THE HAMILTON PROJECT

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Promoting Clean Energy in the American Power Sector

Joseph E. Aldy

MISSION STATEMENT

The Hamilton Project seeks to advance America's promise of opportunity, prosperity, and growth. The Project's economic strategy reflects a judgment that long-term prosperity is best achieved by fostering economic growth and broad participation in that growth, by enhancing individual economic security, and by embracing a role for effective government in making needed public investments. We believe that today's increasingly competitive global economy requires public policy ideas commensurate with the challenges of the 21st Century. Our strategy calls for combining increased public investments in key growth-enhancing areas, a secure social safety net, and fiscal discipline. In that framework, the Project puts forward innovative proposals from leading economic thinkers — based on credible evidence and experience, not ideology or doctrine to introduce new and effective policy options into the national debate.

The Project is named after Alexander Hamilton, the nation's first treasury secretary, who laid the foundation for the modern American economy. Consistent with the guiding principles of the Project, Hamilton stood for sound fiscal policy, believed that broad-based opportunity for advancement would drive American economic growth, and recognized that "prudent aids and encouragements on the part of government" are necessary to enhance and guide market forces.

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Promoting Clean Energy in the American Power Sector

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NOTE: This discussion paper is a proposal from the author. As emphasized in The Hamilton Project's original strategy paper, the Project was designed in part to provide a forum for leading thinkers across the nation to put forward innovative and potentially important economic policy ideas that share the Project's broad goals of promoting economic growth, broad-based participation in growth, and economic security. The authors are invited to express their own ideas in discussion papers, whether or not the Project's staff or advisory council agrees with the specific proposals. This discussion paper is offered in that spirit.

BROOKINGS

Abstract

Despite bipartisan interest in advancing American energy policy, comprehensive energy and climate legislation fell short in the Senate last year after passing in the House of Representatives in 2009. The difficulty of coming to broad agreement highlights the need for a more targeted and incremental approach. One promising intermediate step would be a technology-neutral national clean energy standard that applies to the U.S. power sector. This paper proposes a standard that would lower carbon dioxide emissions by as much as 60 percent relative to 2005 levels over twenty years, streamline the fragmented regulatory system that is currently in place, generate fiscal benefits, and help fund energy innovation. Through a simple design and transparent implementation, the National Clean Energy Standard would provide certainty about the economic returns to clean energy that would facilitate investment in new energy projects and lower the emission intensity of the power sector. It would also serve as an ambitious bridge to economy-wide energy and climate policy.

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Introduction

The general public and their representatives in Washington from both sides of the political aisle agree that the United States should advance a more sensible energy policy. Under the status quo, the U.S. power sector is characterized by dirty power and a complex and potentially costly regulatory environment. The U.S. power sector emits more carbon dioxide (CO_2) than any other country in the world except China. Continuing climate science scholarship highlights the need to take action to mitigate the risk posed by greenhouse gas emissions. Deploying clean energy in the power sector can contribute to the global effort to combat climate change while providing demand for domestic natural gas production and manufacturing and construction associated with new zero-emission power facilities, including renewables and nuclear.

About thirty states have some form of renewable or clean energy mandate in their power sectors. This illustrates significant interest across the country—in both blue and red states—to promote clean energy. In the past year, interest in taking a more expansive approach to promoting clean energy has been evident from both Democrats and Republicans: Senators Lugar, Graham, and Murkowski supported a bill with a "diverse energy standard" (S. 3464) and President Obama called for a clean energy standard.[1]

A national policy could lower bureaucratic burdens of the state regulatory patchwork for those operating in multiple states and deliver societal goals in a more cost-effective manner. Layered on top of this is the prospect for federal greenhouse gas regulations under the Clean Air Act. This Clean Air Act authority is unlikely to result in an approach that effectively promotes clean energy and lowers greenhouse gas emissions at a cost that is justified by its benefits. Well-designed policy requiring new legislation is necessary.

A preferred energy policy should deliver an array of benefits, including reducing the fiscal burden of the energy system, promoting investment that has been inhibited by policy uncertainty, streamlining the regulatory landscape, and improving the global environment. A first-best policy to deliver these objectives would be an economy-wide carbon tax that could finance energy research and development (R&D), tax cuts, and deficit reduction, and replace the existing and potentially complex state and federal regulatory systems.

Given the current political challenge in advancing such a first-best policy, I propose a National Clean Energy Standard (NCES) for the U.S. power sector. The principles of simplicity, cost-effectiveness, and price certainty guided the design for the proposed standard that should make meaningful progress on these policy objectives. The key details of the NCES include

- A technology-neutral performance metric. My definition of clean energy is based on the CO_2 emission intensity of power generation. The lower the intensity, the cleaner the power. This avoids the challenge of picking technology winners that could risk inhibiting future innovation, and makes the assessment of progress transparent and simple.
- Performance goals. The share of power generated by clean energy technologies would increase over time, reflecting a carbon emission performance standard for the power sector that becomes more stringent through 2035. The initial performance goal in 2015 is 0.4 tons of CO_2 per megawatt hour of generation (tCO_2/MWh), which would require meaningful improvement from the 2010 emission

The principles of simplicity, cost-effectiveness, and price certainty guided the design for the proposed standard that should make meaningful progress on key energy policy objectives.

intensity of generation of 0.56. This 2015 goal of 0.4 tCO_2/MWh roughly corresponds to a 60 percent clean energy portfolio standard. The performance goal would tighten by 0.01 tCO_2/MWh each year until reaching 0.2 in 2035, approximately equal to an 80 percent clean energy portfolio.

- Clean energy credits. A power producer that beats the performance goal can create tradable "clean energy credits" that it may sell to utilities that fail to meet the goal. This would promote cost-effective deployment of clean energy in the power sector. Each credit is denominated in terms of a ton of CO_2.
- Compliance. A utility may demonstrate compliance with the policy through a combination of approaches. First, it may reduce the intensity of its generation below the performance goal. Second, it may purchase clean energy credits from other utilities such that its performance and purchased credits meet the goal. Third, it may purchase federal clean energy credits that are available at a preset price, such that these in combination with privately generated credits and the utility's own performance meet the goal. In 2015, the price for these credits will be $15, and it will ramp up 7 percent annually, reaching $30 per credit by 2025. The federal clean energy credit prices are expected to bind on the clean energy credit market, which would provide price certainty to promote and improve investment decisions and provide a guarantee against unexpectedly high prices. Over the first ten years of the program, the price would average $21/MWh per credit, which would deliver the same value to wind and many other renewable producers as they enjoy today through the production tax credit, without the fiscal outlay.
- Clean Energy Fund. Revenues raised through the federal clean energy credit would finance a ramp-up in energy R&D. I propose dedicating $2 billion of revenues in 2015 to the fund, and ramping this up over time to $5 billion in 2025. The fund should support merit-based, competitive research, such as through the Advanced Research Projects Agency–Energy (ARPA-E), and could also support first-of-a-kind demonstration projects as outlined in Deutch (2011) as well as other energy R&D programs. Any excess revenues beyond this would be dedicated to deficit reduction or reducing current tax rates, such as the payroll tax rate.
- Environmental Protection Agency (EPA) Greenhouse Gas Regulatory Authority and State Renewable Mandates. The NCES would eliminate the need for EPA regulations of greenhouse gas emissions in the power sector, and the need for significantly duplicative state renewable mandates. Legislation creating a NCES should strike EPA greenhouse gas regulatory authority in the power sector and preempt state renewable and alternative energy portfolio standards.

The federal clean energy credit prices... would provide price certainty to promote and improve investment decisions and provide a guarantee against unexpectedly high prices.

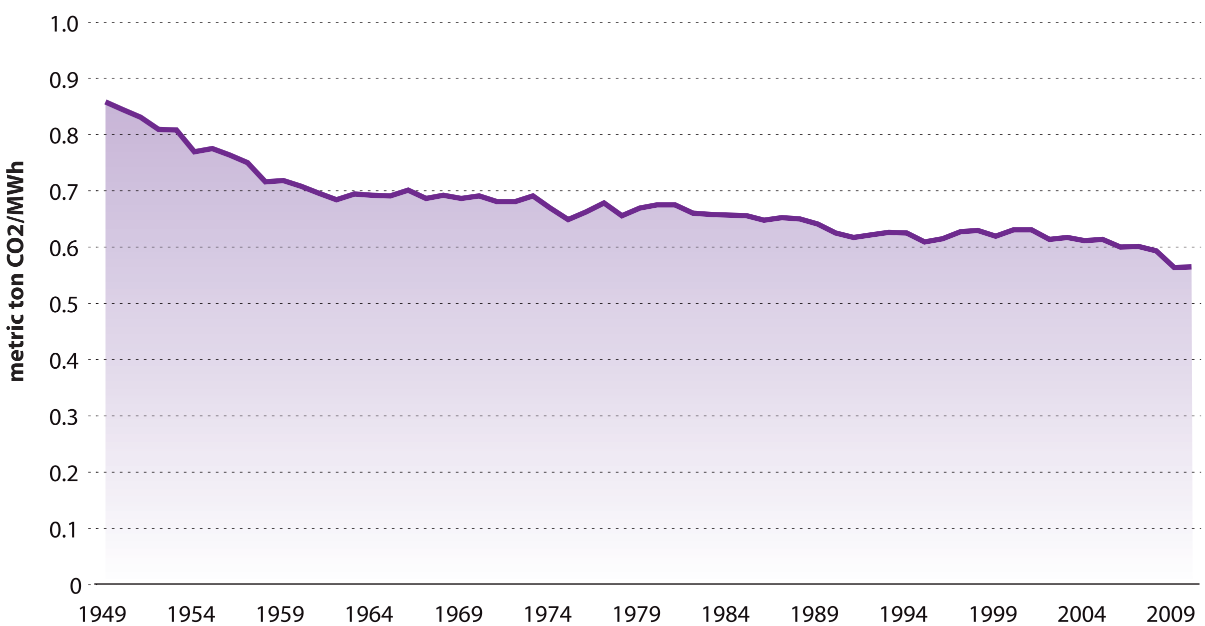
Chapter 1: Reliance on Dirty Power

A by-product of America's reliance on power produced from relatively dirty fuel is relatively high carbon emissions. On average, a megawatt hour of electricity generated in the United States today results in emissions of about 0.56 metric tons of CO_2. Whereas the evolving mix of power generation technologies has resulted in a declining emission intensity of electricity in the post-war period (Figure 1), it remains well above the intensities of Japan and the European Union.

