Promoting Innovative and Clean Energy Technology Deployment in Conjunction with GHG Regulation of Stationary Sources under Section 111 of the Clean Air Act

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ABSTRACT

This paper outlines regulatory strategies that could be implemented under the Clean Air Act (CAA) to help states and emissions sources accelerate the deployment of new and innovative clean energy technologies to achieve air, energy, and climate goals. The U.S. Environmental Protection Agency (EPA) and states already possess the statutory authority to exercise the tools detailed here, which could help minimize barriers to new technology deployment under CAA policies. The appropriate pathway for development and implementation of those tools may vary by strategy, but such technology-stimulating reforms could be deployed in conjunction with the EPA’s establishment of a regulatory program to address greenhouse gas emissions from stationary sources.
INTRODUCTION

Climate change poses a significant challenge to the United States, requiring the nation to reduce greenhouse gas (GHG) emissions in the face of the need for economic recovery, the increasing exhaustion of end-of-pipe solutions for pollution, and complex global climate and energy issues. Some believe that only Congressional action can effectively address GHG emissions from industry, but for the foreseeable future, the Clean Air Act (CAA) is likely to be a primary federal pathway for reducing GHG emissions from stationary sources. Although the technology challenges and the global nature of the climate problem are different from those associated with criteria pollutants and toxics, the U.S. Environmental Protection Agency (EPA) can develop programs to regulate GHG emissions coherently along with existing CAA programs for other pollutants. Indeed, the development of GHG emission programs offers an opportunity for policy makers to reconsider existing CAA authorities and policies and to craft a superior CAA regulatory program as a whole.

One important strategy for meeting the climate challenge is to accelerate deployment of innovative clean air and energy technologies in the nation’s most carbon-intensive industrial sectors, such as power generation, refining and chemical manufacturing, and cement production. Many technologies that reduce GHG emissions from these sectors also have significant additional environmental benefits, including decreases in conventional air pollutants and improvements in water resource outcomes, as well as energy policy benefits, such as increased energy diversity, reliability, and efficiency. Among the promising advancements are improvements in technologies for renewable generation, such as wind and solar power; more energy efficient ways to produce power, such as combined heat and power projects and oxy-combustion technologies for coal and natural gas generation; more carbon-neutral fuel sources, such as biomass-based and bio-refined fuels; carbon capture and use or sequestration technologies; improvements in batteries and other energy storage technologies; and evolutions in microgrids and smart grids that allow cost-effective energy generation and storage.

Some of these technologies are widely available for deployment, yet remain underutilized, while others are undemonstrated, or at least undemonstrated at scale. The reasons for lack of deployment and demonstration involve both economic and regulatory barriers. In some cases, economic barriers are relatively low, such as in the case of energy efficiency and renewable energy technologies, but CAA regulatory barriers associated with permitting installation of technologies at new or existing sources are high. In other cases, development has slowed at the demonstration stage due to concerns about the amount of investment needed for demonstration, combined with uncertainty about the financial return and the regulatory challenges of permitting and operating a new technology.

If the EPA and states implement CAA policies that help to “de-risk” investments in innovative and clean energy technologies, emissions sources might become more likely to make such investments, including investments in demonstrations of relatively untested but potentially game-changer technologies. They might also be more willing to more widely deploy advancing and emerging clean energy technologies with proven track records, such as energy efficiency and renewable energy technologies. Although these technologies may not be game changers on their own, together—and particularly in effective combinations—they could achieve significant air and energy benefits.

Thus, this paper details some of the promising CAA tools that the EPA and states can use, particularly in conjunction with the establishment of CO₂ regulatory programs under Section 111 of the CAA, to promote greater deployment and demonstration of innovative and clean energy technologies. These tools are not costly, and they provide no direct financial support for technology development or deployment. What they do provide to companies considering innovative or clean energy technology investment is greater regulatory flexibility and planning certainty. That flexibility and certainty has economic value to companies making tough investment decisions as well as economic and environmental
value to the nation to the extent that companies are encouraged to advance the technology development and deployment needed to meet air, energy and climate challenges.

**BACKGROUND AND SUMMARY**

The EPA is in the process of developing a GHG regulatory program for stationary sources under the Clean Air Act. The agency determined that CAA permitting requirements apply to GHG emissions from large stationary sources starting in 2011 (Timing and Tailoring Rule). Recently, the EPA re-proposed new source performance standards (NSPS) for new fossil fuel–fired power plants. When the NSPS for new power plants are finalized, the next step will be establishment of performance standards for existing source power plants under Section 111(d), which delegates to states the authority to define existing source requirements under guidance from the EPA. The agency is soliciting stakeholder input and developing concepts for Section 111(d) guidance.

In developing GHG regulatory programs for stationary sources, particularly in the Section 111(d) process for existing sources, the EPA has an opportunity to replace existing CAA policies that at times hamper technology deployment with new regulatory policies that affirmatively support a pipeline of clean air and energy technology innovation and deployment in industrial sectors. History demonstrates that the CAA can be implemented effectively to accelerate development and deployment of clean air technologies. The CAA has enabled a continuing stream of innovative pollution controls such as scrubbers, catalytic converters, electrostatic precipitators, diesel traps, chemical substitutes, and activated carbon injection. Such technologies have cut pollution by 90% or more where put in place and have produced health and environmental benefits that dwarfed their costs. Moreover, the United States has realized competitive advantage in global markets for some control technologies, such as selective non-catalytic reduction and flue-gas desulphurization.

To date CAA implementation policies have tended to focus on bringing along “end-of-pipe” control technologies to achieve significant reductions in toxics and criteria pollutants. But meeting the climate challenge while making further conventional pollutant reductions is likely to require greater innovation—in both technology strategies and regulatory strategies. There are limited opportunities to achieve GHG reductions in stationary source sectors from conventional source-specific technological “controls.” As a result, achieving significant GHG reductions will likely require two kinds of technology pushes: (1) broader deployment of currently “available” technologies to change an emissions source or industry’s

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3 Section 111(d) requires the EPA to issue such guidelines when it sets an NSPS for pollutants, such as CO₂, that are neither regulated by national ambient air quality standards nor national emissions standards for hazardous air pollutants. 42 U.S.C. § 7411 (2012). In June 2013, President Obama directed the EPA to finalize Section 111(d) guidelines for existing power plants by June 1, 2015. Presidential Memorandum from President Obama on Power Sector Carbon Pollution Standards 1–2 (June 25, 2013), http://www.whitehouse.gov/the-press-office/2013/06/25/presidential-memorandum-power-sector-carbon-pollution-standards.
4 In the fall of 2013, the EPA conducted a series of “listening sessions” to collect input for the guidance or rule regarding CO₂ emissions reductions from existing sources. U.S. Envtl. Prot. Agency, Public Listening Sessions, http://www2.epa.gov/carbon-pollution-standards/public-listening-sessions.
general operations (e.g., demand management, greater energy efficiency and renewable energy usage, and fuel switching) and (2) development and deployment of innovative game-changing technologies that can radically reduce GHG emissions from industrial processes.

