GHGs on a per capita basis of any large GHG-polluting nation. It is therefore both necessary and equitable for the US to assume a substantial portion of the mitigation burden. America has already suffered hundreds of billions of dollars in climate-related damages in the past few years

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53. *Greenhouse Gas Bulletin No. 9*, WORLD METEOROLOGICAL ORG., 2 (Nov. 6, 2013), *available at* http://www.wmo.int/pages/prog/arep/gaw/ghg/documents/GHG_Bulletin_No.9_en.pdf.

54. *Climate Change and the American People*, NAT'L CLIMATE ASSESSMENT & DEV. ADVISORY COMM., 1 (Jan. 2013) *available at* http://ncadac.globalchange.gov/download/NCAJan11-2013-publicreviewdraft-fulldraft.pdf.

55. *Id.*

and nearly all scientific risk assessments predict sharply increasing future harms.

Is EPA really trying to respond effectively to these difficult circumstances, or is the Agency intent on providing little more than a Band-Aid to comply minimally with its greenhouse gas regulatory responsibilities? In other words, will the recently proposed EPA regulations make a significant contribution toward controlling the "endangerment" from climate change, or will the Agency focus on ineffectual or minor regulatory practices that "were designed for the climate of the past," to paraphrase the NCADAC quotation above?

Professor Lisa Heinzerling, a highly-respected environmental law commentator and temporary participant in EPA policymaking efforts,[56] noted that when the Obama Administration took office, the new President appointed:

> [A]rdent proponents of action on climate change to head agencies and departments, and these officials in turn appointed like-minded individuals to help them in their tasks. Interagency meetings early in the Administration were crowded with people whose chief, if not sole, job was to imbue their agencies with an action-oriented perspective on climate change.[57]

Unfortunately, as a consequence of partisan political conflicts, scientific uncertainties, decreasing budgets, strong opposition by fossil fuel industries, EPA staff disincentives, and many mistaken judgments by Agency leaders, the Obama Administration and EPA have not achieved any important regulatory progress on climate change during the past six years except perhaps for improving the future fuel efficiency of new motor vehicles. Another potentially positive EPA regulatory initiative is a mandatory reporting system applicable to major GHG dischargers;[58] however, it is too soon to determine if these disclosures have been leading to significant GHG reductions. Although I recognize these potentially useful but limited programs, there is no plausible reason to believe that EPA has been establishing effective climate change mitigation regulations that would respond effectively to its "endangerment" finding. Indeed, I intend to show that EPA's current proposals and plans

56. *See* Lisa Heinzerling, *Climate Change at EPA*, 64 FLA. L. REV. 1, 6 n.a1 (2012).

57. *Id.* at 6.

58. *Greenhouse Gas Reporting Program*, ENVTL. PROT. AGENCY, http://www.epa.gov/ghgreporting/ (last updated Dec. 16, 2013).

will allow the US contribution to global greenhouse gases and resulting climate change risks to continue growing worse indefinitely.

A. Regulation of GHG Emissions from New Motor Vehicles

In cooperation with the National Highway Traffic Safety Administration (NHTSA), EPA in 2012 issued regulations to reduce GHG emissions from new passenger cars and light trucks, and also to improve their average fuel efficiency substantially. EPA contended that: "Combined with the MYs [Model Years] 2012-2016 standards, today's final program will result in MY 2025 vehicles emitting one-half of the GHG emissions of a MY 2010 vehicle, representing the most significant federal action ever taken to reduce GHG emissions and improve fuel economy."[59]

However, the purpose of the "endangerment" rule in the CAA, as interpreted by the Supreme Court in *Massachusetts v. EPA*,[60] is for EPA to impose air pollution regulations that will protect people against significant health and welfare losses. The vital question is therefore whether EPA's Motor Vehicle Regulations and other pollution-control measures will somehow reduce climate change growth as well as vehicle GHG emissions, and will correspondingly reduce the hazards for American people endangered by diverse climate change risks including those exacerbated by large motor vehicle emissions?

The information below was provided by EPA to indicate the multi-year emissions-reduction effects of the motor vehicle GHG standards applicable in model years 2016-2025:

TABLE 2. EPA Fleet-Wide Average GHG Emissions Targets[61]

Projected Fleet-Wide Emissions Compliance Targets under the Footprint-Based CO_2 Standards (g/mi) and Corresponding Fuel Economy (mpg)										
	2016 base	2017	2018	2019	2020	2021	2022	2023	2024	2025
Passenger Cars (g/mi)	225	212	202	191	182	172	164	157	150	143
Light Trucks (g/mi)	298	295	285	277	269	249	237	225	214	203
Combined Cars & Trucks (g/mi)	250	243	232	222	213	199	190	180	171	163
Combined Cars & Trucks (mpg)	35.5	36.6	38.3	40.0	41.7	44.7	46.8	49.4	52.0	54.5

59. *EPA Motor Vehicle Regs*, *supra* note 14, at 2.
60. 549 U.S. 497 (2007).
61. *EPA Motor Vehicle Regs*, *supra* note 14, at 4.

The initial Model Year for 2012-2016 standards were predicted to result in a vehicle fleet "average light-duty vehicle tailpipe CO2 level of 250 grams per mile by MY 2016, equivalent to 35.5 mpg (if achieved exclusively through fuel economy)."[62] The MY 2025 "final standards are projected to result in an average industry fleetwide level of 163 grams/mile of carbon dioxide (CO_2) in model year 2025, which is equivalent to 54.5 miles per gallon (mpg) if achieved exclusively through fuel economy improvements."[63] In essence, EPA claims that its light-duty motor vehicles standard will cut GHGs 50 percent on average in comparison to MY 2010 vehicles.[64]

These regulations undoubtedly will help Americans achieve several goals derived from the implementation of greater fuel efficiency: Less gasoline will be required to operate the fleet of 2025 vehicles; the cost of filling up at the pump should decrease for consumers, although that is not a certainty; less petroleum will need to be imported from foreign sources; and the US will find it easier to attain and maintain energy independence.[65] Moreover, EPA emphasized that using fleet averages for fuel efficiency and GHG discharges will enable consumers to choose the kinds of vehicles they want to buy, large SUVs and pick-up trucks, small compact cars with much lower fuel requirements, or mid-sized models, as long as the overall fleet average reaches the designated target of the fuel efficiency standards.

The EPA neglected to mention that the availability of SUVs, pickup trucks, and other large vehicles, the most heavily polluting vehicles in the automotive fleet but also the most profitable for manufacturers, surely helped the Agency achieve widespread industry support for the fuel efficiency and GHG emissions-reduction regulations.[66] On the other hand, significantly lower GHG discharges and greater fuel efficiency could have been achieved if EPA had imposed a fuel GHG emissions-reduction standard on maximum vehicle emissions, or a standard limiting GHG emissions per vehicle size, that do not dilute mitigation efforts by using fleet averages.

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62. *Id.* at 2.

63. *Id.* at 1.

64. *Id.* at 2.

65. *Id.* at 3-4.

66. *See* Howard Latin & Bobby Kasolas, *Bad Designs, Lethal Profits: The Duty to Protect Other Motorists Against SUV Collision Risks*, 82 B.U. L. REV. 1161, 1166-68, 1179 (2002). The EPA did mention the benefits of providing a range of different models to accommodate consumer choices, but it did not acknowledge that the large, heavy vehicle models allowed by these standards were also by far the most profitable for auto and truck manufacturers. *Id.*

In addition to the various benefits arising from greater fuel efficiency, EPA cited these climate change benefits: "Light-duty vehicles are currently responsible for nearly 60 percent of U.S. transportation-related petroleum use and GHG emissions."[67] By cutting the allowable average vehicle GHG discharges by approximately 50 percent, the Agency emphasized that "the combined program will cut 6 billion metric tons of greenhouse gases over the lifetimes of the vehicles sold in MYs 2012-2025 – more than the total amount of carbon dioxide emitted by the United States in 2010."[68]

Now we must return to a crucial point emphasized throughout my book and this article: The EPA's discussion of the new regulations contends that they will cut GHG emissions from new light-duty vehicles by 50% or 6 billion tons during the 12-year period from 2012 to 2025. But what about the amount of residual GHG emissions that will be authorized during this period, the other 50 percent of light-vehicle GHGs based on emissions during the same period? EPA identifies the 50 percent GHG emissions reductions that ostensibly will be achieved by these regulations, but it does not acknowledge the equally large amount of greenhouse gases that will be discharged into the atmosphere. These authorized residual discharges will increase the GHG concentration in the atmosphere despite the reduction in annual vehicle GHG emissions, and consequently the EPA regulations will not significantly curtail the "endangerment" from increasing global warming and climate change.

It is important to focus on the reality that these new vehicle emissions standards will be reduced appreciably from a 2010 baseline, but they also authorize vast amounts of residual GHG discharges, at least 6 billion tons discharged into the air over a 12-year period according to EPA's 50 percent calculations. There is no legitimate way the Agency could claim that GHG emissions reductions derived from the new motor vehicle regulatory standards will help stabilize or reduce climate change dangers. Continuing to allow very large volumes of residual automotive GHG emissions to reach the atmosphere, even when these discharges are much lower than if the Agency had done nothing at all to cut new vehicle emissions, will still be contributing to climate change degradation rather than to any improvement of climate conditions.

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67. *EPA Motor Vehicle Regs, supra* note 14, at 1.
68. *Id.* at 3.

The absence of palpable climate change benefits from EPA's GHG emissions-reduction standards for new motor vehicles should be even more obvious if we consider that a larger US population will likely lead to a higher number of new motor vehicles on US roads by 2025. The increase in the number of vehicles combined with greater congestion resulting from additional urbanization will likely lead to more GHG discharges during traffic jams and driver attempts to circumvent traffic hotspots. Many owners of older, high-emissions, large vehicle models will hold on to them as long as possible because of the higher costs of purchasing more fuel efficient models. And there will be tens of millions of old or "existing" motor vehicles on the roads for many years, discharging GHGs at the initial 2010 to 2016 projected emissions rates. In short, the cumulative GHG pollution from new and existing vehicles will continue to expand the level of GHGs in the air, and therefore will not reduce climate change dangers.

There is also the likelihood of a "rebound effect" resulting from the greater fuel efficiency required by new motor vehicle standards. If driving costs become lower as a result of improved fuel efficiency, there may be an inverted relationship in which people choose to drive more miles. One recent study of this issue found "a large and robust rebound effect; a one percent fuel economy increase raises driving 0.2 to 0.4 percent."[69] When all of these future circumstances are considered, there is little reason to believe that EPA's projection of a 50 percent GHG reduction from new vehicles is realistic. The factors resulting from driving behavior rather than from vehicle designs would add to the volume of residual GHG emissions that will be authorized under the new light-duty motor vehicle regulations. In short, EPA probably recognized these various sources of additional GHG emissions, but the new motor vehicle standards did nothing to prohibit or restrain the growing residual GHG discharges.

EPA did not have to follow the fleet averages approach applied to other vehicle pollutants under the CAA, which allows the sale of many large, heavy vehicles that put out an excessive amount of GHGs on the problematical rationale that this GHG pollution will be counterbalanced by the sale of more small fuel-efficient vehicles with reduced GHG emissions. A better, although initially costly, strategy would be to require the development over the same 12-year

69. Joshua Lynn, *The Rebound Effect for Motor Vehicles*, (Resources for the Future, Discussion Paper RFF DP 13-19, 2013), *available at* http://www.rff.org/documents/rff-dp-13-19.pdf.

time horizon of "clean" GHG-free or very-low GHG vehicles that could be small or large depending on the efficiency of their designs, and that would not discharge an appreciable volume of greenhouse gases.

EPA implicitly recognized the technological possibility of a decarbonization strategy because its explanation of the new motor vehicle regulations included this statement:

> To facilitate market penetration of the most advanced vehicle technologies as rapidly as possible, EPA is finalizing an incentive multiplier for compliance purposes for all electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), fuel cell vehicles (FCV) and compressed natural gas (CNG) vehicles sold in MYs 2017 through 2021. This multiplier approach means that each EV/PHEV/FCV/CNGV would count as more than one vehicle in the manufacturer's compliance calculation. EVs and FCVs will start with a multiplier value of 2.0 in MY 2017, phasing down to a value of 1.5 in MY 2021. PHEVs and CNG vehicles will start at a multiplier value of 1.6 in MY 2017 and phase down to a value of 1.3 in MY 2021. There are no multipliers for MYs 2022-2025.[70]

If my interpretation of this EPA statement is correct, it means that for every GHG-free or low-GHG motor vehicle model produced between 2017 and 2021, the manufacturer will be entitled to sell more than one offsetting heavyweight high-pollution vehicle until the multiplier is phased out.[71] EPA's regulations allow new motor vehicles in 2025 and beyond to continue using fossil fuels predominantly, and on average the more small, fuel efficient cars are sold, the more large, heavily-polluting, highly profitable vehicles the car manufacturers will be able to market.

EPA could instead have used several mechanisms to reduce the incentives for car manufacturers to continue putting out vehicles that discharge large volumes of GHGs: EPA could have imposed a substantial GHG emissions tax[72] or a mandatory near-prohibition

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70. *EPA Motor Vehicle Regs*, *supra* note 14, at 8.

71. *See* Lindsay Brooke, *For G.M. and Honda, a Fuel-Cell Partnership*, N.Y. TIMES (July 2, 2013), http://www.nytimes.com/2013/07/03/business/for-gm-and-honda-a-fuel-cell-partnership.html?_r=0.

72. THOMAS KLIER & JOSHUA LINN, RESOURCES FOR THE FUTURE, USING VEHICLE TAXES TO REDUCE CARBON DIOXIDE EMISSIONS RATES OF NEW PASSENGER VEHICLES: EVIDENCE FROM FRANCE, GERMANY, AND SWEDEN (2012), *available at* http://www.nhh.no/Files/Filer/institutter/for/conferences/ beeer/2012/linn.pdf.

on large, heavy GHG-polluting vehicles that would give the manufacturers strong incentives to develop as wide a range of decarbonized vehicles as feasible. In addition to abandoning the "fleet average" fuel-efficiency approach, which guarantees that gas-guzzling, high-GHG polluting vehicles will continue to be produced, EPA together with other agencies could have funded refueling stations for EVs and fuel-cell vehicles;[73] they could have reduced the huge subsidies for oil production (thereby increasing fossil fuel prices); and they could have offered higher subsidies for the production of new GHG-free vehicles and for the conversion or replacement of existing GHG-polluting vehicles.[74]

This is not merely conjecture. A recent *New York Times* article noted that General Motors and Honda have formed a partnership to develop relatively inexpensive hydrogen fuel-cell vehicles[75] that will put out no waste discharges except water vapor. The Ford Motor Company, Renault-Nissan and Daimler established a similar partnership to make "affordable, mass-market fuel-cell vehicles by 2017."[76] And other auto manufacturers are working on the same kinds of GHG-free alternative technology.[77] In addition, the production and sales of all-electric vehicles (EVs) has been increasing rapidly from a low base.[78] In November 2013, Toyota "unveiled a concept version of a hydrogen fuel-cell car that it plans to begin

73. *See* Brandon Hofmeister, *Electric Vehicle Charging Infrastructure: Navigating Choices Regarding Regulation, Subsidy, and Competition In a Complex Regulatory Environment*, (Wayne St. U. L. School Legal Stud., Research Paper Series No. 2013-19, 2013), *available at* http://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID2285679_code745030.pdf?abstractid=2283264&mirid=1.

74. John M. Broder, *Obama Seeks to Use Oil and Gas Money to Develop Alternative Fuel Cars*, N.Y. TIMES (Mar. 15, 2013), http://www.nytimes.com/2013/03/16/us/politics/obamas-2-billion-plan-to-replace-fossil-fuels-in-cars.html.

75. Brooke, *supra* note 71.

76. *Id.* (internal citation omitted).

77. *Id.*

78. *See, e.g.*, Alexander Schuller & Fabian Rieger, *Assessing the Economic Potential of Electric Vehicles to Provide Ancillary Services: The Case of Germany*, 37 ZEITSCHRIFT FÜR ENERGIEWIRTSCHAFT 177 (2013); Charley Blaine, *Is Tesla the New Ford or GM?*, MSN MONEY (May 30, 2013), http://money.msn.com/investing/is-tesla-the-new-ford-or-gm; Bradley Berman, *Electric, if not Electrifying: Cars for Short-Range Commutes*, N.Y. TIMES (June 10, 2011), http://www.nytimes.com/2011/06/12/automobiles/autoreviews/12ELECTRIC.html?pagewanted=1&_r=1&ref=automobiles&_r=0;); Christopher Martin, *Electric Vehicles Capture Clean Energy Venture Capital, Ernst & Young Says*, BLOOMBERG (Aug. 3, 2010), http://www.bloomberg.com/news/2010-08-03/electric-vehicles-capture-clean-energy-venture-capital-ernst-young-says.html; Jack Ewing, *Latest Electric Car Will Be a BMW, From the Battery Up*, N.Y. TIMES (July 1, 2010), http://www.nytimes.com/2010/07/02/business/global/02bmw.html?ref=jackewing; Carter Dougherty, *To Hopeful Makers, the Electric Car's Time Is Here*, N.Y. TIMES (Sept. 14, 2009), http://www.nytimes.com/2009/09/14/automobiles/14electric.html?_r=2&.

selling 'around 2015,' as the company put it. The bright blue sedan is shaped like a drop of water to emphasize that water vapor is the only substance hydrogen-powered cars emit from their tailpipes."[79] Yet, under EPA's new motor vehicle fleet-averaging regulations, all of these GHG-free vehicles will allow the manufacturers to market a corresponding number (or more) of heavy fossil-fuel combustion vehicles discharging large amounts of GHGs.