The modest reduction in the emission intensity of the power sector over time reflects both improvements in combustion efficiency and changes in the fuel mix. Emission intensity of power generation varies significantly across technologies and fuels. Natural gas produces less than half as much carbon pollution per unit of electricity generated as does coal, and nuclear and renewable sources have zero CO_2 emissions (Table 1).[2] Within a given type of fossil fuel power plant, emission intensity can vary with the facility's combustion efficiency and fuel characteristics. Successful commercialization of carbon capture and storage technologies could dramatically alter the emission profiles for fossil fuel–based generation technologies.

FIGURE 1

U.S. Electricity Generation Carbon Dioxide Emission Intensity, 1949–2010



Source: Constructed from data presented in EIA (2010a, 2011b).

Note: The 2010 emission intensity is estimated based on 2010 fuel shares and 2009 emission intensities by type of generation.

TABLE 1

Average Carbon Dioxide Emission Intensity by Generation Type, 2009, tCO_2/MWh

Coal	Oil	Natural Gas	Nuclear	Hydroelectric	Other renewables
0.99	0.95	0.44	0	0	0

Source: Constructed from data presented in EIA (2010a).

Coal has served as the leading source of power in the United States since World War II, ranging between about 44 and 57 percent of U.S. power generation (Figure 2), although its share of power generation in 2009 and 2010 was lower than at any point since the late 1970s. The other primary baseload power source, nuclear, experienced an increase in its share of power generation in the 1970s as new power plants came online. Nuclear has represented about one-fifth of U.S. power over the past two decades.

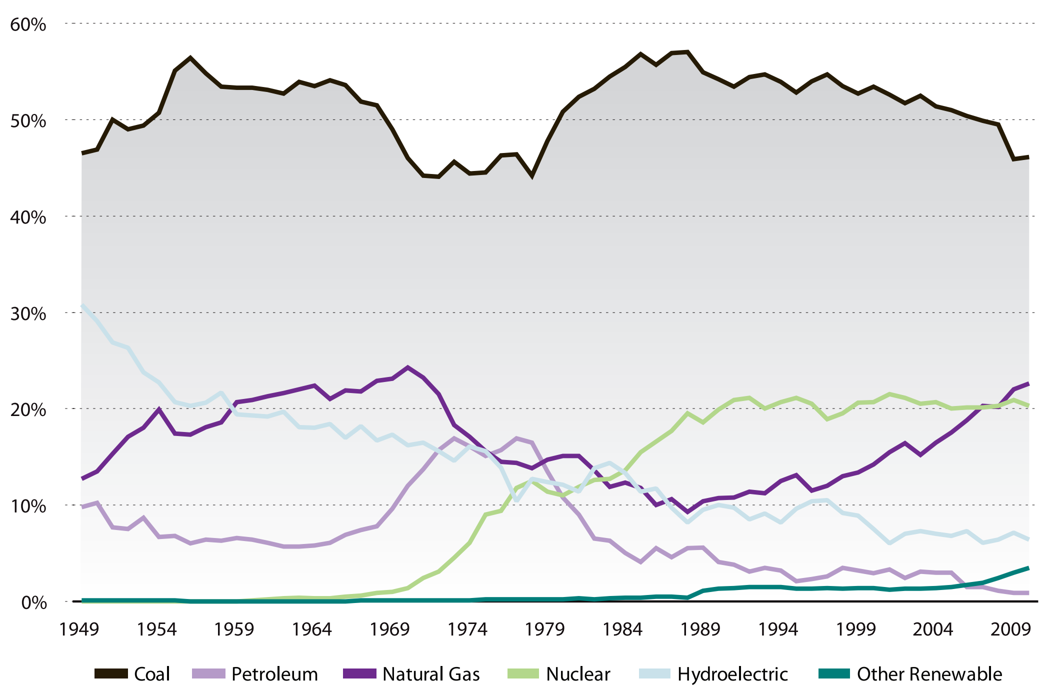
Refined petroleum products, primarily residual fuel, distillate fuel, and petroleum coke once comprised a meaningful share of U.S. power generation. At the time of the first oil shock in 1973, oil-fired power plants generated 17 percent of U.S. power and represented about 10 percent of U.S. oil consumption. By 2010, oil produced less than 1 percent of U.S. generation; the total number of barrels of oil consumed by the power sector has fallen 90 percent since 1973. Given oil's very small share of generation today, the environmental and energy security benefits of further efforts to back oil out of the power sector are quite modest.[3]

The share of power from natural gas plants has varied significantly since 1949. In 1970, nearly one-quarter of U.S. electricity came from gas-fired plants. By 1990, the gas share of power generation had fallen to about 10 percent, but has since rebounded to exceed 20 percent over the past four years. The gas share of generation in 2010 was the highest it has been since 1971.

Renewable power, primarily through hydroelectric dams, delivered more than 20 percent of U.S. power in the 1950s, but hydroelectric's share has declined because of limited investment in dams since then. Other renewable generation sources, including wind, solar, geothermal, and biomass, made up no more than about 1 to 1.5 percent of power generation in the 1990s. The share of other renewables doubled from 2006 to 2010, and is now about 3.5 percent.

FIGURE 2

Share of U.S. Electricity Generation by Type, 1949–2010



Source: Constructed from data presented in EIA (2010a, 2011b).

The shift toward natural gas and renewable power had a material impact on U.S. power sector carbon emissions in 2009, in addition to the effect of declining demand resulting from lower economic activity. If the share of power generated from coal, natural gas, and oil did not change from 2008 to 2009, then electricity sector CO_2 emissions would have been about 5 percent higher (about 100 million metric tons higher) than they were in 2009.

The increase in power generation from natural gas and other renewables reflects the substantial increase in investment in generating capacity over the past two decades. During the period 1990–2008, total U.S. generating capacity increased by about 276 gigawatts, representing growth of more than 37 percent (Table 2). Coal-generating capacity changed by only 6 gigawatts, or about 2 percent of the growth in capacity. In contrast, natural gas capacity increased by more than 250 gigawatts and made up about 92 percent of the growth in total capacity. Other renewable capacity has increased significantly, especially in recent years. By 2010, wind capacity exceeded 40 gigawatts (American Wind Energy Association [AWEA] 2011).

Nameplate-generating capacity does not correspond one-to-one to power generation. Some power plant technologies are intended for baseload, while some are intended to provide power during peak periods of demand. In addition, intermittent sources, such as solar and wind, produce less power per megawatt of installed capacity than baseload coal and nuclear. The Energy Information Administration (EIA 2011a) published estimates of capacity factors for new generating capacity that could come online within five years (Table 3). These estimates show that a megawatt of capacity of combined-cycle natural gas, in contrast to combustion turbine natural gas plants built primarily to meet peak demand, can compete with a megawatt of coal or nuclear in serving a given base demand.

About two-thirds of the new natural gas–generating capacity to come online since 1990 is combined cycle, but high natural gas prices over 2000–2008 limited its use (Kaplan 2010). For example, only 13 percent of the combined-cycle natural gas plants in operation in 2007 had capacity factors that exceeded 70 percent. The average capacity factor for coal in 2007 was 75 percent, significantly higher than the average capacity factor of 42 percent for combined-cycle natural gas in that year (Kaplan 2010).

TABLE 2

U.S. Electricity Summer Generating Capacity, Gigawatts, 1990 and 2008

Type	1990	2008
Total	734	1,010
Coal	307	313
Natural gas	141	397
Other renewable	2	25

Source: Constructed from data presented in EIA (2010a).

Note: Other fuels experienced modest changes from their 1990 levels, with the exception of oil-fired capacity, which declined about 20 gigawatts.

TABLE 3

Estimated Capacity Factor of New Generating Capacity for 2016

Conventional coal	Combined-cycle natural gas	Advanced nuclear	Wind	Solar	Geothermal
85%	87%	90%	34%	18–25%	92%

Source: EIA (2011a).

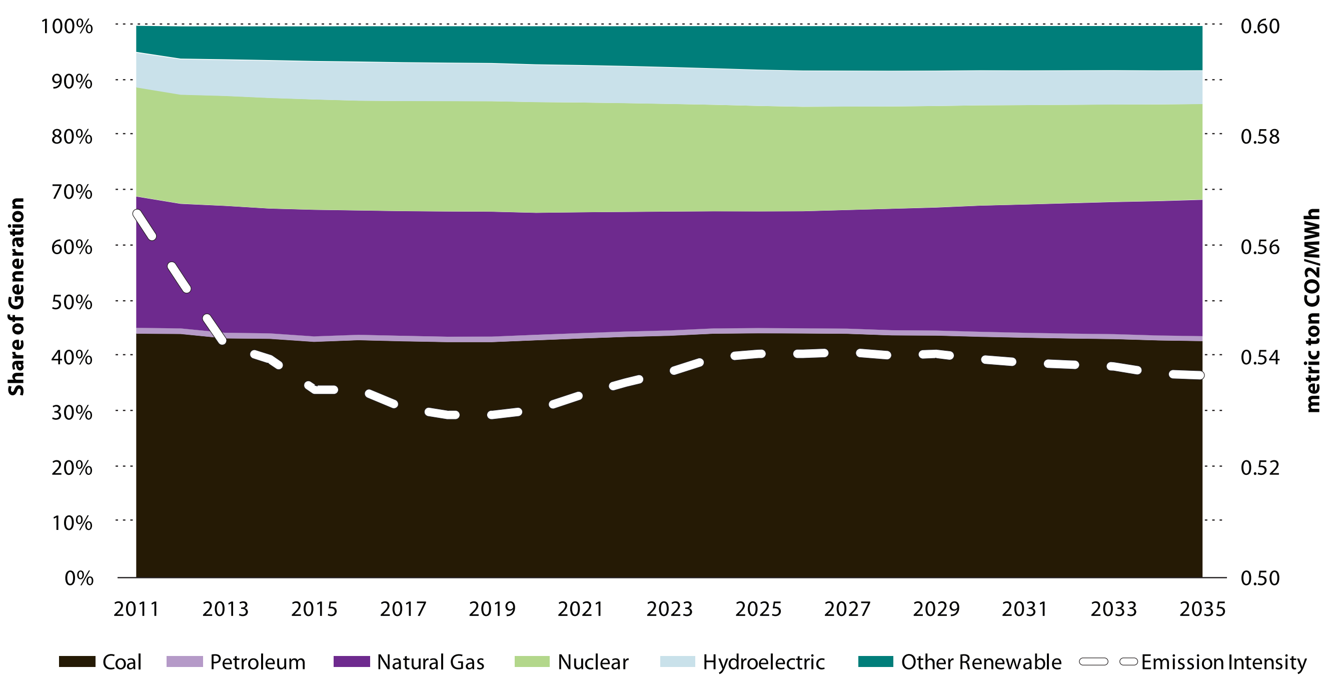
Note: Solar range represents solar thermal (18 percent) and solar PV (25 percent).