Although industrial technology investment decisions are primarily economic in nature, regulatory policies have economic impacts and can play a role in posing or removing barriers to innovative technology deployment. The Clean Air Act is sometimes characterized as a “technology-forcing” statute because many of its provisions require adoption of “best available” or “best demonstrated” technology. In practice, however, this aspect of the Act has sometimes created innovation disincentives in that voluntary deployment of new technologies can increase compliance obligations for individual companies or a sector as a whole. In addition, industry often perceives the permitting requirements of the Title V and New Source Review (NSR)/Prevention of Significant Deterioration (PSD) programs as lengthy and highly uncertain in outcome, and these programs can require costly compliance measures and trigger expensive, comprehensive on-site control technology reviews.

Finding ways to minimize or eliminate some of these CAA regulatory barriers could catalyze broader deployment of existing and emerging clean energy technologies in the near term and could accelerate demonstration and deployment of the game-changing technologies needed to achieve long-term GHG reduction goals. The Nicholas Institute for Environmental Policy Solutions at Duke University has been evaluating the CAA implementation record for lessons on regulatory policies that can help bring new technologies to market sooner rather than later and that can provide the kind of flexibility with accountability needed to permit system-wide solutions to address the climate change problem. Two common elements of CAA technology innovation success stories are (1) significant collaboration and public-private partnerships among the EPA, states, the environmental community, and companies with strong environmental track records with respect to developing and demonstrating technologies, and (2) promulgation of creative regulatory innovations that allow flexibility in CAA compliance options and that expand market-based options such as emissions credits and trading systems.

With these elements in mind, the Nicholas Institute has identified existing CAA tools that could be applied to help accelerate deployment of clean air and energy technology innovations in stationary source sectors. It has also conducted informal outreach with stakeholders from a variety of sectors—industry representatives, environmental advocates, energy and economic policy analysts, and regulators—to evaluate the practical viability of the proposed tools. The following tools appear to have the best potential for reasonably near-term implementation and for success in promoting deployment of innovative and clean energy technology in industrial sectors:

- Guidance from EPA for state Section 111(d) GHG programs for existing-source power plants—specifically, on how these programs can provide greater compliance flexibility through emissions credit and other market-based tools, including recognition of early action and emissions reduction actions that occur beyond a facility’s physical boundaries;
- Broader use of innovative control technology waivers under Section 111(j) to provide extended compliance time for companies demonstrating innovative emissions-reducing technologies;
- More flexible and streamlined permitting processes, including plant-wide applicability limits (PALs) and flexible permits (FPs), to reduce the permitting uncertainties of deploying technologies;
- More flexible use of offset credits in nonattainment NSR programs; and

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• Broader consideration of the economic, energy, and environmental impacts of innovative and clean energy technologies in Step 4 of best available control technology (BACT) analyses.

These strategies could help minimize the CAA regulatory risks to companies that opt to invest in undemonstrated technologies by providing credit in relevant CAA programs for the GHG and other emissions reductions achieved as a result of deploying nonconventional technologies. Providing credit in CAA compliance programs for reductions that result from technology deployments that do not involve on-site controls in the conventional sense—say, installation of renewable energy sources combined with energy storage technologies that allow a facility to reduce its reliance and usage of higher-emissions power from the grid—is particularly appropriate in the GHG context because GHG emissions impacts are not locally specific. Reducing these impacts wherever they occur is broadly beneficial, helping to cost-effectively achieve not only GHG emissions reductions but also other environmental benefits.

Policies that increase compliance flexibility and decrease technology investment risks, however, could at the same time increase environmental risks associated with technology performance shortfalls. Thus, the EPA and states may wish to pair these policies with effective accountability mechanisms and environmental performance guarantees. Mechanisms to ensure superior environmental outcomes from innovative deployment projects include the following:

• Requirements for upfront agreements on shortfall remedial measures and clear actionable triggers for their imposition;
• Strategic use of enforceable commitments to achieve environmental co-benefits;
• Identification of and adherence to appropriate environmental justice best practices;
• Innovative monitoring and reporting requirements, where appropriate, to address local community concerns; and
• Supportive non-regulatory efforts, such as agency and interagency programmatic initiatives, to promote technology deployment projects and to coordinate the requirements of multiple regulatory systems, such as environmental and state public utility regulations in the power generation context.

Using these flexibility and accountability tools, the EPA and states could provide guidance and metrics to help stationary emissions sources quantify and receive CAA credit for net energy and emissions savings resulting from deployment of innovative and clean energy technology. That credit could be earned under several CAA programs, including Section 111 NSPS programs, nonattainment NSR and PSD programs, and Title V permitting. The EPA could also identify streamlined permitting pathways and opportunities for interagency cooperation, including reconciling divergent federal, state, and local agency requirements as well as facilitating project siting in public sector locations, such as U.S. Department of Interior and U.S. Department of Defense properties. In the face of such regulatory flexibility and certainty, leaders of top companies interested in sustainability and long-term bottom-line performance could be more willing to make investments in the potential benefits of deploying innovative clean air and energy technologies. As some entrepreneurial CEOs or VPs become industry leaders in deploying these technologies, their success could induce similar investments in other companies and sectors. Thus, in the relatively near term, the proposed CAA tools could both broaden the diffusion of technologies to achieve significant GHG reductions and facilitate demonstrations that would speed the game-changing technological innovations needed to achieve significant reductions in the longer term.

Section II below details the CAA tools that could provide greater regulatory flexibility to sources seeking to deploy innovative or clean energy technologies. Section III details accompanying accountability measures that can ensure superior environmental performance outcomes result from the greater regulatory
flexibility. To make these concepts more concrete, Section IV provides some examples of promising clean energy technology categories.

**CAA TOOLS FOR PROMOTING INNOVATIVE AND CLEAN ENERGY TECHNOLOGY DEPLOYMENT**

The following discussion focuses on specific opportunities for interpreting the Clean Air Act in ways that encourage deployment of innovative clean technologies by reducing regulatory barriers to investment. Most of the tools provide permitting and operational flexibility to emissions sources. These tools include Section 111(j) innovative control technology waivers, streamlined permitting, broader use of flexible and plant-wide applicability limit (PAL) permits, and recognition of emissions reductions from non-conventional technologies in New Source Review analyses. The appropriate path for implementing these tools will vary, depending on a number of factors. Administrative law requirements, for example, may necessitate formal rulemakings in some circumstances but allow informal guidance or interagency memorandums in others. In addition, any EPA decisions on how to implement the tools would likely balance considerations such as EPA resource constraints, impacts on other policy goals, timing issues, and interagency coordination. This section begins with a discussion of near-term options available to the agency as it promulgates the forthcoming Section 111(d) guidelines for regulating CO₂ emissions from fossil-fuel–fired power plants.

**Section 111(d) Guidance**

One of the EPA’s most promising regulatory tools to promote innovative and clean energy technology deployment in the near term is guidance for Section 111(d) regulatory programs. These are the programs that states will develop to control CO₂ emissions from existing power plants. Design of the programs will have a critical emissions impact but also a precedential impact on the design of future GHG regulatory programs for sectors such as oil refining, chemical manufacturing, and cement manufacturing.

The flexibility permitted under Section 111(d) gives both the EPA and states a unique opportunity to encourage broader and more accelerated development and deployment of innovative and clean energy technologies. State CO₂ plans for existing emissions sources are likely to focus on power management strategies that will promote deployment of existing and near-ready innovations, such as energy efficiency and renewable energy technologies, microgrids, smart grids, renewable energy storage, and combined heat and power (CHP) technology coupled with microgrids and renewables. The EPA could promulgate Section 111(d) guidance to encourage deployment of these types of technologies through provisions that recognize and provide guidance for the following:

- System-based rather than source-based standards,
- Power sector emissions reductions that result from “beyond-the-fence-line” actions, and
- Existing state and regional emissions reduction programs, such as the Regional Greenhouse Gas Initiative (RGGI) and California’s programs under AB 32.

