

The Clean Power Plan Opportunity

Securing Economic and Clean Energy Benefits for All of the States

HIGHLIGHTS

The Clean Power Plan presents a historic opportunity to reduce global warming pollution from the U.S. electricity sector. The plan sets state-specific targets for cutting power plant carbon pollution, leading to a nationwide reduction of approximately 32 percent below 2005 levels by 2030.

It also provides a valuable near-term opportunity to accelerate the transition to a clean energy future—already under way across the country—by spurring investment in greater amounts of renewable energy and energy efficiency.

New analysis by the Union of Concerned Scientists shows that strong growth in wind, solar, and energy-efficient technologies together with a robust national carbon emissions trading program, provides an affordable pathway for the United States to not only cut global warming emissions but also deliver significant health and economic benefits for all Americans.

The Clean Power Plan (CPP), finalized in August 2015 by the U.S. Environmental Protection Agency (EPA), establishes the nation's first-ever limits on carbon dioxide emissions—the primary contributor to global warming—from power plants. The plan sets state-specific targets for cutting carbon pollution, leading to a nationwide reduction of approximately 32 percent below 2005 levels by 2030 (EPA 2015a). Indeed, most states are well positioned to meet their assigned emissions-reduction targets, given their ongoing transitions from coal generation and their commitments to invest in renewable energy and energy efficiency (Richardson et al. 2015).

New analysis by the Union of Concerned Scientists highlights an affordable pathway for states' CPP compliance—a route that features strong growth in wind, solar, and energy-efficient technologies together with a vigorous national carbon emissions trading program. This course toward a clean energy future, which we call our “CPP National Trading Case,” will not only help cut global warming emissions but also deliver significant health and economic benefits for all Americans.

For example, our CPP National Trading Case will:

- Yield 204 gigawatts (GW) of new renewable energy capacity in the United States by 2030, which could stimulate \$189 billion in capital investments¹
- Prompt the investment of \$64 billion in energy-efficiency improvements by 2030 to benefit consumers



U.S. wind capacity has more than doubled—to 70 GW—during the past five years. Increased renewable energy development will help states meet their Clean Power Plan targets while also generating economic benefits.

- Generate an average annual revenue of \$17.8 billion from the sale of carbon allowances during the 2022 to 2030 period that can be used for public benefit
- Provide \$103 billion in public health and climate benefits through 2030 by decreasing carbon dioxide (CO₂), sulfur dioxide (SO₂), and nitrogen oxides (NO_x) pollution

Our Nation's Clean Energy Transition

The U.S. power sector is in the midst of a major transition as electric utilities shift from coal toward cleaner energy sources, and the CPP provides a valuable near-term opportunity to accelerate this transition, especially by investing in higher levels of renewable energy and energy efficiency.

Coal-fired power is declining nationally as aging, inefficient, and polluting power plants struggle to remain competitive. Coal accounted for less than 39 percent of the U.S. electricity supply in 2014, down from about half as recently as 2008 (EIA 2015a). The imperative to meet air and water pollution standards cost-effectively, and serious economic competition from cleaner and lower-cost sources such as renewable energy and natural gas, have led to less frequent use of coal plants, as well as to their retirements, across the country (Cassar 2015; Deyette et al. 2015). Since 2009, utilities have announced plans to close or convert to natural gas at least 445 coal generators in 41 states—equal to about 20 percent, or 71 GW, of total U.S. coal power capacity (SNL Financial 2015).

Many power providers are investing in natural gas to replace coal-generated electricity. Natural gas prices have fallen sharply in recent years, due largely to advances in hydraulic fracturing and horizontal drilling techniques that have made significantly more natural gas reserves accessible (Deyette et al. 2015). As a result, the contribution of natural gas to the U.S. electric power supply has increased, from 22 percent in 2007 to 28 percent in 2014 (EIA 2015a). But while switching from coal to natural gas is delivering some near-term environmental and economic benefits, natural gas expansion can also expose consumers to price volatility and undermine efforts to achieve global warming emissions-reduction goals over the long term (Deyette et al. 2015).