It is certainly true that if EPA had not offered a profitable and commensurately high-GHG-polluting compromise regulatory package to automobile and truck manufacturers, the resulting industry and political opposition may have prevented the Agency from adopting any GHG emissions-reduction program for new motor vehicles. Some climate change mitigation skeptics argue that EPA's hands are tied by partisan politics supported by heavy industry lobbying, and as a result there is no point in even trying to establish successful mitigation initiatives. I cannot refute this sorry claim, but the purpose of this article is to describe what we could and should be doing to address climate change hazards in an effective manner, not how we need to reform our inefficient political system. It is important that concerned people learn to recognize what we should do and could do except for a disturbing, short-sighted, frequently corrupt political system. However, political attitudes on climate change and even business attitudes can change when the dangers become sufficiently salient.[80]

The previously cited *New York Times* article also observed that California has recently imposed "zero-emission vehicle requirements, which are scheduled to be phased in starting in 2018," and at least nine other states are expected to follow this zero-emissions limit.[81] The California Air Resources Board (CARB) declared in June, 2013:

> Mobile sources account for well over half of the emissions which contribute to ozone and particulate matter and nearly 40 percent of the greenhouse gas emissions in California. In order to meet California's health based air quality standards and greenhouse gas emission reduction

79. Eric Pfanner, *Toyota Shows Off Fuel-Cell Automobile*, N.Y. TIMES (Nov. 20, 2013), http://www.nytimes.com/2013/11/21/business/international/toyota-unveils-fuel-cell-concept-automobile.html.

80. *See* Coral Davenport, *Large Companies Prepared to Pay Price on Carbon*, N.Y. TIMES (Dec. 5, 2013), http://www.nytimes.com/2013/12/05/business/energy-environment/large-companies-prepared-to-pay-price-on-carbon.html.

81. Brooke, *supra* note 71.

> goals, the cars we drive and the fuel we use must be transformed away from petroleum.[82]

Don't you wish that CARB was developing our national motor vehicle mitigation policies, rather than EPA and NHTSA? American "[f]uel economy performance for cars and trucks is still among the worst in the developed world,"[83] powered almost entirely by fossil fuel combustion producing a high volume of GHG emissions. The EPA quotation on the previous page shows that the Agency has recognized the currently functional or under-development clean motor vehicle technologies that could be adopted to impose stricter limits on fossil fuel-burning vehicles within the next two decades. But instead, EPA chose to follow the fleet averaging approach of more than two decades ago, dominated by fossil fuel-driven vehicles producing very large GHG discharges, while expecting only a relatively small GHG emissions-reduction contribution from new GHG-free or very-low-GHG vehicles. This choice is clearly antithetical to any genuine attempt to prevent growing climate change harms resulting from one of the major worldwide sources of greenhouse gas pollution. Let me reiterate that a mitigation policy only marginally better than no GHG regulation cannot be a satisfactory response to growing climate change risks.

B. Regulation of New GHG Sources

When the Clean Air Act was adopted, Congress imposed moderately strict technology-based controls on new or substantially modified "stationary sources" of air pollution – these are New Source Performance Standards (NSPS) that require a detailed EPA determination of both technological availability and economic feasibility for each sectoral pollution-control initiative.[84] In 1990, Congress approved the same technology-based standards approach to regulate hazardous air pollutants.[85] In contrast, the 1970 and 1990 CAA provisions left the primary responsibility for regulating ex-

82. *Zero Emission Vehicle (ZEV) Program*, CAL. ENVTL. PROT. AGENCY, AIR RES. BD., http://www.arb.ca.gov/msprog/zevprog/zevprog.htm (last updated June 3, 2013).

83. Eduardo Porter, *A Model for Reducing Emissions*, N.Y. TIMES (Mar. 19, 2013), http://www.nytimes.com/2013/03/20/business/us-example-offers-hope-for-cutting-carbon-emissions.html?_r=0.

84. *See, e.g.*, Howard Latin, *Ideal Versus Real Regulatory Efficiency: Implementation of Uniform Standards and 'Fine-Tuning' Regulatory Reforms*, 37 STAN. L. REV. 1267, 1305-16 (1985).

85. *See* Howard Latin, *Regulatory Failure, Administrative Incentives, and the New Clean Air Act*, 21 ENVTL. L. 1647 (1991) [hereinafter Latin, *Administrative Incentives*].

isting air pollution sources to the states, with EPA providing modest oversight of required State Implementation Plans (SIPs).[86] This was how Congress decided to regulate well-known air pollutants four decades ago, and EPA chose to apply the same regulatory patterns, although GHG emissions to a large extent do not have the same characteristics, timeframes, or diversity of dangers as other air pollutants.

Before regulating GHG emissions from fossil fuel-based electric-generating units (EGUs) and other heavily-polluting stationary sources, EPA officials should have very carefully considered how GHGs differ fundamentally from the other air pollutants regulated under the CAA. Yet, because the Supreme Court interpreted the CAA as requiring the protection of human health and welfare from air pollution, EPA chose to follow specific CAA provisions in creating conventional pollution-control regulations for GHGs though Congress did not contemplate climate change risks or GHG characteristics when it adopted the CAA more than 40 years ago.

In one important departure from CAA precedents, EPA recognized that there may be literally millions of large and small GHG dischargers in the US, and it would be wholly impracticable for EPA to try to impose suitable regulatory rules on all of these GHG sources. EPA consequently created a "tailoring rule" that allows the Agency to focus on the largest GHG polluters while essentially ignoring all other types of dischargers for some unspecified period of time.[87]

I agree that limiting the number of GHG emissions sources to be regulated in the next several years was a sensible and necessary treatment. However, I do not agree with the extent to which EPA used the tailoring rule to reduce its administrative burdens and to avoid potential public discord by excluding categories of major GHG sources, such as oil-burning power plants, petroleum refineries, large cement production and steel smelting plants, and many new fossil fuel power plants that are not among the largest in the industry. Unsurprisingly, EPA claims that it will get around to regulating all of the other major GHG sources someday, but in the meantime the Agency is allowing many large GHG polluters to con-

86. *Id.*

87. *See, e.g., Regulatory Impact Analysis For The Final Prevention Of Significant Deterioration And Title V Greenhouse Gas Tailoring Rule*, ENVTL. PROT. AGENCY (May 2010), *available at* http://nepis.epa.gov/EPA/html/DLwait.htm?url=/Exe/ZyPDF.cgi?Dockey=P10074FR.pdf; Arnold W. Reitze, Jr., *Federal Regulation of Coal-Fired Electric Power Plants to Reduce Greenhouse Gas Emissions*, 32 UTAH ENVTL. L. REV. 391 (2012) [hereinafter Reitze, *Coal-Fired Power Plants*].

tinue putting out huge unregulated GHG emissions for years or decades with virtually no limitations or disincentives other than EPA's mandatory disclosure program for major GHG sources.[88] In essence, I believe EPA was not tailoring its regulatory obligations, but instead escaping from its climate change mitigation responsibilities for the most part.

Another important point about the tailoring rule is that it is not part of, or supported by, any provisions of the CAA. If EPA can adopt a sensible standard that allows it to avoid regulating most categories of GHG pollution sources for an indefinite period to reduce administrative burdens, despite the congressional mandate in the CAA that all major and even medium-sized air polluters must be promptly regulated, why should EPA refuse to impose a wide range of relatively stringent GHG pollution-control measures on the grounds that they are not directly authorized by the CAA? In other words, if the tailoring rule is a defensible divergence from the statutory language of the CAA, then EPA should also be able to impose stricter GHG pollution-control methods on the basis of urgent pollution-control needs not limited by explicit CAA provisions drafted decades ago. Agency convenience and administrative burdens should not be treated as an acceptable basis for weak or deferred regulation, whereas the climate change vulnerability of billions of people apparently is not.

In a regulatory process first begun in 2010, but subsequently delayed and not yet finalized,[89] EPA has proposed two NSPS treatments adopting different pollution-control regulations to curtail GHG emissions from new fossil fuel-fired power plants.[90] In 2012, EPA applied the technology-based regulatory approach commonly employed for NSPS sources under the CAA, mandating relatively permissive limits for new fossil fuel-burning EGUs, and restricting GHG discharges partly as a function of the amount of energy produced.[91] In 2013 EPA withdrew the proposed 2012 NSPS and pro-

88. *Greenhouse Gas Reporting Program*, *supra* note 58.

89. John M. Broder, *E.P.A. Will Delay Rule Limiting Carbon Emissions at New Power Plants*, N.Y. TIMES (Apr. 12, 2013), http://www.nytimes.com/2013/04/13/science/earth/epa-to-delay-emissions-rule-at-new-power-plants.html; John M. Broder, *E.P.A. Plans Delay of Rule on Emissions*, N.Y. TIMES (June 13, 2011), http://www.nytimes.com/2011/06/14/science/earth/14epa.html.

90. EPA, Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units, 77 Fed. Reg. 22,392, 22,392 (proposed Apr. 13, 2012) (to be codified at 40 C.F.R. pt. 60) [hereinafter EPA, *2012 NSPS Explanation*]; *see also* Reitze, *Coal-Fired Power Plants*, *supra* note 87, at 396.

91. Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units, 77 Fed. Reg. 22,392, 22,392, 22,395

posed an appreciably different 2013 NSPS applicable to four categories of fossil fuel-burning power plants. This sub-section of the article describes several unsatisfactory aspects of both proposed NSPS rules, and explains why the 2012 proposed rule was grossly inadequate from a mitigation perspective and why the 2013 proposed NSPS rule is even worse.

1. The 2012 NSPS Proposed Regulation

In 2012, EPA proposed CO_2 pollution controls for new fossil fuel-fired power plants because coal-burning facilities are responsible for discharging approximately one-third of all US anthropogenic CO_2 emissions. The Agency rightly contended that coal-fired power plants are the largest source of GHG discharges in the US[92] and coal-based EGUs must be strictly regulated because otherwise they will continue to exacerbate already severe global GHG pollution levels. In response, EPA chose to impose only one NSPS regulation on new fossil fuel-burning power plants:

> This proposal requires that all new fossil-fuel fired units that exceed 25 MW in capacity be able to meet an emission rate standard of 1,000 pounds of CO_2 per megawatt hour (lbs CO_2/MWh) calculated over a rolling 12-month period. It also proposes an alternative compliance option that would allow units to meet the 1,000 lbs CO_2/MWh standard using a 30-year averaging period. These standards could be met either by natural gas combined cycle (NGCC) generation with no additional GHG control or coal-fired generation using CCS.[93]

In its explanation of the 2012 proposed rule for this category of major GHG dischargers, the Agency concluded that new coal-fired power plants would not be able to meet the applicable NSPS regulation unless they could reduce their GHG discharges by sequestering approximately 50% of their emissions using a Carbon Capture and Storage (CCS) mechanism.[94] The CCS sequestration

(proposed Apr. 13, 2012) [hereinafter *2012 Proposed NSPS*]; EPA, *2012 NSPS Explanation, supra* note 90, at 22392.

92. *2012 Proposed NSPS, supra* note 91, at 22395.

93. *Regulatory Impact Analysis for the Proposed Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units*, ENVTL. PROT. AGENCY, ES-2 (Mar. 2012) [hereinafter *EPA, 2012 RIA*].

94. EPA, *2012 NSPS Explanation, supra* note 90, at 22392; Reitze, *Coal-Fired Power Plants, supra* note 87, at 403-04; *see also Carbon Dioxide Capture and Sequestration*, ENVTL. PROT. AGENCY, http://www.epa.gov/climatechange/ccs/index.html

process[95] would prove expensive and potentially unreliable, which explains why CCS is not yet a proven additional component of coal-fired energy generation in the US.[96] EPA was able to justify the relatively stringent technology-based requirements for coal-fired power plants by showing that the natural gas combined-cycle EGU facilities can meet the NSPS regulatory standard while discharging significantly fewer GHGs per million BTUs of heat and energy.[97]

EPA proposed relatively restrictive GHG pollution-control standards on new coal-fired electricity generating facilities because natural gas appeared to be a cleaner, cheaper alternative fuel that the Agency concluded would reduce annual GHG emissions substantially in relation to the volume of energy produced.[98] Indeed, in response to market forces rather than regulation, very few new coal-burning power plants have been commissioned in the last several years, and a number of existing coal-burning power plants have ceased operations or have modified their combustion process to use natural gas.[99] This market trend has occurred because natural gas has become widely available in the US at lower prices than current coal supplies.[100]

EPA's 2012 proposed NSPS had a number of serious weaknesses. First, there is no question that natural gas is also a harmful fossil fuel, and its widespread combustion over decades will discharge huge quantities of GHGs when natural gas is burned instead of coal.[101] In prescribing reliance on one fossil fuel source of GHG

(last updated Sept. 20, 2013) [hereinafter *EPA Carbon Dioxide Capture & Sequestration*].

95. *EPA Carbon Dioxide Capture & Sequestration, supra* note 94.

96. *Technology Roadmap: Carbon Capture and Storage*, INT'L ENERGY AGENCY (2013), http://www.iea.org/publications/freepublications/publication/ name,39359,en.html; WORLD COAL INST., COAL MEETING THE CLIMATE CHALLENGE: TECHNOLOGY TO REDUCE GREENHOUSE GAS EMISSIONS 17-31 (2008).

97. EPA, *2012 NSPS Explanation, supra* note 90, at 22392; Reitze, *Coal-Fired Power Plants, supra* note 87, at 404.

98. EPA, *2012 NSPS Explanation, supra* note 90, at 22392.

99. *Leveraging Natural Gas to Reduce Greenhouse Gas Emissions*, CENTER FOR CLIMATE AND ENERGY SOLUTIONS 2 (June 2013), http://www.c2es.org/docUploads/leveraging-natural-gas-reduce-ghg-emissions.pdf; *Natural Gas, Not Regulation, Driving Coal Plant Closures Higher: Report*, REUTERS POINT CARBON (Oct. 4, 2012), http://www.pointcarbon.com/news/1.2008872.

100. Clifford Krauss, *Coal Industry Pins Hopes on Exports as U.S. Market Shrinks*, N.Y. TIMES (June 14, 2013), http://www.nytimes.com/2013/06/15/business/energy-environment/a-fight-over-coal-exports-and-the-industrys-future.html?page wanted=all.

101. Jeff Tollefson, *Methane Leaks Erode Green Credentials of Natural Gas*, 493 NATURE No. 7430, 12 (Jan. 2, 2013); *see* Patrick Parenteau & Abigail Barnes, *A Bridge Too Far: Building Off-Ramps on the Shale Gas Superhighway*, 49 IDAHO L. REV. 325, 334-35 (2013).

pollution to reduce the hazards created by a somewhat more harmful source of GHGs,[102] EPA provided only limited information on the entire life-cycle of natural gas operations, including drilling, shipping, storage, combustion, and waste disposal. Considering these life-cycle factors, there is a serious question about how much more efficient and less expensive regulatory reliance on natural gas would actually be.[103]

An important concern arising from the increased reliance on natural gas for energy production is the undesirable release of methane, a potent greenhouse gas, as a result of the natural gas drilling and shipping processes.[104] EPA promulgated the NSPS rule designed to create incentives for replacing new coal-fired EGUs with new natural gas-fired power plants before it had carefully analyzed the various environmental ramifications of natural gas production and especially of hydraulic fracturing, the most plentiful extraction method for marketable natural gas now used in the US.[105]

Methane is the second most common GHG after CO_2, and one molecule of methane can trap more than 20 times as much heat in the atmosphere as a molecule of carbon dioxide. It is true that methane is not nearly as persistent as CO_2, but this may not be a great advantage if the amounts of methane emissions from diverse sources – hydraulic fracturing, melting tundras, increased livestock husbandry, ocean warming, and drilling for undersea methane

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102. *CO_2 Emissions from Fuel Combustion: Highlights 2013*, *supra* note 52, at 9.

103. *See* US EPA Office of the Inspector General, EPA Needs to Improve Air Emissions Data for the Oil and Natural Gas Production Sector, Report No. 13-P-0161 (Feb. 20, 2013) [hereinafter *EPA Inspector General Report*]; Resul Cesur, Erdal Tekin, & Aydogan Ulker, *Air Pollution and Infant Mortality: Evidence from the Expansion of Natural Gas Infrastructure*, (German Inst. for the Study of Labor, Discussion Paper IZA DP No. 7179, 2013), *available at* http://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID2212335_code589005.pdf.

104. Tollefson, *supra* note 101, at 12; Robert W. Howarth, Renee Santoro, & Anthony Ingraffea, Methane and the Greenhouse-Gas Footprint of Natural Gas from Shale Formations: A Letter, 106 CLIMATIC CHANGE 679–90 (2011), *available at* http://link.springer.com/article/10.1007%2Fs10584-011-0061-5.

