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Greenhouse Gas Regulation under the Clean Air Act

Structure, Effects, and Implications of a Knowable Pathway

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RESOURCES FOR THE FUTURE

Greenhouse Gas Regulation under the Clean Air Act: Structure, Effects, and Implications of a Knowable Pathway

Nathan Richardson, Art Fraas, and Dallas Burtraw

Abstract

It appears inevitable, absent legislative intervention, that regulation under the Clean Air Act (CAA) will move beyond mobile sources to the industrial and power facilities that emit most U.S. greenhouse gas (GHG) emissions. We analyze the mechanisms available to the EPA for regulating such sources, and identify one, New Source Performance Standards (NSPS) as the most predictable, likely, and practical, i.e. knowable, pathway. Based on the legal structure of the NSPS and the EPA's traditional approach, we analyze a hypothetical GHG NSPS for one sector, coal electricity generation. This analysis indicates that efficiency improvements and perhaps biomass cofiring could be implemented through the NSPS, yielding modest but meaningful emissions reductions. Trading could also rein in costs. Though analysis is limited to one sector and does not include modeling of costs, it suggests that CAA regulation, though inferior to comprehensive climate legislation, could be a useful tool for regulating stationary-source GHGs.

Key Words: climate policy, efficiency, EPA, Clean Air Act, NAAQS, coal

JEL Classification Numbers: K32, Q54, Q58

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I. Introduction

Until late 2009, most observers considered it likely that the U.S. Congress would pass some form of comprehensive climate legislation, including an economywide cap-and-trade system for greenhouse gases (GHGs). That did not happen in 2009—though the House passed such a bill (H.R. 2454, or "Waxman–Markey"), the Senate did not. It is now unclear when, or even if, Congress will pass any comprehensive legislation.

This legislative inertia has resulted in a shift in interest to actions by the Environmental Protection Agency (EPA) to regulate GHGs under its existing Clean Air Act (CAA) authority. Under President Obama, the EPA has proposed and finalized rules requiring the reporting of GHG emissions and an "endangerment finding" that permits and requires the regulation of GHG emissions from cars and trucks ("mobile sources," in CAA terminology). This endangerment finding was followed by the recent EPA announcement of new GHG emissions standards for these mobile sources.

The steps the EPA will take as it moves to regulate mobile-source emissions are relatively well understood. Substantial uncertainty remains, however, over how the EPA will use its CAA authority to regulate stationary sources—the power plants and industrial facilities responsible for the majority of U.S. GHG emissions.

This paper attempts to resolve some of that uncertainty by analyzing a set of plausible pathways the EPA may use to regulate stationary-source GHG emissions under the CAA. Section III describes each of these pathways, and Section IV offers evidence that points to one program in particular, the New Source Performance Standards, or NSPS, as the most likely, predictable, and practical vehicle for CAA regulation of GHGs. In short, the NSPS are the knowable pathway for regulation of GHGs under the CAA.

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The EPA could choose from a variety of specific measures under its general NSPS authority, with increasing stringency and reach across existing stationary sources. These measures range from performance standards that vary in stringency and are defined over relatively narrow categories of emissions sources to more flexible standards that allow some form of trading to achieve compliance with an average performance standard. It is also possible that the NSPS program could be used as a vehicle to introduce a sector-based cap-and-trade program.

In Section V, we assess the magnitude of emissions reductions that could be achieved under the most modest of the possible approaches outlined in Section IV. We examine only coal-fired electricity generating units, but within this single, narrowly defined class of emitters, we discuss regulatory options that could achieve emissions reductions equivalent to more than 3 percent of U.S. emissions at what we believe would be modest cost and with minimal disruption to current capacity use. Although we do not explore the more expansive options here, substantially greater reductions would be possible from more stringent performance standards and/or from trading across source categories that would allow for substitution from coal to natural gas. An analysis of the costs and emissions reductions of all of these measures would require modeling that is beyond the scope of this paper.

In discussing an NSPS approach, we do not intend to present it as the ideal or even necessarily preferable pathway for controlling GHG emissions. New, comprehensive climate change legislation from Congress would provide a superior alternative. It is also possible that other pathways under the existing CAA could produce better emissions results, could achieve results at lower cost, might be more likely to survive legal or political challenges, or could otherwise constitute a better approach for the EPA. In our analysis of possible GHG NSPS pathways, we are careful to point out both the associated advantages and the disadvantages. Rather than advocating for NSPS regulation of GHGs, our goal is to offer an analysis of what appears to us to be the most likely route for the EPA to choose. Some studies from the EPA[1] and from academic sources[2] discuss the pathways that are available to the EPA in general terms, but

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1 *See generally* Advance Notice of Proposed Rulemaking: Regulating Greenhouse Gas Emissions under the Clean Air Act, 73 Fed. Reg. 44,354, 44,476-44,520 (July 30, 2008) (hereinafter ANPR).

2 *See, for example,* LARRY PARKER & JAMES E. MCCARTHY, CONGRESSIONAL RESEARCH SERVICE, CLIMATE CHANGE: POTENTIAL REGULATION OF STATIONARY GREENHOUSE GAS SOURCES UNDER THE CLEAN AIR ACT, Report R40585 (2009) at 1; INIMAI M. CHETTIAR & JASON A. SCHWARTZ, NEW YORK UNIVERSITY SCHOOL OF LAW, THE ROAD AHEAD: EPA'S OPTIONS AND OBLIGATIONS FOR REGULATING GREENHOUSE GASES (2009) at v,

few if any discuss any of those pathways in depth. It is this gap that we aim to begin to fill with this paper.

We argue that a modest GHG regulatory program under existing CAA NSPS authority could be effective without deviating greatly from traditional EPA practice under this authority. We further find that such a program could achieve meaningful emissions reductions in the electricity sectors (and potentially elsewhere, though we do not study other sectors). Although a more detailed empirical exercise is necessary to fully determine the costs of regulation, it is our sense that a modest regulatory approach is unlikely to impose large costs. Moreover, the inclusion of emissions trading mechanisms could probably be used to reduce the costs of more stringent regulation even under the CAA, although such mechanisms would probably be limited to individual sectors of the economy.

II. A Brief Overview of the Clean Air Act and GHGs

Until and unless Congress enacts legislation that changes EPA authority, the existing CAA gives the EPA authority to regulate GHG emissions.[3] Furthermore, the EPA has already begun to regulate GHGs from some sources under that statute. Understanding how the EPA may regulate GHG emissions, therefore, requires at least a basic understanding of the CAA.

The CAA is a massive, complex regulatory statute with a wide variety of interconnected programs covering different types of pollutants. The principal division within the statute is between the regulation of stationary emissions sources (power plants, industrial facilities, and so forth), primarily under Title I, and mobile emissions sources (vehicles and vehicle engines) under Title II. In the past year, the EPA has moved quickly toward the regulation of GHGs from mobile sources, but has provided only a limited discussion of regulation of stationary-source GHGs. Because stationary sources emit the majority of GHGs in the United States, how the EPA chooses to regulate them is by far the most significant open question in any analysis of the agency's GHG regulatory efforts.

<http://www.policyintegrity.org/publications/documents/TheRoadAhead.pdf>; Timothy Mullins and M. Rhead Enion, (If) Things Fall Apart: Searching for Optimal Regulatory Solutions to Combating Climate Change under Title I of the Existing Clean Air Act if Congressional Action Fails at 35-38 (2010) available at http://works.bepress.com/timothy_mullins/1/; Roger Martella & Matthew Paulson, *Regulation of Greenhouse Gases under Section 115 of the Clean Air Act*, DAILY ENVIRONMENT REPORT, Mar. 9, 2009, at 1.

[3] *See* Massachusetts v. EPA, 549 U.S. 497, 528–29 (2007).

A. The Regulatory Process So Far

Although our focus in this paper is on stationary-source regulation, the story of EPA regulation of GHGs begins with, and to date has been dominated by, mobile-source regulation. The most recent and significant moves by the agency toward GHG regulation are the December 2009 endangerment finding under section 202 of the CAA[4] and subsequent regulation of mobile sources through fleet emissions standards for vehicle manufacturers.[5] The endangerment finding—and the long series of steps leading up to it, including the well-known *Massachusetts v. EPA* decision by the Supreme Court[6]—did not directly impose any regulation of stationary sources. However, the EPA's recent action establishing GHG emissions limits for cars and trucks will lead to stationary-source regulation through the CAA permitting programs and arguably through the NSPS provisions of the Act.

1. The Foundation—Massachusetts v. EPA

EPA action on GHGs under the CAA, and in particular its focus to date on mobile sources, has been driven by the Supreme Court case that forced the agency to consider regulating GHGs, *Massachusetts v. EPA*.[7] That case was filed by states with a narrow claim—that the EPA must regulate mobile-source GHGs. The Supreme Court ruled that GHGs are pollutants under the CAA and, thus, that the agency is required to determine whether GHGs emitted from vehicles endanger public health or welfare (or at least explain why it would or could not do so).[8] The December 2009 endangerment finding therefore fulfills the Court's mandate from *Massachusetts v. EPA*. No equivalent judicial mandate exists for the regulation of stationary sources.

Massachusetts v. EPA and the regulatory steps undertaken by the EPA in response are not, however, irrelevant to an analysis of the regulation of stationary sources. The critical finding by the Court that, contrary to the EPA's position at the time, GHGs are "pollutants" for purposes

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[4] See Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496 (Dec. 15, 2009).

[5] See Light-Duty Vehicle Greenhouse Gas Emissions Standards and Corporate Average Fuel Economy Standards, EPA–HQ–OAR–2009–0472 (to be published in the Federal Register), *available at* http://www.epa.gov/otaq/climate/regulations/ldv-ghg-final-rule.pdf.

[6] 549 U.S. 497.

[7] *Id.*

[8] *Id.* at 533–535.

of the CAA,[9] makes the regulation of stationary sources possible. The EPA must therefore eventually consider the regulation of stationary-source GHG emissions, even if the Court decision does not explicitly instruct it to do so.[10]

2. The CAA Process—From Endangerment to Regulation

Nearly all of the regulatory programs in the CAA follow a similar process. The EPA first identifies emissions of a pollutant from a set of sources. It then undertakes an analysis of whether these emissions present a danger to “public health or welfare,” generally a purely science-based determination. If, based on this analysis, the agency concludes that a pollutant endangers public health or welfare, this endangerment finding is both a threshold requirement and a trigger—it is both necessary and sufficient for the agency to regulate. The agency retains some discretion over exactly *how* to regulate in the wake of an endangerment finding, but it does not have the option of refusing to regulate at all.

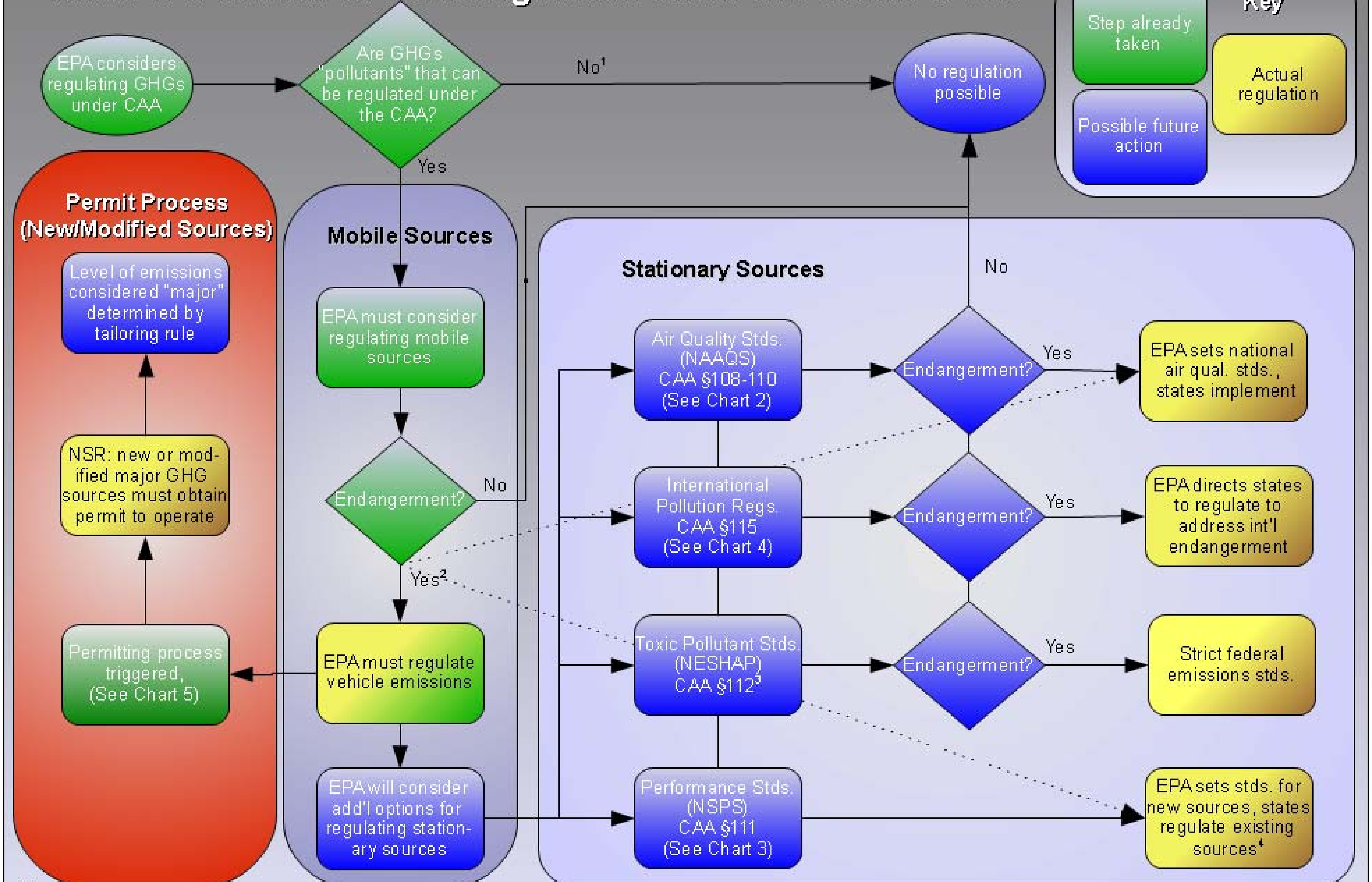
Chart 1 below shows how this process has happened so far for GHG regulation and how it will continue to unfold. The decisions made and steps taken by the EPA to date (in green) show how the agency is well on its way to regulating mobile-source emissions. As discussed above, *Massachusetts v. EPA* set the regulatory process into motion, primarily by determining that GHGs are pollutants within the scope of the CAA. Since that case, the EPA has moved to regulate mobile-source emissions with the recent endangerment finding for such sources and the joint EPA and Department of Transportation rule regulating mobile-source GHG emissions issued in March 2010.[11]

[9] *Id.* at 528–29.

[10] *Id.* at 533–35.

[11] *See* Proposed Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emissions Standards and Corporate Average Fuel Economy Standards, 74 Fed. Reg. 49,454 (September 28, 2009); Light-Duty Vehicle Greenhouse Gas Emissions Standards and Corporate Average Fuel Economy Standards (cited in note 5).

Chart 1: Overview of GHG Regulation under the Clean Air Act



Notes:

1. Foreclosed by *Massachusetts v. EPA*.
2. Some argue that an endangerment finding for mobile sources (under §202) legally requires the EPA to issue air quality standards (NAAQS), performance standards (NSPS), or both for stationary sources. These are open legal questions and will likely be the subject of lawsuits. If these lawsuits are successful, the EPA will be forced to implement NAAQS, NSPS, or both regulatory schemes for stationary sources.
3. The toxic pollutant regulatory scheme under CAA §112 is considered by the EPA and most scholars to be a poor fit for GHG regulation. For this reason, no separate chart has been drawn.
4. Regulation of existing sources with performance standards (CAA § 111(d)) is not permitted when a national air quality standard (NAAQS) has been set under §110 or when §112 regulations are in place for a given pollutant.

3. Agency Discretion

Future possible regulatory actions that might be pursued to regulate stationary sources are illustrated in the remainder of Chart 1 (in blue). The major uncertainty is which of the several CAA regulatory programs for stationary sources the EPA will select.

Most of those who have studied the process of EPA regulation of GHGs under the CAA have explicitly or implicitly assumed that the EPA has discretion to choose among these programs. This is not necessarily the case, however. Richardson[12] and others argue that interconnections among different sections of the CAA (and, therefore, different regulatory programs) may limit the EPA's discretion. Steps that the agency has already taken or will soon take may foreclose certain regulatory options and/or compel others.[13] The EPA admits that this kind of triggering occurs between some programs (most notably that regulation of mobile sources triggers a permitting process for stationary sources, as discussed in Section III.C below), but claims to have general discretion to choose among regulatory programs for stationary sources.[14]

Here, we assume that the EPA has broad discretion to choose among CAA regulatory programs, and that the agency's goal is to regulate GHGs under the CAA as efficiently as possible (to achieve the greatest emissions reductions at the lowest cost). The goal in this paper is to examine plausible candidates for such an ideal CAA GHG regulatory scheme.

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[12] Nathan Richardson, Greenhouse Gas Regulation under the Clean Air Act: Does Chevron v. NRDC Set the EPA Free?, Resources for the Future Discussion Paper 09-50 (December 2009) (forthcoming STAN. J. ENV. L. 2010), <http://www.rff.org/RFF/Documents/RFF-DP-09-50.pdf>.