Renewable energy sources such as wind and solar power are also being deployed to replace polluting coal and meet



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Advances in technology, decreases in costs, and strong policy mechanisms are driving a tremendous expansion of solar power. Accelerating the growth of renewable energy to help meet the Clean Power Plan's emissions reduction targets will help diversify the electricity mix and protect consumers from potential increases in natural gas prices.

the nation's growing demand for electricity. Advances in technology, decreases in costs, and strong policy mechanisms are driving a tremendous expansion of these sources. Installed solar photovoltaics (PV) costs and the price of wind power have fallen by 60 to 70 percent over the past five years in the United States (Barbose et al. 2015; Wiser et al. 2015). Consequently, U.S. wind capacity has more than doubled to 70 GW during that time (AWEA 2015) while total U.S. solar PV capacity has increased 15-fold (SEIA 2015).

Overall, non-hydro renewable sources provided more than 7 percent of the U.S. power supply in 2014, a near tripling of 2007 levels (EIA 2015a). And much higher levels of renewable energy can be reliably and affordably achieved in the upcoming years with existing technologies and measures. A recent study found that renewable sources could contribute 30 percent of the total U.S. power supply or more within the next two decades (UCS 2013). By 2050, with strong investments and modest improvements in existing technologies, renewable energy could account for 80 percent of the U.S. power supply (NREL 2012).

The U.S. power sector is in the midst of a major transition as electric utilities shift from coal toward cleaner energy sources.

How the United States Can Meet the Clean Power Plan's Goals

The CPP, developed by the EPA under the authority of the federal Clean Air Act, sets differing CO₂ emissions-reduction targets among the states because of each state's unique mix of electricity generation sources—and also because of local technological feasibility, cost, and emissions-reduction potential, which vary across the country. States are required to submit a final compliance plan, or an initial plan with a request for an extension of up to two years, by September 6, 2016. However, a February 2016 Supreme Court ruling put a stay on CPP implementation until legal challenges to the rule have been resolved. States may continue to develop their compliance plans in the interim.

The CPP provides a number of options for cutting carbon emissions so that each state can develop a compliance strategy most suited to its own electricity-supply mix, resource availability, and policy objectives. These options include investing in renewable energy, energy efficiency, natural gas, or nuclear power; making coal-fired plants more efficient; or using less power from coal plants—and states are free to combine the options as they wish in order to meet their targets. States can also join together in multistate agreements to find the lowest-cost solutions for reducing their CO₂ emissions, including through market-based carbon trading programs. Further, administering such a program by auctioning off emission allowances is an effective and proven way of preventing potential windfall profits among fossil fuel-based electricity generators and of allowing states to generate revenues that could be used to benefit all of their residents (Hibbard et al. 2015).

The Union of Concerned Scientists examined the likely economic and environmental impacts of achieving the emission reductions required by the CPP. In particular, we modeled each state's compliance with its respective mass-based targets, including old and new power plants combined, and we allowed for nationwide trading of carbon allowances. This choice of target will help limit the potential for “leakage,” or emissions that might arise because of a shift from existing to new fossil fuel-fired power plants (which are not covered under the CPP because they are regulated under a separate section of the Clean Air Act). We found that this approach—that is, the CPP National Trading Case—provides greater environmental, economic, and health benefits when compared with each of two other scenarios: a “Reference Case,” in which no new state or federal policies (including the CPP) are implemented beyond those in place as of October 2015; and a “CPP No Trading Case” that also achieves nationwide compliance with the mass-based targets, but does not allow for interstate

trading of allowances² (see Box 2, p. 7, for more details on our methods and assumptions).

Below, we first summarize the results of comparing our CPP National Trading Case with the Reference Case. We then present results from the CPP No Trading Case as a sensitivity analysis of the CPP National Trading Case, highlighting key differences between these two scenarios.

The Clean Power Plan Accelerates Our Nation's Transition to Low-carbon Electricity

Under the CPP, the United States speeds up its shift toward cleaner, low-carbon energy sources. Indeed, even under the Reference Case, the nation continues to reduce its dependence on coal-fired power generation, which in 2030 is 6 percent lower than in 2014 (Figure 1, p. 4). Natural gas-fired power generation also decreases by more than 6 percent because of the reduced use of less-competitive natural gas plants. Renewable energy generation—led by wind and solar power—increases to more than 17 percent of generation by 2030.