System-based standards (e.g., averaging, trading, or portfolio approach) are likely to be more effective than source-based standards at enabling existing sources to achieve CO₂ emissions goals cost-effectively. Source-based standards require each source to achieve emissions limits independently through on-site actions (e.g., retrofits, fuel switching, and co-firing). System-based standards are more flexible and credit strategies that reduce overall power sector emissions through actions within or beyond the fence line of individual power plants. System-based standards would allow regulated sources to take advantage of the most cost-effective emissions reduction methods available across the power sector. These methods may include demand-side energy efficiency, increased dispatch of low-carbon generation, plant retirements, increased renewable energy, and transmission efficiency. By allowing rather than prohibiting use of these flexible compliance approaches, Section 111(d) regulations can increase demand and market competition for the technologies associated with these flexible compliance approaches.
Beyond allowing the use of system-based standards, the EPA could provide states and regulated sources with guidance on how to take advantage of flexible compliance approaches. Many states and stakeholders have asked the agency to provide guidance on implementation issues such as (1) the required contents of a 111(d) implementation plan for states that participate in regional compliance programs, (2) options for measuring energy savings and emissions reductions from demand-side energy efficiency policies and programs, and (3) ways to incorporate existing state emissions reduction initiatives into 111(d) plans without making the initiatives federally enforceable. Just as companies face risks when choosing whether to invest in innovative technologies, states weigh risks when deciding whether to structure their implementation plans in ways that can encourage the use of innovative technologies.

Guidance to states on how to incorporate flexible compliance strategies into Section 111(d) plans reduces the risk that states will expend time and resources to develop plans that the EPA ultimately does not approve. Moreover, such guidance could enable states to complete the complex process of incorporating averaging, trading, renewable generation, and other technology-driving strategies into their 111(d) plans within regulatory timelines for submitting the plans to the EPA.

Finally, by recognizing early action by states and emissions sources to reduce CO₂ emissions, the EPA could encourage and, equally important, avoid discouraging investment in innovative clean air technologies. California and the nine RGGI states already participate in carbon markets, and dozens of other states have renewable portfolio standards and energy efficiency policies that drive emissions reductions. If these initiatives, enacted before federal mandates, result in tighter baseline determinations for Section 111(d), states and sources may be reluctant to voluntarily invest in cutting-edge emissions reduction strategies in the future. Recognition of early action, by contrast, could spur investment in innovative clean technologies that offer short-term rewards that will likely be recognized in future CAA regulations.

Clean air programs have a history of recognizing early action in new regulatory regimes. Federal emissions trading programs like the NOₓ Budget Trading Program and California’s AB 32 cap-and-trade GHG reduction program each credited early action. In the NOₓ Budget Trading Program, states could receive Compliance Supplement Pool allowances to distribute to emissions sources during the first two years of their implementation programs. These allowances could be used to reward early NOₓ reduction as well as to provide some compliance flexibility to ensure electricity supply reliability during the initial compliance period. In California, the Compliance Offset Program allows some GHG emissions reductions from qualified existing offset projects to be eligible for use in the state’s cap-and-trade program to ensure that early voluntary reductions receive appropriate credit and to help create an initial supply of offset credits for the program. Similarly, in the motor vehicle context, the EPA has included

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7 If the EPA allows emissions trading as a compliance option under Section 111(d), it may have the opportunity to update its general emissions trading policies, which were originally issued December 4, 1986. U.S. Envtl. Prot. Agency, Final Emissions Trading Policy Statement, 51 Fed. Reg. 43,814.


9 In June 2013 President Obama issued a timeline for development of Section 111(d) regulations that gave states 13 months to develop and submit 111(d) implementation plans. The president’s memorandum requires states to submit these plans by June 30, 2016, which is 13 months after the president’s June 1, 2015, deadline for the EPA to promulgate Section 111(d) emissions guidelines. Presidential Memorandum from President Obama on Power Sector Carbon Pollution Standards 1–2 (June 25, 2013), http://www.whitehouse.gov/the-press-office/2013/06/25/presidential-memorandum-power-sector-carbon-pollution-standards.


flexibilities to provide lead time for manufacturers to make technology improvements and reduce compliance costs, without compromising environmental objectives. An important flexibility was an optional program allowing manufacturers with superior GHG reduction performance to generate early credits in the 2009–2011 model years: the early credits represented surplus reductions not otherwise required by law, and they helped manufacturers to transition to increasingly stringent GHG standards.  

Promoting Innovative Technology Deployment under Section 111(d)

There is increasing interest in EPA regulatory policies that allow emissions sources to receive Section 111(d) compliance credit for actions that occur beyond their fence lines but reduce carbon dioxide emissions from the power sector. Such policies could open the door for broader deployment of innovative technologies by increasing their economic feasibility. For example, a company that develops a renewable energy project would be able to obtain 111(d) credit that it could use to meet its own compliance obligations or sell to other companies for their compliance purposes as long as the companies are operating in a state with an established market-based regulatory system.

Section 111(j) Innovative Control Technology Waivers

Section 111(j) is a little-used provision of the NSPS program that provides additional compliance time for emissions sources using new technologies to complete installation of and work out problems associated with innovative technology. The section allows the EPA to waive or delay the application of NSPS standards for a particular emissions source “to encourage the use of an innovative technological system or systems of continuous emissions reduction.” A source has up to seven years after a Section 111(j) permit is granted or up to four years after it starts operating, whichever is earlier, to demonstrate the viability of the technology. If the technology fails to reach viability, the EPA may grant the source up to three years to comply with the regular NSPS. Although Section 111(j) expressly applies to new source performance standards, the EPA extended the provision to emissions sources for purposes of the Prevention of Significant Deterioration (PSD) permitting requirements. The EPA took this action because an NSPS waiver would not be effective in practice if the sources were not also granted flexibility with regard to PSD requirements. These requirements generally track the Section 111(j) provisions,

credits.htm (providing information on early action offset credits under AB 32). California’s Air Resources Board will only allow early action offset credits that have not been retired or used to meet another obligation.


13 42 U.S.C. § 7411(j)(1)(A) (2012). The EPA may grant the waiver to an emissions source if it makes three findings: (1) The technology that the source proposes to employ has not been “adequately demonstrated.” In other words, the technology is not sufficiently developed to serve as the basis for a universally applicable NSPS. (2) There is a “substantial likelihood” that the proposed technology will either achieve greater emissions reductions than the NSPS would require or equivalent emissions reductions at lower cost. (3) The proposed technology will not “cause or contribute to an unreasonable risk to public health, welfare, or safety.” Id.

14 § 7411(j)(2).

15 Requirements for Preparation, Adoption, and Submittal of Implementation Plans; Approval and Promulgation of Implementation Plans, 45 Fed. Reg. 52,676, 52,727 (Aug. 7, 1980). The Prevention of Significant Deterioration (PSD) permitting program requires installation of “best available control technology” (BACT) at major emissions sources in an attainment area when proposed construction of a new source or major modification of an existing source could increase emissions significantly. See infra Section II, Credit for Environmental and Energy Benefits in Step 4 of BACT Determinations.