[13] For example, two environmental groups, the Center for Biological Diversity and 350.org, have petitioned EPA, claiming that the agency is legally required to regulate GHGs under the National Ambient Air Quality Standards (NAAQS) program. *See* Center for Biological Diversity and 350.org, Petition to Establish National Pollution Limits for Greenhouse Gases Pursuant to the Clean Air Act (Dec. 2, 2009) at 15, available at http://www.biologicaldiversity.org/programs/climate_law_institute/global_warming_litigation/clean_air_act/pdfs/Petition_GHG_pollution_cap_12-2-2009.pdf. Richardson, *supra* note 12, writes that such challenges stand a significant chance of success in the courts.

[14] *See* Advance Notice of Proposed Rulemaking: Regulating Greenhouse Gas Emissions under the Clean Air Act, 73 Fed. Reg. 44,354, 44,476 (July 30, 2008) (hereinafter ANPR) (stating that "we explore three major pathways that the CAA provides for regulating stationary sources, as well as other stationary source authorities of the Act, and their potential applicability to GHGs").

III. Stationary-Source Regulation under the Clean Air Act

Stationary-source regulation under the CAA comes in three forms, air quality standards, technology standards, and permits for new and modified sources. Most (but not all) of these programs involve some split of regulatory authority between federal and state governments, termed *cooperative federalism*. The CAA has also traditionally been a command-and-control statute, but amendments in 1977 and 1990 and EPA actions over the same time period have brought the limited application of incentive-based approaches to some aspects of CAA regulation. A substantial portion of our analysis will be dedicated to whether and how such approaches might be implemented for GHGs.

A. Air Quality Standards

Air quality standards are the core regulatory mechanism in the CAA. The primary vehicle for such standards, the National Ambient Air Quality Standards (NAAQS), is the most well-known program in the statute and the source of much of its regulatory impact. However, the standards have some conceptual inconsistencies and practical implementation problems that make them less than ideal for the regulation of GHGs.

1. The National Ambient Air Quality Standards (NAAQS)

In the NAAQS program, as the name implies, a single air quality standard for each regulated pollutant is set for the entire country. The goal of the ensuing regulation is to ensure that areas that fail to attain this standard (“nonattainment areas”) are brought into compliance, and that areas in which the standard is currently met (“attainment areas”) continue to do so in the future. The NAAQS program is governed by sections 108–110 of the CAA.[15]

NAAQS regulatory responsibilities are divided between the EPA and state governments—the NAAQS program is the primary example of the CAA’s cooperative federalism approach. The EPA is responsible for listing pollutants to be regulated under the program and for setting the NAAQS themselves, whereas states are responsible for on-the-ground regulation of emitters to comply with the standards.

The regulatory process for the NAAQS is as follows. First, the EPA must determine whether a given pollutant endangers public health or welfare—this is the NAAQS endangerment

[15] Clean Air Act, 42 U.S.C. §§7408(a) (§108(b)) (hereinafter CAA).

finding, analogous but not identical to that required for mobile sources.[16] Pollutants for which a positive endangerment finding has been made are listed as "criteria pollutants" and the agency must determine what air quality standard is necessary to protect public health or welfare.[17] In principle, the agency could set separate standards to protect health and welfare—these are termed primary (health) and secondary (welfare) standards.[18] In practice, however, the EPA almost never does this, and the only difference between the two types of standard is that the CAA does not include a timeline for compliance with secondary standards.[19] Both of these initial determinations—endangerment and the level at which a NAAQS is set—are designated in the CAA as purely scientific.[20] The EPA is not permitted to consider compliance costs.[21] To date, the EPA has set a NAAQS for only six pollutants: sulfur dioxide (SO_2), tropospheric ozone, nitrous oxides (NO_x), particulate matter (PM; two particles sizes are regulated separately), lead, and carbon monoxide.[22]

Once a NAAQS has been set, states are responsible for compliance; The EPA retains significant oversight, however. States must document how they plan to comply with the standards in state implementation plans, or SIPs, which the EPA must approve.[23] Each plan must illustrate how an area will come into compliance with the (primary) NAAQS within 5 years, though the EPA can extend that period to 10 years.[24] In practice, the EPA may create a "model plan" that states can adopt with the knowledge that it will be approved by the agency, though they are free in principle to deviate from the model as long as EPA agrees that the alternative

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16 CAA, §108(a).

17 CAA, §109(a).

18 CAA, §109(a)(1)-(2).

19 CAA, §172(a)(2)(A).

20 CAA, §108(a), §109(a).

21 Whitman v. Am. Trucking Ass'ns, 531 U.S. 457, 486 (2001).

22 40 C.F.R. §§ 50.2-50.16 (Westlaw 2010); *see also* EPA Air and Radiation, *National Ambient Air Quality Standards (NAAQS)*, <http://www.epa.gov/air/criteria.html> (last visited Feb. 12, 2010) (listing the NAAQS for the six criteria pollutants – carbon monoxide, lead, nitrogen dioxide, particulate mattter PM_{10}, particulate matter $PM_{2.5}$, ozone, and sulfur dioxide).

23 CAA, §110(a), (k).

24 CAA, §172(a)(2)(A).

plan is consistent with the CAA and will attain the standard. [25] States that fail to adequately plan are subject to sanctions, including the potential loss of federal highway funding.[26] The EPA must also establish a federal implementation plan, or FIP, in such cases.[27] Once a SIP has been approved, states are responsible for implementing it. States have their full arsenal of regulatory powers in implementing their plans—they have both significant power and significant flexibility. This flexibility is not unlimited, however. For example, in nonattainment areas, states are required to impose "reasonably available control technology" (RACT) on emitters. [28] The process of NAAQS regulation is detailed in Chart 2 below.

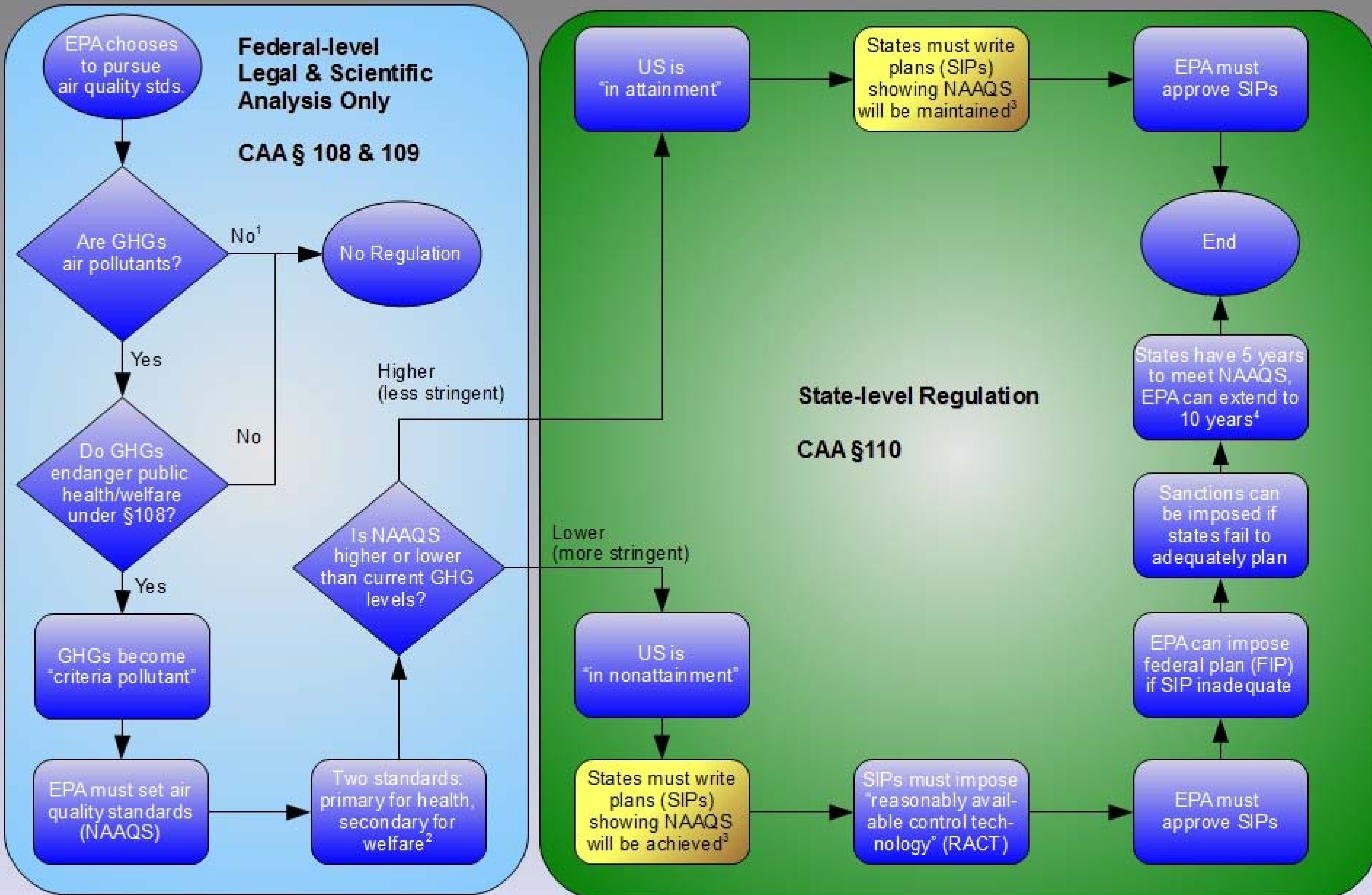
[25] See, e.g., See EPA, Finding of Significant Contribution and Rulemaking for Certain States in the Ozone Transport Assessment Group Region for Purposes of Reducing Regional Transport of Ozone (the "NOx SIP Call"), 63 Fed. Reg. 57356, 57456-76.

[26] CAA, §179.

[27] CAA, §110(c).

[28] CAA, §172(c)(1).

Chart 2: Regulating GHGs with Air Quality Standards (NAAQS – CAA §§108-110)



Notes:

1. Foreclosed by *Massachusetts v. EPA*
2. For all current NAAQS but one (SO_2), primary and secondary standards are the same.
3. The EPA may implement an emissions trading system by issuing requirements for SIPs. This has been done in a nonattainment situation (the NOx SIP Call), but not an attainment situation.
4. If only a secondary NAAQS is set, states have no fixed timetable for compliance.

Despite the apparent rigidity of the NAAQS regulatory process, the EPA succeeded in implementing an emissions trading system through the NAAQS in the late 1990s. Continued failure to reach attainment for the ozone NAAQS in the 1990s led the EPA to require a large group of states to resubmit SIPs that would address problems arising from the transport of NO_x emissions between states. In the call for revised SIPs (known as the "NO_x SIP Call"), the EPA offered a model rule that the states could adopt and thereby opt into an interstate emissions trading system.[29] All of the affected states adopted the model rule, and the result is the NO_x Budget Program, a trading system that has widely been viewed as both effective at reducing emissions and efficient at doing so at low cost.[30] It provides a precedent for the ability of the EPA and regulating states to create a trading program under the NAAQS program.[31] However, the EPA's subsequent 2005 CAIR rule[32]—modeled in some respects on the NOx SIP Call—was remanded to the EPA by the DC Circuit in 2008. The court raised significant questions with respect to elements of emissions trading under the NAAQS.[33]

2. Limitations of the NAAQS for GHGs

Despite the instrumental role of the NAAQS program in CAA regulation, implementing a NAAQS for GHGs may pose significant difficulties. Some of these problems are conceptual—the NAAQS framework does not fit the problem of GHG emissions nearly as well as it does traditional pollutants. Other problems are practical—it may be difficult to impose effective regulation through the NAAQS program.

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[29] See generally NOx SIP Call (cited in note 25).

[30] D. Burtraw & S. Szambelan, U.S. Emissions Trading Markets for SO_2 and NO_x, Resources for the Future Discussion Paper 09-40 (2009).

[31] The DC Circuit's decision in *North Carolina v. EPA, 531 F.3d 896,908 (D.C. Cir. 2008) (per curiam)* remanding the Clean Air Interstate Rule (CAIR) draws into question at least some elements of emissions trading schemes under the NAAQS.

[32] See generally Rule To Reduce Interstate Transport of Fine Particulate Matter and Ozone (Clean Air Interstate Rule), 70 Fed. Reg. 25,162 (Dec. 29, 2005) (creating new interstate trading programs under the NAAQS and modifying existing programs)

[33] See generally *id.* (Holding, among other concerns, that the CAIR rule failed to guarantee that under the trading program, emissions from one state would not "contribute significantly" to nonattainment of the NAAQS in downwind states.) It is possible that a GHG trading program would not have similar problems, since it would not need to be based on states' contributions to nonattainment (or interference with maintenance) elsewhere—since GHGs are globally mixed in the atmosphere, any local GHG emissions affect local concentrations as much as they affect concentrations elsewhere.

Conceptually, problems arise from the global character of the GHG/climate change problem. For traditional pollutants, concentrations are greater near (or downwind of) emitters—pollution is primarily a local or regional problem. In such cases, setting a national air quality standard and allowing state governments to regulate makes sense. Those states with significant emitters and/or high levels of pollution can and must impose stricter regulations. Emissions that are transported across state borders make this somewhat more difficult (notably for SO_2, NO_x, PM, and ozone). This difficulty has inspired EPA to attempt to create interstate trading programs including the NO_x Budget Program and the more recent Clean Air Interstate Rule, the latter of which has come under significant legal challenge, as discussed above.

GHGs are different, however. For the most part, atmospheric concentrations are uniform globally and not related to local emissions. This creates problems at two points in the NAAQS process. First, it is not clear at what level a NAAQS for GHGs should be set. This determination must be scientific rather than policy-driven, and may prove difficult. Second, because concentrations of GHGs are uniform nationally, whatever level is chosen by the EPA for the NAAQS will result in the entire country either being in attainment or nonattainment. If the entire country is in attainment, relatively little regulation can be imposed. If the entire country is in nonattainment, what are individual states supposed to plan to do in their SIPs to address their failure to meet the NAAQS? Nothing any individual state could do would have any significant effect on local GHG concentrations. In short, the cooperative federalism approach that has been successful in regulating other NAAQS pollutants seems unsuitable for GHGs.

The NAAQS is also a slow process. Although there is no guarantee that other CAA programs or even programs implemented in new climate legislation would operate quickly, the NAAQS process is particularly tortuous. Multiple levels of government are involved, with considerable back-and-forth between them. The CAA itself imposes a rigid structure on the process, with a requirement for public comment and an opportunity for litigation at many stages. The process of listing a pollutant, setting a NAAQS, requesting SIPs, approving them, implementing regulation, and verifying attainment takes many years. Legal challenges, disputes between states and the EPA, and bureaucratic foot-dragging can slow this process down substantially. While the EPA does have substantial discretion over the timing of many steps in the process, it (and the states) must complete all of these steps. Neither the agency nor the states have moved quickly or nimbly in regulating other pollutants under the NAAQS program.

GHG regulation under the NAAQS program could also present political problems for the EPA. The NAAQS program is considered by many to be an expansive, complex, and relatively intrusive regulatory program. Regulation of GHGs via the NAAQS program would necessarily be economywide (encompassing all stationary sources) and nationwide. Such regulation is likely to be controversial, and more likely to spur congressional action, although it is plausible that Congress might react by passing comprehensive climate legislation that would supersede the NAAQS.

Anecdotal evidence also suggests that very little support exists for the regulation of GHGs via the NAAQS program within the EPA or most parts of the policy community. The climate bills proposed in both the House (Waxman–Markey) and Senate (Kerry–Boxer) would explicitly take away the EPA's authority to regulate GHGs through the NAAQS program. Most environmental groups oppose a GHG NAAQS as well, favoring new legislation and/or regulation through other CAA programs—though one organization has petitioned the EPA, claiming that the agency *must* issue a NAAQS.[34] In the proposed "tailoring rule," the EPA noted that there is no NAAQS for carbon dioxide (CO_2; or the other primary GHGs) and that it does not plan to promulgate one.[35]

3. International Emissions Regulation—an Alternative Path?

The NAAQS is the only CAA regulatory program based on air quality standards currently in place. No other major, detailed program exists, but a short, rarely used section of the CAA may provide an alternative basis for regulation based on air quality standards.[36] This section (CAA section 115) is directed at international emissions—that is, U.S. emissions that cause environmental problems elsewhere. Superficially, this seems ideal for the GHG problem. The section is extremely short and lacks detail, however. This could be a virtue, in that it leaves significant discretion to the EPA to devise regulation, but it also exposes such regulation to greater legal scrutiny.

International emissions regulation under section 115 has only two requirements: first, the EPA must determine that emissions originating in the United States endanger public health or

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[34] See Center for Biological Diversity and 350.org, Petition to Establish National Pollution Limits for Greenhouse Gases Pursuant to the Clean Air Act (Dec. 2, 2009) at 15, <http://www.biologicaldiversity.org/programs/climate_law_institute/global_warming_litigation/clean_air_act/pdfs/Petition_GHG_pollution_cap_12-2-2009.pdf>.

[35] See EPA. *Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule*, 74 F.R. 55292, 55297 (2009) (hereinafter "tailoring rule").

[36] CAA, §115.

welfare in another country.[37] This determination can be based on reports from an international agency or certification by the Secretary of State.[38] For GHGs, the Intergovernmental Panel on Climate Change (IPCC) report is probably sufficient to meet this requirement. Second, the country affected by U.S. emissions must give the United States reciprocal rights—that is, the country must control its emissions that endanger public health or welfare in the United States.[39]

Once these requirements have been met, the EPA can require states to revise their SIPs (which all states have as a result of the regulation of other pollutants through the NAAQS program) so as to “prevent or eliminate the endangerment” from GHGs.[40] No further guidance as to what kind of regulation is permitted is given in the statute. The section 115 international emissions regulatory process is detailed in Chart 3, below.[41]

[37] CAA, §115(a).