105. *EPA Inspector General Report*, *supra* note 103; Hannah J. Wiseman, *Hydraulic Fracturing and Information Forcing*, 74 OHIO STATE L.J. FURTHERMORE 86 (2013), *available at* http://moritzlaw.osu.edu/students/groups/oslj/furthermore/; Stephen G. Osborn et al., *Methane Contamination of Drinking Water Accompanying Gas-Well Drilling and Hydraulic Fracturing*, 108 PNAS No. 20, 8172–76 (May 17, 2011); Ian Urbina, *Regulation Lax as Gas Wells' Tainted Water Hits Rivers*, N.Y. TIMES (Feb. 26, 2011), http://www.nytimes.com/2011/02/27/us/27gas.html/?pagewanted=all.

hydrates,[106] among others – continue to expand as new methane emissions replace previous methane pollutants in the air. Indeed, a recent study by 15 scientists found that methane "[e]missions from oil and gas activity alone could be five times greater than the prevailing estimate."[107] EPA has not yet seriously addressed the impact of "fugitive emissions" of methane that will be released by the hydraulic fracturing process for recovery of natural gas, which will vary with particular locations and drilling practices.[108] Consequently, the Agency's NSPS public explanation does not describe the overall environmental ramifications of replacing coal combustion with natural gas combustion.

If the 2012 NSPS favoring future reliance on natural gas in place of coal had survived political, business, and environmentalist criticisms, which it did not, it could actually have increased rather than decreased the overall harms resulting from coal-fired electricity generation. EPA has done nothing to prevent the sale of US coal to China, India, and other developing nations that rely heavily on coal combustion to generate needed energy.[109] A recent *New York Times* article stated that exports are "the only sure growth engine for the declining American coal industry."[110] The story also indicated that American coal exports roughly doubled between

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106. Hiroko Tabuchi, *An Energy Coup for Japan: 'Flammable Ice'*, N.Y. TIMES (Mar. 12, 2013), http://www.nytimes.com/2013/03/13/business/global/japan-says-it-is-first-to-tap-methane-hydrate-deposit.html?pagewanted=all.

107. Michael Wines, *Emissions of Methane in U.S. Exceed Estimates, Study Finds*, N.Y. TIMES (Nov. 25, 2013), http://www.nytimes.com/2013/11/26/us/emissions-of-methane-in-us-exceed-estimates-study-finds.html.

108. Michael Obeiter & James Bradbury, *A Close Look at Fugitive Methane Emissions from Natural Gas*, WRI INSIGHTS (Apr. 2, 2013), http://insights.wri.org/news/2013/04/close-look-fugitive-methane-emissions-natural-gas; Tollefson, *supra* note 101, at 12; Ramón A. Alvarez et. al, *Greater Focus Needed on Methane Leakage from Natural Gas Infrastructure*, 109 PNAS, No. 17, 6435-40 (Apr. 24, 2012), *available at* http://www.pnas.org/content/early/2012/04/02/1202407109.abstract; Tom M. L. Wigley, *Coal to Gas: The Influence of Methane Leakage*, 108 CLIMATIC CHANGE 601, 601-608 (2011), *available at* http://link.springer.com/article/10.1007%2Fs10584-011-0217-3.

109. Assaad W. Razzouk, *Asia Set to Roast the Planet: We Need Leadership from China, Indonesia, India and the Philippines*, THE INDEPENDENT (July 2, 2013), www.independent.co.uk/voices/comment/asia-set-to-roast-the-planet-8683620.html; *see also* Mukul Sanwal, *Climate Change Can No Longer Be Ignored: Modify Lifestyles for Sharing Responsibility and Prosperity*, INDIA ENVTL. PORTAL (June 8, 2013), http://www.indiaenvironmentportal.org.in/content/376170/climate-change-can-no-longer-be-ignored-modify-lifestyles-for-sharing-responsibility-and-prosperity/; Andrew C. Revkin, *Tough Truths from China on CO2 and Climate*, N.Y. TIMES (Feb. 26, 2013), http://dotearth.blogs.nytimes.com/2013/02/26/tough-truths-from-china-on-co2-and-climat/.

110. Krauss, *supra* note 100.

2009 and 2012, and "the big potential market for American coal remains in Asia."[111]

One distinctive feature of GHG discharges, in contrast to other air pollutants regulated under the CAA, is that any American coal exported to generate energy in distant nations would create harmful greenhouse gas discharges that will eventually be widely dispersed by the jet stream and other wind currents. The fungible CO_2 discharges from exported coal, oil, and natural gas will combine with the already-too-high atmospheric GHG concentration and will gradually spread around the world. It is vital to understand EPA's proposed NSPS that would substitute natural gas for coal does not prevent the sale of US coal for combustion in other nations, which will ultimately result in GHG pollution adversely affecting climate conditions just as if it had been burned here and endangering our own citizens just as much as the vulnerable people in other nations.

One reviewer of a previous version of this article wrote: "It seems inappropriate to fault EPA for doing nothing to stop exports of coal to China. Does EPA have the authority to address that problem?" I disagree with this comment. In his 2013 State of the Union Address, President Obama asserted: "[I]f Congress won't act soon to protect future generations, I will. I will direct my Cabinet to come up with executive actions we can take, now and in the future, to reduce pollution, prepare our communities for the consequences of climate change, and speed the transition to more sustainable sources of energy."[112] This position makes clear that the President is not relying exclusively on EPA to combat climate change, but instead would consider "executive actions" from all agencies supervised by his Cabinet and Administration.

The government has imposed bans or severe restrictions on a number of dangerous products that may be exported from, or imported into, the US, including heroin, cocaine, and other drugs; various endangered species and endangered species parts such as ivory, rhino horns, and bear gall bladders; and unauthorized black-market sales of munitions and armaments. EPA is not primarily responsible for any of these restricted activities, but it works in partnership with the Fish and Wildlife Service and National Oceanic and Atmospheric Administration (NOAA) to moderate trade in wildlife species.

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111. *Id.*

112. *2013 State of the Union Address, supra* note 17.

I believe it is important to recognize that allowing major coal exports to countries that will burn the coal for energy production will be more harmful to the American people and the world's population than all of the other proscribed products combined. Thus, while I do not believe EPA can directly eliminate coal exports, the Agency has the ability to work with other agencies that do have the necessary authority. Of course, it would be desirable if Congress imposed an explicit ban on coal exports, but in the present hyper-partisan political era, EPA cannot afford to wait for congressional action, and the Agency could work with other relevant agencies as President Obama proposed to restrict dangerous coal exports.

I am sure EPA knows that the proponents of ambitious climate change mitigation want to see fossil fuels left in the ground,[113] where they remained for many millions of years until humans began extracting vast quantities of them during the past two centuries. These mitigation proponents do not want to see coal or other fossil fuels exported to countries that will burn them and release dangerous amounts of greenhouse gases that will come back to haunt us.[114] And yet the EPA proposed NSPS rule and its related regulatory policies would do nothing to prevent this extremely probable climate change mitigation disaster. I have found no documents or evidence suggesting that EPA is trying in any way to cooperate with other agencies in efforts to control coal exports.

Instead of emphasizing the need for decarbonization, which requires that clean GHG-free or very-low-GHG replacement technologies replace fossil fuel-burning technologies as rapidly as feasible, which would greatly reduce the amount of GHGs from energy and heat production, EPA has chosen to replace one harmful fossil fuel with another harmful fossil fuel that may not be quite as dangerous as coal but will still contribute to large annual GHG emissions levels adding to the continuing harmful growth of the

113. *See* HANS-WERNER SINN, THE GREEN PARADOX: A SUPPLY-SIDE APPROACH TO GLOBAL WARMING (MIT Press 2012); PETER TERTZAKIAN & KEITH HOLLIHAN, THE END OF ENERGY OBESITY (John Wiley & Sons 2009); Press Release, *European Climate Foundation*, Scientists Expose Coal Industry's False Claims About "High-Efficiency Coal"; No More Room for New Unabated Coal (Nov. 18, 2012) [hereinafter *European Climate Foundation*], *available at* http://europeanclimate.org/scientists-expose-false-claim-about-high-efficiency-coal-no-more-room-for-new-unabated-coal/.

114. *See* Elijah Zarlin, *The #NoKXL Fight This Summer*, CREDOACTION.COM (July 17, 2013); *see also Unburnable Fuel: Either Governments Are Not Serious About Climate Change or Fossil-Fuel Firms Are Overvalued*, ECONOMIST (May 4, 2013), http://www.economist.com/news/business/21577097-either-governments-are-not-serious-about-climate-change-or-fossil-fuel-firms-are; Sean Lennon, *Destroying Precious Land for Gas*, N.Y. TIMES (Aug. 27, 2012), http://www.nytimes.com/2012/08/28/opinion/sean-lennon-destroying-precious-land-for-gas.html.

cumulative atmospheric GHG concentration.[115] Again, we return to a central theme of this article: Modest reductions in greenhouse gas discharges, such as will probably occur by substituting natural gas in place of coal, cannot be effective mitigation measures if the regulated processes continue to discharge huge volumes of residual GHGs into the atmosphere, thereby increasing the cumulative GHG concentration that more than any other factor causes global warming and climate change.

Because EPA authorized the substitution of natural gas for coal-based energy generation, but would only have applied this approach to the 2012 NSPS for new electricity generators in the first round of regulations, it is likely that industrial GHG sources in other industries will follow EPA's lead and will replace coal use with cheaper natural gas combustion. This transition is already happening in the energy market for purely economic cost reasons.[116] Instead of promoting investments in the development and dissemination of clean GHG-free technologies, other industries may feel "safer" by adopting the same natural gas substitution process that EPA has approved. This is hardly a desirable prospect because it may encourage many different kinds of coal-burning GHG sources, which are not yet subject to regulation, to convert to a natural gas burning process bound to produce a very large quantity of residual GHGs that will increase the critical atmospheric GHG concentration.

Another problem with the proposed 2012 NSPS occurs because EPA has set its EGU regulatory restrictions by comparing the amount of energy produced in relation to the amount of GHGs discharged. As EPA explained, the regulations would impose "an emission rate standard of 1,000 pounds of CO_2 per megawatt hour (lbs CO_2/MWh) calculated over a rolling 12-month period."[117] It is very likely that a substantial increase in US energy demand will occur during the next few decades,[118] which will justify a corresponding quantitative increase in the annual volume of GHGs the NSPS would authorize. In other words, if US energy needs and electricity generation double in the future because of population growth and

115. *See* Parenteau & Barnes, *supra* note 101, at 334-35.

116. US Power Plant Emissions Tumble On Shift To Natural Gas, REUTERS (Oct. 23, 2012), http://www.reuters.com/article/2013/10/23/usa-environment-emissions-idUSL1N0ID1FQ20131023.

117. *EPA, 2012 RIA*, *supra* note 93, at ES-2.

118. Eduardo Porter, *Unavoidable Answer for the Problem of Climate Change*, N.Y. TIMES (Nov. 19, 2013), http://www.nytimes.com/2013/11/20/business/economy/unavoidable-answer-to-problem-of-climate-change.html.

economic growth, the 2012 NSPS would allow a corresponding two-fold increase in the volume of GHG emissions allowed to be discharged into the air. This treatment is inconsistent with the CAA goal of reducing air pollution[119] causing the "endangerment" of Americans, which is the underlying purpose of the entire regulatory scheme.

2. The 2013 NSPS Proposed Regulation

In place of the 2012 single NSPS emissions-reduction target intended to regulate new coal-fired and natural gas-fired power plants, EPA's 2013 proposed NSPS imposes four separate regulations for different types of large fossil fuel generating facilities:

NATURAL GAS-FIRED STATIONARY COMBUSTION TURBINES

- The proposed limits are based on the performance of modern natural gas combined cycle (NGCC) units. EPA is proposing two standards for natural gas-fired stationary combustion units, depending on size. These standards are:
  - 1,000 pounds of CO_2 per megawatt-hour (lb CO_2/MWh-gross) for larger units (>850 mmBtu/hr)
  - 1,100 lb CO_2/MWh-gross for smaller units (≤850 mmBtu/hr)
- New natural gas-fired stationary combustion turbines can meet the proposed standard without the need for add-on control technology.

FOSSIL FUEL-FIRED UTILITY BOILERS AND INTEGRATED GASIFICATION COMBINED CYCLE UNITS

- The proposed limits for fossil fuel-fired utility boilers and IGCC units are based on the performance of a new efficient coal unit implementing partial carbon capture and storage (CCS). This approach ensures that any new fossil fuel-fired utility boiler or IGCC EGU will use modern, available technology to minimize emissions.
- EPA is proposing two limits for fossil fuel-fired utility boilers and IGCC units, depending on the compliance period that best suits the unit. These limits require capture of only a portion of the CO_2 from the new unit. These proposed limits are:

119. *See generally* David M. Driesen, *Cap Without Trade: A Proposal for Resolving the Emissions Trading Problem Under CAA §111*, 43 ENVTL. L. REP. NEWS & ANALYSIS 10555, 10556 (2013).

- ° 1,100 lb CO_2/MWh-gross over a 12-operating month period, or
- ° 1,000-1,050 lb CO_2/MWh-gross over an 84-operating month (7-year) period

- The longer compliance period option provides flexibility by allowing sources to phase in the use of partial CCS. The owner/operator can use some or all of the initial 84 operating month period to optimize the system. EPA is soliciting comment on what the standard should be within the proposed range.[120]

All of the criticisms above of the 2012 proposed NSPS are equally applicable to the 2013 proposed NSPS – high GHG discharges from natural gas combustion; undesirable ramifications of coal exports to other nations; inadequate life-cycle assessments of the long-term environmental impacts of conversion from coal to natural gas; fugitive methane emissions from the natural gas production process; future increases in authorized GHG emissions as a function of higher demand for energy in the US;[121] and relatively small GHG reductions that would not contribute promptly or substantially to reducing the cumulative air pollution concerns at the heart of the CAA and climate change mitigation.

EPA's decision to encourage replacing one fossil fuel with another fossil fuel will reduce domestic annual GHG discharges by some appreciable amount, but it will nonetheless allow vast residual emissions from natural gas combustion to increase the cumulative GHG concentration in the atmosphere. Thus, EPA's natural gas-based NSPS regulations cannot plausibly represent a climate change remedy or significant mitigation improvement, and over time these regulations will instead contribute to raising the atmospheric GHG concentration and allowing climate change risks to become worse, not better.

The most notable change between the 2012 and 2013 proposed NSPS regulations is the relatively more permissive treatment of new coal-fired power plants. EPA stated that it has made these changes as a result of receiving 2.5 million comments on the pro-

120. *EPA Fact Sheet: Reducing Carbon Pollution from Power Plants: Details About the Proposal for New Sources*, ENVTL. PROT. AGENCY, 3-4 (Sept. 20, 2013) [hereinafter *EPA Fact Sheet: Reducing Carbon Pollution*]. For references to the Sept. 20, 2013 draft NSPS materials, see *infra* note 131.

121. *See Regulatory Impact Analysis for the Proposed Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units*, ENVTL. PROT. AGENCY, 5-10 (Sept. 2013) [hereinafter *EPA, 2013 RIA*]. For references to the Sept. 20, 2013 draft NSPS materials, see *infra* note 131.

posed 2012 NSPS.[122] It is doubtful that many laypeople submitted comments on these complicated issues, and I suspect the most influential comments came from coal industry firms, coal industry lobbyists, and politicians from coal mining states. As a result, the 2013 proposed NSPS is somewhat less demanding for coal-based energy interests. Indeed, a close inspection of the four regulations indicates that new coal-burning power plants receive a nine percent competitive regulatory advantage over large natural gas-burning power plants (1100lbs CO_2/MWh for coal, 1000lbs CO_2/MWh for natural gas).

What is a new "efficient coal unit" as identified in the 2013 NSPS? Supercritical and ultracritical pulverized coal EGUs have a significantly higher combustion temperatures than typical coal-fired power plants, and this higher temperature leads to more complete burning of the coal fuel with comparatively fewer GHG pollution emissions per measure of energy output. Innovative coal gasification processes have recently been developed that also enable the coal feedstock to be burned at a higher level of efficiency with fewer pollution byproducts. It is true that these more efficient coal-combustion processes are "cleaner" than traditional coal-burning power plants,[123] but they are not "clean coal" facilities, which do not exist anywhere.[124] Coal is carbon! And the burning of coal in a relatively more efficient manner still generates very large quantities of CO_2 emissions.[125]

A group of more than two dozen scientists, some of whom have participated in IPCC climate assessments, recently issued a statement that I believe is completely valid: "Even the most efficient coal-fired power plants emit more than about 15 times the amount of CO_2 per amount of electricity compared to renewable energy systems, and more than twice the amount of efficient gas powered plants. It is misleading to talk about 'high efficiency low-emissions

122. *Withdrawal of Proposed Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units*, ENVTL. PROT. AGENCY, 1 (Sept. 20, 2013). For references to the Sept. 20, 2013 draft NSPS materials, see *infra* note 131.

123. *See generally* Keith Bradsher, *A Greener Solution, or the Dark Side to Cleaner Coal?*, N.Y. TIMES (June 14, 2011), http://www.nytimes.com/2011/06/15/business/energy-environment/15iht-sreCHINA15.html?pagewanted=all&_r=0.

124. *See* European Climate Foundation, *supra* note 113.

125. *New Unabated Coal is Not Compatible with Keeping Global Warming Below 2° C*, EUROPEAN CLIMATE FOUNDATION, 3 (Sept. 18, 2013), *available at* www.europeanclimate.org/documents/nocoal2c.pdf.

coal combustion technologies' unless equipped with CO_2 capture and storage."[126]

In its explanation of the 2012 proposed rule, EPA predicted that new coal-fired plants could not meet the designated pollution-control target, which was based on the capacities of combined cycle (energy and heat) natural gas-combustion power plants, unless new coal-burning power plants with CCS facilities could sequester at least 50 percent of the GHG emissions they produce.[127] The 2013 proposed NSPS rules, in contrast, "are based on the performance of a new efficient coal unit implementing partial carbon capture and storage (CCS)."[128] This treatment does not present any quantitative measure of how extensive and effective "partial CCS" would need to be. Instead, EPA apparently will have to negotiate individualized GHG pollution-control restrictions and sequestration requirements to establish the "Best System of Emissions Reduction" (BSER) for each new coal-fired power plant planned for construction in the near future.