16 Without the extension of a 111(j) waiver to the PSD program, a new source would have to install BACT under the PSD program despite permission to delay compliance with the new source performance standards. BACT, however, cannot permit a source to exceed the NSPS, and so the new source would have to meet the NSPS through application of BACT, thus moot the 111(j) flexibility.
defining an “innovative control technology” as “any system of air pollution control that has not been adequately demonstrated in practice, but that would have a substantial likelihood of achieving greater continuous emissions reduction than any control system in current practice or of achieving at least a comparable reduction at lower cost in terms of energy, economics, or non-air quality environmental impacts.”

The Clean Air Act limits the number of Section 111(j) permits issued by the EPA to the number that the agency finds “necessary to ascertain whether” a proposed technology will achieve greater emissions reductions than performance standards require or equivalent reductions at lower cost. The EPA’s history of narrowly interpreting Section 111(j) has created the perception that the agency will only issue waivers for pilot projects. Its 1991 memorandum (known as the Kamine memo), for example, indicated that it would grant a 111(j) permit only for multiple applications of a control technology in limited circumstances. In a recent review of Section 111(j), the Climate Change Workgroup (CCW) of the CAA Advisory Committee (CAAAC) identified three general problems with the EPA’s historical approach: Section 111(j)’s limited use under the Kamine memo, the timeframe within which the BACT limit must be met, and the applicant’s risk should the technology fail. The CCW recommended that the EPA disavow the Kamine memo, provide guidance on the section’s broader availability and the circumstances under which a technology would no longer be considered innovative, and allow a range of emissions limits when determining BACT for innovative technologies. In its 2011 GHG permitting guidance, the EPA indicated it would consider approving more than one waiver for a particular technology where the statutory criteria are met. How many waivers are appropriate for an individual technology remains unclear. Perhaps the agency should allow such waivers until the proverbial “new” plant is built, providing a clear picture of the technology’s commercial viability.

The EPA might also increase deployment of innovative technologies through Section 111(j) by clarifying how it evaluates the beneficial “economic, energy, and non-air quality environmental impacts” that can accompany innovative technologies. By considering the foreseeable co-benefits of new clean technologies that will achieve equivalent, but not necessarily greater, emissions reductions than the new source performance standard, the agency could help these technologies qualify for a 111(j) waiver. Guidance about how to account for co-benefits could facilitate the submission of successful 111(j) applications and standardize the application review process across EPA regions.

The intent of Section 111(j) is to provide compliance flexibility to mitigate the risks associated with deployment of undemonstrated innovative control technologies. Section 111(j) is likely most attractive to emissions sources seeking to deploy high-cap technologies, including technologies that may have been demonstrated once or twice but that are as yet unproven to operate feasibly in multiple contexts at scale. For example, undemonstrated forms of carbon capture and sequestration (CCS) technology (alone or in combination with other technologies) and emerging novel thermodynamic technologies for natural gas power plants could warrant Section 111(j) permits. When combined with other tools, such as increased

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17 40 C.F.R. § 51.166(b)(19) (2013) (defining “innovative control technology” for purposes of preparation, adoption, and submittal of SIPs); see also 40 C.F.R. § 52.21(b)(19) (defining “innovative control technology” in identical language for purposes of approval and promulgation of SIPs).
19 Tim Profeta, director of the Nicholas Institute, chairs the Advisory Board for 8 Rivers Capital, which owns a company, Net Power, developing such technology. The Duke University School of Law also has an ownership interest in Net Power through
use of innovative monitoring and verification technologies, Section 111(j) permits could encourage greater willingness to invest in innovative technology deployment while ensuring environmental protection.

The EPA could balance any expansion of Section 111(j) applicability with mechanisms and strategies to ensure superior environmental outcomes from innovative technology deployments. To this end, the EPA could provide guidance for uniform approaches under Section 111(j) for some of the strategies outlined in Section IV, such as ensuring that shortfall remedies are appropriately scaled to address gross versus marginal failures of innovative technology and that enforceable co-benefit commitments or other performance assurance mechanisms can be established to address shortfalls. In addition, the EPA could explore, with stakeholder input, options for interpreting Section 111(j)’s specific terms and definitions (e.g., “innovative technological system”) consistent with statutory intent and in the context of each given GHG emissions reduction problem. It could also specify the number of demonstrations necessary to establish that a technology is deployable.

### Promoting Innovative Technology with Section 111(j) Waivers

Section 111(j) may be appropriate for promoting demonstrations and deployment of high-cap and undemonstrated or inadequately demonstrated technologies such as emerging but costly technologies that produce power more cleanly from fossil-fuel sources. Carbon capture and use or sequestration (CCUS) is an example. Although the EPA regards CCUS as adequately demonstrated, technology developments at individual stages of the CCUS process (capture, compression, transportation, injection, etc.) might qualify for 111(j) waivers. Technologies that facilitate new commercial uses of captured CO₂ might also meet 111(j) requirements.

The EPA could exercise authority under Section 111(j) to solicit demonstrations of technologies identified as promising. For example, it could establish specific terms for section 111(j) permits for these demonstrations. These terms could include specific monitoring and verification requirements, co-benefit commitments, preferable locations, and the number of permits to be granted.

### Credit for Environmental and Energy Benefits in Step 4 of BACT Determinations

The EPA could help promote broader deployment of innovative clean energy technologies by establishing guidance and providing metrics for crediting the environmental and energy benefits of clean air and energy technologies in Step 4 of the BACT analysis. The PSD program requires installation of “best available control technology” (BACT) at major sources in an attainment area when a PSD applicability determination has indicated that proposed construction of a new emissions source or major modification of an existing source could increase emissions significantly. BACT is determined in a five-step process on a case-by-case basis. Step 4 of the BACT analysis allows permitting authorities to take into account “the energy, environmental and economic impacts and other costs” of technologies in determining the best achievable control technology for a source. In guidance for PSD permitting of CO₂ emissions from bioenergy facilities, the EPA recognized that although traditionally Step 4 is used only to eliminate options from the top down on the basis of unacceptable adverse energy, environmental, or economic

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24 The CAAAC has recognized the importance of appropriately scaled remedies in regulatory strategies to implement Section 111(j). When the CAAAC reviewed Section 111(j) in 2010, it noted the agency’s prior consideration of gross versus marginal failure remedies in revisions proposed in 1996. It also recommended changes to provide maximum time and flexibility to achieve standards in conjunction with a Section 111(j) project. CLEAN AIR ACT ADVISORY COMMITTEE, U.S. ENVTL. PROT. AGENCY, PERMITS, NEW SOURCE REVIEW AND TOXICS SUBCOMMITTEE, CLIMATE CHANGE WORK GROUP, PHASE II REPORT 18 (2010), http://www.epa.gov/air/caaac/pdfs/bact_phase_II.pdf.
impacts, the permitting authority “can assess the impacts of all technologies under consideration.”25 In this way, the reviewer can make a BACT determination on the basis of each technology’s range of impacts, such as GHG reductions, energy efficiency, fuel diversity, reliability, visibility, and water consumption.26

To spur investment in innovative clean technologies, the EPA could provide Step 4 guidance similar to that for bioenergy facilities but for the evaluation of sources that utilize innovative clean technologies. Such guidance could aid permitting authorities in considering the benefits of innovative technologies beyond reducing the pollutant that is the subject of the BACT analysis. Benefits for consideration may include successful demonstration of a new technology, the potential for the technology to qualify as BACT for other emissions sources, co-pollutant reductions, more efficient use of energy, and diversity of emissions control options. Demonstration of innovative clean technologies is also consistent with national goals of generating cleaner energy and promoting American leadership in renewable energy.27 The EPA might also address how to estimate the emissions reductions that innovative technologies may achieve. Guidance focusing on innovative technologies could reduce the risk of investing in those technologies by helping emissions sources better evaluate whether the technologies would qualify as BACT in the first place. It also could increase the consistency of BACT analysis by permitting authorities in different jurisdictions and thereby make the BACT evaluation process for new clean technologies more predictable.