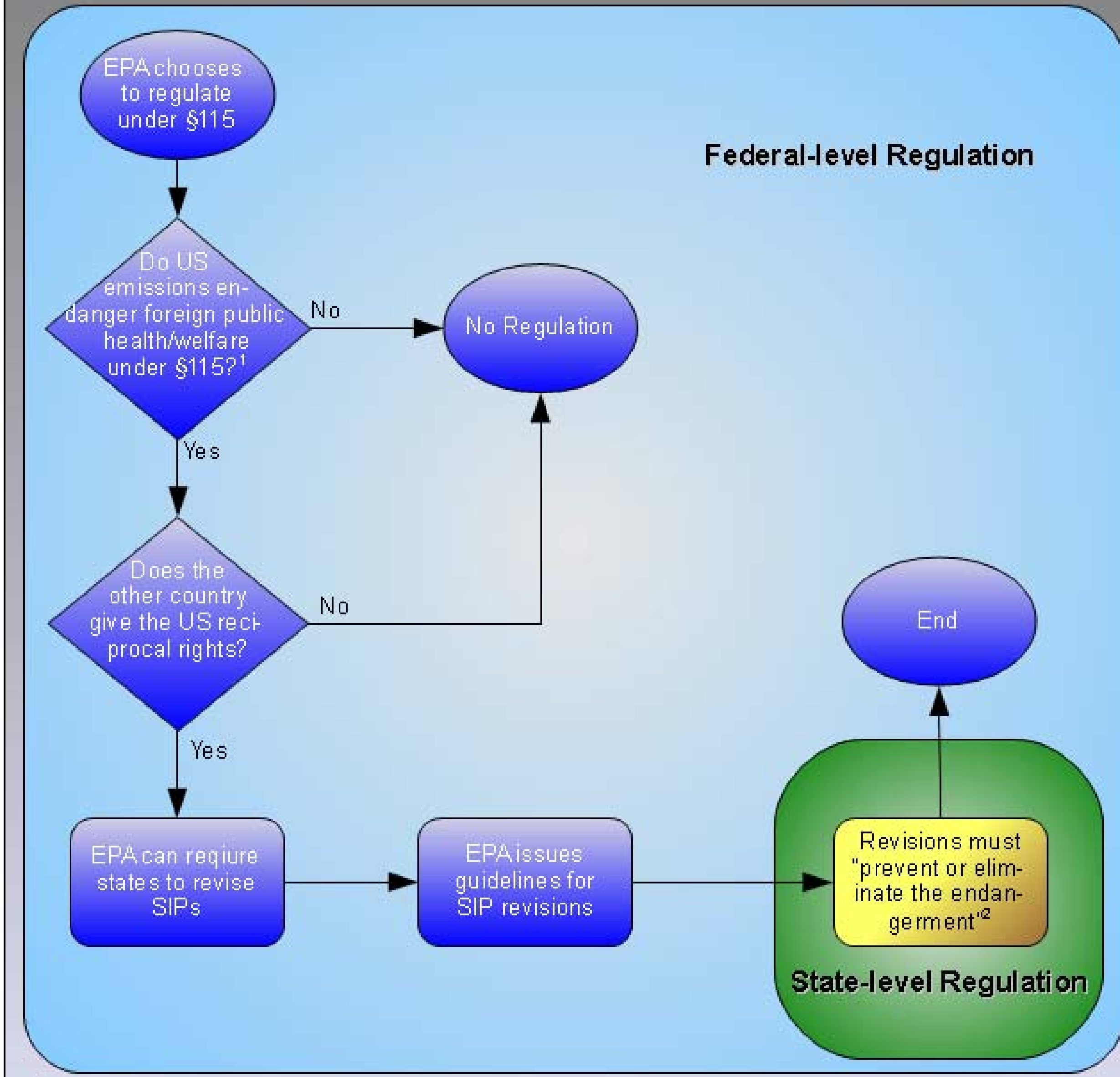
[38] Id.

[39] Id.

[40] CAA, §115(b).

[41] Some, including the EPA itself, have also proposed regulating GHGs under §615 of the CAA, part of Title VI governing stratospheric ozone protection. *See* ANPR at 44,516 (2008). This section, like §115, is short and appears to give the EPA broad authority and discretion—in this case to regulate anything that “may reasonably be anticipated to affect the stratosphere.” This language in principle provides authority to regulate GHGs because all of them eventually make their way to the stratosphere. Attempting to create a broad regulatory program based on such sparse language is relatively unlikely to survive legal challenge, for the same reasons as for regulation under §115. The section may have some promise for the regulation of GHGs that also have effects on stratospheric ozone, however.

Chart 3: Regulating GHGs as International Air Pollution (CAA §115)



Notes:
1. Either a report from a "duly constituted international agency" or a request from the Secretary of State is needed to show endangerment. The IPCC report is likely sufficient.
2. §115 provides no guidance or limitations on EPA authority beyond this language.
3. Martella and Paulson argue that regulation under §115 would not trigger permitting (NSR). We disagree, but this remains an open legal question.

Some analysts, including a former General Counsel of the EPA, have argued that this flexibility makes regulation of GHG emissions under section 115 extremely attractive.[42] The EPA would not need to set a single national air quality standard for GHGs and might therefore be able to require states in their SIPs to make different levels of reductions in GHG emissions.[43] Because the emissions reductions would be determined by how much is necessary to reduce the dangers of GHGs internationally, most, if not all, of the conceptual problems presented by traditional NAAQS regulation are not present. The EPA furthermore might be able to create an emissions trading system through requested changes in states' SIPs, much as it did for NO_x in the SIP Call, again without the other restrictions of the NAAQS process. In short, section 115 may allow the EPA to tie emissions reductions to global, rather than local, risks and give it nearly unlimited flexibility to design an efficient and effective regulatory program.

The problem with such sweeping regulation under section 115 is that it may not be legal. Courts usually take a dim view of attempts by agencies to use short, vague statutory language to justify sweeping regulatory changes. As Justice Scalia has put it, "Congress does not . . . hide *elephants* in *mouseholes*."[44] Such broad regulation of GHG emissions under section 115 (indeed, any GHG regulation) is highly likely to be challenged in the courts. The same brevity in the section that grants the EPA the desired regulatory flexibility is likely to be a fatal weak point in such a challenge. Section 115 may appear to provide a perfect foundation for GHG regulation, but the EPA would risk putting great effort into developing a regulatory program only to discover that its foundation is built on sand.

B. Technology Standards

Although air quality standards (the NAAQS) receive significant attention, technology standards are an equally important part of regulation under the CAA. Furthermore, some of these programs may present a more favorable path for the regulation of GHGs.

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[42] *See* Roger Martella & Matthew Paulson, *Regulation of Greenhouse Gases under Section 115 of the Clean Air Act*, DAILY ENVIRONMENT REPORT, Mar. 9, 2009, at 5, <http://www.sidley.com/files/Publication/c789bb2a-7562-4149-8474-036f21dee348/Presentation/PublicationAttachment/3a6fe43a-22d1-4715-9f69-04c17efdbd00/GreenhouseGases.pdf>.

[43] See generally Hannah Chang, *Cap and Trade Under the Clean Air Act?: Rethinking Section 115*, Columbia Law School Center for Climate Change Law, Working Paper (2010), available at http://www.law.columbia.edu/centers/climatechange/publications/workingpapers.

[44] *Whitman v. Am. Trucking Association*, 531 U.S. 457, 468.

1. New Source Performance Standards (NSPS)

Under section 111 of the CAA, the EPA has the authority to set technology-based standards for new stationary sources and existing sources that make major modifications. The EPA also has the authority to set guidelines for states to use in setting technology standards for existing sources. The program created by this section is called the New Source Performance Standards, or NSPS, even though this section also provides (in some circumstances) authority for the regulation of existing sources.

While air quality standards operate on pollutants, the NSPS under the CAA operate on classes of emitters. These classes are termed "source categories." The EPA has significant discretion to specify these categories. Setting source categories requires the EPA to make an endangerment finding—the agency must determine that emissions from the source category endanger public health or welfare. This is analogous to other endangerment findings in that it is both a threshold requirement and a trigger for mandatory regulation. Unlike the NAAQS endangerment finding, however, the EPA must find endangerment under the NSPS for each source category (each type of emitter), not for each pollutant.

EPA has already made an endangerment finding based on other pollutants and has listed more than 60 source categories and subcategories that cover all major types of stationary sources, including coal, oil, and gas power plants; refineries; cement plants; and many other industrial facilities. Therefore, no new endangerment finding would be necessary to regulate GHGs through the NSPS program for these sources. The EPA can also list additional source categories after making an endangerment finding.[45]

Once a source category has been identified and an endangerment finding made, the EPA must issue performance standards for new and modified sources within that category. These standards must "reflect[] the degree of emission limitation achievable through the application of the best system of emissions reduction"[46] that has been "adequately demonstrated." EPA is permitted to consider costs when setting the standards. The NSPS do not require emitters to install a particular technology—they only require emitters to meet an emissions standard that the EPA determines based on technological options. In practice, emitters may or may not have much

[45] In fact, the EPA is probably legally required to include GHG emissions standards in future revisions of NSPS for existing source categories. See notes 52-55 and accompanying text.

[46] CAA §111(a)(1).

choice over what emissions control measures to take, and they assume some risk if they choose a measure that differs from predetermined options. As a result, the NSPS may force the widespread adoption of specific technology used by only a few plants in the industry (or in a closely related industry). The EPA also periodically reviews the NSPS—at which time it may determine that technological progress justifies a stricter standard. In this sense, the NSPS are moving targets. (The NAAQS can change as well, usually in response to new scientific information about risks from pollutants.)

Once the NSPS for a source category have been set, they apply to all new sources in the category and any sources that undergo a “major modification.” What modifications qualify as “major” is a topic of significant contention, and sometimes litigation, between the agency and emitters; the EPA has, as a result, issued detailed regulatory guidelines for this determination. Emitters must show compliance with the NSPS before construction can proceed.

The NSPS program, as described to this point, applies only to new and modified sources and is primarily federal (the EPA can delegate enforcement authority to states).

Under some conditions, existing sources are also regulated under the NSPS program under section 111(d) of the CAA. Unlike the primarily federal NSPS for new and modified sources, section 111(d) regulation delegates planning and enforcement to the states in a manner similar to that described above for NAAQS regulation. However, this authority to regulate existing sources with performance standards is only available for pollutants not regulated under the NAAQS program or as toxic pollutants under section 112 (discussed in Subsection III.B.2 below). If a pollutant is regulated under either of these programs, no performance standards can be implemented under the NSPS for existing sources. This may be a barrier to integrated approaches that might otherwise combine the regulation of GHGs under the NSPS and the NAAQS programs (or under section 112) for existing sources.

Assuming that a pollutant is not regulated under these other programs, section 111(d) of the CAA provides that the EPA must create a system under which states will create performance standards for existing sources and submit plans to implement the standards (similar to SIPs under the NAAQS program). The agency has the responsibility and the authority to approve or disapprove these plans, and implement a federal plan if states fail to adequately set standards. Subject to EPA approval of their plans, states have significant flexibility to set standards for existing sources. For example, they are explicitly authorized to take into account how much useful life remains for a source.[47] The NSPS regulatory process is detailed in Chart 4, below.

The current precedent for emissions trading under the NSPS program is limited. In principle, the EPA could implement trading within a source category by claiming that trading itself was the "best system of emission reduction." Whether this is a permissible reading of the statute has not been determined by courts. Evidence suggests that it may be permissible, however. First, any challenge would have to overcome the substantial deference shown to agency readings of their own statutes under *Chevron v. NRDC*.[48] Second, EPA issued a regulation establishing a trading program for mercury emissions from electricity generating units in 2005, purporting to use CAA section 111(d) authority.[49] Although the D.C. Circuit rejected EPA's mercury rule, it did so on other grounds—the court gave no indication that emissions trading under the NSPS program was itself problematic (though it is of course possible that the court simply did not reach the issue).[50] A small trading program also exists for NO_x emissions for one source category of emitters, solid waste combustors, though the EPA's authority for this program is only derived partially from section 111.[51]

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47 CAA §111(d)(1)(B).

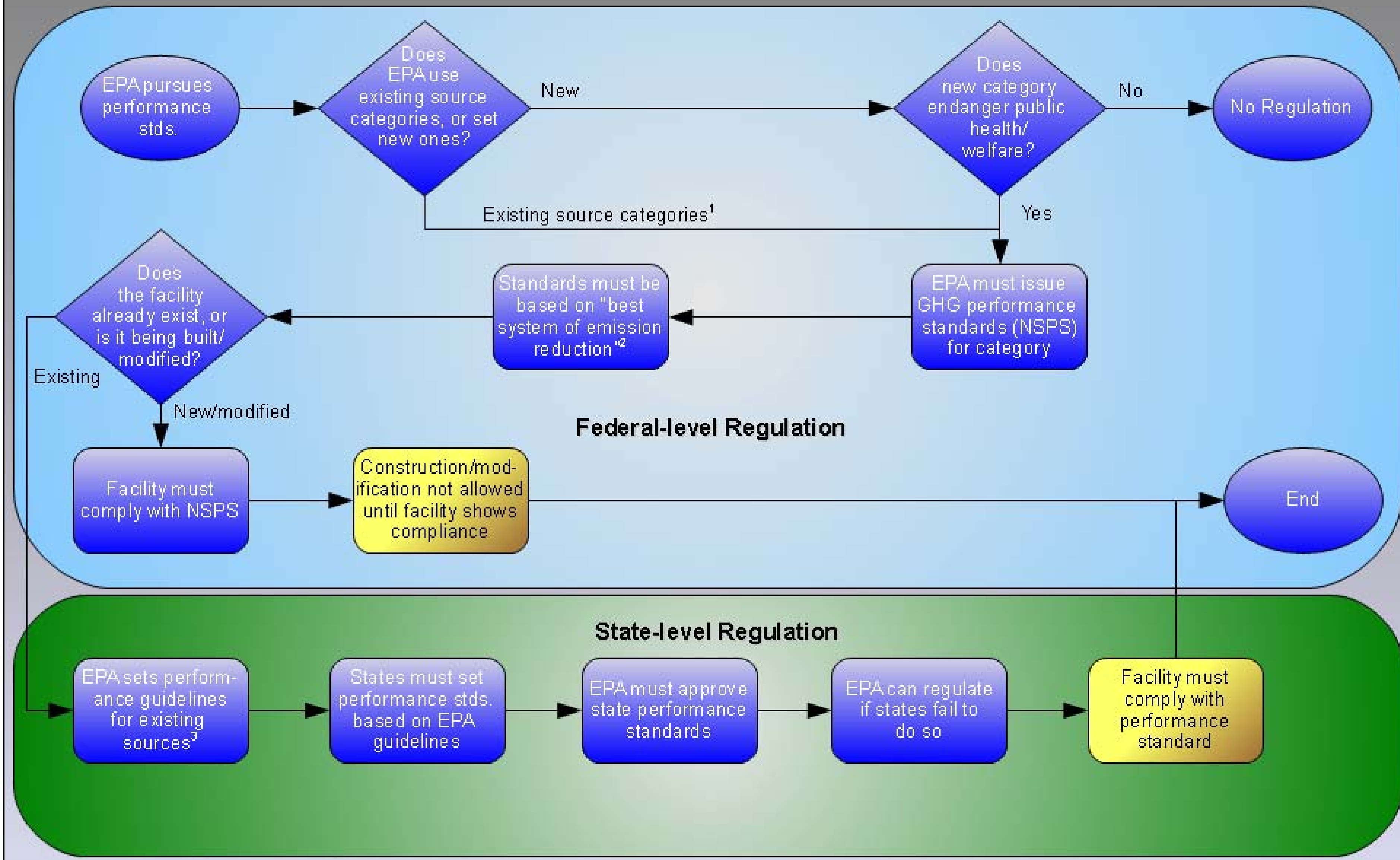
48 In *Chevron U.S.A., Inc. v. Natural Resources Defense Council, Inc*., 467 U.S. 837 (1984), the Supreme Court held that agency interpretations of ambiguous statutory language prevail unless they are not "reasonable" or "permissible."

49 *See* generally EPA, Clean Air Mercury Rule, Basic Information, <http://www.epa.gov/mercuryrule/basic.htm> (stating that the rule was "issued under . . . section[] . . . 111 of the law").

50 *See generally New Jersey v. EPA*, 517 F.3d 574 (D.C. Cir. 2008).

51 See 40 CFR 60.33b(2) (stating that "A State plan may establish a program to allow owners or operators of municipal waste combustor plants to engage in trading of nitrogen oxides emission credits. A trading program must be approved by EPA before implementation.").

Chart 4: Regulating GHGs with Performance Standards (NSPS – CAA §111)



Notes:

1. This assumes that, as some environmental groups claim, the EPA is required to set GHG performance standards for existing source categories once it makes the decision to regulate GHGs under the CAA.
2. This analysis can consider costs. It is unclear whether the EPA can determine that an emissions trading scheme is the "best system," or if trading between source categories would be possible.
3. Like the NSPS for new/modified sources in the same category, these guidelines are technology-based, but can be less stringent. The EPA may be able to set up a NOx SIP Call-like trading program using the guidelines.