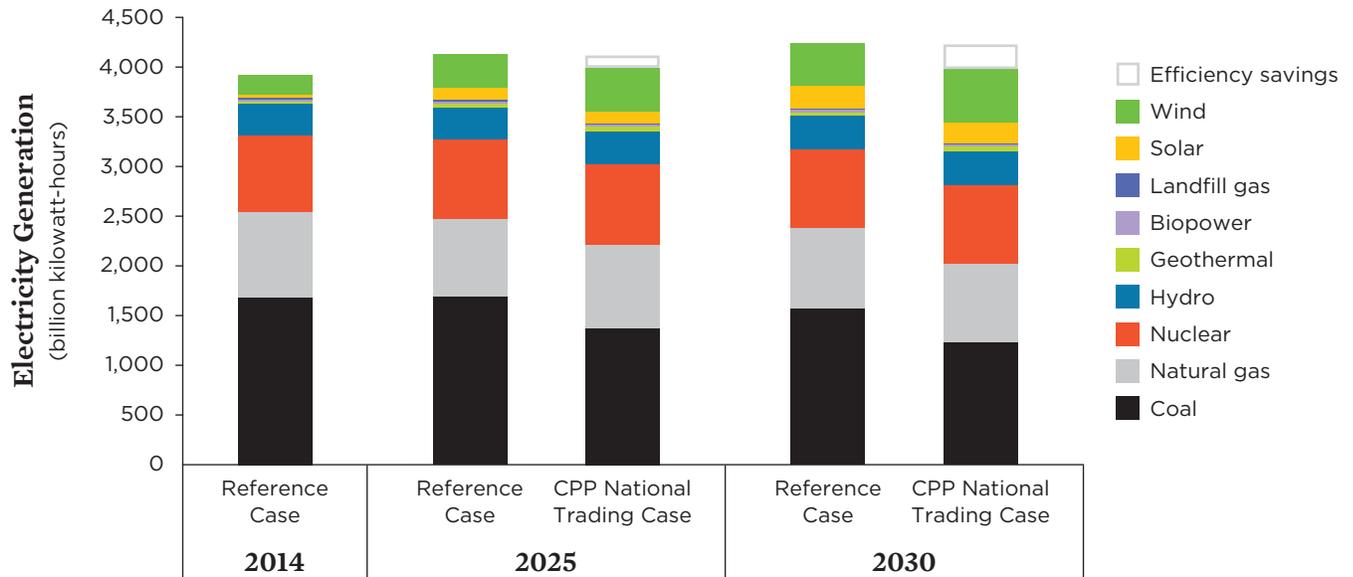
By contrast, the CPP National Trading Case results in a cleaner and more diversified generation mix. Renewable energy accounts for 21 percent of the power supply in 2030, while savings from energy efficiency investments are equivalent to 7 percent of total electricity sales in that year. Relative to the Reference Case, generation from coal and natural gas plants is 22 percent and 2 percent lower, respectively, in 2030.

To provide for renewable energy generation under the CPP National Trading Case, the United States builds 79.4 GW of wind capacity, 120.3 GW of solar capacity—including 75.5 GW of rooftop solar on homes and businesses—and 3.8 GW of geothermal capacity above current levels by 2030. Moreover, the CPP National Trading Case cumulatively drives nearly \$189 billion³ in renewable energy investments in the United States, as well as more than \$64 billion in energy efficiency improvements, by 2030.

A Cleaner Energy Supply Makes Economic Sense

The clean energy growth in the United States spurred by the CPP is not only achievable but also affordable. The outcomes of the CPP National Trading Case policies (including new renewable energy projects, energy efficiency programs, and the price on carbon) lead to modest near-term bill increases over the Reference Case; average monthly electricity bills for a typical household are only 3.2 percent higher in 2022, amounting to a monthly bill increase of about \$2.50.⁴

FIGURE 1. The Clean Power Plan Diversifies Our Nation's Electricity Mix



The Clean Power Plan helps accelerate our nation's transition toward a more diversified portfolio of cleaner energy sources.

Ultimately, though, the CPP National Trading Case leads to small positive savings for consumers by 2030; average monthly bills are reduced by 1.1 percent, or \$0.81. And consumer savings continue to increase in the years following 2030. This occurs because (a) the cost to operate most renewable energy facilities is much lower than that of fossil fuel plants, (b) energy-efficient buildings and appliances cost less to operate, and (c) more renewable energy and efficiency helps diversify the electricity mix and limits the potential impacts from increases in natural gas prices.