The recent increase in power generation from natural gas plants since 2008 represents increasing utilization of existing facilities.

Given the forecast for slow growth in electricity demand (less than 1 percent per year through 2035) and the existing surplus of natural gas–fired generation capacity, the EIA (2011a) forecasts modest investment in new power plant capacity over the next two decades. Through 2030, cumulative electricity capacity investments are forecast to total about 125 gigawatts to meet slightly higher demand and offset retirements of about 35 gigawatts of capacity. The mix in power generation is expected to evolve slowly, with a modest increase in renewable and natural gas over time, and a slightly lower emission intensity of generation over the next several decades (Figure 3).

FIGURE 3

Forecast Power Generation Shares and Carbon Dioxide Emission Intensity, 2011–2035



Source: Constructed from EIA (2011a).

Chapter 2: Detailed Proposal

A well-designed policy to promote the deployment of clean energy in the power sector can help address fiscal challenges, encourage investment, streamline the regulatory landscape, and provide environmental benefits.

OBJECTIVES

Delivering fiscal benefits. A clean energy standard creates demand-side incentives for clean energy that may substitute for the current supply-side subsidies through tax credits and grants. This would enable legislators to allocate future resources to energy programs that complement the clean energy standard (such as R&D on basic energy sciences), to other socially desired policies, or deficit reduction in lieu of clean energy deployment subsidies. A clean energy standard can also generate revenues that could be used to finance energy R&D as well as to reduce the deficit or finance reductions in existing tax rates.

Promoting investment. A clean energy standard would reduce the regulatory uncertainty that could be chilling investment in the power sector. This uncertainty takes two forms. First, power companies face uncertainty over the general regulatory framework. Second, some regulatory approaches are characterized by more uncertainty than others from the perspective of those making investment decisions. For example, moving forward with power sector regulations under the Clean Air Act could address the first form of uncertainty, but may not address the latter form because of the prospect of extended litigation (presuming the regulations survive congressional review) and potential variation and uncertainty in state implementation programs. Moreover, a well-designed clean energy policy should deliver transparent, stable incentives that investors can use as the basis for structuring financing for new power generation projects.

Streamlining regulatory landscape. In addition to resolving investment uncertainty regarding the form and implementation of federal policy, a clean energy standard can establish a single national standard to replace the various state renewable and clean energy mandates. Given the significant variation in the design and implementation of state mandates and the prospect of EPA greenhouse gas regulation, a single, streamlined federal clean energy policy can reduce regulatory complexity and promote clean energy deployment cost-effectively.

Improving the global environment. Finally, a clean energy standard can drive investment and energy deployment decisions that will lower U.S. power sector greenhouse gas emissions and represent a meaningful step in combating the risks of climate change.

PRINCIPLES

In order to realize these policy objectives, three key principles should guide the design of a clean energy standard: simplicity, cost-effectiveness, and price certainty.

Simplicity. Clean energy can be defined along a variety of dimensions, such as its effects on air pollution, water pollution, toxics, resource throughput, solid and hazardous waste, greenhouse gas emissions; alternatively, it can be defined by some predetermined categorization of technologies. A complex set of measures characterizing how "clean" a given energy source may be could create regulatory confusion and inhibit investment. A predetermined class of qualifying technologies could inhibit innovation. A simple, transparent policy would minimize the risk of a bumpy and costly start-up to the program.

Cost-effectiveness. The mandate should be implemented in a way that promotes deployment of clean energy technologies at the lowest possible cost.

...a well-designed clean energy policy should deliver transparent, stable incentives that investors can use as the basis for structuring financing for new power generation projects.

Price certainty. Investment in energy technologies is enhanced when project developers have a higher degree of certainty regarding the costs and benefits of their investment. Price certainty can also mitigate the risk of unexpectedly and excessively high costs to electricity producers and consumers.

POLICY DESIGN

Given these objectives and principles, an NCES should take the following form.

Technology-neutral metric. The proposed NCES would evaluate performance based on the emission intensity of power measured by the tons of CO_2 per megawatt hour of generation. The lower the emission intensity of generation, the cleaner the technology.

An emission intensity-based standard has several virtues. First, it is a simple metric that is based on tons of CO_2 and megawatt hours of generation, two measures that are already monitored at and reported by U.S. power plants. Second, it focuses on the environmental impact of power generation that has not been subject to any regulatory policy, in contrast to conventional air pollution, water pollution, and so on. Third, there is a rough correlation between greenhouse gas emissions and other "dirty" attributes of power generation by fuel source. Thus, greenhouse gas emissions may serve as a proxy for these other attributes. Fourth, a technology-neutral approach provides incentives to all power plant operators to seek out and exploit low-cost ways to clean up their generating capacity. It does not rule out any class of technologies, as a renewable energy standard would, and thus it avoids the problem of the government choosing winners. The private sector, through its innovation and commercialization of technologies and processes, will identify the winners. A technology-neutral approach also avoids the challenge of evaluating new technologies that may not cleanly fit within a previously established classification scheme. A new technology simply demonstrates its "cleanliness" in terms of the emission intensity of its generation.

Performance goals. To ensure that the share of power generated by clean energy technologies increases and the power sector produces lower CO_2 emissions over time, performance goals should be set to drive investment and deployment of these technologies. Given the 2010 U.S. emission intensity of generation of about 0.56 tons of CO_2 per megawatt hour and the near-term forecast for modest improvement in this measure over the next five years to reach about 0.53 tCO_2/MWh, this proposal calls for a performance standard of 0.40 tCO_2/MWh in 2015. The performance would become more ambitious over time, declining by 0.01 tCO_2/MWh per year through 2035, as shown in Table 4.

TABLE 4

National Clean Energy Standard Goals through 2035

Year	National Clean Energy Standard (tCO_2/MWh)
2015	0.40
2020	0.35
2025	0.30
2030	0.25
2035	0.20

Such standards would drive the U.S. power sector to surpass the current extent of clean energy generation in the European Union and Japan. It would require the U.S. power sector to ramp up the generation of cleaner power at approximately the same annual rate over the next five years as China realized over 2005–2008.

Point of regulation. The point of regulation for the NCES would be at the power plant. This would take advantage of the existing monitoring system on fossil power units, replicate the current point of regulation for other power plant policies (such as under the Acid Rain Program), and obviate the need to map electricity distributed to consumers back to original generating units that would be required by establishing the point of regulation downstream from the generating facility.[4] This approach also facilitates expansion of the program to cover on-site power generation at manufacturing facilities to reduce the incentive for leakage—in other words, the relocation of power generation away from regulated utilities and in an unregulated space. To avoid imposing costs on very small power generators in the manufacturing sector, the EPA and Department of Energy (DOE) should jointly establish a minimum size that triggers coverage by the performance standard through rule making. Legislation creating a clean energy standard should provide the regulatory authorities with the flexibility to design rules tailored to combined heat and power facilities to ensure that the clean energy standard does not distort decisions on power and heat production in a way that causes adverse environmental impacts.

Tradable clean energy credits. To promote cost-effective attainment of these goals and to create robust incentives for innovation and deployment, power plants that beat the standard create tradable clean energy credits that can be sold to power plants whose emissions per megawatt hour exceed the standard. A clean energy credit is denominated in increments of one metric ton of CO_2. Clean energy credits may be banked for compliance purposes in a future year.

This approach lowers the cost of compliance by power plants with high-technology costs by allowing them effectively to finance low-emission generation by other power plants through their purchase of performance credits. It thus provides an economic incentive for investment in zero and low-emission power plants since they can produce a revenue stream through the sale of clean energy credits.

Compliance. Power plants would demonstrate compliance with the standard on an annual basis through a three-month "true-up" period after each compliance year. A power plant could demonstrate compliance with the NCES through a combination of the following approaches. First, the power plant has lesser or equal emissions per megawatt hour than the standard set to drive clean energy deployment. Second, the power plant may purchase clean energy credits from other power plants such that the combination of clean energy credits and the power plant's own performance satisfies the standard. Third, the power plant may also purchase additional clean energy credits from the federal government at a preset price that, in combination with its own generation profile and purchased clean energy credits, would satisfy the NCES. This is similar to the "alternative compliance payments" in a number of state renewable portfolio standards (RPSs).

The federal clean energy credits would initially be set at $15 (in 2010 dollars). The price for these credits would increase over time. They would be indexed to inflation (measured by the GDP deflator) and increase 7 percent annually above the inflation adjustment over the first ten years until reaching about $30 per credit in 2025. This ten-year ramp-up in the program would result in a clean energy credit price in 2025 that is on a par with the estimated damages from the carbon pollution associated with power generation (see Interagency Working Group on Social Cost of Carbon, United States Government 2010, Appendix A1). If the clearing price for tradable clean energy credits equals the federal clean energy credit price, zero-carbon power would receive an average price of $21/MWh for generation over the first ten years of the program. This is equal to the current value of the production tax credit for wind, geothermal, and many other renewable sources, and exceeds the value of the production tax credit available to the first 6 gigawatts of new nuclear power under the 2005 Energy Policy Act. Beyond 2025, the price of federal clean energy credits would continue to increase at a rate of 2.4 percent per year (in addition to inflation) to match the estimated increase in the incremental damages from carbon pollution.

Clean Energy Fund. An initial tranche of annual revenues generated by the sale of federal clean energy credits would be dedicated to supporting federal energy research. In 2015, the first $2 billion of annual revenues would be directed to support energy R&D. This initial tranche would increase at a rate of 10 percent per year to provide additional funding for energy R&D, and thus would ramp up to about $5 billion in 2025. Any excess revenues beyond this tranche may be used for deficit reduction or reducing current tax rates, such as the payroll tax. These funds could increase activities at ARPA-E (the new advanced research projects program at the DOE), finance first-of-a-kind demonstration projects as suggested by Deutch (2011), and address other pressing energy research needs.[5]

Implementing agencies. The EPA and the DOE would jointly administer the NCES. This would reflect EPA's experience in implementing cost-effective, market-based approaches to reducing power-generation pollution as well as EPA's existing emission monitoring infrastructure. It also would reflect DOE's experience in monitoring power sector generation and capacity investment and in implementing clean energy R&D programs.