Further, the EPA is arguably required to issue GHG NSPS. Because *Massachusetts v. EPA* determined that GHGs are pollutants, and the mobile-source rules have further made them pollutants regulated under the CAA, any new NSPS probably must include performance standards for GHGs. The EPA, environmental groups, and some states have disagreed in the past about whether GHGs must be included in NSPS revisions. In the first such revision after *Massachusetts v. EPA* was decided, for the petroleum refinery source category, the EPA received comments claiming that it was required to include GHG regulations in the new NSPS.[52] The agency responded that it was not required to do so, and in any event lacked sufficient time to do so (the revised NSPS were finalized four weeks after the decision in *Massachusetts v. EPA*).[53] Many of the EPA's arguments in declining to include GHGs, such as lack of time and the fact that, at the time, GHGs were not regulated under the CAA, are no longer valid—though the EPA's broad claim that it has general discretion in deciding whether NSPS will be set for a given pollutant remains. A group of states challenged the EPA's reliance on this discretion in 2008,[54] and if the EPA chooses not to include GHGs in future NSPS revisions, it will likely be challenged again. The political and legal situations have changed, however, and the EPA is much more inclined to regulate GHGs with CAA tools than it was under the Bush administration in 2008. The EPA may believe that, having issued a positive GHG endangerment finding and regulated GHGs under the CAA, it must now include GHGs in future NSPS revisions.[55]

The NSPS program is the most plausible candidate for regulation of GHGs from stationary sources, chiefly because it lacks the conceptual and practical problems presented by the NAAQS and the legal difficulties presented by section 115 on international emissions. In Sections IV and V of this paper, we present a possible pathway to such regulation under the NSPS program and discuss its advantages and disadvantages in more detail.

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[52] See Standards of Performance for Petroleum Refineries; Final Rule, 73 Fed. Reg. 35,838 (June 24, 2008) at 35,858.

[53] Id. at 35,838-35,360.

[54] See New York Office of the Attorney General, Press Release, *Cuomo Files Lawsuit to Force Bush EPA to Control Global Warming Pollution from Big Oil Refineries,* Aug. 25, 2008, available at http://www.ag.ny.gov/media_center/2008/aug/aug25b_08.html; the outcome of this litigation is unknown.

[55] Roger Martella, former EPA General Counsel, has stated that the EPA will likely take the position that, after the December 2009 endangerment finding, it must include GHGs in future NSPS revisions. See Robin Bravender, EPA *notice sets stage for regulation writing, lawsuits,* Greenwire, Dec 15, 2009. Available at http://www.eenews.net/public/Greenwire/2009/12/15/3.

2. Hazardous/Toxic Air Pollutant Regulation

Section 112 of the CAA creates a separate technology-focused program for the regulation of certain toxic or hazardous emissions.[56] This Hazardous Air Pollutant (HAP) program is an important component of the CAA and covers a vast range of pollutants that present significant health risks. The program gives the EPA broad authority to directly regulate toxic substances—states do not play a significant role.

Although an understanding of toxic emissions regulation under section 112 is important to understanding the CAA as a whole, it is not likely to be a useful vehicle for the regulation of most GHGs. The program is designed for highly toxic substances emitted in relatively low quantities—most GHGs are not toxic and are emitted in large quantities.

Very stringent "major source" emissions thresholds are the first problem with regulating GHGs as toxic pollutants. Section 112 regulations apply to all "major sources" of pollutants listed under the section, with major sources defined as those emitting 10 tons per year or more of any single toxic pollutant or 25 or more tons per year of any combination of listed toxic pollutants.[57] Regulation of CO_2 under a program with such low emissions triggers is impractical to the point of absurdity because it would affect tens of millions of small sources.

Statutory requirements for very strict regulation present another problem for regulating GHGs as toxic pollutants. Section 112 requires the EPA to set emissions standards at the "maximum degree of reduction in emissions" that the agency determines is achievable.[58] For existing sources, this is defined as the maximum degree of emissions reduction achieved by the best 12 percent of existing sources.[59] In any case, this level of mandatory reduction does not allow for the consideration of cost.[60] Furthermore, section 112 provides no legal basis for emissions trading.

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[56] CAA, §112.

[57] CAA §112(a)(1).

[58] CAA §112(d)(2).

[59] CAA §112(d)(3)(A).

[60] Id; note that CAA §112(d)(2) *does* permit the EPA to consider costs when defining "maximum degree of reduction in emissions" generally, but that the MACT floors specified in CAA §112(d)(3) are explicitly defined based on emissions from existing sources, irrespective of cost.

In short, the HAP program is a poor fit for general GHG regulation under the CAA. It may be a useful option for some minor GHGs that are toxic, but the HAP program does not provide the policy flexibility necessary for a cost-effective approach to the regulation of major GHGs.

C. Permitting

The CAA creates programs for permitting new and modified stationary sources that operate in parallel to the air quality standards (NAAQS) and technology standards (NSPS and HAP). The two main permitting programs include one for major new or modified sources and one for major existing sources. In other words, the CAA creates a requirement for both construction and operating permits. The construction permitting program is termed New Source Review (NSR).[61] The operating permit program is referred to by the part of the CAA that created it: Title V.[62] Permitting under the CAA is very complex. What follows is only a very broad overview.

The Title V operating permitting program, at least in theory, does not impose new requirements on the stationary sources that are required to obtain permits—it provides an enforcement tool rather than separate regulation. Title V permits are broad in that they are intended to specify all applicable CAA requirements for the plant.[63] Despite not imposing new requirements, the permitting process can be complex. Permits may take more than a year to obtain, the cost for the process can be high, and administrative costs are shifted entirely onto emitters.

The NSR program for construction permits, on the other hand, does impose new requirements. Permitting under NSR requires both site-specific, technology-based review of the control technology proposed by the source and a demonstration that the plant will not create or exacerbate violations of air quality standards in the area surrounding the plant.[64] NSR requirements differ depending on whether the area in which the plant is located is classified as an

[61] CAA §160-169, §173. NSR is sometimes also referred to as PSD, for Prevention of Significant Deterioration—though this term technically applies only to areas in attainment with respect to a pollutant regulated under the NAAQS.

[62] CAA, §501-506.

[63] CAA, §502(f).

[64] CAA, §165.

attainment area or a nonattainment area under the NAAQS program. The control technology review will result in direct, substantive regulatory requirements. The NSR technology-based review often results in more stringent standards than those required by the NSPS program.

In the case of GHGs, plants subject to NSR will be subject to control requirements independent of EPA decisions on whether and how to implement a GHG control strategy for stationary sources under other applicable provisions of the CAA. The EPA's position is that as soon as any restrictions placed on emissions of a pollutant under any CAA authority become effective, sources that emit that pollutant are subject to permitting—even if the regulation does not apply to them directly.[65] For GHGs, this means that *mobile*-source regulation will trigger NSR and Title V permitting for covered stationary sources.

The inclusion of GHGs in the NSR process will result in significant additional regulation for large GHG emitters (with the determination of which sources are sufficiently large a significant issue, as discussed below). Even though such emitters are already subject to NSR review for new construction (because they also emit other pollutants regulated under the CAA), that process will now involve control technology review for GHGs. It is not yet clear what this control technology requirement will look like, but the EPA will make such determinations on a case-by-case basis. It is also possible that what would in the past have been considered trivial modifications or "routine maintenance" to existing plants, insufficient to trigger modified-source NSR, would now be considered major modifications because of their impact on GHG emissions. This would result in much more frequent NSR for these sources.

Another problem arises, however, from the CAA definition of what a "major" source is (recall that only major sources need NSR or Title V permits). The threshold for sources is defined in the CAA at 250 tons of annual emissions (100 tons in some cases).[66] If a source emits more than this threshold of any pollutant regulated under the CAA, it is a major source and must

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[65] *See* PSD Interpretive Memo from Stephen L. Johnson, EPA Administrator, to EPA Regional Administrators (Dec. 18, 2008) at 6, <http://www.epa.gov/NSR/documents/psd_interpretive_memo_12.18.08.pdf> (stating that EPA interpretation of language in the CAA and its own regulations requiring NSR for facilities emitting pollutants "subject to regulation" under the CAA means that NSR applies to "each pollutant subject to either a provision in the Clean Air Act or regulation promulgated by EPA under the Clean Air Act that requires actual control of emissions of that pollutant.") EPA further has interpreted this requirement to mean that NSR is required once regulations of a pollutant actually become effective. In the case of GHGs, this will be January 2, 2011. *See* Reconsideration of Interpretation of Regulations That Determine Pollutants Covered by Clean Air Act Permitting Programs, 75 Fed. Reg. 17004, 17004 (2010).

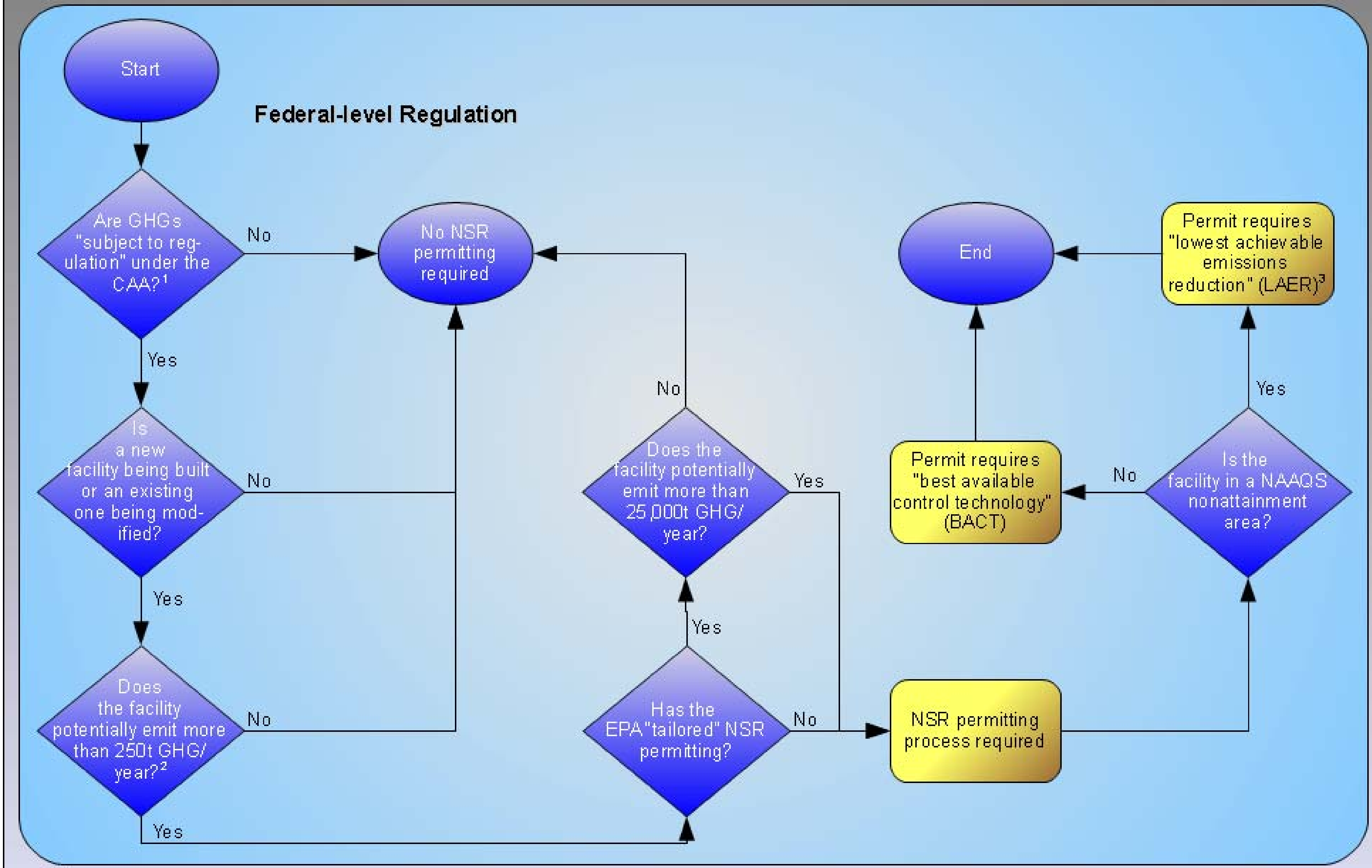
[66] CAA, §169(1).

obtain a permit. This threshold was set with traditionally regulated pollutants in mind—SO_2, PM, NO_x, and so forth. It presents a significant problem if GHGs are regulated because GHG emissions, particularly CO_2, are emitted in large amounts. Fossil fuel power plants and some industrial facilities emit tens of thousands of tons of CO_2 annually. A threshold of 250 (or 100) tons would include not only these large facilities, but also many smaller facilities that are not currently subject to CAA regulation. Large office and apartment buildings, hospitals, commercial facilities, and other emitters could exceed this threshold. This is a significant problem both for regulators and emitters. Regulators, often states under authority delegated by the EPA, are not administratively prepared to deal with such a volume of permit requests. Small emitters are unlikely to have good information about permit requirements and would face significant costs in time and money.

The EPA is attempting to address this looming problem by restricting permit requirements, at least initially, to sources emitting more than 25,000 tons of GHGs in the proposed "tailoring rule."[67] Such tailoring directly contradicts the statutory language in the CAA, however, and its survival in a court challenge is therefore questionable. The EPA has claimed "administrative necessity" and "absurd results" legal defenses against such a challenge, but these doctrines are rarely applied and are best considered a legal last resort. If the tailoring rule fails, however, Congress would probably act to avoid the consequences for small emitters discussed above. Big changes to the CAA would not be necessary—a simple change in the threshold for permitting to a higher level for GHGs would be sufficient. This would not address the burden of more frequent NSR for major sources, however. NSR would, therefore, operate as an independent and continuing regulatory requirement on large GHG sources, even in the absence of GHG regulation with air quality or technology standards (NAAQS or NSPS). The NSR permitting process under the CAA is detailed in Chart 5 below (the Title V process is separate and not shown).

[67] See tailoring rule at 55292 (2009).

Chart 5: Permitting for New and Modified Sources (PSD/NSR – CAA §160-169)



Notes:

1. The EPA interprets this to include regulation actually requiring emissions reductions under any provision of the CAA except §112 (NESHAP), but not regulations that simply require reporting or state regulations in SIPs that exceed federal requirements. Regulation of GHG emissions from mobile sources under §202 would fulfill this requirement and is planned for early 2010.
2. For some categories of facilities, or for Title V permits, the emissions threshold may be 100t GHG/yr.
3. LAER is a stricter standard than BACT, requiring use of the most effective technology in use or required by a SIP anywhere in the US, *regardless of cost*.

IV. The Knowable Path

Among the many pathways toward regulation of GHGs under the CAA presented in the previous section, we believe it is possible to identify one that is the most likely and predictable, i.e. "knowable," pathway, worth describing in more detail. We begin this section with a discussion of the near-future timeline for EPA regulation of GHGs and proceed by discussing how that knowable pathway—NSPS regulation—fits into that timeline and how it would likely develop.

A. Stationary-Source GHG Regulatory Timeline

With so many regulatory programs under the CAA potentially affecting different classes of stationary sources, it is useful to consider the timeline along which regulation is likely to unfold. Chart 1 above provides a general overview of this process and the order in which steps are likely to be taken. Mobile-source regulation was implemented in March 2010. Now that final mobile-source regulations have been issued, GHGs will soon become a regulated pollutant under the CAA (once these regulations become effective in January of 2011), triggering the NSR and Title V permitting processes.[68] In a related action in March of 2010, the EPA determined that the NSR permit program would be triggered when the mobile-source rule becomes effective.[69] Any new stationary sources or existing sources undergoing major modifications after this date would be subject to NSR review. At least initially, the tailoring rule as proposed would restrict permit requirements to large emitters. Whether this remains the case in the long term hinges on the result of a legal challenge to that rule. That challenge is likely to begin shortly after the NSR process itself, but may not be resolved for months or years.

Proceeding separately, NSPS regulation is likely to be the next event to unfold. Under section 111, EPA is required to regularly update NSPS for listed source categories of emissions

[68] See EPA, *Reconsideration of Interpretation of Regulations That Determine Pollutants Covered by Clean Air Act Permitting Programs,* 75 Fed. Reg. 17004, 17004 (2010). The PSD program primarily applies to criteria pollutants covered by the NAAQS. However, some of the substantive NSR requirements of the PSD program—notably the best available control technology (BACT) provisions—also apply to regulated pollutants for which there are no NAAQS (and no other statutory exemptions under sections 112 and 211(o) from PSD). See ANPR at 44497.

[69] See EPA, *Reconsideration of Interpretation of Regulations* at 17004 (cited in note 68). *See also* Letter from Lisa Jackson, EPA Administrator, to Sen. Jay D. Rockefeller IV (Feb. 22, 2010) at 3, <http://epa.gov/oar/pdfs/LPJ_letter.pdf>.

of pollutants regulated under the Act.[70] As these NSPS revisions proceed, the EPA will likely include performance standards for GHGs. New NSPS are scheduled to be issued for several significant categories of GHG emitters over the next two years; the first will be the Portland cement NSPS in June 2010. New NSPS for other source categories, including oil and gas refineries, will follow over the next year.[71] The administration's recent budget request to Congress includes a request for support of NSPS standard-setting for GHGs, which provides a valuable signal that the NSPS pathway is an option under serious consideration by the agency.[72]

By the beginning of 2011, therefore, the general character of GHG regulation under the CAA should be clear—mobile-source regulation will be in place, the GHG NSR will be launched, the tailoring rule will have been finalized (though related litigation will be a possible source of uncertainty), and NSPS for some source categories may begin to reveal EPA's approach to technology standards for GHGs.