In our analysis we also examined some of the broader financial impacts of the changes in the U.S. electricity sector—including the net impact on electricity bills for all customer classes, investments by participants in energy efficiency programs, and net costs for power generators and distributors. In 2022, there is a net cost of \$17.5 billion, or 4.2 percent of total electricity system costs, to implement the CPP National

Trading Case, as compared with the Reference Case. In 2030, the net cost is \$1.9 billion, or just 0.4 percent. However, as in the residential example above, CPP implementation ultimately generates financial savings in the years after 2030, primarily as a result of investments in energy efficiency. Net savings could be realized even sooner if states invest in greater amounts of energy efficiency than the relatively modest levels we assumed under the CPP National Trading Case.

Our analysis also shows that a national mass-based emissions trading program with auctioned allowances would help all states generate significant carbon revenues that could ultimately offset higher consumer electricity bills or be reinvested for the benefit of each state's residents. By setting a carbon cap and issuing allowances equal to state CPP targets, auctioning those allowances, and participating in an interstate carbon trading program, the states generate total revenues of \$14.3 billion in 2022 and \$12.9 billion in 2030 (see the table, p. 5). By 2030, carbon revenues exceed net costs of CPP compliance under the CPP National Trading Case, resulting in net savings of \$11 billion.

Average annual revenue from 2022 to 2030 under the CPP National Trading Case is \$17.8 billion (or cumulatively \$116.8 billion, expressed in present-value dollars) (Figure 2, p. 6). Investment options for these revenues could include: additional deployment of renewable energy and energy efficiency sources;

Under the CPP, the United States speeds up its shift toward cleaner, low-carbon energy sources.

Summary of Savings for the CPP National Trading Case Relative to the Reference Case (in billion \$)		
	2022	2030
Electricity Expenditures	-17.5	-1.9
Revenue from Carbon Allowances	14.3	12.9
Net Savings	-3.2	11.0

Note: The costs of implementing the CPP and the renewable energy and energy efficiency policies are included in electricity prices/bills.

power-grid infrastructure improvements; assistance to communities for the purpose of environmental justice and equity; making buildings and infrastructure more climate-resilient; and worker training and other economic-transition support for communities adversely affected by the states' shift from coal (see Box 1 for more details).

Public Health and Economic Benefits from Less Air Pollution

Under the CPP National Trading Case, the states fully achieve their interim and final CO₂ emissions-reduction requirements set by the CPP. National electricity-related CO₂ emissions in 2022 are 145 million tons (or 7 percent) lower than in the Reference Case and 388 million tons (or 19 percent) lower in 2030. Cumulatively from 2016 through 2030, CO₂ emissions in the CPP National Trading Case are nearly 3.1 billion tons less than in the Reference Case. And the power-sector carbon emissions in 2030 under the CPP National Trading

Case are 38 percent below those of 2005. The lower CO₂ emissions directly reflect the state's cleaner generation mix (see Figure 1), spurred by greater investments in renewable energy and energy efficiency.

The CPP also helps cut other conventional air pollutants, including SO₂ and NO_x, primarily through the reduction in coal generation from older and inefficient plants. Under the CPP National Trading Case, NO_x emissions are nearly 26 percent lower in 2030 than under the Reference Case, while SO₂ emissions are 24 percent lower.

Reducing NO_x, SO₂, and CO₂ emissions leads to tangible health and economic benefits. NO_x and SO₂ are contributors to smog and soot, which exacerbate symptoms of heart disease, asthma, and other lung diseases and can result in premature death from these causes (EPA n.d.). CO₂ emissions are the main driver of climate change, resulting in sea level rise and coastal flooding, worsening droughts and wildfires, and extreme weather events such as heat waves, heavy downpours, and storm surges, all of which can impair human safety and health.

Using the same methodology applied by the EPA in its impact assessment for the CPP, we estimated the monetary savings from reducing these pollutants. The combined carbon and health benefits of the avoided emissions of CO₂, SO₂, and NO_x under the CPP National Trading Case are valued at \$14.8 billion on average each year from 2015 to 2030.⁵ This annual benefit adds up to a total of \$103 billion⁶ for the entire time period, which is nearly 22 times greater than the total net cumulative electric-system cost (\$4.7 billion) of the CPP National Trading Case.