A serious flaw in the 2013 regulatory proposals, perhaps it qualifies as a tragedy, is that EPA evidently devoted much more time and effort to reducing the costs of the NSPS for the coal-burning and natural gas-burning categories of regulated new power plants than EPA expended on limiting the many environmental and human damages from expanded fossil fuel-burning power plant GHG emissions.

As one illustration, the Agency's Regulatory Impact Analysis (RIA) for the 2013 NSPS states: "Consistent with the LCOE [levelized cost of electricity] estimates . . . , the partial capture CCS scenarios achieve the proposed emissions rate of 1,100 lb CO_2/MWh gross output. The full capture CCS scenarios achieve an emissions rate of 200 lb CO_2/MWh and 150 lb CO_2/MWh for SCPC and IGCC,[129] respectively."[130]

Why did EPA choose to impose the less stringent GHG emissions-reduction requirement using partial CCS rather than the mitigation choice using full CCS that in comparison could have cut around 80 percent more of the GHG emissions from coal-fired EGU operations? EPA could have imposed a 50 percent CCS minimum requirement, as the 2012 proposed NSPS would have done,

126. *Id.*

127. EPA, *2012 NSPS Explanation*, *supra* note 90, at 22392.

128. *EPA Fact Sheet: Reducing Carbon Pollution*, *supra* note 120, at 3.

129. The acronyms SCPC and IGCC stand for Super Critical Pulverized Coal and Integrated Gasification Combined Cycle.

130. *EPA, 2013 RIA*, *supra* note 121, at 5-50.

or EPA could have insisted on full CCS (more than 90% CO_2 capture) for newly constructed coal-burning facilities in order to minimize their CO_2 discharges. But the Agency did neither; instead, it chose the least expensive way for new coal-powered facilities to reduce their GHG discharges by a significantly lesser amount than full CCS would have made possible. In the text of the 2013 proposed NSPS, EPA stated:

> The EPA believes the cost of "full capture" CCS without EOR is outside the range of costs that companies are considering for comparable generation and therefore should not be considered BSER for CO_2 emissions for coal-fired power plants. The EPA projects the LCOE [levelized cost of electricity] of generation technologies with full capture CCS to be in the range of $136/MWh to $147/MWh (without EOR benefits). Because these "full capture" CCS costs without EOR are significantly above the price range of potential alternative generation options, the EPA believes that full capture CCS does not meet the cost criterion of BSER.[131]

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131. EPA, STANDARDS OF PERFORMANCE FOR GREENHOUSE GAS EMISSIONS FROM NEW STATIONARY SOURCES: ELECTRIC UTILITY GENERATING UNITS 30-31 (Sept. 20, 2013) [hereinafter *2013 Proposed NSPS*], *available at* http://www2.epa.gov/sites/production/files/2013-09/documents/20130920proposal.pdf.

When EPA published a number of documents supporting the 2013 proposed NSPS for fossil fuel power plants, these documents were accompanied by the following qualification:

> The EPA Administrator, Gina McCarthy, signed the following notice on 9/20/2013, and EPA is submitting it for publication in the *Federal Register* (FR). While we have taken steps to ensure the accuracy of this Internet version of the rule, it is not the official version of the rule for purposes of compliance. Please refer to the official version in a forthcoming FR publication, which will appear on the Government Printing Office's FDSys website (http://fdsys.gpo.gov/fdsys/search/home.action) and on Regulations.gov (http://www.regulations.gov) in Docket No. EPA-HQ-OAR-2006-0790. Once the official version of this document is published in the FR, this version will be removed from the Internet and replaced with a link to the official version.

Id. at 1.

The formal proposed NSPS was eventually published on January 8, 2014, 79 Fed. Reg. 1429-1519. I did not find any material changes with regard to new fossil fuel power plants. However, the Introduction to the proposed NSPS observed: "This action also includes related proposals concerning permitting fees under Clean Air Act Title V, the Greenhouse Gas Reporting Program, and the definition of the pollutant covered under the prevention of significant deterioration program." Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units, 79 Fed. Reg. 1430, 1430 (proposed Jan. 8, 2014) (to be codified at 40 C.F.R. pt. 60, 70, 71, et al.).

In other words, EPA set the "Best System of Emissions Reduction" for new coal-fired power plants not based on what option would reduce CO_2 emissions the most while remaining economically feasible, but rather on what price range for the NSPS rule would be most in line with the costs private power companies now are willing to pay for new coal-fired plants with partial CCS. EPA did not find that the cost of full CCS was outside the financial capacity of the coal-burning energy industry. Rather, the Agency found that the cost of full CCS would be higher than the average costs the industry itself was intending to pay for new power plants.

This is a distinctly unsuitable EPA treatment: technology-based pollution-control standards are statutorily and historically based on the best available control technologies and on what leading firms in a regulated industry can afford to pay (economic feasibility) without losing their competitiveness. Conventional environmental regulations grounded on technological and economic feasibility have never been limited to what an industry chooses to pay voluntarily for its own private new facilities.

For decades, if not centuries, coal-burning power plants have been among the greatest externalizers of severe air pollution and water pollution harms resulting from emissions of mercury, sulfur oxides, nitrogen oxides, and vast quantities of particulate matter, as well as unpleasant aromas and vistas. These externalized harms have never been incorporated into the production and operating costs of the coal-fired power plants or into related energy prices, and consequently the market price of coal combustion for energy has consistently been much lower and the profit margin much higher than it should have been. And yet, EPA has chosen to ignore these externalities and market price distortions, and instead to set the BSER for the 2013 NSPS according to the externality prices of privately-owned coal-burning power plants and combined cycle natural gas plants while the Agency flatly dismissed the substantial GHG reductions that the Agency's own documents show would be attainable through the application of full CCS because this regulation would force the coal industry to make larger mitigation investments.

Here is another questionable treatment involving the potential utility of CCS to reduce CO_2 discharges into the atmosphere. EPA

In light of this article's projected publication date, there was not enough time to change all the cited pages from the Sept. 20, 2013 draft to the Jan. 8, 2014 Federal Register page numbers. The Sept. 20, 2013 proposed NSPS draft materials are available on the author's web site at http://ecovitality.org/climate/2013NSPS.zip.

based the 2013 NSPS pollution-control target on the currently achievable GHG discharge rate for natural gas combined-cycle (energy and heat) power plants, which are expected to dominate the future market for energy production in America.[132] This prediction was based on the relatively low price and wide availability of natural gas fuels. EPA set the fossil fuel NSPS to be no more demanding than the projected costs of new natural gas combined-cycle generating facilities, and therefore the NSPS rule imposed no additional GHG emissions-reduction limits on natural gas power plants. This approach did not require EPA to explain satisfactorily why the annual volume of CO_2 emissions from natural gas combined-cycle generators could not be substantially reduced at an affordable price by requiring new natural gas-fired combined-cycle power plants as well new coal-burning plants to adopt partial or full CCS.

EPA tried to draw a distinction between coal and natural gas by contending that most new coal-fired power plants include partial CCS in their design plans, but no new natural gas combined-cycle plants are voluntarily planning to include CCS.[133] This is a weak argument: the coal-fired industry recognizes that it cannot build new coal-fueled power plants without CCS, but the natural gas energy industry can meet the 2013 NSPS targets without CCS and therefore has no incentive to spend more money to add CCS to their design choices. This preference for avoiding additional regulatory costs does not mean that CCS for natural gas combined cycle plants cannot be reasonably "demonstrated," as the BSER standard requires. Instead, it simply means that the natural gas industry does not wish to spend more than they have to spend under weak EPA regulations. If pollution-control regulations were generally limited to whatever mitigation measures the polluters were willing to pay for, it should not be surprising that the 2013 NSPS could only achieve "negligible" emissions reductions.

EPA also claimed that emissions from coal-burning power plants have a much higher percentage of CO_2 than discharges from natural gas plants, which the Agency interpreted to mean that CCS experiences with coal would not ensure that CCS for emissions from natural gas facilities have been "demonstrated."[134] However, EPA failed to explain why CCS would not work reasonably well for

132. *See 2013 Proposed NSPS*, *supra* note 131, at 34. For references to the Sept. 20, 2013 draft NSPS materials, see *supra* note 131.

133. *Id.* at 34-35.

134. *Id.* at 35-37.

CO_2 emissions from natural gas plants even if the particular mix of polluting gases is not the same as emissions from coal plants. CCS involves storing waste gases deep underground; it does not require that all of the gases have the same mix or composition.

According to EPA there is sufficient evidence of "demonstrated" CCS technology for coal-fired facilities but not for natural gas power plant discharges. However, coal and natural gas combustion facilities are producing the same core pollutant, persistent CO_2, and we also have a lot of experience in pushing high pressure substances underground using hydraulic fracturing techniques. The requirement for "demonstrated" emissions reduction technologies under the BSER standard has never been applied solely and exclusively to each particular regulated industry.

I believe a close reading of the 2013 NSPS documents shows that EPA did not want to impose CCS requirements on natural-gas combined-cycle power plants because CCS, although affordable, would add additional regulatory costs beyond the expectations of new natural gas facility owners. Again, minimizing regulatory costs for heavily polluting industries seems to be a higher EPA priority than substantially reducing GHG emissions and climate change risks.

CCS could prove very useful if the sequestration process is safe and successful,[135] because this process might reduce some of the adversarial conflicts and political wrangling that are bound to play a major part in the transition from fossil fuel combustion to adopting clean energy alternatives. However, EPA did not provide sufficient information on the long-term safety of sequestering CO_2 underground for centuries or millennia.[136]

After describing a variety of commercial uses that could be made of the captured CO_2, the 2013 NSPS RIA observed: "Consideration of how these alternatives could meet the performance standard involves understanding the ultimate fate of the captured CO_2 and the degree to which the method permanently isolates the CO_2 from the atmosphere, as well as existing methodologies to verify this permanent storage."[137] That insubstantial comment was the longest statement I found in the entire Regulatory Impact Analysis

135. *See Global Action to Advance Carbon Capture and Storage Accelerating the Transition to Clean Energy Technologies: A Focus on Industrial Applications*, INT'L ENERGY AGENCY (2013), *available at* http://www.iea.org/publications/freepublications/publication/CCS_Annex.pdf.

136. *See* BERT METZ, ET AL., IPCC SPECIAL REPORT ON CARBON CAPTURE AND STORAGE (Cambridge Univ. Press 2005).

137. *EPA, 2013 RIA*, *supra* note 121, at 4-22.

pertaining to the safety of sequestering CO_2 for a very long period of time.

CO_2 is the most persistent GHG, which means it must remain sequestered underground for centuries or longer before the CCS process can fairly be described as "safe." EPA should not have developed and publicized a proposed NSPS emphasizing the need for "partial" CCS for new coal-fired power plants without discussing the climate risks associated with a longitudinal safety problem of major dimensions. Let me be clear that there was plenty of discussion in the 2013 NSPS materials about the availability of thousands of potential geological sites suitable for CCS sequestration; about the current and planned coal-energy projects that had chosen to use partial CCS; and especially about the relative costs of varying degrees of CCS and whether they would make a new coal-burning power plant too expensive to compete effectively with other "efficient" facilities.[138] What EPA did not do was to devote serious attention to the long-term environmental safety of these projects.

An EPA "technical fact sheet" accompanying the proposed 2013 NSPS was one of the documents identifying the "proof" on which the Agency relied in determining that partial CCS would be an effective technology for new fossil fuel-fired power plants:

> Current and planned implementation of CCS projects, combined with the widespread availability and capacity of geological storage sites, makes it clear that the technology is feasible.
>
> In the US, a coal gasification plant has been capturing approximately 50 percent of its CO2 and providing it for EOR use for more than 10 years. Another coal gasification project with CCS is over 75 percent complete. Two more IGCC projects – both of which include CCS – are in advanced stages of development.[139]

This is hardly sufficient proof of the long-term safety of CCS. EPA accepted partial CCS as the best system of emission reduction (the statutorily required BSER) for new coal-fired power plants with very little practical experience ensuring the safety requirements for CO_2 storage underground for a very long period.

In January 2014, a group of business representatives arranged a meeting with Janet McCabe, the EPA official responsible for air pol-

138. *See 2013 Proposed NSPS*, *supra* note 131, at 155-56. For references to the Sept. 20, 2013 draft NSPS materials, see *supra* note 131.

139. *EPA Fact Sheet: Reducing Carbon Pollution*, *supra* note 120, at 4.

lution programs, to challenge the Agency's decision to require partial CCS for new coal-burning power plants. At this meeting:

> National Association of Manufacturing Vice President for Energy and Resources Policy Ross Eisenberg led the delegation of approximately 15 industry representatives, which included CCS manufacturers Babcock & Wilcox Power Generation Group and Thermo Fisher Scientific.
>
> The message, Eisenberg said, was that CCS is not at a stage where it can allow industry to comply with EPA's proposed requirement for new coal plants. In fact, requiring its use, the group said, would make it even less likely that new coal plants would be built at all, with or without CCS.
>
> "All of us basically said the same thing, which is 'This is not ready,'" Eisenberg said.
>
> It is a point that NAM has made repeatedly in comments on a 2012 version of the proposal for new power plants and plans to make again in comments on the newly published reproposal. But Eisenberg said he hoped that McCabe and her staff were particularly impressed that companies that build and sell CCS components were also making it.[140]

Nevertheless, the availability of partial CCS technology is a crucial factor in EPA's determined attempts to justify the development of "dirty" new coal-burning power plants, and EPA has not yet modified or qualified its reliance on CCS in the 2013 NSPS for fossil fuel power plants.

A central theme in the 2013 RIA was that, instead of immediately storing the CO_2 in deep formations under the earth's surface or beneath the ocean, many fossil fuel-powered EGUs could reduce their operating costs by selling their CO_2 emissions to facilitate Enhanced Oil Recovery (EOR) or Enhanced Gas Recovery (EGR). The stream of compressed CO_2 would be sent by pipelines to depleted oil or gas fields, where the CO_2 would be injected under high pressure into the underlying rock and would force the fossil fuels through rock fissures into accessible areas where they could be pumped out of the renewed energy fields.[141]

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140. Jean Chemnick, *Manufacturers Meet with McCabe on New Power Plant Rules*, E&E NEWS PM (Jan. 16, 2014).

141. *EPA, 2013 RIA, supra* note 121, Chapter 4.

The EOR/EGR process should appear familiar to environmentalists and energy experts because it shares most characteristics of the controversial practice of hydraulic fracturing (aka hydrofracking), except that the latter process uses chemical-adulterated water under pressure instead of compressed CO_2 to free up recalcitrant fossil fuels from their long-time sedimentary formations. The 2013 RIA did not mention the similarity between EOR and hydrofracking or acknowledge any environmental problems that are becoming progressively better recognized as hydrofracking is authorized in some areas and prohibited in others.[142]

The 2013 NSPS Regulatory Impact Assessment did not discuss the risk of CO_2 "leakage" into unknown fissures in the underground rocks or into moribund oil and gas wells;[143] or the possibility that the compressed gas in particular instances might reach so high a pressure that it could cause a subterranean explosion, releasing significant amounts of CO_2. The RIA analysis also did not address potential drinking water contamination[144] if escaped CO_2 interacts with groundwater to form carbonic acid – which is the major cause of well-publicized ecological damage from ocean acidification.[145]

Concerned citizens who care whether these environmental and community problems will materialize in the EOR context should be displeased that the EPA materials explaining the 2013 proposed NSPS regulations encourage EOR and CCS applications for dozens of pages, but they do not discuss the environmental and social risks of using CO_2 for EOR on more than one or two pages. Of greater concern, the captured CO_2 will be used in the EOR process to promote additional oil production from depleted oil fields, and will

142. *See, e.g.*, Hannah J. Wiseman, *Risk and Response in Fracturing Policy*, 84 U. COLO. L. REV. 729 (2013); Elizabeth Burleson, *Cooperative Federalism and Hydraulic Fracturing: A Human Right to a Clean Environment*, (Pace U. L. Sch., Working Paper, 2013).

143. *See* Mathew L. Wald, *New Tools Pinpoint Natural Gas Leaks, Maximizing a Fuel's Green Qualities*, N.Y. TIMES (Aug. 6, 2013), http://www.nytimes.com/2013/08/07/business/energy-environment/new-tools-pinpoint-natural-gas-leaks-maximizing-a-fuels-green-qualities.html?_r=0 (discussing the danger of natural gas "leakage," which would be similar to CO_2 leakage).

144. *See* Thomas W. Merrill & David M. Schizer, *The Shale Oil and Gas Revolution, Hydraulic Fracturing, and Water Contamination: A Regulatory Strategy*, (Colum. L. Sch. Ctr. for L. & Econ., Working Paper No. 440, 26-27, 2013), *available at* http://www8.gsb.columbia.edu/sites/richman/files/files/Fracturing3_13.pdf.