The NSPS pathway probably has the broadest support among the various parts of the policy community. As noted above, little support exists for regulation of GHGs via the NAAQS program within or outside of the EPA. In addition, a robust NSPS program regulating both new and existing sources may provide a way to avoid the problems and disadvantages that attend the NAAQS process. A GHG NAAQS is still a long-term possibility. Even if it is relatively unpopular now, litigation over whether a GHG NAAQS is required will likely continue. Even if the EPA eventually decides to or is forced to implement a GHG NAAQS, that regulatory process will take years. Consequently, we focus on NSPS regulation as the most likely, and most readily knowable, path for regulation under the CAA.[73]

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[70] CAA, §111(b)(1)(B).

[71] *See* EPA, Regulatory Plan and Semiannual Regulatory Agenda, Fall 2009 at 7 (2009), available at http://www.epa.gov/lawsregs/documents/regagendabook-fall09.pdf.

[72] *See* Office of Management and Budget, Budget of the United States Government, Fiscal Year 2011 at 126 (February 1, 2010) (stating that "The Budget also requests $7 million to develop New Source Performance Standards to control GHG emissions from a few categories of major stationary sources.") <http://www.whitehouse.gov/omb/budget/fy2011/assets/environmental.pdf>.

[73] Recall, however, that if the NAAQS process, or regulation under section 112 for that matter, were to come to fruition it would block any regulation of existing sources under NSPS. In other words, NSPS regulation of existing sources requires that these sources not be regulated in these other CAA programs.

B. The Traditional New Source Performance Standard (NSPS) Regulation Framework

NSPS regulation (under section 111) offers the potential for a comprehensive program of regulation for new and existing major stationary sources of GHGs. Traditionally, NSPS have been set as technology-based standards for new or modified sources. The EPA has significant discretion to identify the types of facility covered by NSPS regulations in terms of setting size thresholds and in determining the types of equipment covered. Under this approach, EPA defines categories or subcategories of covered sources based on specific characteristics of the industrial process—for example, EPA has established standards for catalytic cracking units at petroleum refineries and for coal-fired boilers. The EPA then identifies control technologies that can be applied to the source category or subcategory. After consideration of a variety of factors (including the cost and effectiveness of control), the EPA typically establishes a performance standard (e.g., pounds of SO_2 per million British thermal units [Btu]) that the selected control technology can meet.[74]

Under section 111(d), as noted above, EPA sets guidelines for state regulation of existing sources. These guidelines would be binding requirements that the states must address in their state plans. As with the NAAQS planning process, state plans under section 111(d) are subject to EPA approval, and if a state fails to adopt a state plan, then EPA must issue a FIP for that state.[75] In the past, EPA has issued model plans for adoption by the states. These guidelines should follow the same basic standard-setting elements used in setting NSPS for new and modified sources. Section 111(d) and EPA regulations recognize, however, that different, less stringent requirements may be appropriate for existing sources. As discussed in Section III.B.1 above, EPA has interpreted section 111(d) as allowing the adoption of an emissions trading program for NO_x emissions from municipal waste combustors and for mercury emissions from coal-fired electric utility units.[76] Hence, there is a precedent under the NSPS program for implementing a trading program for GHGs that would affect both new and existing sources.

[74] EPA also has the authority to set work practice standards under specific conditions.

[75] CAA §111(d)(2).

[76] As noted above, the Clean Air Mercury Rule for coal-fired power plants was vacated by the D.C. Circuit in *New Jersey v. EPA*, 517 F.3d 574 (D.C. Cir. 2008). However, that decision did not reach the question as to whether EPA has the authority to adopt an emissions trading approach under §111(d).

C. Advantages and Disadvantages of New Source Performance Standard (NSPS) Regulation of GHGs

Beyond the fact that they are the most likely next step in CAA GHG regulation, NSPS for GHGs offer identifiable advantages relative to regulation of GHGs under other CAA provisions—as well as their share of disadvantages.

1. Advantages of New Source Performance Standard (NSPS) for GHGs

1. **NSPS regulation is an established program.**
   The EPA has significant experience in regulation under the NSPS program. NSPS currently regulate almost all emitting sectors of the U.S. economy and include a large number of pollutants. Although section 111(d) regulation of existing stationary sources is more limited because it does not include those pollutants regulated under the NAAQS program or section 112, it also is a well-established regulatory mechanism. This experience and precedent reduces the risk of litigation, and the program is familiar to emitters, environmental groups, and other stakeholders. Even for untested elements of the regulatory approach discussed here (notably, emissions trading options under the NSPS program), there is significant value to building on the foundation of an established regulatory program such as the NSPS, rather than creating a program out of whole cloth as would have to be done with, for example, GHG regulation under section 115 (see Section III.A.3). As discussed in Section IV.A above, EPA will also likely be required to include GHGs in future NSPS for existing source categories.

2. **The NSPS process may be relatively fast.**
   Compared to some other regulatory programs under the CAA that might be used for GHGs, the NSPS may proceed relatively quickly. The NAAQS process requires a great deal of time, as discussed in Section III.A.2 above. Case-by-case review of new and modified sources through the NSR process is also expensive in terms of time and administrative resources, though that program is legally required regardless of how the EPA proceeds with regard to stationary-source GHGs.

3. **The NSPS regulation provides a flexible, cost-effective approach.**
   NSPS regulation has traditionally applied to individual sectors, as defined by EPA through its regulation by source category. This sectoral focus provides EPA with flexibility in terms of selecting source categories for regulation, redefining source categories, and identifying size thresholds for regulation. This allows EPA to focus on

source categories for which regulation is more straightforward or those that present the greatest opportunities for emissions reduction (such as coal-fired power plants).

4. **NSPS regulation of existing sources operates through the states.**
As discussed above, under section 111(d) regulation, the EPA sets guidelines for states to issue performance standards for existing sources, with the agency retaining approval authority over those policies. This system distributes administrative burdens and allows states to tailor regulation to local conditions. States also have powers that the EPA, due to statutory or constitutional limitations, does not. States, for example, would probably have the power to auction emissions allowances or impose fees.

5. **Emissions trading under the NSPS program is legally plausible.**
As discussed in Section III.B.1 above, emissions trading under the NSPS program is legally plausible, though it has limited precedent. The EPA has already asserted that it has the authority under section 111 to adopt an emissions trading approach for new and existing sources in the Clean Air Mercury Rule.[77] Such an approach provides an incentive for sources to identify and make low-cost emissions reductions beyond those required to meet a technology-based standard, ensuring a cost-effective regulatory approach. EPA also believes that a trading approach could allow it to consider larger reductions in GHG emissions than it would otherwise be able to require under technology-based standards and to adopt a phased approach with more stringent emissions limits in the later phase(s)[78].

6. **The EPA may consider costs under NSPS regulation.**
Under the Supreme Court's interpretation of the CAA, the EPA is forbidden to consider costs under the NAAQS program.[79] This is not the case under section 111(d) NSPS regulation—the CAA explicitly allows the agency to consider costs when setting NSPS.[80] Consideration of costs should lead to a more efficient regulatory program, especially because regulations address sectors independently of each other.

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[77] *See* EPA, Clean Air Mercury Rule, Basic Information, <http://www.epa.gov/mercuryrule/basic.htm> (stating that "The Clean Air Mercury Rule established a cap-and-trade system for mercury that is based on EPA's proven Acid Rain Program").

[78] ANPRM, 44490.

[79] *See generally Whitman v. Am. Trucking Association*, 531 U.S. 457.

[80] CAA §111(a)(1).

2. Disadvantages of New Source Performance Standards (NSPS) for GHGs

1. **A potential GHG NAAQS would make NSPS regulation of existing sources impossible.**
   As discussed above, section 111(d) allows regulation of existing sources only for pollutants that have not been listed under section 108 (the first step of the NAAQS process). If a NAAQS has been established for a pollutant, no section 111(d) regulation is possible, and if section 111(d) regulation is in place and a NAAQS is subsequently issued, that section 111(d) regulation is effectively cancelled. The EPA has no apparent plans to issue a GHG NAAQS, but it is possible that it will be forced to do so by litigation.[81] If this were to happen, any section 111 program in place would no longer cover existing sources. The EPA might understandably be concerned about wasting its limited resources on creating a program that could be killed not by direct legal challenge, but by such an indirect attack.

2. **Emissions trading under the NSPS program carries some legal risk.**
   As discussed above, emissions trading schemes under the NSPS program have limited legal precedent. Whether the "best system of emission reduction" definition of "standard of performance" can be interpreted to include emissions trading is an untested legal question. The EPA is probably entitled to *Chevron* deference on this point, but challenge is likely and victory is not certain. If NSPS emissions trading were ruled to be incompatible with the CAA, the agency's regulatory options would be limited to traditional, technology-driven performance standards with a corresponding increase in sectorwide compliance costs.

3. **NSPS regulation is traditionally highly technical.**
   Past NSPS regulations have required technical, data-intensive analysis of regulated source categories to identify the technology behind the "best system of emissions reduction." Such analysis is time consuming and places high demands on EPA resources. These demands would undoubtedly increase if NSPS analyses had to include GHGs as well. One of the chief advantages of a nationwide emissions trading

[81] One of us has written elsewhere that such a challenge would be likely to succeed. *See* Richardson, *supra* note 9. We assume for purposes of this paper that such a challenge would not affect NSPS regulation, either because it is rejected by courts or because Congress enacts legislation granting the EPA discretion not to issue a NAAQS for GHGs.

> program is that such industry-level technical analyses are not necessary—trading allows this information to be expressed in terms of the allowance price. In addition, of course, the regulation of individual sectors one at a time will give up the opportunity for lower-cost emissions reductions that can be achieved through an economywide trading program.

In addition to these disadvantages in comparison to other CAA regulatory programs, all CAA programs are likely to be inferior to regulation under new, climate-specific legislation. Because section 111 standards are tied to a showing that they are based on a demonstrated control technology, the emissions reductions achievable under section 111 requirements may be limited to feasible and cost-effective reductions. The EPA may not be able to require GHG reductions that are as stringent as those that would be mandated by current proposed legislation. In addition, because these standards are established for source categories that have traditionally been narrowly defined, it may be difficult to expand the regulatory scope enough to encourage fuel switching (and it is probably impossible to include alternative, renewable sources of energy within the scope of the regulation because such sources emit no pollutants, and are therefore outside the scope of the CAA). The EPA also would be unable to include international offset mechanisms.[82] Regulation under the NSPS, or for that matter any CAA program, would not solve any difficulties arising from permitting requirements.[83] Finally, the sectoral approach allows Congress and the regulated entities within the sector to focus attention and political pressure on emissions regulations to get a better deal.

3. Summary

On balance, we feel that the advantages of NSPS regulation outweigh the disadvantages. The benefits of possible emissions trading and the flexibility of NSPS in general seem to outweigh the associated legal risks. State involvement appears to have more positive than negative impacts. It is not our purpose here, however, to advocate on behalf of the NSPS as an ideal or even attractive option for GHG regulation under the CAA. Instead, we present these advantages and disadvantages to support the claim, further buttressed by anecdotal evidence

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[82] See Nathan Richardson, *International Greenhouse Gas Offsets Under the Clean Air Act*, RFF Discussion Paper 10-24 at 6-9 (2010), available at http://www.rff.org/Publications/Pages/PublicationDetails.aspx?PublicationID=21070.

[83] These potential problems with CAA permitting processes are discussed in Section III.C above.

from the EPA and president Obama's proposed budget, that the NSPS program is a plausible, even likely, route for GHG regulation of existing sources under the CAA.

V. Analysis of GHG New Source Performance Standards (NSPS) in the Electricity Sector

In this section, we explore the potential magnitude of emissions reductions that might be achieved, and how they might be achieved, by regulation under the CAA in one important case study—the electricity sector. We focus primarily on coal-fired electricity generation, which represents 50 percent of the electricity generation and accounts for 33 percent of CO_2-equivalent (CO_2e) emissions nationally.[84] Hence, electricity is probably the most important sector for consideration. In addition, it is a sector with extensive, detailed data for individual plants. We focus on the regulation of existing sources in the electricity sector because they will constitute the majority of emissions in the sector for decades into the future and because the design of regulation to affect existing sources is the most challenging part of regulation under the CAA.[85]

In general, this paper further assumes that no changes are made to the EPA's existing NSPS source categories. The EPA generally has broad discretion to make such changes, although it has rarely done so.[86] This assumption has been made to simplify the analysis, rather than to suggest that such changes would be problematic.

A. General Options for New Source Performance Standards (NSPS) Regulation in the Electricity Sector

In its Advance Notice of Proposed Rulemaking (ANPRM), EPA identified several approaches it might take in regulating GHG emissions from existing power plants under its section 111(d) NSPS authority, including the following:[87]

- work practice and design standards
- an energy efficiency standard for boilers or power plants

[84] ENERGY INFORMATION ADMINISTRATION, ANNUAL ENERGY OUTLOOK 2010 EARLY RELEASE, DOE/EIA-0383(2010) (December 14, 2009).

[85] EPA is likely to require new sources to comply with a unit-specific emissions limit.

[86] See Mullins and Enion, *(If) Things Fall Apart* at 35-38 (cited in note 2).

[87] See ANPR at 44,486–44,493.

- a standard requiring the substitution of biomass (cofiring) for some types of coal-fired plants
- market-based regulatory mechanisms

We do not address work practice and design standards as a regulatory approach, but focus on the other approaches listed above: energy efficiency standards, biomass cofiring requirements, and market-based regulation.

1. Energy Efficiency Standards

The efficiency of a power plant can be expressed by its heat rate, which is the heat input (Btu) required per unit of electricity output (kilowatt-hour [kWh]). EPA has suggested that energy efficiency–based regulation is likely to achieve only modest improvements in heat rates (and, consequently, relatively modest reductions in GHG emissions).[88] This is not a surprising conclusion. Electric utilities already face substantial incentives to improve heat rates to reduce fuel costs. However, evidence indicates that there is a range of performance characteristics across coal-fired power plants, and even within specific boiler technology categories.

For existing coal-fired steam-electric plants, options to reduce the heat rate include: optimizing the performance of basic plant systems, improving control systems, installing high-efficiency electrical components (e.g., motors), and reducing the moisture content of solid fuel. EPA has reported that a reasonable expectation for individual coal-fired plants would be a 2 to 5 percent reduction (ranging up to as much as 10 percent for a few plants). Although an assessment of broad applicability and cost would need to be done, a reasonable expectation for the average fleetwide heat rate reduction is in the range of 2 to 5 percent.[89] A recent draft National Energy Technology Laboratory (NETL) report suggests that even greater improvements, on average, are possible.[90] Because the emissions from coal-fired generation at existing facilities are roughly proportional to fuel use, an improvement in heat rate leads to a proportional reduction in emissions

[88] Id at 44,488.

[89] EPA, TECHNICAL SUPPORTING DOCUMENT FOR THE ANPRM: STATIONARY SOURCES, Section VII, at 16–17.

[90] NETL, Improving the Efficiency of Coal-Fired Power Plants for Near Term Greenhouse Gas Emissions Reductions, (Feb. 24, 2010) (draft).

In its assessment for the ANPR, EPA did not provide an estimate of the likely improvement in heat rate for existing natural gas–fired electricity generating plants. Instead, EPA simply reported that much more limited options are probably available for significant efficiency improvements for these plants.[91]

2. Biomass Cofiring Requirements

Biomass can be mixed with coal and fired in a conventional coal-fired boiler up to a limit at which it begins to degrade boiler performance. On average for most types of boilers, roughly 10 percent of the heat input at a coal-fired boiler can be provided through biomass. Since biomass is roughly CO_2 neutral, the substitution of biomass for coal leads directly to net emissions reductions. Because biomass supply constraints in some geographic regions limit the use of cofiring for existing coal-fired boilers, EPA is likely to find it difficult to establish cofiring requirements on a plant-by-plant basis. However, EPA has reported that biomass cofiring might replace 2 to 5 percent (on a fleetwide basis) of the coal used by existing coal-fired plants.[92]

3. Market-Based Regulation

As discussed above, EPA has interpreted section 111(d) as allowing the use of a market-based approach for regulating emissions from existing sources. These emissions trading systems could include cap-and-trade and rate-based regulations that allow trading to achieve GHG emissions reductions. EPA believes that because of the cost savings associated with these approaches, it could consider deeper reductions through a market-based approach than it could support through a conventional technology-based standard.[93]

As discussed in Section III.B.1 above, EPA generally believes that such programs would be consistent with the NSPS provisions of section 111 because they would be structured to satisfy the definition of "standard of performance."[94] That is, the trading program would establish a standard for emissions that:

- reflects the degree of emissions limitation achievable

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[91] EPA, TECHNICAL SUPPORTING DOCUMENT at 16.

[92] EPA, TECHNICAL SUPPORTING DOCUMENT at 17. *See also* ELECTRIC POWER RESEARCH INSTITUTE, BIOMASS CO-FIRING UPDATE 2002, 1004319, Final Report (July 2003).

[93] ANPR at 44,490.

[94] CAA, §111(a)(1).

- constitutes the "best system" of emissions reduction, and
- has been adequately demonstrated.

With respect to an electricity sector NSPS specifically, the agency would probably argue that the trading program would reflect its judgment on the overall degree of emissions reduction that could be achieved by the source category. This program would achieve greater emissions reductions than could be achieved through the more traditional approach of establishing a generally applicable technology-based standard that applies to each plant. In addition, it would provide sources with the flexibility to determine the best way to meet the program emissions requirements. The resulting program establishes a "price" for the control of emissions and provides an incentive for innovation. As a result, the EPA could plausibly argue, a trading approach would constitute the "best system" of emissions reduction.