Although the design of our CPP National Trading Case differs from the cases considered by the EPA in its impact

BOX 1.

Ensuring an Equitable Transition to a Clean Energy Economy

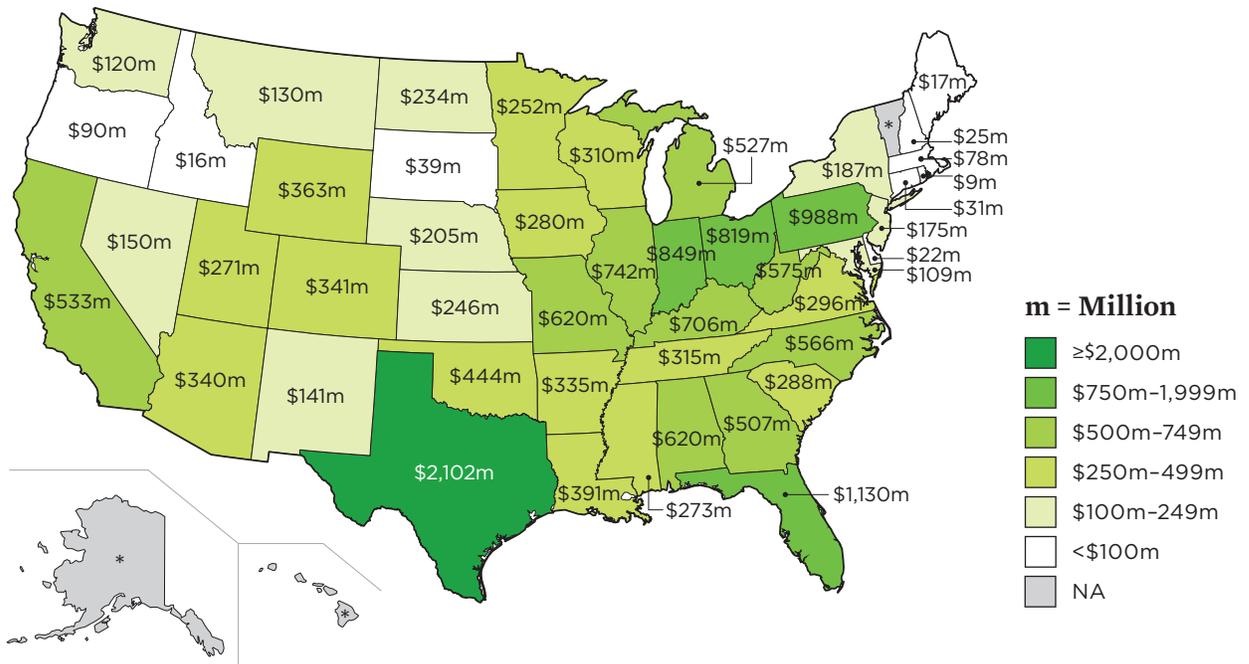
Communities of color and low-income communities bear a disproportionate burden of pollution from coal-fired power plants (EJLFC 2016). The CPP provides an opportunity to significantly reduce not only heat-trapping CO₂ emissions, but also toxic "co-pollutants" such as SO₂, NO_x, and mercury. To ensure that disadvantaged communities benefit from the transition away from coal, state compliance plans should include specific provisions for meaningfully engaging with residents in these communities and conducting an environmental justice analysis to evaluate localized impacts of the plans. The EPA has provided guidance and tools to aid in this effort (EPA 2016).

States that adopt carbon trading programs should be vigilant about the potential for concentrating fossil fuel generation in

overburdened communities and creating co-pollutant "hot spots." Pairing trading programs with complementary measures such as targeted investments in local clean energy and energy efficiency initiatives, tighter limits on co-pollutants, and incentives for coal plant retirements could help limit the public health burden in these communities. Revenues from the auctioning of carbon allowances can be used to fund some of these efforts.

The shift away from coal also has an adverse economic impact on coal miners and coal-dependent communities (EJLFC 2016). To minimize these impacts, state compliance plans should include provisions to help with transition assistance, including programs for worker training and economic diversification.

FIGURE 2. State-by-State Average Annual Carbon Revenues from Auctioning Allowances under the CPP National Trading Case, 2022–2030



By auctioning carbon allowances and participating in an interstate carbon trading program, states could generate a combined \$17.8 billion in average annual revenues from 2022 to 2030 under the CPP National Trading Case. These carbon revenues could help offset higher consumer electricity bills or be reinvested for the benefit of each state’s residents.