ECONOMIC IMPACTS

Cost-effectiveness. The envisioned NCES includes several cost-effective design elements intended to minimize the cost of driving clean power generation and of providing environmental benefits. First, the opportunity to buy and sell clean energy credits should enable utilities, entrepreneurs, innovators, and others to seek out and exploit the lowest-cost ways of providing clean energy. Second, power plants maintain the option to bank, or save, clean energy credits generated from current clean energy power generation for use in a future compliance period. This will promote dynamic cost-effectiveness. Third, and perhaps most important, the federal clean energy credits available at a preset price provide a guarantee that prices for credits, and hence generation costs net of the NCES and electricity prices, will not exceed specified levels.

[Tradable credits provide] an economic incentive for investment in zero and low-emission power plants since they can produce a revenue stream through the sale of clean energy credits.

The federal clean energy credit price will very likely determine the clearing price for tradable clean energy credits, given the ambition of the performance goal and the levels of the federal clean energy credit prices, at least in the early years. In doing so, all power plants will face the same incentive to deploy clean energy. Given the increasing stringency in the performance goals over time and the opportunity to bank unused clean energy credits for future use (even if unexpectedly low-cost technologies and fuels come into the power market that might result in compliance at a credit price below the federal credit price) there will be the future demand that can serve to bring the clean energy credit price back to the federal credit price level.

Investment certainty. Uncertainty about the magnitude of the incentive for clean energy deployment risks undermining investment. For example, in the context of state renewable energy standards, it is not uncommon for renewable project developers to seek out power purchasing agreements that lock in electricity prices for delivered power over the long term (e.g., twenty years). Volatile prices for state renewable energy credits complicate project financing. In order to secure debt and equity financing, the project developers often have to eliminate this price uncertainty by negotiating a set price for power in the power purchasing agreements with distribution utilities. Designing a clean energy standard that will very likely yield a stream of clean energy credit prices set by the federal credit price over time will provide the kind of certainty that will promote project financing for new power projects. It also will deliver more certainty for those making upstream investment decisions, such as in shale gas development and wind turbine manufacturing capacity, so that decision-makers can understand the potential market demand and returns to such investments.

It is also important to recognize that this certainty in the price can have very important implications for the start-up of a new policy. Under this proposal, a power plant (or a generation utility operating a number of power plants) considers the time profile of the federal clean energy credit prices and then assesses its opportunities for reducing the emission intensity of generation at a cost below that of the credit. In a policy regime in which credits are tradable and the price of the credits will reflect the eventual clearing price in the credit market, power plants and utilities need to resolve the uncertainty about their own opportunities to deploy clean energy and form expectations about other power plants' opportunities to do so, and thus plan against an expected credit price. Some power plants may expect high credit prices and make one set of investments, and other power plants may expect low credit prices and make another set of investments. Given the irreversible nature of some of these investments, these decisions, which ex post may appear as mistakes once the market credit price has been established, may increase the total cost of deploying clean energy relative to this proposal in which power plants do not need to plan against the uncertainty in credit prices.

Electricity prices and policy costs. To illustrate the potential impact of this NCES on electricity prices, let us assume that the federal clean energy credit price is binding. Given the variation in electricity regulatory regimes across the nation, I will focus on a simple version of marginal cost pricing to represent competitive markets and a simple version of cost-of-service (average cost) pricing to represent regulated markets. To provide regional price impacts, I focus on twenty electricity markets as identified by the EIA and for which 2008 and forecast 2015 electricity rates have been published in the Annual Energy Outlook (EIA 2011a).[6] Given the focus on the near term (through 2015), this illustration assumes no changes in emission intensity relative to their 2008 levels and no changes in generating capacity, which yields a potentially upward bias in the electricity rate impacts.

Uncertainty about the magnitude of the incentive for clean energy deployment risks undermining investment.

In 2015, the federal clean energy credit price will be $15. Power plants would make investments in reducing the emission intensity of their generation until it reached the value set by the federal clean energy credit price. By effectively exempting the first 0.4 tCO_2/MWh, this NCES provides an implicit rate-based output subsidy. Thus, power plants and utilities would adjust generation to reflect this implicit generation subsidy. Changes in electricity rates should reflect both the $15 credit price and the implicit generation subsidy in the NCES. Fischer (2010) and Fischer and Newell (2008) illustrate how, in some cases, the implicit generation subsidy in renewable energy standards and performance-based clean energy standards akin to this proposal could dominate the credit price and effectively result in a net decline in electricity rates in competitive markets. Average costs, and hence rates in cost-of-service regulated markets, would not experience a net decline. To be conservative, I have assumed that electricity prices do not decline under an NCES relative to the forecast business-as-usual levels.

In most competitive markets, natural gas is the marginal source of power generation. Given the underutilization of existing combined-cycle natural gas capacity, the marginal source of power in these markets will often have an emission rate on the order of about 0.44 tCO_2/MWh. In some cases, less-efficient combustion turbines may provide power to meet peak demand, and have a higher emission rate, perhaps on the order of about 0.67 tCO_2/MWh. This suggests that the upper-bound price impact with combined-cycle generation technology would be on the order of about 0.06¢/kWh, and as much as about 0.4¢/kWh with less-efficient combustion turbine technology in 2015, based on this equation:

upper-bound retail price impact per megawatt hour = [marginal intensity in 2008 – standard] * $15,

where the marginal intensity refers to the emission intensity of the marginal generation plant. To be conservative, the estimates presented below reflect an assumption that marginal power is always generated from combustion turbine plants.

In regulated markets, a coal-fired power plant with an emission rate of 1.0 tCO_2/MWh does not need clean energy credits to cover the first 40 percent of its emissions in 2015. An upper bound on the 2015 average cost impact, and hence the electricity price increase, can then be represented by

upper-bound retail price impact per megawatt hour = [average intensity in 2008 – standard] * $15,

where the average intensity refers to the mean emission intensity of power generation in a given regulated market. The competitive and cost-of-service regulation price impact estimates represent upper bounds because a generator may find low-cost ways to improve the intensity of generation at a unit for less than $15/$tCO_2$ between 2008 and 2015. This could take the form of modifying the fuel mix (changing the type of coal, cofiring with biomass, and so on), investing in more-efficient boiler technology, improving maintenance of existing boiler equipment, and so on. The effect of improving existing units could be more pronounced in cost-of-service markets, since an improvement in every generator impacts the cost impact through the rate-making process, while only improving the marginal generators would impact the electricity rates in competitive markets.

Employing this upper bound, illustrative approach to price impacts shows that the average retail price impact in the United States of complying with the proposed NCES is less than 3 percent of the average retail price of electricity forecast for 2015. In competitive electricity markets, if combustion turbine gas plants serve as the marginal source of power (a conservative assumption), then compliance would result in an upper-bound estimate of electricity rates about 3–5 percent higher than they are forecast to be in 2015 but still about 8–29 percent lower than they were in 2008. In cost-of-service markets, electricity rates would range between 0–9 percent higher than their 2015 forecast (Figure 4). Fourteen of the twenty electricity markets—representing about two out of every three states—would have lower electricity prices under this proposed NCES in 2015 than they did in 2008.

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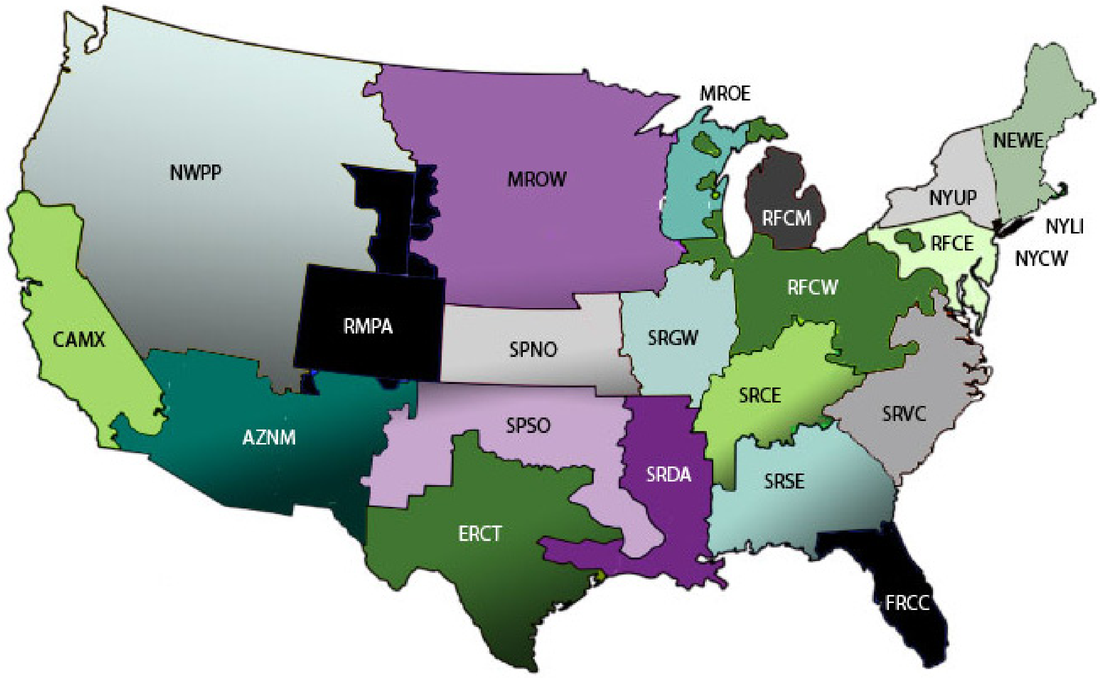
FIGURE 4

Upper-bound Electricity Rate Impacts (2010 cents per kWh)



Region Code	States	2008 Rate	2015 Rate	2015 Rate with CES
ERCT	Texas	11.7	7.9	8.3
FRCC	Florida	11.0	10.9	11.1
MROE	Michigan, Wisconsin	9.2	8.1	8.5
MROW	Iowa, Minnesota, Montana, Nebraska, North Dakota, South Dakota, Wisconsin	7.5	7.3	7.8
NEWE	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont	16.4	14.1	14.5
NY*	New York* (NYCW, NYLI, and NYUP markets)	19.7	17.8	18.2
RFCE	Delaware, Maryland, New Jersey, Pennsylvania	12.4	10.4	10.8
RFCM	Michigan	9.3	8.6	8.9
RFCW	Illinois, Indiana, Ohio, West Virginia, Pennsylvania	8.2	8.9	9.4
SRDA	Arkansas, Louisiana, Mississippi	9.3	7.5	7.6
SRGW	Illinois, Missouri	7.6	6.6	7.2
SRSE	Alabama, Georgia, Mississippi, Florida	9.2	8.3	8.6
SRCE	Alabama, Kentucky, Mississippi, Tennessee	7.6	6.5	7.0
SRVC	North Carolina, South Carolina, Virginia	8.2	8.1	8.2
SPNO	Missouri, Kansas	7.7	8.4	9.0
SPSO	Arkansas, Louisiana, New Mexico, Oklahoma, Texas	8.0	7.4	7.8
AZNM	Arizona, California, Nevada, New Mexico	9.6	8.8	9.0
CAMX	California	12.7	14.2	14.6
NWPP	Idaho, Montana, Nevada, Oregon, Utah, Washington, Wyoming	6.9	6.2	6.2
RMPA	Colorado, Nebraska, South Dakota, Wyoming	8.5	9.2	9.7

Source: Figure 4: Constructed by author based on EIA (2011a).