145. *UN General Assembly Set to Explore Impacts of Ocean Acidification*, UN NEWS CENTRE (June 17, 2013), http://www.un.org/apps/news/story.asp?NewsID=45191#.UrI_avRDtqU; Sarah R. Cooley, et al., *Ocean Acidification's Potential to Alter Global Marine Ecosystem Services*, 22 OCEANOGRAPHY 172, 172-81 (Dec. 2009), *available at* http://www.tos.org/oceanography/archive/22-4_cooley.pdf.

consequently increase the fossil fuel pollution from oil exploitation.[146] EPA's core assertion that CCS will reduce CO_2 emissions from coal-burning power plants is questionable if we recognize that the EOR process that EPA recommends is bound to increase discharges of GHG emissions from greater reliance on oil in a variety of ways. Yet, I have not found any serious EPA discussion of this major shortcoming in the Agency's positive treatment of EOR usage in conjunction with partial CCS. This analytical imbalance shows EPA's greater priority on reducing regulatory costs for the coal industry than on reducing CO_2 discharges that are compounding the atmospheric GHG concentration and causing climate change dangers to become progressively worse.

If the 2013 proposed NSPS is challenged in lawsuits, which it probably will be, on the grounds that EPA failed to provide a comprehensive and balanced assessment of the benefits and risks created by the proposed regulatory mandates, I do not see how EPA could possibly prevail except perhaps on a no-standing rationale.

Because the CAA requires NSPS regulations to be reviewed every 8 years, EPA used an 8-year assessment period in calculating most of the costs, benefits, and energy impacts of the 2013 NSPS.[147] However, this is not an adequate timeframe for controlling or utilizing CO_2 emissions that will be persistent for centuries or longer. The fact that EPA's 2013 NSPS documents rarely discussed or even mentioned the long-term climate and health risks from EOR and CCS shows the Agency's emphasis on minimizing regulatory costs rather than on minimizing climate change degradation.

In another example showing EPA's attempts to reduce administrative burdens imposed by GHG regulation, the Agency decided under its "tailoring rule" to "defer" restricting GHG emissions from nearly all other categories of major GHG dischargers, including biological (biogenic) CO_2 sources. This deferred non-regulation of the biogenic industry GHG emissions was rejected in *Center for Biological Diversity v. EPA*, by the US Court of Appeals for the District of Columbia Circuit,[148] on the grounds that companies building new biogenic power plants or other GHG-polluting biogenic facilities during EPA's "deferral" period would never have to meet relatively more demanding NSPS mandates unless they modified their opera-

146. *Obama's Clean Coal Boosts Oil Production*, MSN NEWS, http://news.msn.com/videos?videoid=7ae4c68f-8abb-3965-f42a-34351c102ac8 (last visited Dec. 30, 2013).

147. *See EPA, 2013 RIA*, *supra* note 121, at 1-2.

148. *Ctr. for Biological Diversity v. EPA*, 722 F.3d 401, 404-12 (D.C. Cir. 2013).

tions substantially in the future after the "deferral" period has ended. The court held that EPA's convenience and the absence of scientific certainty were not sufficient rationales for insulating major new GHG sources from any NSPS pollution-control regulations for an indefinite period of time.[149]

This EPA treatment of biogenic sources would have created an undesirable "double-whammy" in situations where tree log combustion was being used to generate electricity in place of coal-fired EGUs. The "deferral" period would have authorized a large volume of GHG pollution from burning tree trunks to remain unregulated, and it would also have encouraged deforestation – reducing one of the leading "natural sinks" for CO_2 – because forestry businesses could profit by turning raw logs into energy fuels with minimal or no air pollution controls.

The decision of the D.C. Circuit Court in *Center for Biological Diversity* suggests the weakness of the 2013 proposed NSPS treatment that goes no further than matching whatever degree of CO_2 emissions reduction targets the coal-fired and natural gas-fired power industries have voluntarily chosen to meet in constructing new generating facilities. The EPA documents and arguments supporting the 2013 proposed NSPS for new fossil fuel-fired power plants certainly do not place environmental protection in a primary position despite EPA's supposed institutional focus.

I am not contending that the major EPA leaders were evil or "captured" by energy industry interests, but rather that they allowed themselves and their subordinates to succumb to a difficult array of political, economic, and cognitive pressures.[150] They became more focused on minimizing the potential economic costs of their proposals than on the health and environmental ramifications, because they were being attacked by frequent claims of prohibitive costs, lost jobs, bad science, and negatively impacted political jurisdictions. This assessment may be speculative, but I believe the EPA leaders placed higher priorities on their administrative budgets, personal reputations, professional workloads, and lack of political support[151] than on their environmental protection responsibilities.

149. *Id.*

150. *See* Latin, *Administrative Incentives*, *supra* note 85.

151. *See, e.g.*, Thomas O. McGarity, *EPA at Helm's Deep: Surviving the Fourth Attack on Environmental Law*, 24 FORDHAM ENVTL. L. REV. 205 (2013); Robert R.M. Verchick, *Politics And Progress: Will the White House Stall Its Own Climate Change Plans?*, THE HILL (July 25, 2013), http://thehill.com/blogs/congress-blog/energy-a-environment/313513-politics-and-progress-will-the-white-house-stall-its-own-climate-change-plans; Latin, *Administrative Incentives*, *supra* note 85.

Let me summarize my positions to this point: Carbon Capture and Storage mechanisms can be beneficial if they work effectively and safely; however, EPA has put very little emphasis on assuring the long-term safety of CCS. If CCS is shown to be reasonably safe, then we should choose the CCS implementation pattern that could achieve the greatest extent of CO_2 reductions at an economically feasible cost. EPA's 2013 proposed NSPS for fossil fuel-fired power plants fails both of these conditions: the Agency did not show that CCS would safely contain CO_2 underground for the long timeframe required by CO_2's extreme persistence; and the EPA staff chose to base the NSPS not on the best emissions-reduction efforts the fossil fuel energy industry could feasibly afford, but rather on the average market prices the fossil fuel energy industry has voluntarily been spending, or plans to spend, for new energy-production facilities.

If these criticisms are not sufficiently persuasive on the inadequacy of the 2013 proposed NSPS for new power plants, let me note that the following paragraph and equivalent statements in the EPA rulemaking materials were more disturbing than any other conclusion in the entire portfolio of relevant EPA documents:

> Under a wide range of electricity market conditions – including EPA's baseline scenario as well as multiple sensitivity analyses – EPA projects that the industry will choose to construct new units that already meet these standards, regardless of this proposal. As a result, EPA anticipates that the proposed EGU New Source GHG Standards will result in negligible CO_2 emission changes, energy impacts, benefits or costs for new units constructed by 2020. Likewise, the Agency does not anticipate any notable impacts on the price of electricity or energy supplies.[152]

Another 2013 NSPS document published by EPA similarly stated: "Because these standards are in line with current industry investment patterns, these standards are not expected to have notable costs and are not projected to impact electricity prices or reliability."[153] And the 2013 Regulatory Impact Assessment found: "[T]he proposed EGU New Source GHG Standards are not expected to change GHG emissions for newly constructed EGUs, and are anticipated to yield no monetized benefits and impose negligi-

152. *EPA, 2013 RIA, supra* note 121, at 5-54.

153. *EPA Fact Sheet: Reducing Carbon Pollution, supra* note 120, at 2.

ble costs, economic impacts, or energy impacts on the electricity sector or society."[154]

During a speech at the most recent conference of the parties to the UN Framework Convention on Climate Change (COP 19), the UN Secretary General, Ban Ki-moon, nearly begged the other participants to focus greater efforts on climate change mitigation: "We must rise to these challenges with wisdom, urgency and resolve to address climate change. I am deeply concerned that the scale of our actions is still insufficient to limit global temperature rise to below 2 degrees Celsius from pre-industrial levels."[155] These comments reflect hundreds of recent appeals for greater "ambition" to inspire or implore GHG-polluting nations, businesses, organizations, and individual people to modify their harmful behaviors by sharply reducing their GHG emissions. The major GHG-polluter nations – there are only about 14 of them including the US – have repeatedly been asked by vulnerable nations and by climate mitigation proponents to increase the "ambition" of their emissions-reduction efforts,[156] which is perhaps the one position on which all advocates of climate change mitigation and sustainable development programs can agree.

Yet, as stated in the bloc quotation above, EPA has promulgated a nationwide program for new fossil fuel-fired power plants that imposes no additional GHG pollution-reduction targets beyond what the energy industries are supposedly already doing on their own to reduce GHG emissions. The 2013 proposed NSPS is expected to achieve no greater climate change pollution reductions than would have happened in the same timeframe without any NSPS regulation, as "more efficient" coal-burning EGUs and combined-cycle natural gas EGUs are constructed. The EPA quotation rather proudly declares that the 2013 NSPS will not promote significant "CO_2 emission changes, energy impacts, benefits or costs for new units constructed by 2020."[157] It would be difficult for anyone

154. *EPA, 2013 RIA, supra* note 121, at 5-1.

155. *Secretary-General Tells Leaders at Climate Change Conference in Poland 'We Must Rise to the Challenges with Wisdom, Urgency and Resolve'*, UN DEP'T OF PUBLIC INFO. (Nov. 19, 2013), http://www.un.org/News/Press/docs/2013/sgsm15480.doc.htm.

156. *See, e.g., Tackling the Climate Reality: A Framework for Establishing an International Mechanism to Address Loss and Damage at COP19*, ACTIONAID (Nov. 2013), http://www.actionaidusa.org/sites/files/actionaid/tackling_the_climate_reality.pdf; Charlotte Cuntz, Christoph Bals, & Sven Harmeling, *Short-Term Mitigation Ambition Pre-2020: Opportunities To Close The Emissions Gap*, (GermanWatch, Briefing Paper, 2013), *available at* https://germanwatch. org/fr/download/7124.pdf.

157. *EPA, 2013 RIA, supra* note 121, at 5-54.

to call this an *ambitious* climate change mitigation program, or an acceptable response to urgent nationwide and worldwide climate change hazards.

In the Overview at the beginning of the 2013 NSPS Regulatory Impact Analysis, EPA contends that: "This rule is consistent with the Climate Action Plan announced by the President in June 2013 to cut the carbon pollution that causes climate change and affects public health."[158] This EPA claim is difficult to understand because the Agency has proposed a pollution-control regulation that only would achieve "negligible CO_2 emission changes."[159] This "negligible" emissions-reduction target clearly does not cut GHGs in any manner corresponding to the President's Climate Action Plan.

Could the 2013 NSPS have achieved greater mitigation? As noted previously, EPA indicated that imposing full CCS on new coal-fired power plants could reduce CO_2 emissions about 80 percent more effectively than partial CCS. Yet, EPA chose partial CCS because its cost to the energy industries would be lower than the cost of full CCS, without any Agency determination that full CCS costs would be unaffordable or economically infeasible. EPA did not seriously discuss the option of imposing partial or full CCS requirements on combined-cycle natural gas power plants, which the Agency predicts will overwhelmingly be the new energy generation facilities of the future. Yet, natural gas power plants produce the same CO_2 pollution as coal-fired power plants and likely could just as easily be equipped with CCS capabilities.

Instead of greater reliance on CCS for fossil fuel emissions, I prefer investing our mitigation efforts and dollars in GHG-free or very-low-GHG replacement technologies. Nevertheless, this decarbonization strategy may still be somewhat speculative, whereas EPA itself has chosen partial CCS as a supposedly proven mitigation measure and the Agency did not question the technological feasibility of full CCS. In essence, the 2013 proposed NSPS could have mandated significantly stricter GHG emissions-reduction targets by requiring more widespread reliance on full CCS mechanisms; but EPA chose instead to limit industry costs rather than greenhouse gas pollution.

EPA's rationalizations for the feeble 2013 proposed NSPS show that the Agency has been primarily concerned with protecting its own reputation, budget, and personnel from fierce political and industry criticisms by choosing a "negligible" pollution-control stan-

158. *Id.* at 1-2.
159. *Id.* at 5-54.

dard that will have virtually no impact on climate change gases, energy prices, employment, or energy industry costs beyond what they have voluntarily accepted, and that will attain no genuine mitigation benefits of any kind.

In the hundreds of pages of documents EPA published to accompany the 2013 proposed NSPS for new fossil fuel-burning power plants, the Agency did not provide any assessment of how much residual CO_2 pollution would be allowed to reach the atmosphere under the proposed rule. The 2013 proposed standard for combined-cycle natural gas power plants, predicted to be the most popular energy-generating technology by far in the near future, is that new natural gas facilities can emit up to 1000 pounds of CO_2 per MegaWatt hour of energy. Based on this regulatory treatment, the total volume of residual CO_2 emissions would probably be more than a billion tons of persistent CO_2 discharges per year multiplied by all the years the NSPS remains in effect.

Regrettably, I cannot quote the specific amount of residual CO_2 discharges that will degrade the climate under the 2013 proposed NSPS because EPA failed to identify or disclose the aggregate amount of those residual GHG emissions. The Agency's treatment ignores (or illustrates) the core theme of the first section of this article: The annual volume of residual GHGs allowed to contaminate the atmosphere and exacerbate climate change risks under the 2013 proposed NSPS rule is more crucial to a sensible climate policy analysis than the "negligible change" emissions-reduction target set by the proposed standards. EPA's inability to recognize or acknowledge the huge volume of residual CO_2 emissions that will be allowed to reach the atmosphere under the 2013 proposed NSPS is certain to increase the already-too-high cumulative GHG level in the air, and consequently is an unacceptable formula for climate change mitigation failures.

C. Regulation of Existing GHG Sources

Under the CAA structure, regulation of air pollution from existing sources rather than from new sources is mainly a federalism function with the primary responsibilities delegated to the states.[160] EPA has maintained the same bifurcated pollution-control policy despite the fact that this regulatory pattern was established decades

160. *See, e.g.*, David Driesen, *The Sleeping Giant Awakes?: US Actions to Mitigate Climate Disruption*, (U. of Syracuse L. Sch., Working Paper, 2013); Brigham Daniels, et al., *Regulating Climate: What Role for the Clean Air Act?*, 39 ENVTL. L. REP. 10837 (2009).

before climate change became a known public danger. The Agency's 2013 statement on its proposed treatment of GHGs from existing sources makes this characterization clear:

> Standards for currently operating plants are set through a federal-state partnership that includes federal guidelines and state plans to set and implement performance standards. Reflecting the significant differences between currently operating sources and those not yet built, the standards that will be developed for currently operating sources are expected to be different from, and less stringent than, the standards proposed today for future sources. Over the coming months, EPA will be engaging with states and a diverse set of partners, including the power sector, environmental groups, and the public, to identify innovative, pragmatic approaches that build on the leadership that many states have already shown to cut carbon pollution from the power sector.[161]

GHG emissions from new and existing coal-burning power plants are indistinguishable and equally dangerous, except that there are hundreds more existing coal-burning facilities than planned new ones. At present, there are fewer than a dozen "efficient" new coal-fired power plants under construction or undergoing advanced planning in the US, while there are roughly 500 existing coal-fired power plants that are the most harmful sources of GHG discharges in America. It makes little sense for EPA to devote far more attention to new GHG sources than to existing GHG sources when the imbalance in fossil fuel power plant numbers and aggregate GHG discharges is so pronounced. However, EPA finds compliance with the CAA provisions more convenient or politically "safer" than imposing strong GHG pollution-control requirements on the much more prevalent and harmful large existing GHG sources.

In drafting the 2012 proposed Regulations for existing fossil fuel-burning power plants, EPA planned to address high GHG emissions from existing polluters by using the Agency's permit-issuing power under the Prevention of Significant Deterioration Program and the Title V Program of the CAA.[162] The problem with this ap-

161. *Carbon Pollution Standards: What EPA Is Doing*, ENVTL. PROT. AGENCY, http://www2.epa.gov/carbon-pollution-standards/what-epa-doing (last updated Sept. 23, 2013).

162. *See* Reitze, *Coal-Fired Power Plants*, *supra* note 87, at 404.

proach is that there is no ambient air quality standard for GHGs that EPA could use to provide coherent emissions-discharge limits in the various permits, and there was no other widely-accepted scientific basis for whatever pollution-control restrictions might be included in existing power plant permits.

In the 2013 regulatory proceedings, EPA abandoned the permit-based approach for regulating existing fossil fuel-fired plants and returned to the basic CAA architecture, which allocated the primary authority for pollution-control strategies imposed on existing sources to the states and required them to produce State Implementation Plans (SIPs) subject to EPA's approval.

The 1970 CAA and subsequent amendments adopted this decentralized approach based on the recognition that pollution, political, economic, and social conditions can differ greatly among the 50 states. Congress apparently presumed that state government authorities would often be in the best position to determine which pollution control measures would be most effective and politically acceptable in their regions.[163] It is doubtful that this presumption should be applied to fungible GHG emissions from existing sources, which will eventually drift around the world, potentially affecting all states, nations, and peoples.

Nevertheless, as recently as July 13, 2013, the EPA revised its definition of a State Implementation Plan:

> The State Implementation Plan (SIP) is a plan for each State which identifies how that State will attain and/or maintain the primary and secondary National Ambient Air Quality Standards (NAAQS) set forth in section 109 of the Clean Air Act ("the Act") and 40 Code of Federal Regulations 50.4 through 50.12 and which includes federally-enforceable requirements. Each State is required to have a SIP which contains control measures and strategies which demonstrate how each area will attain and maintain the NAAQS. These plans are developed through a public process, formally adopted by the State, and submitted by the Governor's designee to EPA. The Clean Air Act requires EPA to review each plan and any plan revisions and to approve the plan or plan revisions if consistent with the Clean Air Act.[164]

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163. *See* Latin, *Administrative Incentives*, *supra* note 85.