If EPA adopted a cap-and-trade approach for existing sources, states would have the responsibility to allocate allowances. In previous CAA rules that have authorized a cap-and-trade system, EPA has left the allocation decisions to the states. Thus, states would probably determine the frequency of allocations (i.e., a onetime allocation or a periodic allocation every, say, three years), the basic method of allocation (e.g., a grandfather approach, updating output-based allocation, or an auction), and the use of set-asides (e.g., set-asides for energy efficiency projects, renewable energy sources, or for new units).[95]

If, on the other hand, EPA were to adopt a model trading rule based on a performance standard, then sources would trade offsets and the "allocation" would effectively be a grandfathering approach with "allocations" determined by the existing performance and capability in the fleet. This approach would avoid the contentious allocation issues associated with cap-and-trade. But it carries its own disadvantages. The grandfathered allocation approach implicit in a tradable performance standard could lead to changes in revenues through increased product prices that greatly outstrip the change in costs to comply with the standard, resulting in so-called windfall profits.[96] In addition, a tradable performance standard market may not be as smoothly functioning a market. Compliance with a tradable performance standard may be less

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[95] *See, e.g.*, Rule to Reduce Interstate Transport of Fine Particulate Matter and Ozone (CAIR), 70 Fed. Reg. 25,278–25,282 (May 12, 2005); Standards of Performance for New and Existing Stationary Sources: Electric Utility Steam Generating Units, 70 Fed. Reg. 28,627 (May 18, 2005).

[96] D. Burtraw & K. Palmer, *Compensation Rules for Climate Policy in the Electricity Sector,* 27 J. POL. ANAL. MANAGE. 819 (2008).

transparent than an emissions allowance under a cap-and-trade approach, and trading of offsets may require demonstration that a source was not going to shutdown anyway, giving rise to higher transaction costs associated with ensuring the quality of the offset credits. Also, it is not clear whether banking of offsets would be allowed. In addition, a performance-based measure would not cap emissions from the regulated sector. With growth in production, a corresponding increase in energy use and emissions would occur.

B. Opportunities to Reduce Emissions

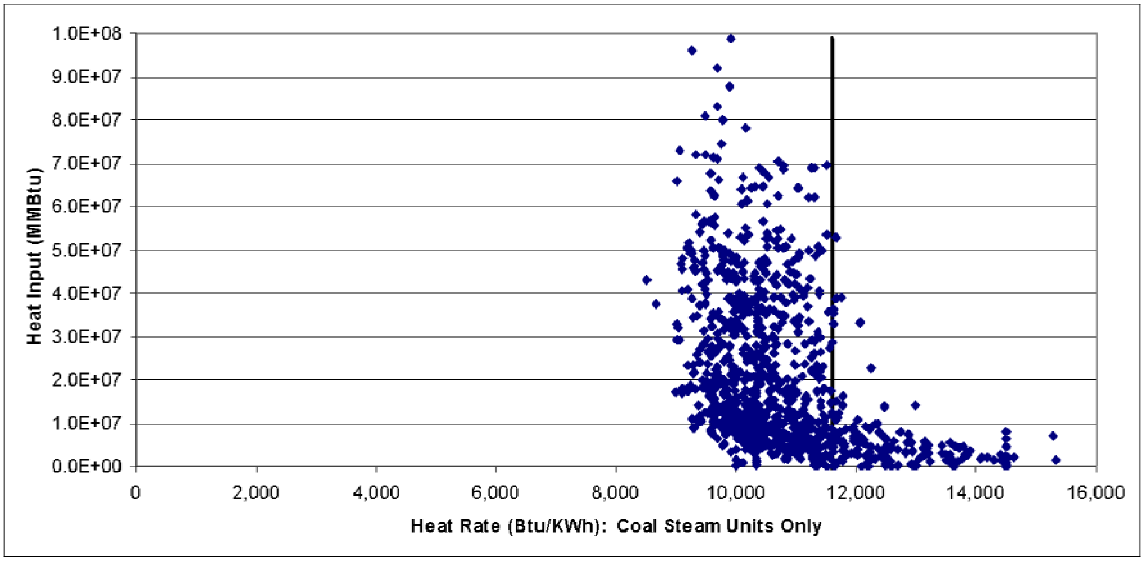
The primary way that emissions reductions might be obtained from the electricity sector is through reducing emissions from coal, including fuel switching from coal to natural gas or nonemitting generation sources. However, as we have noted, under the CAA, EPA might start with opportunities for efficiency improvements at existing facilities.

Figure 1 displays existing coal-fired plants according to their heat rate along the horizontal axis.[97] The vertical axis is heat input, indicating where most of the generation occurs. As one might expect, the most heavily used plants are among the most efficient, with heat rates less than 10,000 Btu per kWh of electricity generation. However, the figure displays a substantial right-hand tail, with a number of facilities that appear to be outliers with respect to their operational efficiencies. The vertical line in the figure denotes a heat rate of 11,609 Btu per kWh. Five percent of total heat input (fuel use) at coal-fired power plants occurs at units with a heat rate greater than this amount.

[97] This analysis uses data on existing electricity generating units in the lower 48 states during 2007. The population is based on units included in the Energy Information Administration's *Annual Energy Outlook 2009*. For each of these units, EPA databases provided additional information on efficiency. Annual heat input, which is a measure of use, came from EPA's Continuous Emissions Monitoring Database for 2007. EPA calculates this information for all emitting fossil-fired facilities greater than 25 megawatts by multiplying the quantity of fuel used at a unit by the fuel's heat content. Heat rate data are provided in EPA's National Electric Energy Data System (NEEDS). The most recent annual data available for NEEDS are from 2006. For both heat inputs and heat rates, EPA reports data at the boiler level for steam units and at the generator level for all other units. Observations that did not contain data for both heat rate and heat input were dropped for this analysis.

To calculate CO_2 emissions for each of the policy scenarios, we used the national average emissions rates as given by Resources for the Future's electricity model, Haiku. The assumed rates are 116.6 pounds of CO_2 per million Btu for natural gas–fired units and 208.4 pounds of CO_2 per million Btu for coal-fired units. In addition, the scenario in which natural gas–fired generation replaces inefficient coal-fired generation assumes that all generation is replaced by a natural gas plant with a 7,000 Btu/KWh heat rate, which is the national average heat rate for natural gas.

Figure 1. Coal Steam Units—Heat-Input Weighted Heat Rates



Given that plant operators already face an incentive through the cost of fuel to operate efficiently, one might expect that the distribution of heat rates would have an obvious technical explanation. One plausible explanation is that performance characteristics may vary across technology, vintage, or fuel type. In the Appendix, we illustrate that none of these factors appears to explain the distribution in heat rates across plants. The four most important types of boilers—tangentially-fired, wall-fired, cyclone, and fluidized bed—share similar distributions of heat rates and have similar right-hand tails. The least efficient units have less control for SO_2 than the fleet as a whole, but the difference is not convincing. The least efficient units are somewhat older than the fleet as a whole, but the distribution of vintage overlaps for the most part. And an important fraction of lignite and waste coal used nationally is used at these least efficient units, but that accounts for only a small portion of heat input at those units. Other coal types are used much more extensively and in rough proportion to the national average.

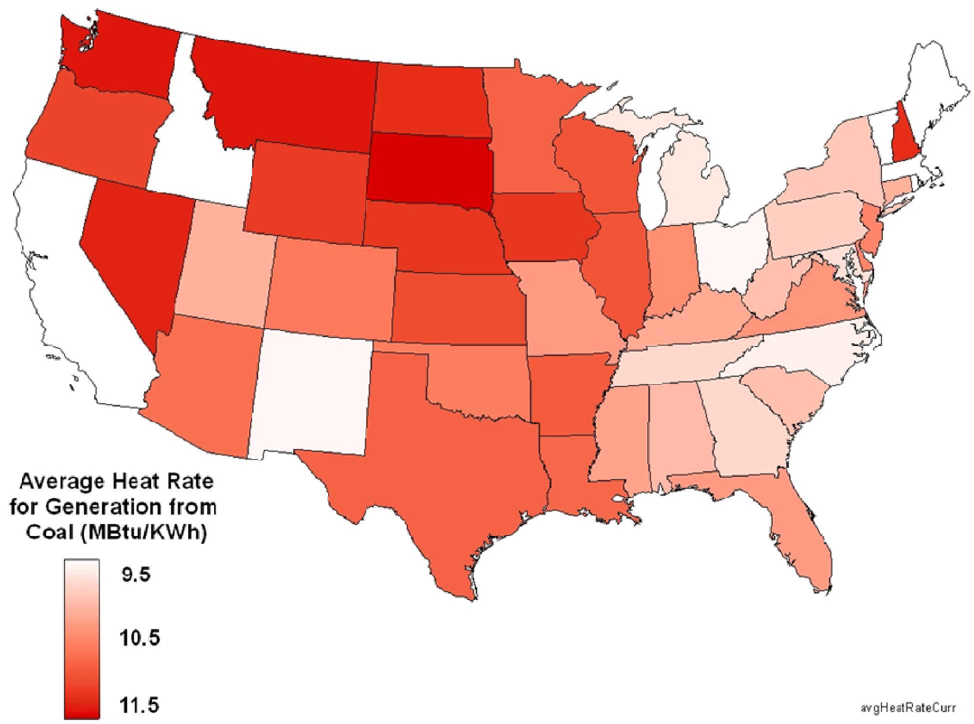
Having considered technology, vintage, and fuel type as potential explanations for the difference in operational efficiency at coal plants, one might also consider institutional factors. One such factor is the prospect that modifications to improve efficiency might trigger a permitting process for NSR for other pollutants that could be time consuming and costly (see Section III.C above). Alternatively, the state-level regulatory environment and the firm's ownership structure might provide different incentives for efficiency improvements at different plants. Fuel cost adjustment clauses that allow for the automatic pass-through of fuel cost into rates is another factor suggested by NETL.[98] Such provisions remove the risk from price fluctuations; unfortunately, such provisions also may remove the incentive to harvest low-cost efficiency improvements. If institutional factors such as these play an important role in perpetuating the operation of relatively inefficient facilities, then performance standards might contribute to a remedy. Performance standards focus attention on a specific metric that can elevate its visibility within the firm and to regulators. A tradable performance standard should do even better, by taking important steps toward a cost-effective distribution of emissions reductions.

In summary, we find no obvious explanation for the persistence of a right-hand tail in the distribution of heat rate efficiency among plants. Further investigation requires statistical analysis that is not part of this paper.

An important element of the political debate regarding GHG policy is the potential regional distribution of regulatory costs. Substantial interest has focused on the disparity in the reliance on coal for electricity generation in different parts of the country. Figure 2 illustrates the state-level average heat rate for generation from coal across the continental United States. The darker-shaded states have higher average heat rates, meaning that more coal is used—and more CO_2 emissions result—per unit of electricity generated. Note that regions of the country often associated with heavy coal use—midwestern, Appalachian, and southeastern states—are not those with the greatest average heat rate. In the appendix, we illustrate a similar geographic pattern for the geographic distribution of the least efficient plants.

[98] NETL, *supra* note 48.

Figure 2. State-Level Average Heat Rate Map



C. Three Plausible Regulatory Scenarios

Based on this information on the possible improvements in efficiency in the electric utility sector and the potential use of cofiring of biomass, several alternative regulatory scenarios under the NSPS program are plausible for reducing GHG emissions from the electric utility sector. The first two options are performance-based options focused on plant efficiency with no trading between plants. The third option would establish required reductions in GHG emissions mobilized by a trading approach based on plausible reductions from both energy efficiency improvements and the cofiring of biomass.

Option 1. A plant-by-plant mandated improvement (reduction) in heat rate of 5 percent at coal-fired plants. Some improvement at gas- and oil-fired plants might also be required.

Option 2. A strict heat rate efficiency performance standard that specifies the minimum performance characteristics for coal-fired boilers. This familiar regulatory approach under the CAA would require efficiency improvements or shutdown for the 5 percent least efficient plants. To illustrate its effects, we identify a standard applied to the operating efficiency of coal-fired power plants set equal to the 95th percentile of existing plants, or 11,609 Btu of heat input per kWh of electricity production. If all plants with a heat rate greater than this threshold were taken out of service, it would result in a 5 percent reduction in emissions from coal-fired generation. These plants generate 4.3 percent of electricity from coal; the difference (0.7 percent) reflects the relative inefficiency of these plants. The vertical line in Figure 1 indicates the cutoff for a strict performance standard. The actual emissions reductions that would be achieved would hinge on the technology used to replace generation from these facilities.[99]

An inflexible efficiency standard applied either as a strict uniform reduction in heat rates (Option 1) or as a strict heat rate performance standard (Option 2) could be expected to result in marginal costs of emissions reductions that would vary across facilities. For example, the uniform standard would require facilities that are already efficient to make further efficiency improvements comparable to efforts at inefficient facilities. Meanwhile, the strict heat rate performance standard (Option 2) would target only the least efficient facilities, even though low-cost opportunities may be available elsewhere in the fleet. Consequently, the cost of such approaches would be greater than might be achieved under a regulation that allowed flexibility across facilities to achieve the same emissions reductions at least cost.

Option 3. A market-based approach requiring a roughly 10 percent reduction in CO_2 emissions from coal-fired electricity generation. The 10 percent is based on a fleetwide 5 percent reduction from energy efficiency improvements at coal-fired plants plus a 5 percent fleetwide reduction in CO_2 emissions with the cofiring of biomass. For a cap-and-trade system administered at the national level, plants would receive allowances based on generation in a year previous to the start of a program. For a heat rate–based program, the metric would be fossil fuel energy input (CO_2 emissions rate–adjusted) to kWh generation for the utility system.

A flexible standard for coal or a cap-and-trade program (Option 3) could potentially capture even greater gains if it were to allow for cofiring of coal with biomass. EPA identifies emissions reduction opportunities from cofiring of 2–5 percent, on average, across the fleet, in

[99] If the reduced generation were made up by non-emitting sources, the standard would achieve a 5 percent reduction overall. If it were made up by the average natural gas combined cycle units, the standard would have to target the least efficient 7.22 percent of heat input at coal plants (11,416 Btu per KWh). See appendix for discussion.

addition to the 2–5 percent they identify from the heat rate improvements discussed above.[100] However, the geographic opportunity for biomass cofiring may be even more uneven than the opportunities for efficiency improvements. The ability to cofire depends in part on the configuration of the boiler and, importantly, on the availability of local, low-cost biomass. A flexible efficiency standard calibrated to reduce coal heat input by 10 percent per unit of electricity generated by coal could capture potential improvements in efficiency and from biomass cofiring. The net effect on emissions from the electricity sector would depend on whether this led to greater use of some coal- or natural gas–fired facilities. However, a standard of this nature would be likely to result in an overall emissions reduction of about 3 percent of total U.S. CO_2 emissions.

An investigation of the effects of a flexible performance standard requires modeling that is beyond the scope of this paper. Nonetheless, such an approach is a possible outcome if the EPA were to implement a standard for existing emissions sources under section 111(d). The agency might identify an average heat rate improvement that would apply across the industry but allow flexibility in the implementation of the standard. Tradable performance standards have been used previously under the CAA, including, for example, in the phaseout of lead in gasoline.[101] Such an approach would be likely to capture relatively low-cost opportunities for efficiency improvements by introducing a price on CO_2; thereby, such an approach is expected to reduce the overall cost of the program. Flexible compliance options might lead to the retirement of some of the least efficient plants, but it also would allow improvements across the spectrum where it is least expensive to achieve the overall industrywide performance standard.

The Appendix illustrates that similar opportunities may exist in the fleet of natural gas turbines and steam natural gas units, although these plants are used much less intensively than coal plants are. Turbine efficiency has benefited from the aeronautic revolution in the 1980s, but many turbines with heat rates more than double that of a new turbine remain in service. Steam gas units also display a right-hand tail in their distribution of heat rate efficiency. Although their heat rates are roughly comparable to the rates at coal plants, the CO_2 content per Btu of gas is less than half of that for coal.

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[100] EPA, TECHNICAL SUPPORTING DOCUMENT FOR THE ANPRM: STATIONARY SOURCES, Section VII, at 16–17.

[101] R. Newell & K. Rogers, *Leaded Gasoline in the United States: The Breakthrough of Permit Trading*, in CHOOSING ENVIRONMENTAL POLICY (W. Harrington et al. eds., 2004).

The most ambitious effort plausible under the NSPS program would be a sectoral cap-and-trade program that would allow trading across fuel types. To accomplish this, the agency would have to redefine the regulated emissions source category to include all fossil-fired electricity generating units or allow trading across existing source categories. An Energy Information Administration (EIA) analysis of an economywide cap-and-trade program under H.R. 2454 provides a useful indication of what might be achieved from the electricity sector under a sectoral cap.[102] By 2020, EIA projects that H.R. 2454 would achieve emissions reductions of 10.4 percent from coal-fired power plants compared to 2009 levels. [103] For the entire electricity sector, emissions in 2020 would fall by 11.4 percent from their 2009 levels. This constitutes a 4.6 percent reduction in total national emissions. The EIA modeling does not incorporate endogenous improvements in the operational efficiency of existing units. Instead, those reductions occur from exogenous technological change, a shift in investments to lower-emitting sources of generation, and fuel switching.[104] In contrast, the opportunities for emissions reductions from coal- and gas-fired plants that we illustrate above are explicitly the result of improvements in the operational efficiency of existing units. If EPA were able to expand the definition of source category to include all fossil-fired electricity generating units, it should encourage emissions reductions from operational efficiency as well as through fuel switching. Nonetheless, this comparison poses some questions for the agency. If opportunities for improvements in operational efficiency remain available today given existing fuel prices, could an increase in fuel prices resulting from an emissions cap be expected to harvest those improvements? Would a tradable performance standard capture different types of emissions reductions than a cap-and-trade program?

