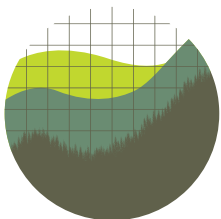# The Falling Cost of Clean Power Plan Compliance

Institute *for*
Policy Integrity
NEW YORK UNIVERSITY SCHOOL OF LAW

Executive Summary

In 2015, the U.S. Environmental Protection Agency (EPA) released the Clean Power Plan (CPP), a Clean Air Act rule designed to address the threat of climate change by cutting carbon dioxide (CO_2) emissions from fossil fuel-fired power plants.[1] The CPP established CO_2 emission targets that phased in gradually, with full compliance not required until 2030, and allowed states substantial discretion in designing plans to meet those goals. EPA projected that the rule would, once fully implemented, reduce the U.S. electric sector's CO_2 pollution to 32 percent below 2005 levels.[2]

The Trump Administration has signaled its intention to suspend, revise, or rescind the Clean Power Plan, as part of a broader review of regulations that "may place unnecessary, costly burdens" on utilities and coal producers.[3] But when EPA issued the CPP, it found that the rule's compliance costs were far outweighed by its climate and health benefits. Specifically, the agency's Regulatory Impact Analysis (RIA) estimated that the CPP would generate between $32 and $54 billion in annual benefits, compared to between $5.1 and $8.4 billion in annual costs.[4] (To put those compliance costs in perspective, note that EPA projected total generating costs for the electric sector of about $180 billion in 2030.[5])

Furthermore, the electric sector has changed since 2015, in ways that make the CPP's emission targets easier to achieve. Key market and policy developments include:

- Ongoing declines in the costs of renewable energy, particularly solar energy;
- The 2015 extension of federal tax credits for renewable energy;
- State programs to support the adoption of clean energy technologies; and
- Further declines in the forecast price of natural gas.

If EPA were to update its RIA with current data that reflected these developments, it would project even lower compliance costs than it did in 2015.

Indeed, more recent economic analyses conducted by independent, non-governmental entities have estimated substantially lower compliance costs than EPA did. A June 2016 analysis by M.J. Bradley & Associates (MJB&A), which used the same electric sector model as EPA but updated several key inputs, provides a particularly clear illustration of the extent to which post-2015 market and policy developments have reduced CPP compliance costs. In January 2016, MJB&A estimated annual CPP compliance costs in 2030 that ranged from $4.5 to $8.2 billion, depending on

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[1] Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 80 Fed. Reg. 64,662 (Oct. 23, 2015).

[2] *Id.* at 64,665.

[3] EPA Status Report, West Virginia v. EPA, No. 15-1363 (D.C. Cir. Sept. 7, 2017); Press Release, EPA, EPA to Review the Clean Power Plan Under President Trump's Executive Order (Mar. 28. 2017), https://www.epa.gov/newsreleases/epa-review-clean-power-plan-under-president-trumps-executive-order.

[4] *See* EPA, Regulatory Impact Analysis for the Clean Power Plan Final Rule tbl.ES-9 & tbl.ES-10 (2015) (using 3% discount rate) [hereinafter CPP RIA]. EPA estimated costs assuming two different compliance frameworks, reflecting the flexible compliance options the final rule provided to states. The $5.1 billion estimate assumes that all states adopt a mass-based compliance framework. The $8.4 billion estimate assumes that all states adopt a rate-based compliance framework.

[5] *Id.* tbl.3-9.

certain assumptions regarding state implementation choices.[6] Five months later, after updating its modeling to reflect the extension of renewable tax credits and falling price forecasts for natural gas, MJB&A projected costs for the same compliance scenarios that were, on average, 65 percent lower than its prior estimates.[7]

The cost-lowering effects of recent market developments were also reflected in an October 2016 analysis by the American Petroleum Institute (API). Using the same computer model as EPA but incorporating updated fuel price assumptions, API estimated that, under one possible compliance scenario, the CPP would impose no costs at all in 2030.[8] Under another compliance scenario, API projected costs that were more than 40 percent lower than EPA's estimate.[9]

This report summarizes the findings of EPA's 2015 RIA, discusses subsequent market and policy developments that have lowered the cost of complying with the CPP, and, finally, surveys more recent CPP cost analyses by independent groups that incorporated some or all of those market and policy developments.

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[6] *See infra* Table 3.
[7] *Id.* (projecting compliance costs ranging from $0.8 to $3.7 billion).
[8] *See infra* Table 4 (projecting compliance costs of $0 for mass-based compliance framework that applies only to existing sources).
[9] *See id.* (projecting compliance costs of $3 billion for mass-based compliance framework that applies to both new and existing sources).