Note: New York figures reflect the New York City–Westchester electricity market. The 2015 Rate with CES estimates represent upper bounds that reflect several conservative assumptions: (1) no new generation capacity comes online by 2015; (2) regional emission intensities do not improve relative to their 2008 levels; and, (3) combustion turbine natural gas plants serve as marginal sources of production (and hence determine marginal cost pricing) in the ERCT, NEWE, NY*, RFCE, and CAMX regions.

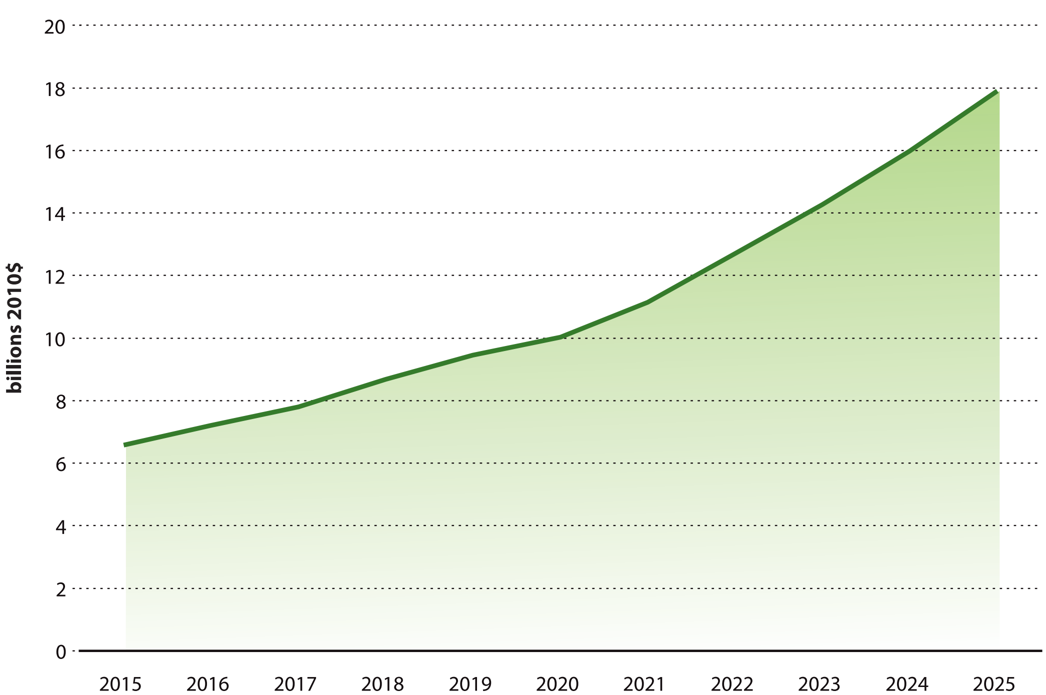
Revenue Raised through the Federal Clean Energy Credit. The federal clean energy credit ramps up from an initial price of $15 in 2015, and, given recent analyses of the potential for increasing the share of clean energy in U.S. power generation, it will very likely bind in (at least) the early years of the program. This provides a revenue source that could support investment in advanced energy R&D to promote the development of lower-cost technologies that could accelerate the eventual commercialization and deployment of clean energy. Some revenue could also address the potential increase in federal outlays to the extent the NCES increases electricity prices. The balance of the revenue could finance deficit reduction or a reduction in existing tax rates (e.g. reduce the payroll tax rate).

To illustrate the potential magnitude of the revenue generation through the clean energy credit, recent carbon pricing analyses by the EIA suggest that the emission intensity of the U.S. power sector could fall to about 0.50 tCO_2/MWh in 2015 at a $15 credit price (EIA 2010b). Thus, the 0.40 tCO_2/MWh performance goal is a stretch for the economy in 2015, and sale of federal clean energy credits would net the government about $6.5 billion in revenues in 2015 (Figure 5). Other analyses that suggest that more clean energy could be deployed at this price (e.g., if wind or natural gas prices, or both, are lower) would deliver lower revenues. Given estimated improvement in emission intensity over the first decade of the NCES at the binding federal clean energy credit price, revenues are expected to increase to about $10 billion in 2020 and reach about $18 billion in 2025. These revenues would easily cover the proposed funding levels of $2 billion for a Clean Energy Fund in 2015 that ramps up to $5 billion in 2025.

Impacts on manufacturing. The modest increase in electricity prices should have a limited impact on major industrial sector consumers of electricity. To illustrate these modest impacts, I have drawn from previous work that estimated the relationship between electricity prices and production and trade for more than four hundred U.S. manufacturing industries over twenty years (Aldy and Pizer 2009). This analysis allows for the effect of an increase in electricity price on an industry's production and on an industry's consumption (measured as production plus net imports) to vary with the energy intensity of manufacturing. The empirical model illustrates that the production from energy-lean manufacturing—representing up to about the first 80 percent of the manufacturing sector when measured by energy intensity of output—does not meaningfully change as electricity prices increase. More energy-intensive manufacturing, however, has historically experienced a decline in production and an increase in net imports when electricity prices have increased.

FIGURE 5

Revenues Generated Through the Sale of Federal Clean Energy Credits, 2015–2025 ($ billions)



Source: Constructed by author based on estimated emission intensity and electricity generation under various scenarios presented in EIA (2010b).

I have employed our empirical model to simulate the impacts of a $15 federal clean energy credit price on select energy-intensive manufacturing industries and the manufacturing sector as a whole (Table 5). Since the implicit generation subsidy mutes the price impact of a clean energy standard, the impact of this policy on industrial sector electricity prices is lower than it would be under a $15 per ton CO_2 cap-and-trade allowance price (the basis for the initial simulation presented in Aldy and Pizer 2009). The average national increase in the retail price of electricity in 2015 under the NCES would be about 0.25¢/kWh, representing about a 4.1 percent increase in industrial sector electricity rates.[7] The manufacturing sector as a whole would experience about a 0.7 percent decline in production, with about half of this (0.4 percent) made up by an increase in net imports. For energy-intensive manufacturing, the decline in production is greater than the average for manufacturing—ranging between 0.9 and 1.9 percent for the six major classes of energy-intensive manufacturing listed in the table—but is relatively small within the context of historic annual swings in manufacturing output. Across the energy-intensive manufacturing industries, the competitiveness effect—the increase in net imports—ranges from about 0.4 to 0.6 percent. This net import effect is also relatively small within the context of historic annual swings in the U.S. trade position. The start-up of the NCES in 2015 with a federal clean energy credit price set at $15 would appear to have only very modest effects on energy-intensive manufacturing.

TABLE 5

Estimated Impacts of a $15 Clean Energy Credit Price on Energy-Intensive Manufacturing in 2015

Industry	Production	Consumption	Competitiveness
Industrial Chemicals	–1.5%	–1.0%	–0.5%
Paper	–1.8%	–1.3%	–0.6%
Iron & Steel	–1.5%	–1.1%	–0.5%
Aluminum	–1.1%	–0.7%	–0.4%
Cement	–0.9%	–0.5%	–0.4%
Bulk Glass	–1.9%	–1.5%	–0.4%
Manufacturing average	–0.7%	–0.3%	–0.4%

Source: Constructed by author based on Aldy and Pizer (2009).

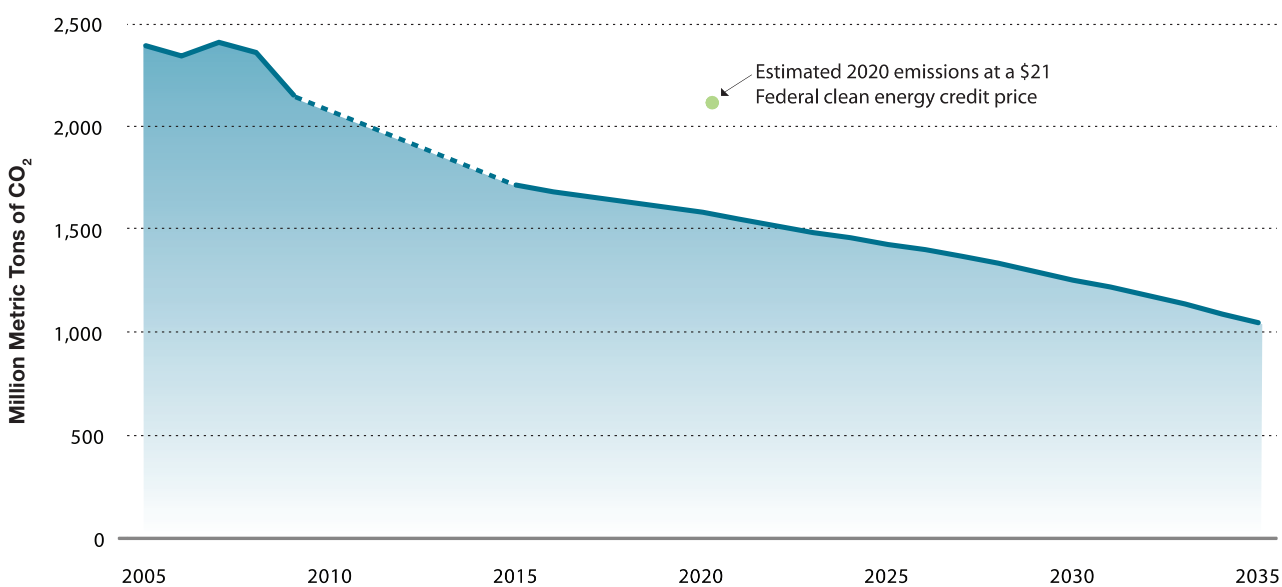
Note: Simulation results based on the assumption that a $15 credit price raises electricity prices in the industrial sector by 4 percent on average nationally. Competitiveness = Production – Consumption.