164. EPA, *What is a State Implementation Plan (SIP)?*, ENVTL. PROT. AGENCY (Feb. 11, 2011), http://www.epa.gov/reg3artd/airregulations/sips/sipdetail.htm.

It is important to emphasize that there is no National Ambient Air Quality Standard (NAAQS) for greenhouse gases, and consequently there cannot be either attainment or nonattainment areas in the 50 states.[165] Without a federally-imposed minimum standard defining unacceptable GHG discharges in each state, it is hard to see how different states with diverse priorities could effectively plan individualized "control measures and strategies"[166] that in the aggregate could lead to significant national climate change mitigation.

In his June 2013 speech on climate change and energy, President Obama emphasized the presumed benefits of decentralized pollution control: "I'm also directing the EPA to develop these standards in an open and transparent way, to provide flexibility to different states with different needs, and build on the leadership that many states, and cities, and companies have already shown."[167] That is certainly a politically-oriented statement. A newspaper story covering the President's speech observed: "The political attraction of a state-led approach is that it would move a lot of the nitty-gritty decision making out of Washington. But, for that very reason, it would entail legal risk."[168]

In this speech, the President categorized natural gas combustion as a means to produce "clean energy,"[169] which simply is not true. Natural gas may be less "dirty" than coal, but it is nevertheless a fossil fuel that will result in very large residual CO_2 emissions and an increase of greenhouse gases in the atmosphere. Unfortunately, with the favorable evaluation of natural gas in the President's speech and in EPA's 2013 proposed NSPS regulations for new power plants, we must expect numerous states and localities to follow the federal lead by relying on natural gas combustion as their major future source of energy and their primary response to existing GHG pollution sources.

As one illustration, a couple of years ago Governor Chris Christie withdrew New Jersey from participation in the Regional Greenhouse Gas Initiative (RGGI), the first interstate cap-and-trade

165. *See* Reitze, *Coal-Fired Power Plants, supra* note 87, at 404.

166. *Id.*

167. *Obama's Climate Change Speech, supra* note 1.

168. Justin Gillis, *Obama Puts Legacy at Stake with Clean-Air Act*, N.Y. TIMES (June 25, 2013), http://www.nytimes.com/2013/06/26/science/earth/clean-air-act-reinterpreted-would-focus-on-flexibility-and-state-level-efforts.html?pagewanted=all.

169. *Obama's Climate Change Speech, supra* note 1 ("Today, we use more clean energy – more renewables and natural gas – which is supporting hundreds of thousands of good jobs.").

program for reducing carbon dioxide discharges in the US.[170] The Governor's rationale was that RGGI was imposing a tax on New Jersey citizens and businesses despite "no discernible or measurable impact upon our environment."[171] Governor Christie announced that rather than relying on the RGGI program, he was "committed to increasing the proportion of electricity generated by natural gas, the sun and the wind."[172] Increased reliance on renewable energy sources is desirable when it is affordable, but energy from natural gas combustion is neither "clean" nor "renewable."

Drawing distinctions between new and existing GHG dischargers in the climate change context, or between NSPS and SIP regulations, and allowing different states to create different climate change mitigation policies, is bound to impose high implementation costs, longer regulatory timetables, and more opportunities for obstructive behaviors by regulated parties. Because most states have had higher political priorities for decades than air pollution control and also have limited budgetary resources and technical expertise, the SIP process established by the CAA has functioned very poorly in many states.[173] For example, most major urban regions are still designated as "non-attainment areas" for ozone (marker for photochemical smog) after more than 40 years of regulation under the CAA.[174] The weaknesses of the SIP process for air quality criteria pollutants and other decentralized provisions under the CAA are too complicated to warrant more detailed discussion here except in relation to climate change issues.

No other pollutant than GHGs has presented such difficult and consequential choices for each and every state. In states with major fossil fuel production, distribution, and combustion industries, with many thousands of related jobs, large revenues from fossil fuel resources exploitation, and long-established energy industry and political links, it is difficult to imagine that these states would undertake aggressive GHG mitigation programs jeopardizing state revenues and employment.

One recent commentary, for instance, observed that: "Democrats from West Virginia, concerned about jobs in the major coal-producing state, urged President Barack Obama's chief environ-

170. Mireya Navarro, *Christie Pulls New Jersey from 10-State Climate Initiative*, N.Y. TIMES (May 26, 2011), http://www.nytimes.com/2011/05/27/nyregion/christie-pulls-nj-from-greenhouse-gas-coalition.html?_r=0.

171. *Id.*

172. *Id.*

173. *See* Latin, *Administrative Incentives*, *supra* note 85.

174. *See id.*; *see also* Reitze, *Coal-Fired Power Plants*, *supra* note 87, at 404.

mental regulator to be flexible when putting in place future federal curbs on carbon emissions."[175] The politically-oriented definition of being "flexible" is certainly not one that a climate mitigation advocate would accept because it would prioritize short-term, limited-locale economic benefits above growing climate change dangers imposed on everyone.

In the present vitriolic political partisanship era, some states are now led by conservative ideologues who will oppose strong climate change regulation because they oppose almost all government spending on anything except national defense and subsidies for the rich. The realm of climate change policy is a splendid one for illustrating the cognitive psychology finding that people see what they want to see or expect to see, rather than accepting an accurate but unpleasant message conveyed by new information.[176]

There is a likelihood that all of these states, mostly "red" states, will compete in a "*race to the bottom*" to see which state can impose the least onerous restrictions on existing fossil fuel-fired power plants and other major GHG sources. The states with low regulatory costs and a friendly, constructive attitude towards heavily-polluting industries would have an improved chance to attract more businesses, jobs, and financial opportunities, at the expense of states that are not as dedicated to market ideologies or to ignoring the perils of climate change risks. The anti-regulation states cannot entirely ignore EPA's SIP guidelines for GHG pollution-control, whenever they are promulgated, but these states can certainly drag their proverbial "feet" and plead fiscal inability based on their limited financial capacity and the existence of many higher state priorities.

On the other hand, some states will be influenced by liberals and environmentalists who insist that strong mitigation measures are essential to protect the states' inhabitants and to preserve nature as we know and enjoy it. Quite a few other states, such as farming states and coastal states with large residential housing and tourism industries, may push for ambitious GHG regulatory programs because many citizens of these states believe substantial mitigation and adaptation efforts are in their own personal best interests.

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175. Valerie Volcovici, *U.S. Coal State Lawmakers Seek Regulatory Relief from EPA Chief*, REUTERS (Aug. 1, 2013), http://www.reuters.com/article/2013/08/01/us-usa-epa-coal-idUSBRE9701HE20130801.

176. *See* Howard Latin, *Framing the Climate Change Debate*, *in* CLIMATE CHANGE: A READER 741-93 (William H. Rodgers et al. eds. 2011).

The coastal residents in New Jersey and New York, for example, who were adversely affected by Hurricane Sandy, overwhelmingly want the federal and state governments to help them rebuild their homes and to provide at least partial compensation for their losses – this climate change policy would involve shifting much of the rebuilding-cost responsibilities to taxpayers who often will not directly benefit from the compensation program. Even if this kind of remedial program raises questions about the fairness of wealth redistribution, both the potential taxpayers and the parties who suffered climate-related damages are likely to support strong climate change mitigation and remedial measures to prevent a recurrence of the painful losses they experienced.

There is a likelihood that all of these states, mostly "blue" states with a few "red" states mixed in, will compete in a "*race to the top*" to see which states can take the lead in protecting their own citizens and in serving as a model for vulnerable people in other states and countries. California appears to be the current leader in the race to support active mitigation programs and policies, but other states will undoubtedly want to raise their own mitigation profiles to convince their residents who value environmental protection and local people with vulnerable properties or jobs that the state governments will be responsive to the public's perceived needs.

Then there are some states, such as Louisiana and possibly Alaska, that are primarily conservative in their politics but are also extremely vulnerable to climate change dangers and would like to receive ample financial assistance the next time they are affected by extreme climate conditions – and almost everyone in these states knows that there will be a next time. In other respects, however, these borderline states and their leaders may find the race to the bottom more congenial. There is nothing to prevent state political leaders from vilifying governments, almost all governments and regulations including their own, while they continue receiving substantial government subsidies before climate change disasters occur and large remedial assistance using government funding and resources after a climate-change disaster has occurred.

If readers agree with this two-page-sans-footnotes political excursion, the meaning should be quite clear. Except in California, which resembles a separate nation in many respects, there will be little chance of genuinely coordinated mitigation programs from the decentralized SIP process. Instead there will be widespread conflicts and chaos. Business firms will complain about competitive advantages offered by other states; workers will be concerned about

potential job losses; environmentalists will be concerned about the continuing degradation of nature; economists and businesspersons will be concerned about the seemingly inescapable conflicts between climate change mitigation and expanding economic development. The states will very likely not be able to create a collective-action mitigation policy for a critical pollution problem that spans the world.

Under the CAA, EPA has the authority to review and replace inadequate SIPs with Federal Implementation Plans (FIPs).[177] However, this substitution of federal for state authority has been a very rare occurrence for political, technical, and budgetary reasons. EPA cannot be expected to correct deficient state mitigation plans with expensive federal implementation plans very often. Choosing the SIP model from the CAA architecture to regulate existing GHG polluters is bound to be very expensive and cumbersome. This decentralized regulatory approach makes little sense in terms of realistic climate change mitigation requirements, although adoption of the SIP program may be rationalized in part by EPA's pursuit of its own institutional incentives and constraints. Because EPA has not demonstrated any dedication to making the hard choices on crucial climate change mitigation issues, I predict any genuine attempt to implement the SIP process as a means to achieve tangible climate change progress will inevitably turn out to be a multi-party tragi-comedy with few or no constructive results and a vast amount of wasted money, administrative resources, and time.

There is little more to say about the substance and credibility of the SIP-based approach in light of EPA's lack of ambitious mitigation priorities. The Agency has announced that it is developing a plan for regulating existing fossil fuel-fired power plants, subject to the institutional restrictions imposed by the architecture of the CAA and SIPs. EPA says this plan will be proposed for public comments sometime in 2014, and is not expected to be adopted as a formal regulation until 2015.[178]

If we consider the intended purposes and implementation practices under the new motor vehicle GHG emissions restrictions, the NSPS standards with "negligible" emissions-reduction effects applied only to the largest GHG dischargers, and the decentralized, chaotic, not-yet-promulgated SIP process, it would be difficult for anyone to claim that EPA's regulatory treatments of greenhouse gases are "ambitious" efforts to curtail climate change risks. These

177. *See* Latin, *Administrative Incentives*, *supra* note 85.

178. *EPA Fact Sheet: Reducing Carbon Pollution*, *supra* note 120, at 5.

weak regulations do not have any appreciable chance to reduce the "endangerment" to which the US population is increasingly exposed.

There has already been a stream of lawsuits brought by potentially regulated parties and by environmental organizations trying to push EPA's GHG mitigation programs in one direction or another,[179] thereby diverting the Agency's personnel, resources, and time away from essential mitigation tasks that EPA has been doing poorly or not doing at all. This litigation has produced conflicting judicial opinions that rarely help to resolve the core climate change problems, and it has forced EPA to focus on decades-old legal precedents under the CAA rather than on developing innovative regulatory strategies that might actually contribute to reducing the nationwide and global "endangerment."

Although EPA's regulatory initiatives thus far may be a little better than doing "nothing," they cannot justify the high expense, wasted efforts, and loss of precious time that implementing these grossly inadequate mitigation measures are certain to require. Doing a little better than doing nothing at all is not nearly good enough in the global climate change context. By following the rigid multi-decade GHG emissions-reduction regulatory approaches relied on by EPA and other federal agencies, we will be losing the opportunity to pursue more promising alternative strategies that could make a meaningful difference in climate change mitigation outcomes.

IV. DECARBONIZATION

Decarbonization is a climate change mitigation strategy that is fairly easy to describe but difficult to implement. The responsible government officials and expert advisors need to identify the worst sources of GHG discharges, which include existing fossil fuel-burning power plants, petroleum refineries, several transportation sectors, and a number of polluting industries such as cement manufacturing and steel production. Then the core technologies and processes used by these "dirty" GHG sources must be replaced by an array of "clean" GHG-free or very-low-GHG alternative technologies, processes, and practices that can maintain or improve cur-

179. *See* Kirsten H. Engel, *Climate Policy at the Federal Level, and the Courts, in* U.S. CLIMATE CHANGE POLICY AND CIVIC SOCIETY (Yale Wolinsky ed., forthcoming, Jan. 2014); Kirsten H. Engel, *Courts and Climate Policy: Now and in the Future, in* GREENHOUSE GOVERNANCE: ADDRESSING CLIMATE CHANGE IN AMERICA (Barry G. Rabe ed., 2010).

rent standards of living without further damaging the climate. Because an increasing proportion of GHGs are being generated in developing countries, a trend certain to increase, the clean alternative technologies must be sufficiently uncomplicated and affordable to enable technology transfers from developed nations to developing states.

In my opinion, the major obstacles to an effective decarbonization strategy are largely political, economic, and institutional, not the absence of innovative energy and transportation technology developments.[180] There are dozens of potentially clean GHG-free or very-low-GHG replacement technologies, most of which will be suitable for some particular environmental and business conditions but not for others. Instead of one *master* alternative energy technology that can replace all fossil fuel uses in all places, we will need to develop and disseminate many distinctive replacement technologies able to fill specific economic niches in particular locations and times.[181] The primary questions applicable to each clean GHG-free alternative technology are (1) can it work consistently and safely; (2) will the climate mitigation benefits and economic development gains exceed the clean technology's costs; and (3) will the clean technology be able to compete effectively in national and worldwide markets against "dirty" GHG-discharging fossil fuel technologies, including large fossil fuel energy producers and fossil fuel combustion vehicles, that currently occupy the same market niches?[182]

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180. *See* PAUL G. HARRIS, WHAT'S WRONG WITH CLIMATE POLITICS AND HOW TO FIX IT (Polity Press, 2013); *see also* WILLIAM F. HEWITT, A NEWER WORLD: POLITICS, MONEY, TECHNOLOGY, AND WHAT'S REALLY BEING DONE TO SOLVE CLIMATE CHANGE (University of New Hampshire Press, 2013).

181. Thijs Etty et al., *Transnational Dimensions of Climate Governance*, 1 TRANSNAT'L ENVTL. L. 235, 235-43 (Oct. 2012), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2277617.

182. A similar list of issues impeding decarbonization presented six major problems:

- Denial of the necessity and urgency of action
- Power of fossil fuel industry and its allies
- Political paralysis, short termism and 'moral corruption'
- The dominant economic paradigm of unconstrained and unsustainable consumption
- Technological and social path dependencies and outdated infrastructure and systems
- Financial and governance constraints

See John Wiseman, Taegen Edwards, & Kate Luckins, *Post Carbon Pathways Towards a Just and Resilient Post Carbon Future*, 25 (Melbourne Sustainable Soc'y Inst., Ctr. for Policy Dev., Discussion Paper, Apr. 2013), http://www.postcarbonpathways.net.au/wp-content/uploads/2013/05/Post-Carbon-Pathways-Report-2013_Final-V

I am not suggesting reliance on a cost-benefit regulatory approach to compare dozens of prospective alternative technologies. And yet, the array of decarbonization technologies needed to accomplish the transition from reliance on fossil fuels[183] to reliance on clean GHG-free replacement technologies must be able to function effectively and must also be affordable. Thus, some comparative assessment of the technological and economic feasibility of competing replacement technologies cannot reasonably be avoided. Here is a partial list of some current or projected GHG-free or low-GHG replacement technologies that might succeed in reducing greenhouse gas emissions significantly while offering reasonable economic benefits:

- Fusion as a clean energy technology
- Concentrating Solar Power (steam boilers heated directly by concentrated solar rays)
- Solar Photovoltaic Cell Panels
- Off-Shore Wind Energy
- On-Shore Wind Energy
- Tidal Power
- Wave Power
- Heat Pumps
- Geothermal Energy
- Plasma Arc Gasification (Intense laser beams turn garbage into combustible molecules)
- Hydroelectric Power
- Hydrothermal Energy
- Hydrogen Fuel Cells
- Algae-Based Biofuels
- Bio-methanol fuels
- Bio-ethylene production
- Second generation cellulosic biofuels (vegetative scraps, not corn ethanol)
- Biogas Digester Plants (from cow dung or other disposable biological waste materials)
- Artificial Photosynthesis using solar power
- Thorium Fuels & Fourth Generation Nuclear Energy Plant Designs

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.pdf. I do not think there is any appreciable difference between their list of necessary conditions for decarbonization success and mine.

183. *See* Dr. Naoko Ishii: *Transformational Change Needed to Address Climate Change Threat,* GLOBAL ENVTL. FAC. (Mar. 20, 2013), http://www.thegef.org/gef/news/gef-ceo-transformational-change-needed-address-climate-change-threat.

- Extraction of Methane Hydrate Deposits from the Ocean floor
- Coal Gasification with Carbon Capture and Storage

None of these potential replacement technologies is perfect, and all of them must be compared to determine which ones are worth pursuing on the basis of positive mitigation effects, ability to support economic growth, especially in developing countries, and affordable economic costs.