## Promoting Innovative Technology with Appropriate Step 4 BACT Analyses

Under Step 4 of the BACT analysis, innovative technologies, such as advancements in fairly well-demonstrated, unit-level energy efficiency or renewable energy technologies, could be evaluated for their associated environmental and energy impacts. Consider a company that seeks to modify its boiler with CHP technology as well as install other renewable energy technologies and advanced storage and microgrid technologies. Although this set of technologies would achieve large systemic reductions in GHG emissions, the CHP technology may not be considered the best available control technology for some conventional pollutant emissions from the boiler. Nevertheless, the company could argue that its proposed set of technologies add up to the best available control technology. First, it would identify the comprehensive environmental, energy, and economic benefits of the non-CHP technologies—increased energy efficiency, power generation and storage, and facility production. Next, it would adjust its estimation of emissions from the end of the boiler pipe to reflect the conventional pollutant emissions that would be avoided by the facility’s reduced power generation needs. By taking such emissions reduction impacts into account, the company could demonstrate that its proposed technology combination is the best available control technology.

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26 Bioenergy BACT Guidance, supra note 26, at 18–21.

27 Executive Office of the President, The President’s Climate Action Plan 6 (2013), http://www.whitehouse.gov/sites/default/files/image/president27sclimatetionplan.pdf; see Bioenergy BACT Guidance, supra note 26, at 27 (noting a benefit of biomass as furthering the national objective to reduce dependence on fossil fuels).
Offset Credits in Nonattainment NSR Program
In areas that do not meet current clean air standards (i.e., nonattainment areas), owners wanting to install a new major emissions source or make a major modification to an existing source that increases emissions are required to obtain “offsets” for any increased emissions for purposes of nonattainment NSR programs. In other words, the sources must demonstrate emissions reductions from other sources in the area sufficient to offset their own new emissions. Such offsets are increasingly scarce and expensive in nonattainment areas such as southern California, and their price may rise in other areas as air quality standards tighten.

The EPA could allow facilities seeking to deploy or support innovative technologies to utilize alternative emissions crediting strategies in seeking NSR offsets. Given that innovative technologies can often provide emissions reductions beyond those achievable with traditional approaches, the EPA could help early adopters by giving clear guidance that additional reductions and pollution prevention could be used as offsets and by specifying acceptable quantification metrics. To address concerns about potential innovative control technology failures, programs should include stringent monitoring, reasonable further progress, and quantification requirements to help protect air quality while encouraging innovative technology deployment.

Promoting Innovative Technology with Nonattainment NSR Offsets
The EPA could develop guidance on crediting offsetting emissions resulting from deployment of innovative clean air and energy technologies in nonattainment NSR programs (perhaps based in part on the most effective aspects of the EPA’s roadmap policies for crediting energy efficiency and renewable energy actions in state SIP programs). In nonattainment areas in California, this approach would add another economic incentive to the incentives created by the AB 32 climate initiative and help to increase the number of available offsets in a way that drives deployment of innovative control technologies while ensuring air quality improvements.

Streamlined and Flexible Permitting
The financial and operational risks of deploying a new technology combined with the regulatory risks of delays and complications in obtaining needed permits can erect a high hurdle even for low-cost investments. Thus, expediting permit processing and problem resolution could help promote broader deployment of innovative and clean energy technologies. The EPA could accomplish this task by working with states to identify the best streamlining practices and by promoting standardized approaches to them.

The EPA has been exploring permit-streamlining concepts in the context of GHG regulation, and the Clean Air Act Advisory Committee released a report in 2012 that evaluated options for streamlining GHG permitting. Some of the concepts addressed in the CAAAC report could be helpful for designing mechanisms to expedite and streamline permitting in the context of specific technology projects. For example, the report addresses how to establish plant-wide applicability limit (PAL) emissions baselines and monitoring requirements for new facilities or new technologies that lack actual performance.

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28 PSD and NSR program regulations for major sources are found at 40 CFR Parts 51 and 52.
29 CLEAN AIR ACT ADVISORY COMMITTEE, U.S. ENVT. PROF. AGENCY, AIR PERMITTING STREAMLINING TECHNIQUES AND APPROACHES FOR GREENHOUSE GASES FINAL REPORT (2012) [hereinafter “CAAAC AIR PERMITTING STREAMLINING TECHNIQUES”]. Also, in the Tailoring Rule, the EPA sought comment on mechanisms for more efficient GHG permitting such as general permits, permits-by-rule, defining potential to emit for source categories, establishing presumptive BACT for source categories, electronic permitting, and leaner permitting processes. Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule, 75 Fed. Reg. 31,514, 31,526 (June 3, 2010).
data. Such concepts could be used in issuing a PAL or facility-wide permit to sources seeking to deploy a clean air or energy technology without a demonstrated GHG emissions record.\(^\text{30}\)

In developing appropriate guidance for state permitting agencies, the EPA can also look to states that have effectively streamlined and improved permitting times (e.g., Washington, Idaho, and Iowa) and identify transferrable strategies for other states. It could then encourage other states to adopt these strategies through federal incentives, such as accelerated review of states’ SIP revisions that streamline permitting for innovative technology deployment. Further, given the declining staff levels and other resource constraints faced by both federal and state agencies, EPA could identify regulatory strategies that reduce agencies’ permitting burden and increase their permitting efficiency.

Another strategy for streamlining PSD permitting requirements is for states to issue sector- and technology-specific permitting guidance for lower-cost and lower-complexity technologies that deliver large environmental benefits. Candidate technologies may include energy-efficient equipment with operating and emissions impacts that are well documented and easily monitored. In addition, states could implement stationary source permitting strategies equivalent to environmentally beneficial motor vehicle strategies such as ridesharing and HOV lanes to incentivize clean energy technology deployment. An analog “ridesharing” strategy would be appropriate, well-defined regulatory and permitting pathways for groups of stationary sources that want to pool resources and work together to demonstrate a particular, costly innovative technology at scale in a particular context. An analog HOV-lanes strategy could be an expedited process for permitting innovative technologies, whereby the EPA and other relevant federal and state agencies give priority to decisions on and, if necessary, resolution of issues with these technologies.