CLEAN ENERGY DEPLOYMENT AND EMISSION IMPACTS

If U.S. clean energy generation delivers an emission intensity consistent with the proposed 2035 standard, then power sector emissions are likely to be about 60 percent below their 2005 levels (Figure 6). The 2020 performance goal for that year of 0.35 tCO2/MWh would result in power sector emissions about 34 percent below 2005 levels. An illustration of the potential impact of the federal clean energy credit on emissions drawn by the author from past carbon price modeling analyses by the EIA (2010b) suggests that the $21 credit price in 2020 would result in power sector emissions of 2.04 billion metric tons of CO_2—15 percent below 2005 levels (and equal to about 13 percent below the "no new policy" reference case).

FIGURE 6

U.S. Power Sector Carbon Pollution 2005–2009 and Estimated Through 2035 with National Clean Energy Standard Performance Goals



Source: Constructed by author based on EIA (2010b).

Note: The 2015–2035 estimates reflect an assumption that the performance goals are met without accessing the federal clean energy credits and a conservative assumption that generation levels do not fall relative to the expectation under the status quo.

Chapter 3: Responses to Some Likely Questions

As the debate over a clean energy standard evolves, a number of questions about this proposal and about the concept of a clean energy standard more generally will arise. (For example, refer to the Clean Energy Standard White Paper [U.S. Senate n.d.]). I identify three sets of likely policy questions: (1) design questions specific to this proposal; (2) questions about the role of EPA regulatory authority and state RPSs in the context of an NCES; and (3) questions about a clean energy standard relative to more-comprehensive energy and climate policies.

NATIONAL CLEAN ENERGY STANDARD DESIGN CHOICES

Why an intensity-based performance goal instead of a portfolio standard? An intensity-based performance goal is by definition technology-neutral. In contrast, a portfolio standard—as implemented in state RPS programs and as envisioned in some federal RPS proposals—identifies a set of "qualifying" technologies that are eligible for generating clean energy credits. This reflects a static assessment of generation technology that risks chilling innovation in new technologies that may not fit neatly in the initial list of qualifying technologies. It also risks picking winners and losers among existing technologies that may not be internally consistent or transparent.

Instead of picking winning technologies, a performance-based goal establishes a transparent, easily measured metric that sends clear signals to innovators undertaking work on possible energy breakthroughs. It also delivers a clear incentive to plant managers to make marginal improvements in existing facilities—for instance, to improve the efficiency of combustion or to test carbon sequestration and storage with a small stream from the smokestacks—since this can generate clean energy credits (or reduce demand for credits) that would not be available under a portfolio approach. In doing so, a performance-based goal promotes cost-effectiveness across power plants. Dynamic cost-effectiveness and efficiency may be lost under a portfolio standard because of the adverse impacts it could have on innovation relative to a performance goal.

If mitigating greenhouse gas emissions is so important, why do you recommend an intensity performance metric instead of emission caps? An emission-intensity approach is consistent with the typical approach to promoting cleaner power generation in the U.S. electricity sector. For example, the Bush administration proposed regulations in 2007 that would limit emissions of sulfur dioxide, particulate matter, nitrogen oxides, and mercury on a pounds-per–megawatt hour basis from new electricity and industrial steam-generating sources (72 Federal Register 32710). The Obama administration recently proposed to regulate hazardous air pollutants—including mercury, hydrogen chloride, and particulate matter—on a pounds-per–megawatt hour basis (EPA 2011a). In implementing the Clean Air Act's Title V operating permits program, state regulatory agencies also establish power plant–specific emission intensity limits for conventional air pollutants. The EPA (2011b) guidance to the states for Title V permitting programs recommends an output-based standard, such as pounds-per–megawatt hour of electricity, for greenhouse gas emissions. Thus, utilities operating power plants and state and federal regulators have substantial familiarity and experience with policies that limit emissions per megawatt hour.

The federal government also has a positive track record implementing this kind of emission-intensity approach with tradable credits. In the 1980s, to phase down lead in motor gasoline, the federal government established lead performance goals (grams of lead per gallon) for refineries. Those refineries that beat the standard could generate lead credits that could be sold to other refineries or banked for future compliance (Kerr and Newell 2003).

The Canadian province of Alberta recently began implementing a greenhouse gas emission–intensity program that covers power plants, other industrial sources, and oil sands development. Under this program, power plants must reduce their emissions per megawatt hour by 12 percent relative to a historic baseline. Since 2007, this policy has reduced greenhouse gas emissions by about 17 million tons relative to business as usual. In addition, the Alberta program has directed nearly $200 million to a clean energy technology fund financed through an alternative compliance payment mechanism similar to the federal clean energy credit in this proposed NCES (Government of Alberta 2010).

How did you choose the performance goals for the NCES? The 2015 goal is a stretch—going from about 0.56 to 0.40 tCO2/MWh in five years. International experience suggests that this goal is feasible. The 2015 goal is approximately equal to the recent (2008) emission intensity of European and Japanese power sectors. Ambitious goals ensure that the federal clean energy credit price sets the clearing price in the tradable credit market and thus delivers certainty to facilitate investment and efficient operating decisions. In the event that the cost of clean energy falls significantly over the next two decades, there is a greater likelihood that the long-term performance goals would be met and a lower credit price would be necessary (and a lower price would be realized in the tradable credit market) to drive clean energy deployment. If the federal clean energy credit price is not binding in 2035, then power sector emissions would be some 60 percent below 2005 levels by 2035.

How did you choose the federal clean energy credit price? The deployment of clean energy technology depends on the returns investors receive from the installation and use of such technologies. The returns are not determined by economy-wide emission or emission-intensity goals: they are determined by the prices faced by investors for a given project. Uncertainty about those prices, and hence the returns on investment, will delay or deter investment.[8] A federal clean energy credit price that provides a transparent, stable investment signal is critical to advancing clean energy deployment. The level of the federal price, in conjunction with the ambitious performance goals, would make it very likely that the clearing price on credits will be set by the federal credit price.

The federal credit price starts at a modest level of $15 and then ramps up 7 percent annually (in addition to inflation) such that by 2025 the credit price will be consistent with the estimated damages from carbon pollution (Interagency Working Group on Social Cost of Carbon, United States Government 2010). Thus, a business investing in clean energy under this policy would generate social benefits equal to or greater than the cost of the project. This delivers the efficient outcome that would be realized by a competitive market if businesses accounted for and mitigated the damages caused by carbon pollution. This is analogous to the incentives a business faces to dispose of its solid waste—the fees paid to waste haulers can encourage a business to find ways to limit its waste stream (e.g., "reduce, reuse, recycle"). Businesses do this because they cannot simply dump their waste on their neighbor's property, but that "dumping on the neighbor" is exactly what businesses (and consumers) do every day with carbon pollution, under current law.

Zero-carbon power would receive an average price of $21/MWh for generation over the first ten years of the program as long as the federal credit price determines the tradable clean energy credit-clearing price. This is equal to the current value of the production tax credit for wind, geothermal, and many other renewable sources, and exceeds the value of the production tax credit available to the first 6 gigawatts of new nuclear power under the 2005 Energy Policy Act. In contrast to current tax credits, the proposed NCES would provide credits and a revenue stream to these renewable sources beyond just the first ten years of the policy. Certainty about the value of the clean energy credits will facilitate project finance by removing one variable from the evaluation of project risk.

This approach of setting a ceiling on the price of tradable clean energy credits through the federal clean energy credit price is akin to the common practice of allowing utilities to comply with state RPSs by making an "alternative compliance payment." The alternative compliance payment is a preset per megawatt hour price, ranging between $10/MWh to more than $60/MWh among state RPS programs. Several legislative proposals, including the RPS in the 2009 American Clean Energy and Security Act (H.R. 2454), the RPS in the 2009 American Clean Energy Leadership Act (S. 1462), and the Federal Diverse Energy Standard in the 2010 Practical Energy and Climate Plan Act (S. 3464), have included an alternative

...a performance-based goal establishes a transparent, easily measured metric that sends clear signals to innovators undertaking work on possible energy breakthroughs.

compliance payment ranging between \$21/MWh and \$50/MWh.

Why allow all power plants to produce clean energy credits instead of just new capacity? In this proposal, I have focused on providing clean energy credits—and thus an incentive for clean energy power generation—to all generating capacity that beats the performance goal. Some have suggested that a clean energy standard should provide incentives only to incremental investments in power generation technology with a low emission profile. The current underutilized natural gas–generating capacity, in combination with increasing domestic gas supplies at low cost, provides an inexpensive means to lower the emission intensity of the U.S. power sector. Crediting only new capacity would increase the costs of changing the generation mix in the power sector and, given the most recent forecasts for relatively slow growth in electricity demand over the next decade or more, would likely increase generating capacity in an industry with existing underutilized capacity.

Most states that have implemented an RPS allow all qualifying generation facilities—not just new or incremental renewable power investment—to generate renewable energy credits. For example, eighteen of twenty-two state RPS programs on the books by 2007 allowed for existing plants to be eligible to generate credits (Wiser, Namovicz, Gielicki, and Smith 2007).

Why exclude efficiency and other ways to offset emission intensity? In this proposal, I do not provide an explicit opportunity for utilities to offset some of their clean energy generation through energy efficiency measures. In addition, I do not provide for power plants to seek out emission offset opportunities beyond the scope of the power sector as a compliance option. In both cases, estimating the offset is complex, requires extensive review and monitoring by third parties or the regulatory agencies, and risks undermining the objective of the NCES to the extent that some projects do not, in practice, deliver meaningful emission reductions. To maintain the simplicity of this program, I focus on granting credits for what is observed. In contrast, offsets aim to grant credits for what is not observed; since the counterfactual cannot be observed, there is uncertainty about the actual environmental integrity of an offset. Unlike past legislative proposals, the use of the federal clean energy credits protects the power sector from unexpectedly high costs of the policy and thus reduces the need for offsets as a cost-containment mechanism.

It is important to note that the NCES will provide several implicit incentives for improvements in energy efficiency. First, the standard will encourage investments and process modifications to improve the efficiency of fossil fuel boilers. Second, to the extent that electricity prices increase, consumers will have an incentive to become more efficient in their consumption of electricity.