Identifying the last two entries in this list as "clean" energy technologies is problematical. While the efficiency of coal use can be improved through applying greater high-temperature combustion of pulverized coal or by converting the coal to a gas that will burn more completely, making the discharges somewhat resemble those of natural gas, the reality is that coal is still a harmful high-carbon substance. Coal combustion will inherently produce a large volume of carbon dioxide emissions unless full-scale CCS mechanisms can sequester a very substantial portion of the GHG discharges from coal-fired power plants.[184]

In the same vein, frozen methane hydrate is still methane. Japan is looking for a relatively inexpensive fuel to serve as a substitute for nuclear energy after the Fukushima disaster,[185] but extracting sufficient methane hydrate from beneath the ocean floor and burning the methane is virtually the same as natural gas combustion. The extraction and combustion of methane hydrate involves very large GHG emissions from a fossil fuel that cannot be "clean" even if it can be cleaner than coal and safer than nuclear energy.

Methane is the most common molecule in natural gas, and that remains true upon its combustion even if the methane has been frozen under the ocean floor for millions of years.[186] The methane hydrates are a form of fossil fuel that would release large amounts of GHGs into the atmosphere as a result of drilling, processing, and combustion activities. In the same manner as oil, coal, and natural gas emissions, large quantities of GHGs would be released from methane hydrates by countries that regard short-term energy availability as a more important factor in pursuit of

184. *See* Bradsher, *supra* note 123.

185. *See* NASSRINE AZIMI, *When Nature Is Not Enough*, N.Y. TIMES (May 7, 2013), http://www.nytimes.com/2013/05/08/opinion/global/Japans-Shift-From-Nuclear-Energy.html?pagewanted=all; Bradsher, *supra* note 123.

186. *See* Tabuchi, *supra* note 106.

their perceived national interests than mitigation of climate change risks.

Coal producers, natural gas producers, and natural gas from methane producers have implausibly claimed that their fuels can be characterized as "clean" if the most efficient available combustion, processing, and sequestration technologies are applied to them. I strongly disagree with these claims, but nonetheless feel that these dubious claims should be mentioned here.

The various biofuels in the alternative technologies list are claimed by their producers and users to be part of a carbon cycle: the diverse biological feedstocks absorb CO_2 while they are growing, and then they release CO_2 when they are burned as fuel. Because the biological materials absorb CO_2 in one part of their life-cycle and discharge CO_2 during the other part of the carbon cycle, the proponents of numerous biofuels contend that the biofuels are "carbon neutral" - neither increasing nor reducing the cumulative volume of GHGs in the atmosphere.[187] In comparison, traditional fossil fuels have been buried for millions of years and, when they are extracted and burned, they are freeing long-trapped GHGs that are not part of any cyclical process.

I question whether the assertion of "carbon neutrality" is defensible because biofuels must be grown, harvested, collected, shipped to processing locations, prepared for combustion, burned in boilers, and the ashes or other wastes must be removed after combustion.[188] All of these stages in biofuel preparation, combustion, and waste disposal require energy inputs that are not counterbalanced by other factors in the carbon cycle. Biofuels release many GHGs during and after combustion that will rise into the atmosphere, which means the best we can expect is that the biofuel combustion process will generate energy in a somewhat less harmful manner with fewer GHGs per energy increment than fossil fuel combustion. It would take a detailed life-cycle analysis of each separate biofuel to determine whether it will be *cleaner* than a life-cycle assessment of efficient natural gas combustion would be.

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187. Fantu Farris Mulletta, *Biofuels And Development: Questioning Environmental And Social Sustainability From A Developing Country Perspective*, 7 (BKP Dev. Res. & Consulting, Discussion Paper No. 03/2013, 2013), *available at* http://www.bkp-development.com/index.php/publications/discussion-papers.

188. *See*, Roger A. Sedjo, *Comparative Life Cycle Assessments: Carbon Neutrality and Wood Biomass Energy*, (Resources for the Future, Discussion Paper RFF DP 13-11, Apr. 2013), *available at* http://www.rff.org/RFF/Documents/RFF-DP-13-11.pdf.

Controversial reliance on diverse biofuels may be technologically feasible[189] but may also have dangerous dimensions. There is a well-established literature describing the conflict between biofuel production and negative impacts on food supplies.[190] For example, Congress insisted on forcing the automotive industry to add corn-based ethanol to gasoline at the urging of agricultural interests, which raised US and international prices for corn and livestock feeding costs.[191] As another example, Indonesia and other Southern countries have been replacing many natural forests with palm oil plantations, which can serve as relatively inexpensive regional fuel sources but are disastrous for the conservation of ecological biodiversity.[192]

As a more positive but still problematical biofuel example, Brazil has been operating its entire motor vehicle fleet for several decades using fuel fermented from sugar cane plants.[193] Brazil is now considering building large "stationary source" power plants that would also run exclusively on fermented sugar cane fuels.[194] However, substantial biofuel energy facilities typically require large amounts of agricultural production and land that may degrade important terrestrial resources – such as extending sugar cane crop planting into regions carved from the priceless Amazon rainforest, often called "the lungs of the planet."

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189. *See* Matthew L. Wald, *Milestone Claimed in Creating Fuel From Waste*, N.Y. TIMES (July 31, 2013), http://www.nytimes.com/2013/08/01/business/energy-environment/company-says-its-the-first-to-make-ethanol-from-waste.html.

190. *See, e.g.*, Seth Meyer et al., *Global Biofuel Trade: How Uncoordinated Biofuel Policy Fuels Resource Use and GHG Emissions*, (Food and Agriculture Organization, Issue Paper No. 48, 2013), *available at* http://ictsd.org/downloads/2013/05/global-biofuel-trade-how-uncoordinated-biofuel-policy-fuels-resource-use-and-ghg-emissions.pdf; *see also* Andrea Bastianin et al., *Biofuels and Food Prices: Searching for the Causal Link*, NOTA DI LAVORO 22.2013, FONDAZIONE ENI ENRICO MATTEI (2013), *available at* http://www.feem.it/userfiles/attach/2013711041444NDL2013-060.pdf.

191. Carl Hulse, *Effort to End Tax Credit for Ethanol Fails in Senate*, N.Y. TIMES (June 14, 2011), http://www.nytimes.com/2011/06/15/us/politics/15senate.html?_r=0.

192. *See, e.g.*, Nigel Sizer, *Indonesia Haze Risk Will Remain High Unless Ministers Keep Promises*, WRI INSIGHTS (July 17, 2013), http://insights.wri.org/ news/2013/07/indonesia-haze-risk-will-remain-high-unless-ministers-keep-promises.

193. *See* Harry de Gorter et al., *An Economic Model of Brazil's Ethanol-Sugar Markets and Impacts of Fuel Policies*, (World Bank, Working Paper No. 6524, 2013), *available at* http://elibrary.worldbank.org/content/workingpaper/10.1596/1813-9450-6524.

194. Heather Davis, *Brazilian Farmland: Converting Sugarcane Pulp Into Electricity And Investment Opportunity*, TIAA-CREF (July 12, 2013), https://www.tiaa-cref.org/public/assetmanagement/insights/commentary-perspectives/perspectives/Brazilian-farmland.

In effect, some biofuels, such as ethanol processed from corn crops, have had deleterious impacts on international food prices and food security. Biofuel processes using woody scraps up to full logs as the feedstocks present a significant danger of encouraging deforestation or forest degradation. Biofuels produced from algae and other biological materials in agricultural wastes materials will often require substantial water resources and land or marine areas, which are scarce in many regions. It is also important to recognize that a full carbon-neutral process, which I doubt can exist during the production of biofuels, would still involve discharging large volumes of GHGs into the atmosphere unlike clean GHG-free replacement technologies.

One advantage of biofuels is that they can be produced in poor nations and regions that lack access to cleaner, more efficient energy technologies. In these poor locations, the choice is often between imported coal and biofuels. As a result, biofuels are not "clean" but they may be the most realistic and affordable energy-fuel alternatives in many developing countries. Moreover, while they will generate large amounts of GHGs, they will often reduce reliance on coal combustion that is even dirtier as a function of the amount of energy produced.[195]

There are a number of radically different and much improved designs for nuclear power plants that are being supported by some prominent environmentalists, such as James Hansen, and by entrepreneurs, such as Bill Gates, on the rationale that "improved" nuclear energy production can generate substantial amounts of needed energy at feasible costs and will produce very few GHGs in comparison to any fossil fuel or biofuel process.

On the other hand, after 60 years of research and experimental projects, the US government and the nuclear energy industry have not been able to develop a reliably safe method for long-term nuclear waste disposal and storage. The Fukushima and Chernobyl disasters and the possibility of terrorist "suicide attacks" also call into question the long-term safety of an energy source that inherently relies on very dangerous materials to function at all. Virtually all nuclear generating facilities require large amounts of water for cooling purposes, and therefore will be dependent on uncertain water availability in the climate change era, in which rains in varying locations may be unusually scarce or unusually torrential, lead-

195. *See id.*; Amy Yee, *India Increases Effort to Harness Biomass Energy*, N.Y. TIMES (Oct. 8, 2013), http://www.nytimes.com/2013/10/09/business/energy-environment/india-increases-effort-to-harness-biomass-energy.html?_r=0.

ing to floods that would potentially create unacceptable risks for nuclear plants located within wide flood plains. The industry's water demand would also conflict with various other water needs in given areas, such as for drinking water, agricultural uses, and preservation of dependent biodiversity.

Contrary to the optimistic views of the people supporting the resurrection of the nuclear energy industry, including numerous people in the Obama Administration, this list of unresolved dangers appears too long, and the potential consequences of unexpected failures or mistakes would be too severe, to warrant a substantial expansion of this category of GHG-free replacement technology. However, I am not a nuclear power expert and this negative assessment is only my opinion based on the reasons stated here.

Not all of the alternative energy technologies cited in the list above, or other potentially innovative methods not listed, would always succeed on a stable basis even if they are subsidized by governments or generously supported by private investors. Some pitfalls and mistakes are inevitable. As Bill Gates recently mentioned while evaluating his investment in a new form of nuclear fission plant: "The room for [energy] innovation is simply mind-blowing . . . . Frankly, we need hundreds of ideas because many of them won't succeed."[196]

There seems little chance of successful clean technology innovation without the experimentation and funding necessary to test a wide range of potential improvements over a reasonably prompt period of time. I agree with Mr. Gates that many attempted energy innovations are bound to fail. However, we must remember that fossil fuels are failing every day to limit the growth of climate change hazards, while their substantial air and water pollutants are imposing vast externalized damages on countless millions of vulnerable people.

The costs of implementing dozens of different GHG-free or very-low-GHG technologies will vary greatly depending on the characteristics of specific innovations in different locations. For example, scientists and engineers in Scotland are now conducting extensive research on wave power and tidal power because of the

196. Clifford Krauss, *By 2023, a Changed World in Energy*, N.Y. TIMES (Apr. 24, 2013), http://www.nytimes.com/2013/04/25/business/energy-environment/by-2023-a-changed-world-in-energy.html?pagewanted=all.

consistently turbulent conditions in the North-Atlantic Ocean.[197] In contrast, there is no reason to expect that comparable ocean-energy-based technologies would be cost-effective in Bangladesh or Fiji, which do not have comparably rough seas on a consistent basis.

Nearly every year, new scientific and economic analyses have been emphasizing terrible risks and enormous long-term costs certain to occur from present human behaviors that are increasing the cumulative GHGs in the atmosphere. Thus, I feel confident in predicting that the short-term and medium-term (two to three decades) costs of implementing a diverse decarbonization process will be much lower than the probable human and ecological losses from continuing to pollute the atmosphere with more heat-trapping gases that will progressively degrade the climate.[198]

There is insufficient space in this article to describe the institutional framework that would be necessary to implement a worldwide decarbonization strategy. Decarbonization supporters would have to rely on a group (or multiple groups) of technological and economic experts to determine which clean replacement technologies will offer the best prospects for the future, and consequently would be worth subsidizing and actively disseminating. In my book on climate change mitigation failures, I suggested using a decarbonization commission primarily composed of members of the National Academy of Sciences and National Academy of Engineers, with several agency officials and economists, to serve as the institution responsible for determining which GHG-free technological innovations should be supported by subsidies and various types of business-growth assistance.[199] There undoubtedly will be differences of opinion among these experts that will often prove frustrating, and they may sometimes succumb to political and industry pressures or to personal greed; however, I believe their decarbonization judgments on the whole are likely to be better than those of partisan politicians or ardent proponents of "free market" forces.

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197. Mark Scott, *Off Scottish Coast, Harnessing Motion of Ocean Waves*, N.Y. TIMES (Oct. 8, 2013), http://www.nytimes.com/2013/10/09/business/energy-environment/off-scottish-coast-harnessing-motion-of-ocean-waves.html.

198. *See, e.g.*, Vinod Thomas, Jose Ramon G. Albert, & Rosa T. Perez, *Climate-Related Disasters in Asia and the Pacific*, (Asian Development Bank, Working Paper, 2013), *available at* http://www.adb.org/publications/climate-related-disasters-asia-and-pacific; Quirin Schiermeier, *Extreme Measures: Can Violent Hurricanes, Floods and Droughts Be Pinned on Climate Change? Scientists are Beginning to Say Yes*, 477 NATURE 148, 148-49 (Sept. 7, 2011), *available at* http://www.nature.com/news/2011/110907/full/477148a.html.

199. LATIN, CLIMATE POLICY FAILURES, *supra* note 19, at 162-70.

It is inevitable that powerful fossil-fuel companies and other opponents of clean energy regulations, such as politicians from states that are dependent on fossil fuel industries for jobs and tax revenues, will find some failing enterprises to criticize. A couple of years ago, for example, the Solyndra Corporation, a manufacturer of thin-film solar cells, declared bankruptcy with a resulting loss of public money provided by a $535 million loan guarantee.[200] This result proved that Solyndra was a poorly managed, losing investment, but it did not invalidate the need to subsidize clean energy processes and innovative companies intended to maintain high standards of living while sharply reducing harmful GHG emissions. The decarbonization process, though far from perfect, can combine substantially reducing greenhouse gas discharges with increasing economic benefits from new opportunities for energy growth and jobs creation.

Not all decarbonization improvements would require appreciable new technological developments. Instead, many useful innovations may be mainly "tweaks" that would improve the performance and economic returns of already existing clean technologies. As one illustration, Natcore Technology, Inc. is a small company in upstate New York that claims they have developed a patented mix of chemicals able to turn (paint) conventional solar photovoltaic panels completely black, instead of the usual blue.[201] This seemingly trivial process could cut the reflectivity of solar rays from conventional solar panels and thereby could significantly increase the percentage of daily energy that can be harvested from each solar cell.

This innovation assertedly could improve the energy yield from existing solar cell panels as well as new panels by a substantial proportion at a very low cost.[202] Although Natcore has already won public prizes for innovation, I am using qualified language to describe this process because I cannot personally verify the company's contentions. This is a good illustration of why we need a focused institution with recognized experts in diverse energy, technology,

200. Joe Stephens & Carol D. Leonnig, *Solyndra Scandal: Key Coverage of the Investigation Into Solyndra, The Silicon Valley Startup That Collapsed, Leaving Taxpayers Liable for $535 Million in Federal Guarantees*, WASH. POST (Dec. 25, 2011), http://www.washingtonpost.com/politics/specialreports/solyndra-scandal.

201. *Local Researchers Create 'Absolute Black' Solar Cells*, GREECE POST (Apr. 12, 2012), http://www.greecepost.com/x1170670488/Local-researchers-create-absolute-black-solar-cells.

202. *Natcore Technology Named to 2013 TSX Venture 50*, NATCORE TECH. (Feb. 14, 2013), http://www.natcoresolar.com/news/natcore-technology-named-to-2013-tsx-venture-50.

and environmental fields to serve as a decarbonization commission, rather than depending on politicians, lobbyists, or even law professors to make the critical decisions.

Some innovations that might be included under the decarbonization strategy, such as energy from fusion, will require major technological improvements and a great deal of financial support before they can become commercially viable. Widespread fusion energy production in the future would surely be desirable because the fuels, deuterium and tritium, can be cheaply extracted from sea water by any country with access to an ocean. Yet, we cannot count on this complex technology to reach the level of commercial clean energy production within the two decade timeframe that will probably be necessary to stabilize the growth of GHGs in the atmosphere. At the moment, unfortunately, fusion appears more of an idealized prospect for the distant future than it does a practical clean replacement technology that can help us achieve a substantial level of climate change mitigation when we need it.

Despite various problems and uncertainties with every potential replacement technology, the world is now developing a broad array of distinctive renewable energy production and consumption methods, including suitable clean technologies for different social, economic, and ecological contexts.[203] The use of the more familiar renewable clean technologies, such as wind and solar energy, has already been expanding at a relatively rapid pace in recent years. In practice, the major stumbling blocks that decarbonization must overcome are not generally derived from the need for technological innovation, but rather from political, financial, and market-imperfection impediments.

It is worthwhile to emphasize that many scientists, engineers, and inventers have been making progress in developing clean GHG-free alternative technologies.[204] They can point to varied climate mitigation technical innovations with concurrent economic benefits supporting the central decarbonization strategy, and I do not believe that the advocates of multi-decade GHG emissions-reduction schemes, including EPA, could make any similarly plausible claims.

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203. *See, e.g.*, MICHAEL LEVI, THE POWER SURGE: ENERGY, OPPORTUNITY, AND THE BATTLE FOR AMERICA'S FUTURE (Oxford University Press 2013); TERTZAKIAN & HOLLIHAN, *supra* note 113.