* The EPA has exempted Alaska and Hawaii from the CPP for now because of insufficient data to establish emissions-reduction targets for these two states. Vermont has no obligation under the CPP because there are no fossil-fuel power stations within its borders.

assessment, both sets of analyses conclude that the modest increased costs of providing electricity under the CPP (as shown in the table) are significantly outweighed by the health and social benefits of reduced pollution (EPA 2015b).

Interstate Trading of Carbon Allowances Lowers Costs

To gain a better understanding of the impacts from allowing interstate trading of carbon allowances, below we compare the CPP No Trading Case with the CPP National Trading Case and describe several key differences in their results.

Total electric-system cost. Under the CPP No Trading Case, the cumulative cost through 2030 of changes in the electricity sector from complying with the CPP is \$9.8 billion higher than under the CPP National Trading Case. This figure is derived as follows: Total cumulative electric-system cost under the CPP No Trading Case is \$14.5 billion (or

0.4 percent) from 2015 to 2030, relative to the Reference Case. Under the CPP National Trading Case, total cumulative electric-system cost relative to the Reference Case is nearly \$82 billion through 2030, but there is also a total revenue of \$77 billion from the auctioning of carbon allowances. As a result, the net cost for the CPP National Trading Case is \$4.7 billion through 2030, a savings of about \$9.8 billion compared with the CPP No Trading Case.

Generation mix and coal plant retirements. Compared with the CPP National Trading Case, coal generation as a percent of the total U.S. power supply in 2030 is slightly lower under the CPP No Trading Case (29 percent vs. 31 percent), while natural gas generation is slightly higher (22 percent vs. 20 percent). Contributions to the U.S. power supply from all other sources remains roughly the same under both cases. However, a more telling difference revealed by our analysis is that the trading provisions in the CPP National Trading Case actually lead to increased retirements of inefficient polluting plants and greater use of the nation’s more efficient

Methodology

We used a modified version of the Regional Energy Deployment System (ReEDS)—a power-sector model developed by the National Renewable Energy Laboratory—to analyze various possible versions of CPP compliance. ReEDS determines through simulation the electricity-supply mix that would meet electricity demand in the future (through 2050) throughout the contiguous United States at the lowest overall system cost while meeting reliability, environmental, and other legal requirements. The assumptions in our version of the model are based on information used by the Energy Information Administration for the *Annual Energy Outlook 2015* (EIA 2015b), supplemented by data from the recent Wind Vision and SunShot Vision studies (DOE 2015; DOE 2012). We also updated the model's data for existing power plants to include recent retirements and plants under construction (see the technical appendix, online at www.ucsusa.org/CleanPowerPlanNational, for more information).

In this analysis, we compared the Reference Case with two policy cases, each of which achieves nationwide CPP compliance. While the CPP offers “flexible” compliance options—i.e., a wide range of potential strategy mixes—for each state, in our analysis we investigated just two sets of options for CPP compliance: a CPP Compliance Pathway with full trading of

emission allowances nationwide (i.e., our CPP National Trading Case); and a CPP Compliance Pathway with no national trading of allowances (i.e., our CPP No Trading Case).

For the CPP National Trading Case, we modeled the CPP mass-based targets including both new and already existing fossil fuel-fired power plants. We assumed that each state has the option to meet its CPP target by trading carbon allowances with any other state. We also assumed that all states, as part of their compliance strategy, invest in energy efficiency at a level that achieves a reduction in electricity sales of at least 1 percent per year from 2022 to 2030.⁷

The CPP No Trading Case includes the same elements as the CPP National Trading Case, with the exception that each state achieves its CPP target without interstate trading of carbon allowances (though allowances may be traded among generators within each state's boundaries). We did, however, assume that interstate trading is allowed between the nine Northeast states participating in the Regional Greenhouse Gas Initiative (RGGI)—a preexisting cap and trade program that limits power-sector carbon emissions. We further assumed that the current RGGI cap applies through 2020 and is then extended through 2030 at a similar level of stringency.

coal plants. Between 2015 and 2030, 83 GW of coal plant capacity are retired under the CPP National Trading Case, compared with 78 GW of capacity retired under the CPP No Trading Case. This finding may help alleviate some concerns that an emissions trading program could enable old and inefficient coal plants to continue operating.