Permitting barriers for companies seeking to deploy innovative technologies also could be reduced through more effective use of plant-wide applicability limits and flexible permits. By providing appropriate facility-wide permitting approaches and operational flexibility for technology deployment, such policies would eliminate unnecessary and uncertain permit review processes. Plant-wide applicability limits allow a facility to make operational changes without triggering an NSR review as long as the facility’s total emissions remain under established limits in the PAL permit. PALS can address a single pollutant or multiple pollutants as well as particular emissions points or multiple emissions points, including all the emissions of a particular facility. Flexible permits allow sources to include alternative operating scenarios and methodologies in their operating permits to avoid the need for future permit revisions in the case of known or anticipated operational changes.\(^\text{31}\)

The EPA could evaluate proposed innovative technology opportunities that are good candidates for facility-wide permitting or for new GHG PAL concepts through development of guidance for flexible, source-wide permitting that promotes innovative clean air and energy technology deployment. For example, the EPA could promote broader use of flexible permits and PALs in conjunction with GHG regulation by identifying best practices for determining appropriate baseline calculations for greenhouse gases. It also could work with states to explore innovative regulatory flexible permit and PAL concepts through pilot programs. For example, one concept proposed in conjunction with the EPA’s evaluation of sector-specific, multi-pollutant regulatory initiatives involved a facility-wide permit for major emissions sources subject to new source performance standards and national emission standards for hazardous air pollutants. This concept combines conventional technology-based performance standards with a plant-

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\(^{30}\) CAAAC AIR PERMITTING STREAMLINING TECHNIQUES, supra note 30, at 35–36.

wide reductions strategy. With a strong enforceability component, this concept could promote innovative technology deployment in facility- or sector-specific contexts. Such an approach could help facilities better manage the multiple standards applicable to them under NSPS and other programs. It also could reduce facilities’ reluctance to implement new technologies or processes for fear of opening the door to unpredictable permitting reviews and delays, even when their proposed innovations would yield superior environmental outcomes.

In developing appropriate guidance on how states could use plant-wide applicability limits to promote technology deployment, the EPA could look to the experience of states that have developed some facility with PAL permits, such as Pennsylvania, North Carolina, and South Carolina. In addition, environmental stakeholders could help find solutions to their concerns about the methodologies for calculating plant-wide applicability limits. These concerns include the appropriate “look back” period for a PAL baseline, the role of community involvement when changes are made, and how and when plant-wide applicability limits are revised or ended.

### Promoting Innovative Technology with PALS and Flexible Permitting

A GHG plant-wide applicability limit could help a facility with multiple production units achieve CAA compliance by, for example, allowing GHG reductions from installation of an innovative technology on one unit to defer GHG expenditures on other units at the facility. Another potential context would be when installation of supply-side efficiency technologies raises concerns about increases in emissions of other pollutants—for example, when installation of energy-efficient fans in a production line would allow increased operations and thus raise NOx emissions. EPA could set the stage for both broad and streamlined deployment of supply-side efficiency technologies by designing a GHG+ PAL that covers both greenhouse gases and other pollutants consistent with NSR-permissible increases (up to 40 tons per year in the case of NOx increases).

### ACCOUNTABILITY TOOLS TO ENSURE SUPERIOR ENVIRONMENTAL PERFORMANCE

When the EPA implements regulatory innovations, such as expanded market-based compliance options, it historically has preferred that the environmental outcomes of such options be not only equivalent to but superior to those that would be achieved under “regulation as usual.” Thus, if the EPA expands operational and permitting flexibility for technology deployment, it may want at the same time to provide guidance to ensure that the resulting permitted projects will achieve superior environmental outcomes.

Such outcomes are of particular importance to the environmental community. Environmental stakeholders generally wish to preserve regulatory requirements relating to permit review and consider permitting requirements to be important tools for community input about local impacts. At the same time, industry stakeholders tend to regard CAA permitting processes, particularly for PSD and BACT requirements, as unnecessarily costly and burdensome. Thus, any streamlined permitting or increased flexibility in PSD

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33 For example, the EPA requires that state permitting programs and other control strategies be consistent with general obligations relating to accountability, replicability, and enforceability, including effective monitoring and verification requirements. See, e.g., State Implementation Plans; General Preamble for the Implementation of Title I of the Clean Air Act Amendments of 1990, 57 Fed. Reg. 13,498, 13,567–68 (Apr. 16, 1992) (detailing requirements for enforceability, replicability, and accountability). Similarly, states seeking to implement economic incentive programs are required to demonstrate that the programs resulted in more or faster reductions than would have occurred in their absence. Office of Air and Radiation, U.S. Envtl. Prot. Agency, Improving Air Quality với Economic Incentive Programs 51 (2001), http://www.epa.gov/ttn/caaa/11/memoranda/cipttn.pdf.
applicability determinations or in Step 4 of the BACT analysis would need to be sensitive to the concerns on both sides. With these concerns in mind, EPA could include in any proposed flexible compliance policies or guidance a clear and easily applied set of guidelines relating to how states and sources can best ensure accountable and superior environmental performance outcomes.

As detailed here, the EPA could issue guidance with model provisions and pathways for how state permitting processes could ensure superior environmental performance from technology deployment projects through strong, consistent permit requirements. These requirements include specific shortfall measures in permits (including potential enforceable commitments to achieve multi-pollutant co-benefits), adherence to environmental justice best practices, and voluntary adoption of innovative monitoring and social media technologies. Compliance with such requirements could be evaluated as part of a permit’s public review processes to ensure that any local community concerns are addressed. In addition to such measures, the EPA could also develop agency and inter-agency programmatic initiatives to promote innovative and clean energy technology deployment efforts in conjunction with stationary source regulation under the Clean Air Act.

**Specific Remedial Measures with Clear Triggers**

To ensure environmental integrity, regulatory policies or projects to foster innovative technology development and deployment could require permits to include upfront agreements about appropriate remedial steps to be undertaken if a new technology does not provide superior environmental results. Such agreements would ensure adequate performance backstops and appropriate graduated remedies for gross failures.

Potential actions to backstop innovative technology deployment include mid-stream evaluation measures to ensure on-track performance and well-defined triggers and pathways for off and on ramps. Design for evaluation measures will depend on context, but best practices could be identified through a stakeholder process that includes input from the regulated industry, the public and state agencies, vendors, policy experts, and environmental justice advocates.

Triggers for backstops could include achievement shortfalls (e.g., failure to comply with source or area emissions forecasts) or health-risk triggers based on ambient and localized monitoring. Backstop measures can include off ramps from the innovative technology program when monitoring and other evaluation processes (such as designated period program reviews and individual facility audits) indicate potential program or facility shortfalls and on-again ramps when a performance shortfall or failure is remedied.

Shortfall triggers and remedies will be more supportive of efforts to deploy innovative technologies if they are designed as graduated mechanisms that scale remedies on the basis of degree of shortfall. That is, a source that falls 5–10% short of the expected emissions achievement should not be treated the same as one that falls 25% short of the goal; similarly, a 25% shortfall should not require a “do it all over” remedy, such as might be expected at shortfall rates greater than 75%. Tailoring responses in proportion to shortfalls could help incentivize and de-risk innovative technology investments.

The EPA has explored the need for graduated shortfall remedies in other contexts. In its recent reconsideration of the innovative control technology waiver provisions of Section 111(j), for example, the agency noted prior proposals to distinguish between marginal failures and gross failures with regard to replacement remedies and potential contingency measures. In appropriate cases, deadline extensions to achieve a goal might be appropriate if progress is shown.

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Environmental Justice Best Practices

CAA strategies to promote innovative technology deployment at stationary sources can be designed to achieve specific improvements for overburdened communities and to ensure such communities are not exposed to any new environmental risks. One way to ensure that environmental justice improves in conjunction with deployment of innovative technology at stationary emissions sources is to allow local community members to evaluate the potential impacts of such technology. To that end, the EPA could develop a set of best practices for early, constructive engagement of communities by innovative technology developers; it also could make adoption of these practices a pre-requisite for the use of regulatory and operational flexibilities in conjunction with innovative technology deployment. Agency guidance on engagement practices could detail community safeguards when emissions sources seek to operate with flexibilities such as streamlined permitting or Section 111(j) waivers. The guidance could also cover practices related to environmental justice concerns that arise under co-located USDA, DOE, or DOD area projects.