Why are power plants the point of regulation? Requiring power plants to comply with the NCES would simplify its implementation by taking advantage of the existing monitoring of CO_2 emissions at most generating units and the reporting of power generation to state public utility commissions and the DOE. Such an approach could also easily cover power-generating facilities on manufacturing sites—akin to the current EPA practice of implementing emission-intensity performance standards for conventional air pollutants for power plants and large industrial boilers. This would limit the extent of leakage under the policy. It would not be very effective to promote clean energy in the power sector while allowing manufacturing facilities to burn dirty fuel; if manufacturers decided to generate more of their electricity on site instead of purchasing it from a utility, it would circumvent the intent of the policy.

Why dedicate revenues from the sale of the federal clean energy credit to energy R&D? The financing for a Clean Energy Fund reflects a general consensus on the need for increasing support for advanced energy R&D. For example, the American Energy Innovation Council (2010) has called for \$16 billion per year to support energy innovation, including a \$1 billion annual commitment to ARPA-E, and the President's Council of Advisors on Science and Technology (PCAST; 2010) has recommended increasing funding for total energy R&D and demonstration and deployment to \$16 billion per year. The suggested energy R&D funding levels by these groups exceed the amount set aside under this proposal. Nonetheless, the Clean Energy Fund would deliver a significant increase in energy R&D, which can facilitate the development and commercialization of new energy technologies that could lower the cost of attaining the longer-term clean energy goals and thus benefit electricity consumers in the long run. This reflects the strong complementarity, as opposed to substitutability, of an energy R&D program and a clean energy deployment policy like this NCES. Both incentives for clean energy deployment and support for energy R&D are necessary for an effective national energy policy (Stavins 2010).

This also reflects the approach taken by a number of states in how they direct alternative compliance payment revenues to clean energy investment. Pennsylvania uses its alternative compliance payment revenues to finance the state Sustainable Energy Funds program. Massachusetts dedicates alternative compliance payment revenues to the Massachusetts Clean Energy Center. The Ohio Advanced Energy Fund receives any revenues generated through the Ohio RPS alternative compliance payment. New Jersey also channels alternative compliance payment monies to its Clean Energy Program.

The political calculus of a clean energy standard may be different from the cap-and-trade debate for several major players in the oil and gas industry, which could help drive a business coalition of renewable, nuclear, and oil and gas companies to support such an approach.

Why don't you exempt small power plants? Exempting small power plants runs the risk that utilities and perhaps some manufacturing facilities will decide to generate more power from small units that fall under any exemption threshold to avoid the need to comply with the policy. This will undermine the incentive to innovate and deploy clean energy and lower the program's benefits. The regulatory authority can determine if some very small facilities may be exempt, just as EPA employs a minimum generating capacity threshold for some of its conventional air pollutant regulations, without causing significant risk of policy circumvention.

NATIONAL CLEAN ENERGY STANDARD VS. STATE RPS VS. EPA REGULATORY AUTHORITY

Why would Congress support legislation to create an NCES? First, such an approach, in a variety of forms, is similar to the status quo policy in twenty-nine states and Washington, DC (N.C. Solar Center and IREC). While most of these state programs focus on renewable power, some do extend to nonrenewable technologies that have zero or low emissions of greenhouse gases, such as integrated gasification combined cycle (IGCC) coal technology under Pennsylvania's Alternative Energy Portfolio Standard, landfill methane under North Carolina's Renewable Energy and Energy Efficiency Portfolio Standard, and advanced nuclear power under Ohio's Alternative Energy Resource Standard. The power generated in these twenty-nine states and Washington, DC, represented about 65 percent of U.S. power generated in 2008. Adding another six states with renewable goals covers nearly 73 percent of U.S. power generation. This illustrates significant support for promoting various kinds of clean energy technologies through new policies, although the variation in design and implementation across states also suggests value in harmonizing policy through a national approach.

Second, a well-designed clean energy standard obviates the need for EPA greenhouse gas emission regulatory authority in the power sector. An NCES bill should preempt EPA regulatory authority for power plants and existing state renewable energy standards. The current debate over EPA's greenhouse gas emission regulatory authority has several adverse outcomes for the power sector. First, uncertainty about whether EPA will retain authority and, if so, whether its promulgated rules would withstand legal challenge, will continue to chill investment. Second, time and resources dedicated to debating various kinds of riders regarding EPA authority reduce the opportunities for a serious discussion about how to advance effective U.S. energy policy.

Third, an NCES likely represents the most effective way to drive demand for domestically produced natural gas. The significant expansion in domestic gas resources, especially of unconventional sources of natural gas such as shale, has the potential to serve a significant increase in gas demand. Yet, over the next ten years, there are not obvious opportunities in transportation, industry, or the buildings sector to meaningfully increase gas consumption. The costs of driving the use of natural gas in transportation—in terms of infrastructure and building new kinds of vehicles—will likely limit gas use to centralized fueling fleets. Gas consumption in the industrial sector in 2010 returned to its 2007 levels after declining in 2009, but it is not likely that the oil and gas industry views domestic manufacturing as a major growth sector for natural gas. Continued efforts to improve the energy efficiency in buildings will limit opportunities to increase gas consumption in this sector. Thus, the power sector—especially given the build-out of combined-cycle natural gas capacity over the past two decades—is the single best market for the potential increase in domestic natural gas production (MIT Energy Initiative 2010).[9] Since there is very little oil consumed in the U.S. power sector, a policy that promotes gas consumption to generate electricity does not cannibalize the oil and gas industry's profits from refined petroleum products. The political calculus of a clean energy standard may be different from the cap-and-trade debate for several major players in the oil and gas industry, which could help drive a business coalition of renewable, nuclear, and oil and gas companies to support such an approach. In addition, responsible development of shale gas resources provides an employment opportunity that could complement the potential employment impacts from manufacturing parts for renewable facilities, and construction of new power plants.

Why don't you implement this approach through existing EPA Clean Air Act authority?[10] Under the new source performance standard provision of the Clean Air Act, EPA could design a "system" similar to the tradable performance standard envisioned under this NCES (Burtraw, Fraas, and Richardson 2011). There are several potential drawbacks to the Clean Air Act approach. First, it is unlikely that EPA could implement a system that could provide the price certainty that is envisioned in this NCES—in other words, it would not likely include a federal credit that could limit costs and generate revenues for the U.S. Treasury. Perhaps more important for clean energy project finance, it may be legally challenging for EPA to design a system that covers energy sources that do not produce greenhouse gas emissions—such as nuclear and renewable—that would allow for those sources to generate a revenue stream under EPA regulation just as they could under this proposal. It is also not clear if an EPA "system" would account for the net emission impact of biomass energy power plants (i.e., account for the biological sequestration) or if it would account only for the gross emissions from the power plant smokestack. If EPA could only account for the gross emissions, then it would adversely impact the deployment of biomass energy power plants and biomass cofiring at existing fossil plants.

Second, an approach focused on new sources under the new source performance standards provision of the Clean Air Act would deliver very little environmental benefit since the vast majority of power generation over the next few decades will come from existing sources. EPA would need to design, implement, and harmonize an "existing" source performance standard with the new source performance standard in order to mimic the scope of this proposal (Burtraw et al. 2011).

Third, an EPA regulatory approach probably would not provide a means to finance clean energy R&D, at least not one implemented or coordinated at the federal level.

Fourth, the Clean Air Act approach would be more likely to face congressional review and legal challenge than the implementation of new legislation that expressly creates a clean energy standard for the power sector. Finally, in the absence of new legislation, some advocates may take legal action to press EPA to employ additional provisions of the Clean Air Act to address greenhouse gas emissions in the power sector, some of which would be more costly and less effective than a new source performance standard approach. These challenges highlight the fundamental problem that Clean Air Act authority is not sufficient to drive the extent of clean energy deployment that is necessary, nor is it capable to do so as cost-effectively as would new legislation to create a clean energy standard.

Why do you preempt state RPSs? The states have served as very important laboratories of policy innovation and experimentation in the clean energy space. Once we have learned from the experiments, it is prudent to move forward with a national policy that reflects the best insights drawn from these state efforts. Continuing state RPSs with an NCES will have at least one of the following two impacts: First, the duplication of policies will increase the administrative costs of complying with state and federal policies. Second, the benefits from deploying clean energy in a state with an aggressive RPS could be completely offset by reduced clean energy generation in less-aggressive states under the federal policy (Goulder and Stavins forthcoming). In effect, electricity consumers in the more-aggressive states subsidize the electricity consumers in less-aggressive states. This raises the total cost of promoting clean energy deployment and undermines the cost-effectiveness of the national policy.

An NCES could represent a significant simplification of the existing regulatory regime by substituting for EPA greenhouse gas emission regulatory authority in the power sector and existing state renewable and alternative energy standards.

NATIONAL CLEAN ENERGY STANDARD VS. COMPREHENSIVE ENERGY AND CLIMATE POLICIES

Isn't this just a back-door cap-and-trade program or carbon tax? There are basically just three ways to promote clean energy deployment: (1) pay utilities to build and generate electricity from clean energy power plants, (2) make utilities build more clean energy power plants and increase their dispatch from such plants, or (3) raise the price on dirty energy commensurate to the harm to society this source of generation imposes. The first option has been federal policy, through tax credits, for nearly two decades, but fiscal constraints and the costs associated with imposing taxes on other parts of the economy necessary to finance tax credits for the power sector does not portend a bright future for this policy option. The second option reflects regulatory mandates that do not have much current political favor, that risk increasing the costs necessary to deploy a given amount of clean energy, and that may not deliver strong incentives for innovation. The third option represents a cost-effective, market-based approach to driving clean energy deployment that includes cap-and-trade; carbon tax; most state RPSs; the renewable electricity standard in the bipartisan 2009 Senate energy bill (S. 1462); the Lugar, Graham, and Murkowski diverse energy standard (S. 3464); and the proposed NCES.

This approach differs from the 2009–2010 versions of cap-and-trade along a few key dimensions. First, this NCES does not have a cap on emissions. Second, this NCES is designed to be transparent and technology-neutral. While cap-and-trade allows for the government to allocate emission allowances in a way to build political support potentially without undermining cost-effectiveness (Hahn and Stavins forthcoming, Stavins

An NCES could represent a significant simplification of the existing regulatory regime by substituting for EPA greenhouse gas emission regulatory authority in the power sector and existing state renewable and alternative energy standards.