In summary, substantial emission reduction opportunities appear available from existing power plants under the CAA section 111(d) NSPS authority. Moreover, incentive-based

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[102] EIA, ENERGY MARKET AND ECONOMIC IMPACTS OF H.R. 2454, THE AMERICAN CLEAN ENERGY AND SECURITY ACT OF 2009, SR/OIAF/2009-05 (2009), <http://www.eia.doe.gov/oiaf/servicerpt/hr2454/pdf/sroiaf(2009)05.pdf>.

[103] In the absence of the program coal-fired power plant emissions would be expected to grow by 12.5 percent from 2009 to 2020.

[104] It also includes only limited demand response because the change in electricity prices is small as a result of the free allocation to local distribution companies. This probably resembles what could be achieved by a sectoral program under the NSPS program. As noted above, the EPA would not have the authority to run an auction for emissions allowances, although if allocation decisions are delegated to the states, they could do so.

approaches that place an explicit price on CO_2 should do a better job of capturing emissions reductions than uniform, strict performance standards.

VI. Conclusion

The CAA provides a well-known, longstanding, and broadly effective set of regulatory tools. It has been sufficiently flexible to regulate a wide variety of pollutants with diverse effects, physical characteristics, and roles in the economy. Great skepticism has been expressed, however, about whether the CAA is up to the task of regulating GHGs. Our analysis indicates that, at least in some limited but meaningful ways, the statute remains a powerful and flexible tool for this new challenge. Moreover, absent legislative intervention, regulation under the CAA will move forward; ultimately, this regulation could achieve substantial emissions reductions.

To be sure, we are convinced that new legislation targeted specifically at GHGs would be superior to an approach based purely on the CAA. Because fossil–based energy is such an important part of our economy, we need to move away from it in a careful fashion. New legislation could capture the lowest-cost emissions reductions via economy-wide carbon pricing and incorporate international offsets, among many advantages over a CAA-only approach.

Nevertheless, our analysis suggests that even a modest regulatory program using a well-worn and well-known CAA pathway—the NSPS—is capable of producing real reductions in emissions by targeting efficiency gains in the coal electricity sector.[105] Incorporation of trading mechanisms into this NSPS approach is legally plausible, would reduce costs, and would unlock further emissions cuts via biomass cofiring or (slightly less plausibly) fuel switching from coal to natural gas.

Our analysis of just the one source category, coal-fired electricity generating units, indicates that an NSPS approach including gains from coal-plant efficiency and biomass cofiring could achieve reductions of nearly 3 percent of total national emissions. It is worth noting that these emissions reductions are associated with a relatively modest NSPS approach. CAA regulation that expands on a narrow NSPS program by modifying source categories or allows trading across source categories in the electricity sector to permit fuel switching, for example,

[105] Further opportunities for emissions reductions exist in other sectors of the economy beyond the electricity sector. For example, the figure stated above does not include emissions reductions from the transportation sector associated with the EPA’s regulations under other provisions of the CAA—regulations that most comprehensive climate proposals in Congress leave intact.

might be able to capture significantly more emissions reductions. By comparison, we infer from EIA analysis that an electricity sector cap comparable in stringency and cost to the Waxman–Markey analysis could achieve emissions reductions of 11.4 percent in the electricity sector in 2020, compared to 2009 emissions levels. This would be equal to 4.6 percent of total national emissions in 2009.

The greatest area of uncertainty with a CAA NSPS approach is cost. Estimates of costs would require a modeling exercise that is unfortunately beyond the scope of this paper. Because the NSPS program we identify is relatively modest, capturing known opportunities for emissions reduction (efficiency and biomass cofiring), it is our sense that costs are likely to be modest as well. Costs will clearly be lower if NSPS regulation includes some form of trading.

To many observers, incentive-based approaches adopted through new climate legislation are viewed as a discrete alternative to prescriptive approaches that are common under the CAA. But these alternatives may not be mutually exclusive. As we have discussed, various provisions of the CAA offer opportunities to introduce flexibility—and thereby to realize at least a portion of the potential cost savings associated with incentive-based approaches—though an economywide emissions trading program created by new legislation would reduce costs even further.

In short, this analysis leads us to conclude that the CAA—and specifically, NSPS—despite being a suboptimal vehicle for GHG regulation, is nevertheless a knowable, practical, and effective one. Furthermore, until and unless Congress passes new legislation, the CAA is the tool we have. It appears that this tool remains very useful, even if it cannot finish the job alone.

VII. Appendix

A. Explaining the Variation in Heat Rates at Coal-Fired Boilers

One plausible explanation for the distribution of heat rates is that performance characteristics may vary by technology.

Figure 3-6 illustrate the distribution of heat rates for the four most important types of boilers: tangentially-fired, wall-fired, cyclone, and fluidized bed. These boilers exhibit similar distributions of heat rates, so at a qualitative level, technology does not appear to explain the distribution in plant efficiency.

Figure 3. Coal Tangential Boilers—Heat Input–Weighted Heat Rates

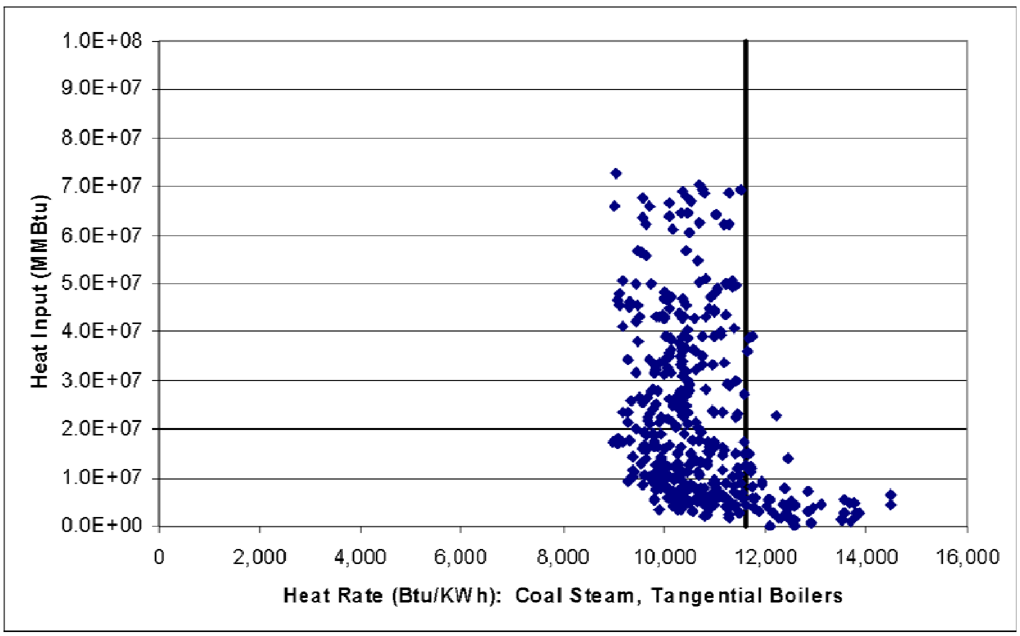


Figure 4. Coal Wall Boilers—Heat Input–Weighted Heat Rates

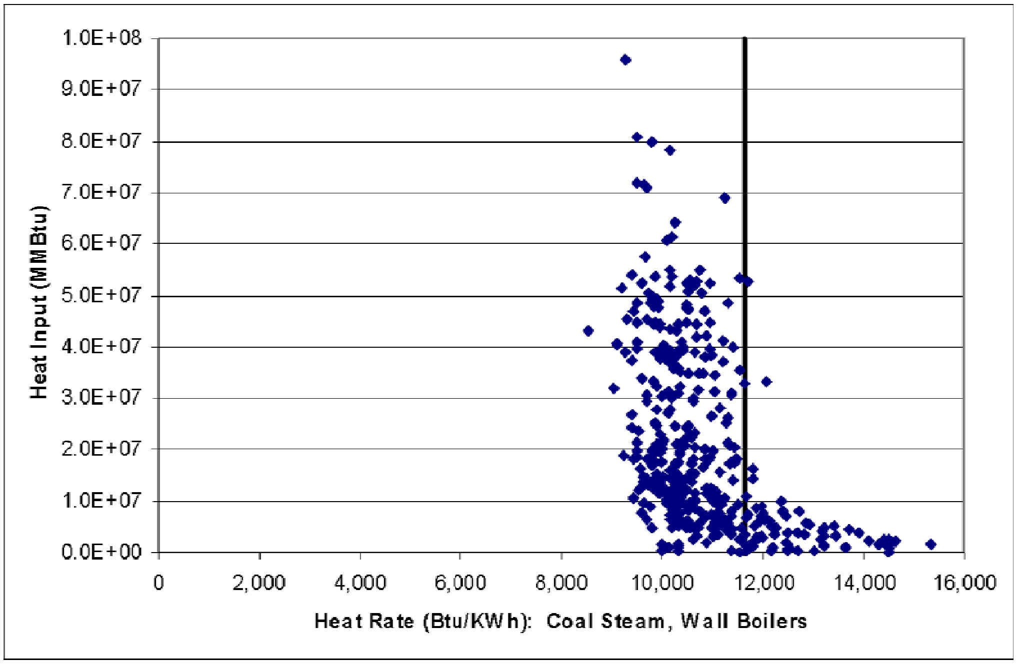


Figure 5. Coal Cyclone Boilers—Heat Input–Weighted Heat Rates

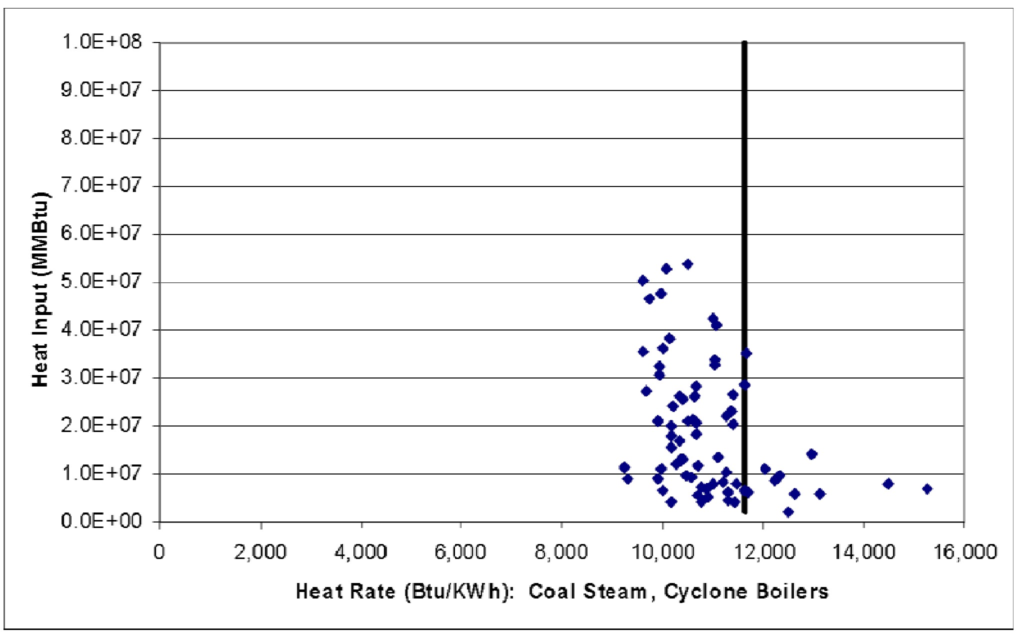
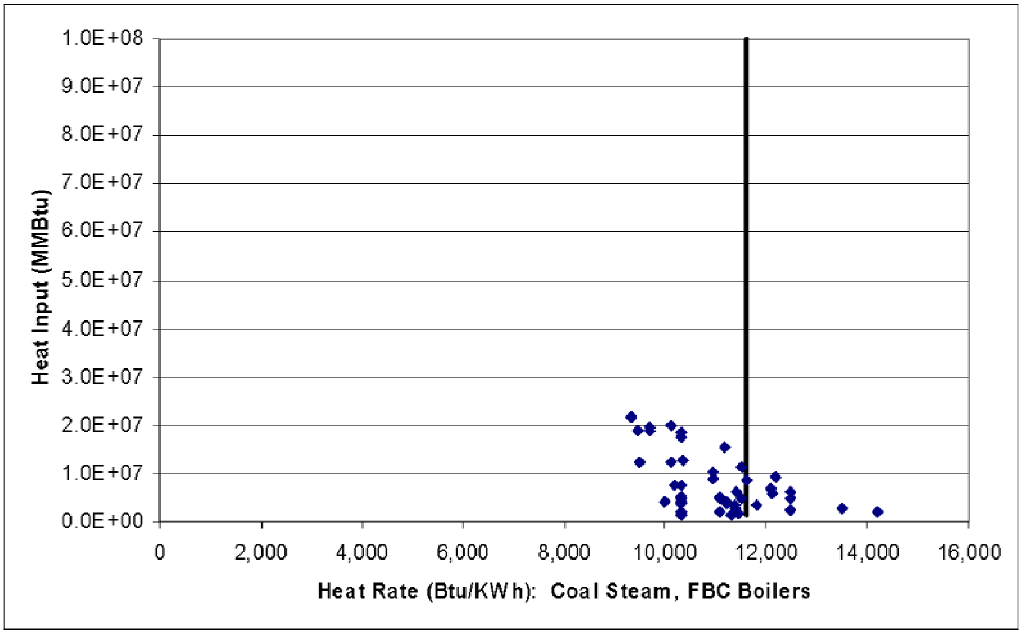


Figure 6. Coal Fluidized Bed—Heat Input–Weighted Heat Rates

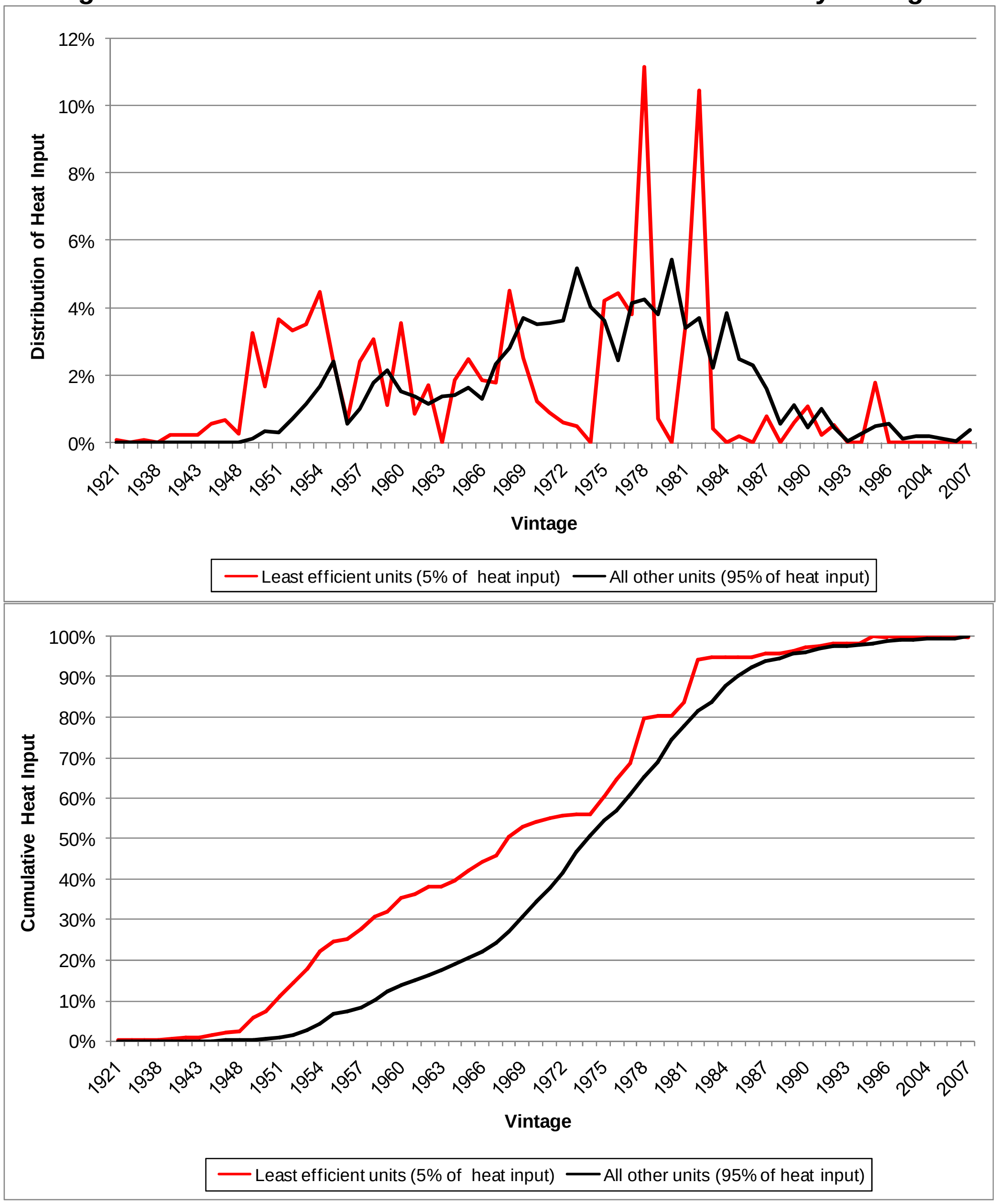


Notes: FBC, fluidized bed combustion.