Tools for developing community engagement practices include the EPA’s “Plan EJ 2014,” which contains an appendix detailing strategies to better integrate environmental justice considerations into permits issued under the Clean Water Act, the Clean Air Act, and other environmental laws. In addition, recommendations by the National Advisory Council for Environmental Policy and Technology (NACEPT) address how the EPA can better promote use of innovative technologies to promote environmental justice goals. Recommendations include improved community participation in research design and conduct. NACEPT also notes that the EPA could develop an inventory of innovative technologies that could be deployed to meet the needs of environmental justice communities and regulatory requirements.

Indeed, environmental justice strategies could provide an important tool for the EPA to promote environmental justice and innovative technology deployment goals in tandem. As discussed below, expanded use of innovative pollution detection, monitoring, and assessment technologies (from portable sensors that can be used by members of an affected community to complex systems operated by trained personnel) could be particularly beneficial. These technologies could increase capacity to assess the multiple community impacts and significantly improve environmental justice outcomes in conjunction with accelerating innovative technology deployment under the Clean Air Act. These technologies may, for example, help enhance local air quality management relating to emissions inventories and air quality monitoring (such as micro-scale monitoring), compliance reviews, outreach and education to facilitate local empowerment, community training on air quality and data gathering, public information dissemination, and communication channels between local governments and communities.

Innovative Monitoring and Reporting Strategies

As advanced emissions control and clean energy technologies emerge so, too, do advanced emissions monitoring and verification technologies. Current CAA regulation relies primarily on continuous emissions monitoring systems for stacks coupled with leak detection and repair for fugitive emissions, but new monitoring methods that include micro-sensing instruments and passive collection through hand-held photoionization detectors with real-time sensitivity are in development. New detectors can register particular volatile organic compound (VOC) concentrations to one part per billion and can process equipment leaks tens of feet away. Fence-line or open-path monitoring sensors can identify contaminants

35 Environmental justice issues in permitting are particularly addressed in Appendix 2 to the Plan EJ 2014 Report, “Considering Environmental Justice in Permitting.”

36 Letter from NACEPT to Lisa Jackson, Technologies for Environmental Justice Communities and Other Vulnerable Populations (Feb. 15, 2012). In particular, NACEPT details the need for assessment technologies such as risk assessment, life-cycle assessment, environmental footprint assessment, resilience analysis, integrated assessment models, and sustainability impact assessment. Id. at 7.

37 Id. at 15–16.
by projecting a beam of ultraviolet or infrared light over distances as far as a kilometer. Such devices have improved the transfer of measurement capabilities from the lab to the field and enabled more accurate measurement of ground-level emissions concentrations at facilities’ property boundaries, a measurement of particular interest to local communities.

The EPA has begun to evaluate cost and other market-based challenges for accelerating fence-line and other innovative monitoring technologies and to initiate programs to utilize these technologies for enforcement purposes. Such strategies could be extended in the context of accelerating the voluntary deployment of innovative clean air and clean energy technologies. Innovative monitoring and verification technologies can help ensure superior environmental outcomes because accurate and publically accessible emissions data can help drive more aggressive pollution control investment and the deployment of innovative clean air and energy technologies. For example, the 2009 Mandatory Reporting of Greenhouse Gases Rule that requires specific emissions sources and facilities to report their GHG emissions to EPA is expected to motivate innovative technologies deployment as well as ensure consistency in GHG reporting and establish a solid data foundation for addressing global climate change.

With respect to emissions sources seeking greater flexibility to deploy innovative technologies, one way to ensure that they deliver superior environmental results and data is to require them to also deploy relevant monitoring, particularly fence-line monitoring. Where the risk of environmental performance shortfalls is greatest, such monitoring could mitigate concern by enhancing capability to detect and correct underperformance or other implementation failures. Increased use of innovative monitoring technologies could warrant updated strategies for reporting and communicating emissions and other data to the public in timely and appropriate formats. Such strategies may include mechanisms to provide for well-informed or expert evaluation of the emissions information and use of social media to communicate raw data as well as summary findings.

Supportive Non-Regulatory Programs and Outreach

The EPA can increase uptake of CAA-based tools and strategies for promoting the deployment of innovative clean air technologies through supporting non-regulatory programs and outreach. The EPA recognizes the value of such activities and has undertaken promising initiatives. For example, in April 2012, it published Technology Innovation for Environmental and Economic Progress: An EPA Roadmap, detailing its vision and strategy for promoting innovation. The EPA could augment its leadership in proactive technology efforts by appointing an innovation ombudsmen, forming an innovative technology coordinating council, or both.

EPA programmatic initiatives also could more strongly promote development and deployment of innovative technologies. Current EPA initiatives that promote technology innovation include E3 (Energy, Economy and the Environment) and the Partnership on Technology Innovation and the Environment (a voluntary collaboration that has included American University, Duke University, the World Business Council for Sustainable Development, the Environmental Defense Fund, and the EPA).

39 Id.
41 EPA Administrator Gina McCarthy stated in regard to the release of third year of data that, “Putting this data in the hands of the public increases transparency, supports accountability, and unlocks innovation.” EPA’s GHG Reporting Program Data and Data Publication Tool can be accessed at http://www2.epa.gov/ghgreporting/.
and the Combined Heat and Power Partnership as well as specific location-based projects integrating federal, state, and local efforts (such as in California’s South Coast and San Joaquin Valley). Through such programmatic efforts, EPA has significant ability to help broker demonstrations of innovative technology supplemental environmental projects and mitigation projects.

EPA’s interagency outreach also could focus more on promoting development and deployment of innovative clean air and energy technologies. A number of DOE, DOD, DOI, and USDA research, technology, siting, and loan programs could be more effectively integrated with EPA expertise and initiatives. For example, the EPA could work with other agencies to increase demonstration incentives and platforms, such as coordinating with the departments of Defense and Interior in their efforts to deploy innovative technologies at military installations and other public sites, or with the Department of Commerce on efforts like the Environmental Export Initiative to help innovators break into overseas pollution control markets.

**SOME PROMISING CLEAN ENERGY TECHNOLOGIES**
The following nonexclusive list highlights some innovations that could be more broadly and potentially more cost-effectively deployed if promoted through effective use of the CAA tools and accompanying accountability measures described above.

- **Combined Heat and Power (CHP):** By combining production of electric and thermal energy for use at one location, CHP technology offers a cost-effective strategy for reducing GHG emissions, particularly if deployed widely at facilities such as military installations, hospitals, and universities and particularly if combined with microgrids and energy storage. However, conventional CAA regulatory policies and emissions standards can discourage CHP investments because the technology is treated as a new emissions source. Where standards are based on fuel and heat inputs, CHP technology sometimes fares worse than a conventional boiler or generator with respect to local emissions, even though overall emissions associated with a site’s activities will be lower than they would be with separate electrical and thermal generation. Applying tools discussed here, the EPA could develop guidance and standardized metrics to quantify the net energy and emissions savings from CHP technology for purposes of Section 111(j) NSPS waivers, plant-wide applicability limits, NSR offsets, BACT Step 4 analyses, and, potentially, future Section 111(d) programs. The EPA could also identify streamlined permitting pathways and opportunities for interagency cooperation, such as increased siting of CHP technology at DOD, DOI, and other governmental installations, and could also help coordinate state efforts to address electric utility regulation barriers for CHP grid access.