To fully benefit U.S. residents, stakeholders should develop state CPP compliance plans that not only prioritize renewables and energy efficiency, but also generate revenue through interstate carbon emissions trading.

Recommendations

Achieving the CPP National Trading Case's full range of benefits will require policy makers and regulators across the country to work with utilities, electricity generators, advocates, regional transmission organizations, and other stakeholders to develop state compliance plans that prioritize renewable energy and energy efficiency and generate revenue through interstate carbon emissions trading. Toward these ends, the Union of Concerned Scientists offers the following recommendations:

1. **States should develop strong mass-based CPP compliance plans.** State agencies should work closely with a broad and diverse set of stakeholders, in an equitable and transparent process, to create a workable compliance plan. In building its plan, each state should prioritize renewable energy and energy efficiency, and it should develop a mass-based emissions trading program that includes both new and existing sources and allows for interstate trading of carbon allowances. While some states could benefit from a rate-based approach, from a national perspective a mass-based approach offers



With well-designed state and federal policies and careful planning and coordination, the United States can greatly increase its clean energy resources, cost-effectively comply with the emissions reductions required by the Clean Power Plan, and reap important economic and public health benefits in the process.

a lower administrative burden, has a long history of successful implementation, and provides the greatest certainty for achievement of an emissions budget. Also, a mass-based approach is better able to incorporate additional carbon-mitigation efforts that must eventually be undertaken for other parts of the economy. In developing their compliance plans, states should also ensure they provide benefits to communities that bear a disproportionate burden of pollution from power plants, and address transition assistance for coal-dependent communities (see Box 1).

2. **As needed, state legislatures should authorize the auction of carbon allowances as part of their state's emissions trading program.** Revenues generated from the auctions should be directed toward programs that benefit all residents, reduce carbon emissions, and promote equitable approaches to transitioning to a low-carbon economy.
3. **Congress and state legislatures should enact strong clean-energy policies.** Policy makers at all levels of government should adopt new or enhanced policies and programs aimed at hastening the deployment of renewable energy and energy efficiency. These measures should include: (1) adopting new, or strengthening existing renewable electricity standards and energy efficiency resource standards; (2) extending tax and other financial incentives; (3) developing carbon-pricing programs; and (4) encouraging clean energy innovation.

With well-designed policies and careful planning and coordination, all states across the country could greatly enhance their clean energy resources, affordably comply with

the emissions reductions required by the Clean Power Plan, and reap important economic and public health benefits. And with a robust national emissions trading program, the states could generate significant carbon revenues that could be used to support high-quality jobs in renewable energy and energy efficiency, strengthen disadvantaged communities, make buildings and infrastructure more resilient to climate change impacts, and boost economic development in regions dependent on the fossil-fuel economy. These benefits would help ensure a sound and prosperous future for all Americans.

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ENDNOTES

1. Unless otherwise indicated, all dollar amounts are expressed in 2015 dollars.
2. While the No Trading Case does not allow for the trading of carbon allowances between states, it does implicitly permit trading of allowances among entities within each state and among the nine Northeast states that participate in the Regional Greenhouse Gas Initiative. The No Trading Case also allows for interstate trading of electricity, which can serve as a means of CPP compliance.
3. Assuming a 7 percent discount rate, based on recommendations outlined in OMB 2014.
4. Electricity costs in the Reference Case are based on the monthly consumption of 600 kilowatt-hours (kWh) for a typical residential nonelectric heating customer. In the CPP National Trading Case, average monthly consumption is lower in 2030 (563 kWh) due to the implementation of stronger energy efficiency programs.
5. The health benefits are calculated from the Regional Particulate Matter (PM_{2.5}) Benefit per Ton Estimates reported in OAQPS 2015. See the technical appendix, online at www.ucsusa.org/CleanPowerPlanNational, for values and additional information.
6. This is the net present value from 2022 through 2030 using a 7 percent discount rate, based on recommendations outlined in OMB 2014.
7. This energy efficiency assumption serves a proxy for state or utility action; it is needed because the ReEDs model does not include choices on energy efficiency. States with stronger mandatory energy efficiency resource standards are assumed to continue meeting their respective targets.

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