204. *See, e.g.*, WILLIAM F. HEWITT, A NEWER WORLD: POLITICS, MONEY, TECHNOLOGY, AND WHAT'S REALLY BEING DONE TO SOLVE THE CLIMATE CRISIS (New Hampshire, 2012); LEVI, *supra* note 203.

In his 2013 State of the Union Address, President Obama emphasized the need to develop better clean energy businesses:

> Four years ago, other countries dominated the clean energy market and the jobs that come with it. And we've begun to change that. Last year, wind energy added nearly half of all new power capacity in America. So let's generate even more. Solar energy gets cheaper by the year – let's drive down costs even further. As long as countries like China keep going all in on clean energy, so must we.[205]

China is hardly a paragon of clean energy, but it has been developing clean energy technologies for export sales to other countries and for increasing implementation within China itself to reduce its horrible air pollution and water pollution problems. Unfortunately, China continues to expand its use of coal for energy production with related increases in its GHG pollution. Nevertheless, President Obama's emphasis on the need to create more clean energy businesses and jobs is consistent with the decarbonization process, and may help persuade China to reduce its annual GHG emissions. Renewable energy production, especially from wind, solar, and second-generation biofuels, has been growing much faster than was predicted less than a decade ago, and there is no reason why the rapid rate of growth for clean energy industries cannot accelerate in the future.

For data supporting this presumption, the International Energy Agency (IEA) reported in June 2013:

> Power generation from hydro, wind, solar and other renewable sources worldwide will exceed that from gas and be twice that from nuclear by 2016 . . . . despite a difficult economic context, renewable power is expected to increase by 40% in the next five years. Renewables are now the fastest-growing power generation sector and will make up almost a quarter of the global power mix by 2018, up from an estimated 20% in 2011.[206]

In another 2013 report, the IEA found that "solar PV capacity grew by an estimated 42%, and wind by 19% compared with 2011

205. *2013 State of the Union Address, supra* note 17.

206. Press Release, Int'l Energy Agency, Renewables to Surpass Gas by 2016 in the Global Power Mix (June 26, 2013), *available at* http://www.iea.org/newsroomandevents/pressreleases/2013/june/name,39156,en.html.

cumulative levels."[207] A similar compilation of data on energy production trends by another non-governmental organization concluded that: "American wind power's generation shot up 17 percent last year, and produced more than 10 percent of the electricity in nine states, up from five states in 2011."[208] The same report indicated: "In 2013, solar photovoltaic installations in the United States are expected to grow 29 percent to reach 4.3 gigawatts. Concentrating solar thermal power is forecast to reach 946 megawatts."[209] And the US Energy Information Administration conservatively predicted that "renewable energy, not including hydroelectric power, will account for 32 percent of the overall growth in electricity generation through 2040."[210]

President Obama also observed in his June 25, 2013 speech: "Over the past four years, we've doubled the electricity that we generate from zero-carbon wind and solar power."[211] He then stated his intention for the US to double again its clean renewable energy production in the next few years.[212] The relatively rapid transition to clean replacement technological alternatives has been working, though it is still only in the initial phases. This decarbonization transition can and will do better in the near future even without a coherent overall energy plan and strong government or multilateral support.

The decarbonization process undoubtedly will be relatively expensive, and we must consider how sufficient financial resources could be mobilized. A first possibility would be to redirect present national and international subsidies from the fossil fuel industries to support clean GHG-free production methods. The participants at a recent UN meeting in the Philippines contended that redirecting the world's fossil fuel subsidies could free up around $600 billion per year to help climate change mitigation and adaptation efforts.[213] A publication of the Organization for Economic Co-op-

207. *Tracking Clean Energy Progress 2013: IEA Input to the Clean Energy Ministerial*, INT'L ENERGY AGENCY (2013), http://www.iea.org/publications/TCEP_web.pdf.

208. Richard Cyphus, *Tracking Renewable Power Sources Worldwide, Data on US Energy*, RENEWABLE FACTS, http://www.renewablefacts.com (last visited July 26, 2013).

209. *Id.*

210. Krauss, *supra* note 196.

211. *See Obama's Climate Change Speech*, *supra* note 1.

212. *Id.*

213. *U.N. Talks Target $600-bln Fossil Fuel Subsidy for Climate Aid*, REUTERS POINT CARBON (July 18, 2013), http://www.pointcarbon.com/news/1.2469480; *see* Manuel Frondel, Rainer Kambeck, & Christoph M. Schmidt, *Hard Coal Subsidies: A*

eration and Development (OECD) concluded: "One way to foster wider international mitigation action is to first implement those measures that yield both climatic and economic benefits, including in particular the removal of fossil fuel energy subsidies."[214] President Obama stated in his June 25th speech on Climate Change: "because billions of your tax dollars continue to still subsidize some of the most profitable corporations in the history of the world, my budget once again calls for Congress to end the tax breaks for big oil companies, and invest in the clean-energy companies that will fuel our future."[215]

Another decarbonization approach to financing the development of clean technologies, which is recommended in my book, is a carbon tax. Quite a few climate experts have recently advocated a carbon tax on GHG producers or users that would apply some of the tax revenues to provide subsidies or other forms of fiscal support for the widespread deployment of GHG-free replacement technologies. Although taxes in virtually all forms are extremely unpopular in the US, the tax would unarguably be far less expensive than the current and future costs of allowing climate change hazards to continue growing worse.

There have been many frameworks suggested for carbon taxes, ranging from returning all of the revenues back to US consumers, to using the taxes to decrease the government budget deficit, to using the taxes for some other altruistic purpose.[216] My argument is that if we want to confront and gradually overcome climate change perils, we will need to employ a significant proportion of the carbon tax revenues to support stringent GHG emissions reductions resulting from clean replacement technology enabling effective decarbonization.

Giving all carbon tax revenues back to consumers in an effort to make the tax more palatable for the public will not create a GHG emissions-deterrent instrument because the fossil fuel industries are extremely wealthy, as well as politically influential, and they could probably afford to pay the carbon tax for many decades without

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Never-Ending Story?, (Rheinisch-Westfälisches Institut, Discussion Paper No. 53, 2006).

214. Jean-Marc Burniaux et al., *The Economics of Climate Change Mitigation: How to Build the Necessary Global Action in a Cost-Effective Manner*, OECD ECO/WKP 42 (2009), *available at* http://search.oecd.org/officialdocuments/displaydocument pdf/?doclanguage=en&cote=eco/wkp(2009)42.

215. *See Obama's Climate Change Speech*, *supra* note 1.

216. *See* LATIN, CLIMATE POLICY FAILURES, *supra* note 19, at 91-108, 170-76.

losing their profitable energy-market revenues.[217] Reducing the government deficit surely will not lead to decreasing climate change dangers, and it is unclear how high the carbon tax would have to be to make any meaningful impact on the deficit.

Climate change will cost American citizens trillions of dollars in damages, as well as a considerable loss of life, in the next several decades. It is hard to imagine a more appropriate application of carbon tax revenues than to help finance the development of clean GHG-free replacement technologies that would gradually reduce the atmospheric GHG concentration to a point at which "natural sinks" will be able to absorb enough of the remaining annual GHG emissions.[218] This statement assumes that the large GHG-polluting developing nations will also benefit from these clean technologies, which will enable increasing economic growth without imposing increasing climate degradation. This view may prove quite optimistic, but I do not see any other realistic mitigation strategy.

With regard to the institutions that would determine which current or prospective clean technologies would be most likely to succeed and would benefit most from government subsidies and assistance, I recommend the establishment of a National Research Council decarbonization commission composed mainly of prominent scientists and engineers with a broad understanding of climate change problems and potential solutions. I intend this proposed institution to minimize the amount of direct government control, although there is no doubt that government agencies and officials will have a substantial impact on what the commission decides and how much financial resources it receives and distributes.

Sadly, Congress and our national political system are now infused with so much more partisanship hostility than foresight and cooperation that a fairly impartial NRC decarbonization commission empowered to make clean technology recommendations is more realistic, or less unrealistic, than expectations that the present Congress will develop a comprehensive climate change mitigation plan in the foreseeable future. A non-partisan expert commission might also receive a more favorable reception from most developing nations than a congressional or Presidential administration proposal would.

In the past three years, the UN has created a Climate Technology Centre and Network (CTCN), a Technology Executive Committee, a Technology Transfer Network, and a Technology Needs

217. *See* Davenport, *supra* note 80.

218. *See* LATIN, CLIMATE POLICY FAILURES, *supra* note 19, at 37-39.

Assessment Network under the Secretariat of the UN Framework Convention on Climate Change (UNFCCC).[219] These UN institutions are meant to assist developing countries in creating or identifying the clean technologies they need, and also to arrange for technology transfers from developed nations to poor countries.[220] This clean technology program is a well-meant but typical UN initiative, with more than a year devoted to negotiating in which city the Technology Executive Committee should be located.

Every developing country that is interested in becoming the beneficiary of expert advice and technology transfers must now designate its own *nationally dedicated entity* (NDE), whether an agency or a specific official,[221] that "will perform the role of the NDE focal point in interacting or submitting their country requests for the support of the CTCN."[222] This UN clean technology program was designed to help provide technical expertise, funding, and technology transfers for the benefit of developing nations, and I hope it will be reasonably successful at this mission despite the UN's abysmal bureaucracy.

Although the UN Technology Centre documents call for designing and disseminating new or improved clean technologies that will help reduce greenhouse gases from many sources in many countries,[223] I do not believe this is a credible prospect for UN operations. It is much more likely that the UN staff experts will be able to help developing nations receive various clean technologies that have been designed and marketed by companies in developed nations, often with the assistance of the governments of those states. Then there will be a continuing "battle royale" about the role of intellectual property rights, conflicts among affluent nations that have agreed to provide an unspecified amount of international funding at some time to some poor nations; and disputes between the large GHG-polluting developing countries, such as China and India, which want to receive substantial funding from developed nations despite the fact that they have rapidly growing economies

219. *See* TECHNOLOGY INFORMATION CLEARING HOUSE, http://unfccc.int/ttclear/pages/home.html (last visited July 28, 2013).

220. *See* CLIMATE TECHNOLOGY CENTRE AND NETWORK, http://unfccc.int/ttclear/templates/render_cms_page?TEM_tcn (last visited July 28, 2013).

221. *See* NATIONAL DESIGNATED ENTITIES, http://unfccc.int/ttclear/templates/render_cms_page?TEM_nda (last visited July 28, 2013).

222. *Id.*

223. *See Options for a Facilitation Mechanism that Promotes the Development, Transfer and Dissemination of Clean and Environmentally Sound Technologies,* UNITED NATIONS GENERAL ASSEMBLY A/67/348 (Sept. 4, 2012), *available at* http://unfccc.int/ttclear/templates/render_cms_page?TEM_nda.

and could afford to purchase or produce clean replacement technologies if they chose to.[224]

I do not see any plausible advantages to moving the development of clean technologies from somewhat co-operative and somewhat competing individual nations to an international forum where very little new technological innovation is likely to take place. There is no reason to believe that the US, EU, China, Japan, and other developed nations will choose to develop clean, GHG-free technologies on a collaborative rather than separate competitive basis. Little doubt exists that a degree of cooperation in the creation of some innovative technologies will take place among some developed nations, but I do not believe this cooperative pattern will be common, much less mandatory. Until there is concrete evidence to the contrary, my recommendation for a national decarbonization commission to select, review, endorse, subsidize and otherwise support promising clean technology innovations in the United States appears more plausible than any collaborative international process that would require widespread cooperation and information transfers among technologically advanced nations and GHG-polluting developing countries.[225]

The major GHG-polluting developing nations have for 20 years consistently rejected any kind of ambitious emissions-reduction commitments. This position remained undiluted in COP 19 of the UN Framework Convention on Climate Change, which concluded in Warsaw at the end of November 2013. There is no reason to expect the large GHG-polluting developing nations to agree to major emissions cutbacks because that mandate would impede their highest-priority goal of increasing economic and social welfare. These nations, despite their substantial current GHG discharges, contend that the developed nations are responsible for most of the anthropogenic GHG emissions in the atmosphere and that these affluent nations should have to pay for the elimination of the harmful gases as well as provide compensation for the severe damages that many people in the developing countries have already suffered.

In contrast, the decarbonization strategy depends on devising clean GHG-free alternative technologies that can support continuing energy growth and economic growth in developed and develop-

224. *See* Stéphanie Chuffart, *Technology Transfer and Dissemination Under The UNFCCC: Achievements and New Perspectives*, COLUM. LAW SCHOOL CENTER FOR CLIMATE CHANGE LAW, 8, 19-21, 29-37 (May 2013), *available at* http://web.law.columbia.edu/climate-change/publications/collaborations-visiting-scholars.

225. *See* HARRIS, *supra* note 180.

ing countries. In my opinion, this approach is much more compatible with what most developing countries want than any request from developed nations for all countries to agree to ambitious emissions-reduction cutbacks over the next several decades. Indeed, the recently concluded Warsaw COP 19 conference devoted much effort to reaching international agreement on an emissions-reduction program that would apply to all countries, not only affluent developed nations, and yet no such pollution-reduction agreement was forthcoming or came even close to producing an international consensus.[226]

Many of the comments in this section were meant to show that decarbonization using clean GHG-free replacement technologies is already underway and is making relatively fast progress.[227] However, there is a still a long way to go before this transformative mitigation strategy can be regarded as a major success. The primary difficulties involve the continuing strong political influence of the fossil fuel industries and the unwillingness of most governments and large corporations to invest actively in many renewable energy technologies and processes. I believe these complicated problems will eventually be at least partially resolved, but there is no present reason to expect that the transition from fossil fuel applications spewing GHGs into the air to widespread adoption of clean replacement technologies will occur soon enough and broadly enough to stave off the prospective climate change disasters now looming over the heads of all people in all nations, and especially in highly vulnerable places.

V. CONCLUSION

Over the past two centuries, the world's peoples, especially Americans and Europeans, developed a set of energy-intensive technologies and processes based on fossil fuel combustion that provided historically unparalleled prosperity for many people and an almost infinite variety of production and consumption choices. But now we have come to recognize that those same fossil fuel technolo-

226. *See, e.g.*,Vikas Nath, *Post 2020 Climate Agreement: Lowering Commitments, Phasing Out Responsibilities, Growing Emissions*, PAMBAZUKA NEWS (Dec. 12, 2013), http://pambazuka.org/en/category/comment/89937; Daniel Mittler, *COP 19's Main Lesson: More Pressure Needed to End the Corporate Control of Politics*, OUTREACH, http://www.stakeholderforum.org/sf/outreach/index.php/previous-editions/cop-19/200-cop19wrapup/11644-cop-19-s-main-lesson-more-pressure-needed-to-end-the-corporate-control-of-politics (last visited Dec. 18, 2013); Chandra Bhushan, *World Gets a Yellow Card*, DOWN TO EARTH (Dec.15, 2013), http://www.downtoearth.org.in/content/world-gets-yellow-card.

227. *See, e.g.*, Krauss, *supra* note 196.

gies are severely damaging our climate with disastrous consequences predicted for the near and far future.

We can either retain the GHG-polluting technologies while trying to reduce their persistent CO_2 and methane emissions over an extended period of time, or we can acknowledge that what worked well in the past has come up against inherent environmental limitations that will destroy us in the future unless we rapidly change our ways. Either we continue using the harmful fossil fuel technologies that no longer can meet our most vital human needs because we are familiar with these technologies and they are deeply entrenched in the fabric of our social and economic systems; or we recognize that these destructive technologies must be replaced with economically equivalent clean GHG-free technologies and methods that can serve our welfare needs without further degrading the Earth's climate.

The only arguable benefit of the conventional "too little, too late" emissions-reduction programs is that global warming and climate change might become a little worse a little sooner if we do absolutely nothing to restrict GHG pollution. But accepting a bad mitigation approach at high social costs for an irreversible period of time is not a good climate policy. We cannot tolerate any climate change mitigation initiative, including EPA's 2013 proposed NSPS regulations for new fossil fuel power plants, that is certain to allow huge residual GHG discharges that will compound the cumulative atmospheric GHG concentration and worsen global climate change for centuries or longer. We cannot accept these ineffectual efforts based on the foolish argument that climate conditions would be even worse, only slightly worse, if we do nothing at all to curtail GHG pollution. We must devise mitigation strategies that are much better than "nothing" and are actually capable of attaining meaningful climate change progress.

The decarbonization approach recommended here will require a major transformation of many industrial processes and institutional responsibilities. So would any "ambitious" GHG emissions-reduction initiative. The necessary transition will prove difficult and expensive to implement effectively, no one could doubt the great expenses, social dislocations, and conflicting national and private interests. However, conventional multi-decade GHG emissions-reduction programs and EPA's proposed NSPS regulations will ultimately also cost a great deal of money, administrative resources, and precious time, and they will go on contributing to a higher GHG concentration in the air and related climate change

dangers. There is no perfect mitigation strategy, but in comparison with the conventional emissions-reduction approaches challenged in this article, decarbonization appears to be a much more promising plan that has a reasonable chance, even a good chance, to achieve genuine climate change progress.

After considering the comparisons among the three mitigation strategies evaluated here, I hope readers will recognize that the fundamental climate change policy choice for America is between a decarbonization strategy that will be "difficult to accomplish" and the conventional multi-decade emissions-reduction approaches that are "certain to fail." There cannot be any question that "difficult climate change mitigation" is a lot better than "impossible mitigation failures."