Another possible explanation is that these outliers represent older plants, perhaps smaller plants with lower capacity-utilization rates. To investigate this, we plot the distribution of heat input by vintage in Figure 7. The curves in the top panel of the figure represent density distribution functions, and the area under the curves sum to one. One curve represents the heat input–weighted distribution by vintage of 95 percent of existing coal-fired plants that are relatively more efficient, the other curve represents the distribution for the least efficient plants—those with a heat rate above 11,609 Btu per kWh. Although both curves are irregular, the curve representing heat input at the inefficient units appears to lie somewhat to the left of the distribution for all plants, indicating that these plants tend to be older units.[106] However, plants that are relatively inefficient continued to be built throughout this time horizon. The bottom panel represents cumulative distribution functions. Moving from left to right, the curves illustrate the portion of plants in each category that are younger than a given vintage. This figure illustrates that the less efficient plants tend to be older, but forty percent of the heat input at inefficient plants occurs at plants that were built after 1975.

[106] The vintage indicates the year of initial commercial operation.

Figure 7. Coal Steam Boilers—Distribution of Heat Rate by Vintage



Yet another factor that might explain the relative performance of plants could be the type of fuel available. Coals vary according to moisture content and other measures of quality. Table 1 describes the fuel-use characteristics of the least efficient plants and indicates that the least efficient 5 percent of generation uses a variety of coal types. The coal types that are most affected are lignite (42 percent of total lignite used) and waste coal (18 percent), but these coal types account for only a small portion of the total coal used among the facilities that would be affected by the regulation—lignite represents only 7 percent and waste coal only 3 percent of fuel use at the least efficient generators. The remaining 90 percent of fuel used is distributed proportionally according to the contribution of each fuel to total generation.

Finally, we look at the existence of flue gas desulfurization equipment (scrubbers). These post-combustion controls to reduce SO_2 emissions cost hundreds of millions of dollars, so one would expect them to be less common at plants that are relatively inefficient. For the entire fleet, about 61 percent of heat input occurs at units with post-combustion controls for SO_2, whereas 35 percent of the fuel use at the least efficient plants is at plants that have such equipment.[107] This finding is consistent with expectations, yet it is nonetheless surprising that more than one-third of the least efficient generation occurs at units with SO_2 controls.

Based on this qualitative analysis, no single simple factor explains the variation in heat rates across plants, and particularly the surprising right-hand tail. Other factors—including operational practice, general maintenance, or the introduction of electronic combustion controls in the boiler—may explain lingering opportunities for improvements in plant efficiency as a way to reduce CO_2 emissions from electricity generating units.

[107] A little more than half of the heat input at the least efficient units that have SO_2 controls in place is at units with wet scrubbers. Among all units with SO_2 controls, wet scrubbers are in place for more than 86 percent of the heat input.

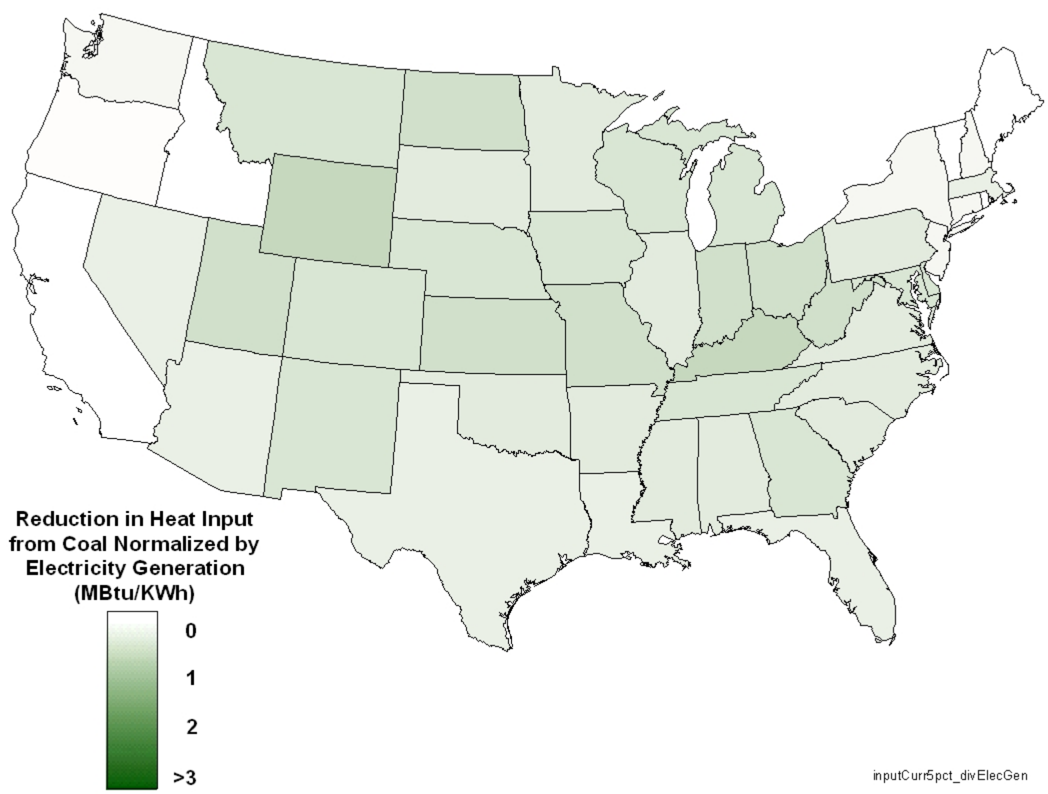
Table 1. Changes in Use of Coal-Fired Units by Fuel Type

	All Units				*Units with heat rates above 11,609 Btu/kWh*					
Coal type	**Number of units**	**Generation (MWh)**	**Percentage of total generation**	**CO_2 emissions (tons)**	**Number of units**	**Generation (MWh)**	**Percentage by coal type**	**Percentage of total generation**	**CO_2 reduction (tons)**	**Percentage of CO_2 reduced**
Bituminous	489	750,968,640	37.39%	788,268,928	75	20,055,258	2.67%	23.25%	26,228,603	3.33%
Bituminous & subbituminous	357	701,144,960	34.91%	746,669,568	64	32,573,522	4.65%	37.76%	41,028,115	5.49%
Lignite	5	14,029,976	0.70%	16,262,573	2	5,873,214	41.86%	6.81%	7,118,209	43.77%
Lignite & subbituminous	30	108,432,520	5.40%	122,885,184	2	4,852,081	4.47%	5.62%	5,981,477	4.87%
Subbituminous	159	418,986,528	20.86%	462,743,072	23	20,273,054	4.84%	23.50%	25,411,746	5.49%
Waste coal	28	14,754,307	0.73%	16,793,920	6	2,643,915	17.92%	3.06%	3,397,136	20.23%
TOTAL		**2,008,316,931**	**100%**	**2,153,623,245**		**86,271,044**	**4.30%**	**100%**	**109,165,287**	**5.07%**

B. The Geographic Distribution of Less Efficient Generation at Coal-Fired Boilers

A standard requiring a uniform 5 percent improvement in heat rate at every plant (Option 1) would have a diffuse effect across the nation. Figure 8 illustrates where emissions reductions would occur, represented as a fraction of total electricity generation to indicate where the reduction would be a relatively important part of overall electricity generation. This view makes it appear that the burden of such a standard would be distributed in a fairly uniform way across the country. Clearly, such an approach would not be cost-effective because a strict uniform reduction in heat input that was not tradable would not take advantage of opportunities at plants that currently are least efficient and could be expected to have the least-cost opportunity to reduce emissions. Moreover, it would require the same percentage reductions in heat input at the most efficient plants even though these plants may already have exhausted all cost-effective opportunities for reductions.

Figure 8. Coal Plants—Uniform 5 percent Efficiency Improvement



A strict efficiency performance standard might specify a maximum heat rate for coal-fired boilers. A standard set equal to the 95th percentile of existing plants would be set at 11,609 Btu per kWh. The vertical line in Figure 1 indicates the cutoff for a strict performance standard; the plants to the right of this line with heat rates in excess of 11,609 Btu per kWh are those represented in Figure 9. The scale in this figure represents the heat input that would be reduced in each state, divided by the total electricity generation in that state. This scale illustrates the degree to which the reduction in heat input represents an important part of overall electricity generation in the state. Much of the generation that would be affected is located in the upper plains states. South Dakota is the outlier, with a value of nearly four thousand Btu per kWh of total electricity generation. Although Figure 2 and Figure 8 illustrate that coal-fired generation is not a large share of electricity generation in the state compared with other states, Figure 9 indicates that the state hosts a relatively large share of inefficient plants. The next state that would be most affected is Wyoming, with a value of approximately three thousand Btu per kWh, and other states in the upper plains also would be affected. So, although most of the coal used for electricity generation is consumed east of the Mississippi River, and the state with the greatest total quantity of coal-fired generation is Texas, the greatest burden of emissions reductions under a strict performance standard would occur elsewhere.

A strict heat rate efficiency performance standard could have consequences. If electricity generation were reduced from the least efficient coal-fired facilities, it might be replaced by an increase at other emitting facilities. Natural gas–fired generation is the second-most-important form of electricity generation after coal and is expected to grow in the future, especially in light of emerging climate policy. To achieve the 5 percent net emissions reductions, assuming that all reductions in generation are made up by an increase in generation at the average natural gas combined cycle power plant, the performance standard for coal-fired generation would be set at 11,416 Btu per kWh, directly affecting 7.22 percent of the heat input at the least efficient coal-fired plants. Figure 10 illustrates that the states in the upper plains region remain most directly affected by such regulation.

Figure 9. Coal Plants—Strict 5 percent Greater Efficiency Performance Standard

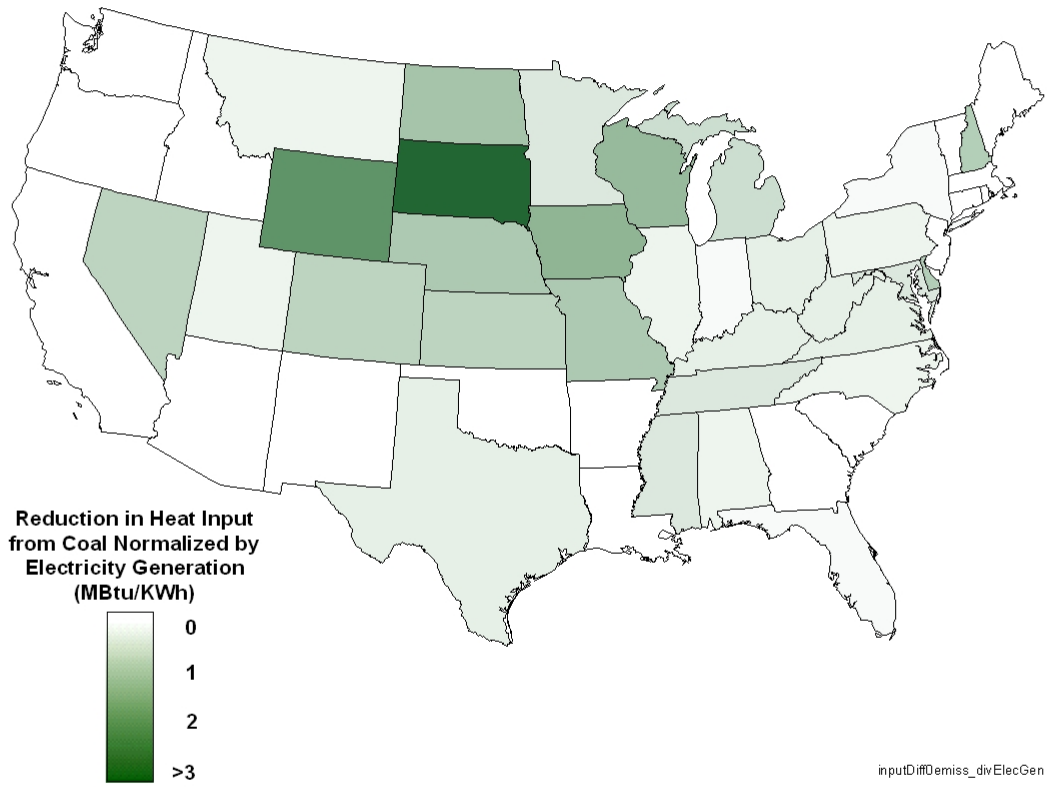
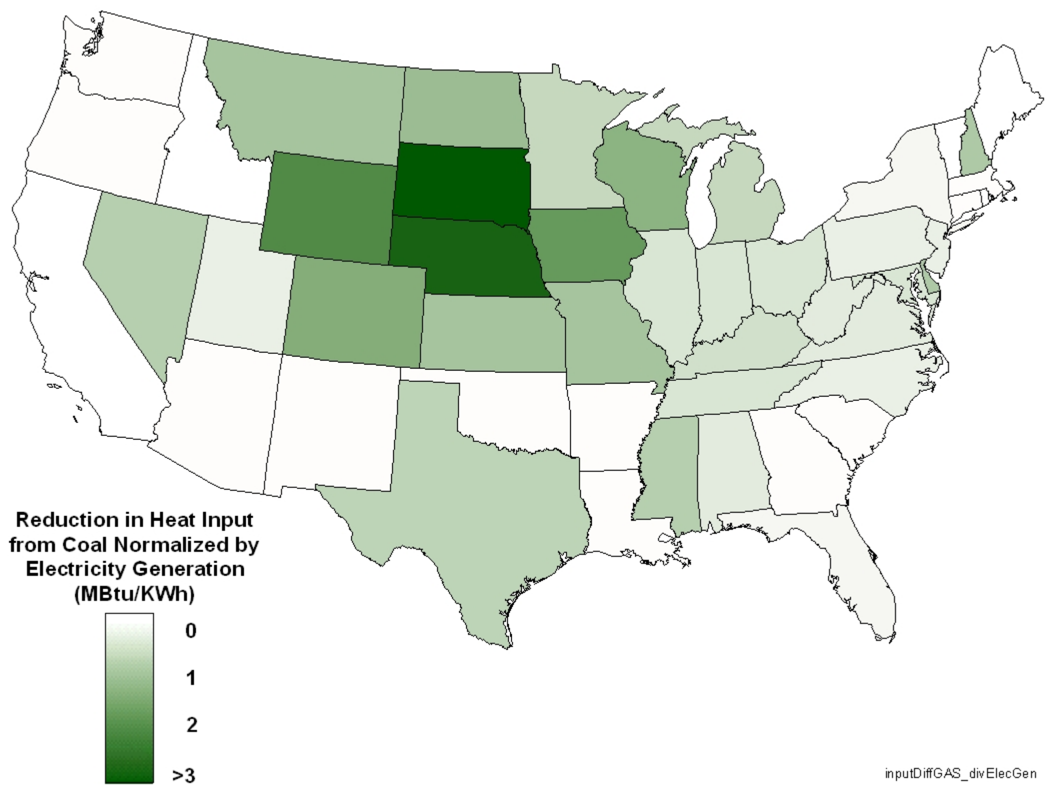


Figure 10. Coal Plants—Strict 7.2 percent Greater Efficiency Standard



C. Variation in Natural Gas-Fired Plant Efficiency

A brief look at the distribution of natural gas–fired electricity generation illustrates a similar distribution of operational efficiency. Figure 11 illustrates the distribution for natural gas turbines. In this case, heat rate efficiency is likely to be closely related to vintage. Facilities built since the aeronautic revolution in turbines in the 1980s are more efficient and more heavily used. There is relatively little opportunity to improve a specific turbine, short of complete refurbishment, and most turbines are used only for peak-period generation and have relatively few emissions overall. Figure 12 illustrates the operational efficiency of steam natural gas units, many of which have greater heat input than the average turbine and offer greater technical opportunities for efficiency improvements.

Figure 11. Natural Gas Turbine—Heat Input–Weighted Heat Rates

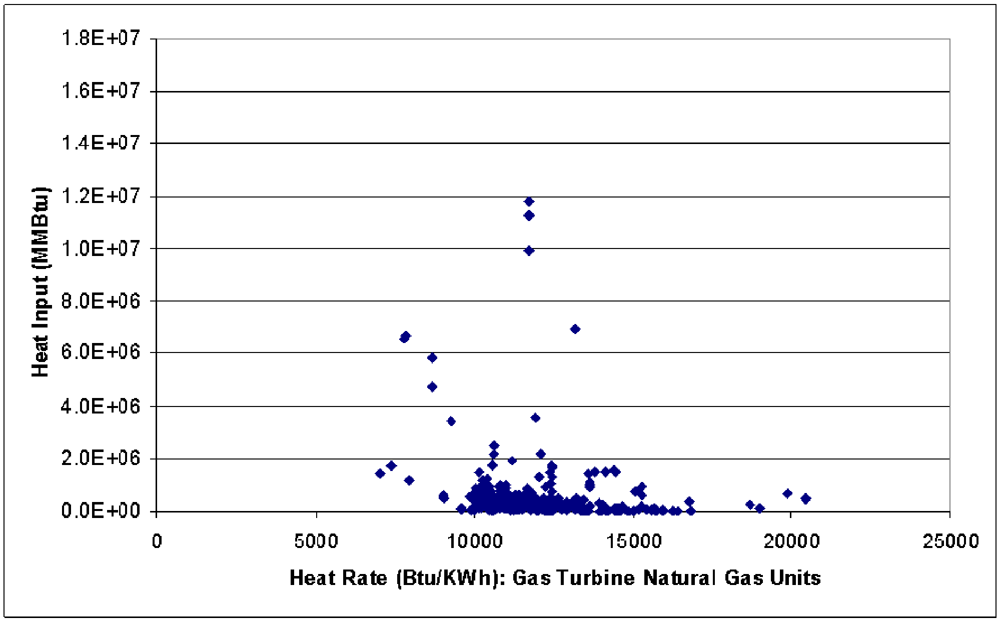


Figure 12. Natural Gas Steam—Heat Input–Weighted Heat Rates