- **Polygeneration from Coal:** A polygeneration plant simultaneously produces electric power from coal and other chemical products, such as feedstocks and liquid fuels by combining power generation and chemical-processing operations, typically using advanced gasification technologies. A polygeneration system can improve profit margins as well as reduce GHG emissions and increase energy and chemical supply flexibility. EPA guidance on and metrics for crediting energy and emissions savings from polygeneration for Section 111(j) NSPS waivers, plant-wide applicability limits, BACT Step 4 analyses, and, potentially, future Section 111(d) programs would encourage polygeneration, as would streamlined and more flexible permitting pathways and opportunities for interagency cooperation, which might include facilities siting at mine-mouth locations near DOD properties.

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• CCUS and Oxy-Combustion: Innovative technologies to address the high GHG emissions from combustion-intensive industries such as power generation, refining, and chemical manufacturing will be needed to make significant progress on climate change mitigation. Technologies like carbon capture and oxy-combustion are promising but can be costly to deploy, and some of them can increase energy or water usage and associated costs. The economic feasibility of carbon capture and storage improves, however, when its implementation is coupled with marketable production strategies such as enhanced oil recovery. Its viability would increase if the costs of enhanced oil recovery, a process for using CO$_2$ to extract oil from mature oil fields while sequestering CO$_2$ underground, were reduced. Similarly, aligning oxy-combustion technologies with marketable production strategies could make their deployment more cost-effective. The EPA can help promote such projects by promulgating guidance on crediting net energy usage and GHG emissions reduced by carbon capture use and storage and oxy-combustion technologies in Section 111(j) NSPS waivers, plant-wide applicability limits, BACT Step 4 analyses, and, potentially, future Section 111(d) programs. In addition, the EPA could identify streamlined permitting pathways, clearly demarcate applicable water regulatory requirements, and pinpoint opportunities for interagency cooperation, including working with DOI to site projects on western lands.

• Bio-refining from Biomass: Like petroleum refineries, biomass refineries produce multiple products, such as power, fuels, and chemicals, from a biomass-based feedstock. Technologies vary, using feedstocks such as corn fiber or fermentation byproducts to derive products such as ethanol, polyactic acid, and other chemicals. Biorefining has been projected to offer comparable or lower costs and GHG emissions compared to petroleum-derived fuels, particularly where the biorefinery process integrates biological and thermochemical processing, using waste heat from the thermochemical process to power the biological process.\textsuperscript{46} One CAA tool to support deployment of such technologies is guidance on crediting any net emissions and energy benefits from producing biofuels that offset oil emissions in Section 111(j) NSPS waivers, plant-wide applicability limits, BACT Step 4 analyses, and in potential future Section 111(d) programs. Another such tool is development of streamlined permitting pathways and interagency cooperation opportunities, which could include project siting near DOI forestry service facilities or USDA agricultural waste facilities.

• Innovations in Industry Process Technologies: Many industries are developing innovative and cleaner energy technologies for producing their products, but investment and deployment can be deferred or avoided due to fears about regulatory impacts. For example, in the cement sector, there are technologies in various stages of development to produce cement with reduced CO$_2$ footprints, such as clinker substitute processes, geopolymer cement processes, carbon capture, and magnesium oxide technologies.\textsuperscript{47} In the chemical and refining industries, hydrogen-based production of ammonia and methanol, along with biomass feedstocks, are considered potential game changers.\textsuperscript{48} CAA tools that would encourage greater investment and risk-taking to bring these technologies to scale could include guidance and metrics for crediting net energy and emissions savings in Section 111(j) NSPS waivers, plant-wide applicability limits and flexible permits, NSR offsets, BACT Step 4 analyses, and, potentially, future Section 111(d) programs. In addition, the EPA could identify streamlined permitting pathways and opportunities for


\textsuperscript{47} \textit{INTERNATIONAL ENERGY AGENCY \\& WORLD BUSINESS COUNCIL FOR SUSTAINABLE DEVELOPMENT}, \textit{Cement Technology Roadmap 2009}, at 5–14.

interagency cooperation, such as reconciliation of industry product standards and environmental regulatory standards.

- **Innovative Technology Combinations:** Some of the greatest emissions reduction potential is expected to be realized by combining two or more emerging clean energy technologies in strategic ways—for example, by combining advanced battery storage or micro-grid technologies (or both) with intermittent renewable energy sources like wind or solar at a single facility or installation to ensure reliable energy delivery or by producing mineral products from industrial waste streams through co-generation of saleable carbonate and bicarbonate materials. The EPA and states could encourage such projects through guidance on and metrics for crediting the projects’ net energy and emissions savings in Section 111(j) NSPS waivers, plant-wide applicability limits and flexible permits, NSR offsets, BACT Step 4 analyses, and, potentially, future Section 111(d) programs. In addition, the EPA could identify streamlined permitting pathways and interagency cooperation opportunities. For example, DOD military installations, which have proven to be valuable “testbed” opportunities for innovations generally, would be optimal sites for evaluating promising technology combinations.

**CONCLUSION**

There is much to gain from using the Clean Air Act to promote innovative clean air and energy technology in conjunction with GHG regulatory programs. Broader deployment of commercially available clean energy innovations has the potential not only to reduce emissions, but also to lower associated costs. Strategies to encourage broader deployment of advancing energy efficiency and renewable energy technologies in conjunction with emerging developments like micro-grids could provide near-term environmental progress and also buy time for further development of more costly technologies.

Even minimal success in increasing deployment of technology innovation nationwide could speed significant reductions in GHG and other emissions. Indeed, some economic modeling predicts that clean energy innovation could simultaneously accelerate economic growth, improve energy security, and reduce carbon pollution by nearly 15% as early as 2030.49

As the EPA and states consider regulatory options to address the climate change challenge in the context of the Clean Air Act and other legal and political realities, it is important that regulators look to the two elements of success observed in past CAA regulatory initiatives to promote innovative control technologies: (1) ensuring that projects and policies are developed through strong partnerships of the EPA, states, the environmental community, and companies with strong environmental track records and (2) ensuring that permits provide both flexibility and accountability in CAA compliance options. With these two guiding principles and a willingness to explore and experiment with some of the innovative technologies and innovative regulatory tools detailed here, America could make significant progress in the near term on urgent air, energy, and climate challenges.

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The Nicholas Institute for Environmental Policy Solutions

The Nicholas Institute for Environmental Policy Solutions at Duke University is a nonpartisan institute founded in 2005 to help decision makers in government, the private sector, and the nonprofit community address critical environmental challenges. The Nichols Institute responds to the demand for high-quality and timely data and acts as an “hon-est broker” in policy debates by convening and fostering open, ongoing dialogue between stakeholders on all sides of the issues and provid-ing policy-relevant analysis based on academic research. The Nicholas Institute’s leadership and staff leverage the broad expertise of Duke University as well as public and private partners worldwide. Since its inception, the Nicholas Institute has earned a distinguished reputation for its innovative approach to developing multilateral, nonpartisan, and economically viable solutions to pressing environmental challenges.

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