2007), the complexity of the emission allocations in recent legislation give the appearance of rewarding specific interests and technologies (to at least some political observers). Third, the federal clean energy credit in this proposal contains the costs of this policy and thus eliminates much of the uncertainty and anxiety about potentially unexpected, high costs associated with past cap-and-trade proposals. This certainty also improves the prospects for clean energy project finance relative to the uncertainty associated with the impacts of volatile emission allowance prices on the revenue stream of a clean energy power plant. Fourth, this approach to promoting clean energy is focused on simplicity. There are no redundant or duplicative policies targeting power sector technologies and emissions under this proposal. Finally, this policy focuses on just the power sector and avoids the political pitfalls of raising the price of gasoline under an economy-wide cap-and-trade program.

How could this NCES transition to a more comprehensive energy and climate policy? As noted at the top of this paper, the first-best public policy to promote clean energy and combat climate change would be an economy-wide carbon tax that channels a fraction of revenues for energy R&D, and the balance to reducing the marginal tax rate on income or labor, or for deficit reduction. This NCES would be amenable to a transition to this first-best policy. First, the fixed profile of prices over time set by the federal clean energy credits would provide similar information for utilities' investment planning as a carbon tax would. Transitioning the policy from an NCES to a carbon tax would not meaningfully disrupt the planning if the carbon tax profile follows the federal clean energy credit price set under the standard. Second, the implicit transfer of rents to the power sector through the NCES decline over time as the performance goals become more stringent. This would reduce opposition to transition from a clean energy standard to a carbon tax. Third, the channeling of federal clean energy credit revenues to the Clean Energy Fund could be transitioned over to a carbon tax financing scheme without much difficulty. The challenge, however, is to avoid the risk of policy lock-in and the weakening of resolve for more comprehensive policy down the road (Coglianese and D'Ambrosio 2008).

What are the international policy implications of an NCES? In recent years, the international community has paid particular attention to U.S. domestic climate change policy. The Copenhagen Accord and the Cancun Agreements establish objectives for U.S. greenhouse gas emissions consistent with final energy and climate legislation as well as goals for international climate financing by developed countries. An NCES would have several positive impacts on the international climate regime, and two potential adverse impacts. First, passing legislation on a clean energy standard would demonstrate a bipartisan effort to move forward to combat the challenge of climate change. Second, the emission reductions that could be achieved by this standard, while focused on just the power sector, are meaningful and, on a sector-specific basis, consistent with the commitments made in Copenhagen and Cancun. A 0.35 tCO2/MWh performance goal for 2020 would result in emissions in the power sector well below the "in the range of 17 percent below 2005 levels" emission objective submitted by the United States under the Accord. Even if this performance goal is not achieved as power plants take advantage of federal clean energy credits, a conservative illustration suggests that emissions could fall 15 percent below 2005 levels by 2020 in the power sector.

It is also important to assess the comparability of this effort with the progress of major developed and developing countries. The International Energy Agency (IEA) publishes power sector generation and CO_2 emission statistics in its annual World Energy Outlook that enables comparisons of emission intensity across major economies over time (IEA 2007, 2010).[11] In 1990, the United States and the European Union had equivalent emission intensities (Table 6).[12] Through 2008, the United States experienced a modest decline while the EU's intensity fell by nearly 30 percent and surpassed the carbon-lean Japanese power sector. The EU's generation mix has changed significantly over the past two decades: as total power generated increased, coal generation fell about 10 percent as natural gas generation more than quadrupled and non-hydroelectric renewable sources increased their generation share to more than 7 percent. Pushing toward a 0.35 goal for 2020 would significantly surpass the carbon intensity achieved to date in the EU and Japan.

The NCES could also serve to illustrate a potential policy tool that emerging economies could employ as they reduce the emission intensity of their development. Both China and India have indicated that they intend to reduce the carbon intensity of their economic output. Given the very strong correlation between electricity generation and GDP, a clean energy standard could be a policy instrument well-tailored to their climate goals. In addition, advancing a clean energy standard in the United States may enable the U.S. to press for more-aggressive energy and climate policies by China and India.

An NCES based on an intensity performance metric, however, may complicate efforts to integrate U.S. energy and climate policy with the EU Emission Trading Scheme (Jaffe, Ranson, and Stavins 2010; Metcalf and Weisbach 2010). Linking a clean energy standard to the EU's cap-and-trade program would increase emission uncertainty in Europe because of both the intensity measure and the federal clean energy credit in the NCES. In effect, linking would result in the EU having a price ceiling determined by the U.S. federal clean energy credit price schedule, and it may not be likely that the Europeans would choose to link the systems, given this potential outcome.

Related to this trading point, a clean energy standard would not deliver private market incentives for international climate finance. The Copenhagen Accord and the Cancun Agreements envision a significant ramping up of international climate finance to facilitate adaptation, slow deforestation, and promote clean energy technology deployment in developing countries. The scale called for in the Accord and Agreements is feasible only with a very robust system of international emission trading. The proposed NCES would not serve as the necessary foundation for such an enhancement of international emission trading.

TABLE 6

Electricity Generation CO_2 Emission Intensity, Select Countries, 1990, 2005, 2008

Country or region	1990	2005	2008
United States	0.58	0.58	0.55
European Union	0.58	0.43	0.41
Japan	0.43	0.42	0.44
China	1.00	0.98	0.90
India	0.85	0.94	0.97

Source: Constructed from data presented in IEA (2007, 2010).

Conclusion

An NCES would address the need and interest to advance U.S. energy policy. The NCES would establish a level playing field for power generation technologies through a technology-neutral approach to promoting clean energy deployment. All efforts to reduce the pollution-intensity of electricity, from wind and solar to improved combustion efficiency and carbon capture and storage at coal-fired power plants, would be rewarded. The NCES would provide a transparent, nonvolatile price incentive that will facilitate clean energy deployment. This certainty also ensures that any economic or technological surprises do not result in unexpectedly high electricity rates.

This technology-neutral approach with price certainty will enable the American economy to get the biggest bang for its buck in terms of clean energy deployment. As the analysis in this paper indicates, this approach is not free, but no serious effort to advance U.S. energy policy can be done on the cheap if it is to meaningfully improve our energy economy. Nonetheless, the costs are modest—the maximum possible nationwide electricity rate impact would be about 0.3¢/kWh, and under this proposed policy about two-thirds of the nation would still face lower electricity prices in 2015 than they experienced in recent years. The benefits to the whole of American society clearly exceed the modest costs of an NCES.

An NCES represents a simple, transparent, more cost-effective, and more effective alternative to greenhouse gas regulatory authority under the Clean Air Act and the patchwork of state renewable and alternative energy portfolio standards. Pursuing the proposed clean energy policy to substitute for the Clean Air Act authority and the various state policies would streamline power plants' regulatory environment and reduce their administrative burden. In addition, a clean energy standard would deliver a long-term price incentive for clean energy that would replicate the current benefits of renewable production tax credits without the requirement of budget outlays. Given the current fiscal environment, the opportunity to raise revenue to fund energy R&D and enable deficit reduction and tax cuts also makes this standard more appealing than the status quo federal and state policies.

Although an NCES could promote significant deployment of clean energy and finance necessary energy R&D, it is not sufficient to transform the American energy system and combat climate change. The United States will need to identify and pursue energy and climate policy beyond the power sector. An NCES could serve as the starting point for a more efficient, long-term, comprehensive policy, such as a carbon tax that would also deliver significant fiscal or tax reduction benefits, or both.

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Endnotes

1. Refer to Freed, Horwitz, and Cunningham (2011) for further discussion of bipartisan interest in a clean energy standard.

2. The manufacturing of parts and construction of nuclear power plants, wind farms, solar farms, and so on has associated CO_2 emissions. This analysis focuses on emissions at the time of power generation and does not attempt to assess life-cycle CO_2 emissions by generation technology.

3. There are potentially meaningful benefits to displacing oil consumption through the electrification of the transportation sector with electric vehicles.

4. Michel (2011) describes an alternative approach in which the point of regulation would be at local distribution companies that would not require the tracking of the electricity's emission characteristics back to the generation unit.

5. See, e.g., American Energy Innovation Council (AEIC) 2010; Greenstone 2010; Hayward, Muro, Nordhaus, Shellenberger 2010; and President's Council of Advisors on Science and Technology (PCAST) 2010 for more details on need for and targeting of energy R&D funding.

6. The EIA (2011a) presents price data for twenty-two electricity markets that cover the entire continental United States. For this analysis, I have combined the three New York markets (NYCW, NYLI, NYUP) into one statewide New York market. I have not extended the analysis to Alaska or Hawai`i due to lack of forecast electricity prices (in the absence of a NCES) for these markets.

7. The percentage increase for the industrial sector is greater than for the national average because industrial electricity rates are 45 percent lower than residential rates.

8. For evidence of this, refer to Metcalf (2009) for an assessment of the adverse impact occasional lapses in the renewable production tax credit has had on U.S. wind investment.

9. A renewable-only policy, such as a national renewable portfolio standard, would likely displace the use of natural gas in the U.S. power sector, at least in the near term (MIT Energy Initiative 2010).

10. Thanks to Dallas Burtraw and Nathan Richardson for several productive conversations on the use of regulatory authority under the Clean Air Act. Any remaining errors in interpretation of the Clean Air Act are solely those of the author.

11. The IEA's published data yield emission intensity values for the United States lower than those derived from EIA published data. To ensure consistency in source data and methods across countries, this comparison uses the IEA data for the United States instead of the EIA data presented in Figure 1.

12. All EU statistics are constructed based on the current twenty-seven member states.

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Highlights

Joseph Aldy of the Harvard Kennedy School of Government proposes the establishment of a National Clean Energy Standard (NCES) that applies to the U.S. power sector.

The Proposal

A technology-neutral, emission intensity-based standard. There are many ways to define “clean energy.” A technology-neutral approach based on emission intensity would enable all sources in our current energy mix to contribute towards meeting the standard. It also would keep government focused on the bottom line—environmental outcomes—instead of on picking winners and losers.

Tradable clean energy credits. Power plants would be able to trade clean energy credits. Clean facilities that beat the standard generate credits than can be sold to less-clean facilities that fail to meet the emission-intensity performance goal. If the price of credits exceeds a preset level, power plants would be able to buy credits from the federal government.

A Clean Energy Fund. Revenue raised under the standard would go towards a Clean Energy Fund that would support energy innovation through R&D and technology demonstration. About $2 billion in revenues would be initially dedicated in 2015, ramping up to $5 billion in 2025.

Benefits

The National Clean Energy Standard Aldy proposes would significantly reduce CO_2 emissions in the power sector, streamline the existing regulatory framework, fund energy innovation, and serve as a bridge to a more comprehensive economy-wide carbon pricing system.

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