EPA's 2015 Analysis of the Clean Power Plan's Costs and Benefits

When evaluating rules that affect the electric sector, EPA has long relied on the Integrated Planning Model (IPM), a peer-reviewed model developed and maintained by the consulting firm ICF International.[10] Used by a wide variety of private and public-sector entities, IPM integrates key operational elements of electric power generation and assesses the sector's total generating costs given specified constraints, such as limits on air pollution emissions. To estimate a rule's costs, EPA first models what the electric sector's total capital and operational costs would be in a given year without the new regulation in place. The agency then estimates the sector's total costs for the same year with the rule's emission constraints added. The difference between the two estimates represents the incremental cost of compliance.

The CPP provides states and power companies with significant flexibility as to their method of compliance. As a result, in its RIA for the CPP, EPA had to make a number of assumptions about how states would design compliance plans and how power companies would comply. These included assumptions about the use of interstate emissions trading or averaging, whether states would allow affected power plants to bank compliance instruments for later use, and the amount of energy efficiency that states and companies would pursue as an emission-reduction tool. Ultimately, EPA chose to model two illustrative compliance scenarios: a rate-based scenario (in which all states met a standard limiting pounds of CO_2 per megawatt hour of electricity generated) and a mass-based scenario (in which all states capped *total* CO_2 emissions from the electric sector).[11] Under the rate-based scenario, EPA assumed that fossil fuel-fired generating units subject to the CPP could achieve the rule's emission-rate targets by averaging emissions with other units in the same state and by lowering their effective emission rates through the procurement of renewable energy generation and energy-efficiency savings anywhere in their interconnection region.[12] Under the mass-based approach, EPA assumed that units could trade emissions allowances only with other units in the same state.[13] It also assumed that state governments would pursue cost-effective energy efficiency projects to reduce electricity demand and emissions.[14]

As summarized in Table 1, EPA estimated annual incremental compliance costs in 2030 of $8.4 billion for the rate-based approach and $5.1 billion for the mass-based approach.[15] These incremental compliance costs reflect the change in the electric sector's capital and operation costs under the CPP, relative to a business-as-usual scenario without the CPP.[16] Estimated compliance costs also reflect both the expenditures necessary to achieve expected levels of energy efficiency and the offsetting value of the energy savings that flow from those efficiency improvements.[17] In this way, the annual incremental compliance costs reflect the net costs of energy efficiency.

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[10] *See* EPA, Clean Air Markets – Power Sector Modeling, https://www.epa.gov/airmarkets/clean-air-markets-power-sector-modeling (last visited Sept. 28, 2017).

[11] CPP RIA, *supra* note 4, at 3-7.

[12] *Id.* at 3-8 to 3-10.

[13] *Id.* at 3-10.

[14] *Id.* at 3-9 to 3-10.

[15] *Id.* at ES-9.

[16] *Id.* at ES-10.

[17] *Id.*

Table 1: EPA Estimates of Annual Incremental Compliance Costs (billion 2011$)

Compliance Approach	2025	2030
Rate-based	$1.0	$8.4
Mass-based	$3.0	$5.1

In addition to estimating the costs of the CPP, EPA estimated the rule's benefits that could be given a monetary value. These included both the climate benefits of CO_2 emission reductions and the health benefits—such as avoided premature deaths, heart attacks, and asthma hospitalizations—of reductions in sulfur dioxide (SO_2), nitrogen oxides (NO_x), and particulate matter (PM2.5) emissions that would result from the CPP.[18] The IPM model projected the quantity of these pollutants that would be reduced under the CPP, which EPA then monetized using established metrics such as the social cost of carbon (SCC).[19] EPA expressed health co-benefits as a range to reflect different estimates in the scientific literature of the relationship between air pollution and health outcomes.[20]

For 2030, EPA estimated combined annual climate benefits and health co-benefits of $32 to $48 billion under the mass-based approach and $34 to $54 billion under the rate-based approach.[21] These benefits reflect the net present value of the emission reductions achieved by the CPP, using a three percent discount rate.[22]

Overall, EPA estimated that, in 2030, the CPP's annual benefits would exceed its annual costs by $26 to $43 billion under a mass-based approach and $26 to $45 billion under a rate-based approach.[23]

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[18] *Id.* at ES-10 to ES-11.

[19] The SCC is a monetary estimate of the net economic impact of each ton of carbon dioxide that is released into the air. Based on the results of multiple, independent modeling efforts, and developed by an interagency working group with review and input from the National Academy of Sciences, the metric has been used by a variety of agencies to evaluate policies that affect greenhouse gas emissions. For additional background on the SCC, *see* Institute for Policy Integrity, Social Cost of Greenhouse Gases (2017), http://policyintegrity.org/files/media/ Social_Cost_of_Greenhouse_Gases_Factsheet.pdf.
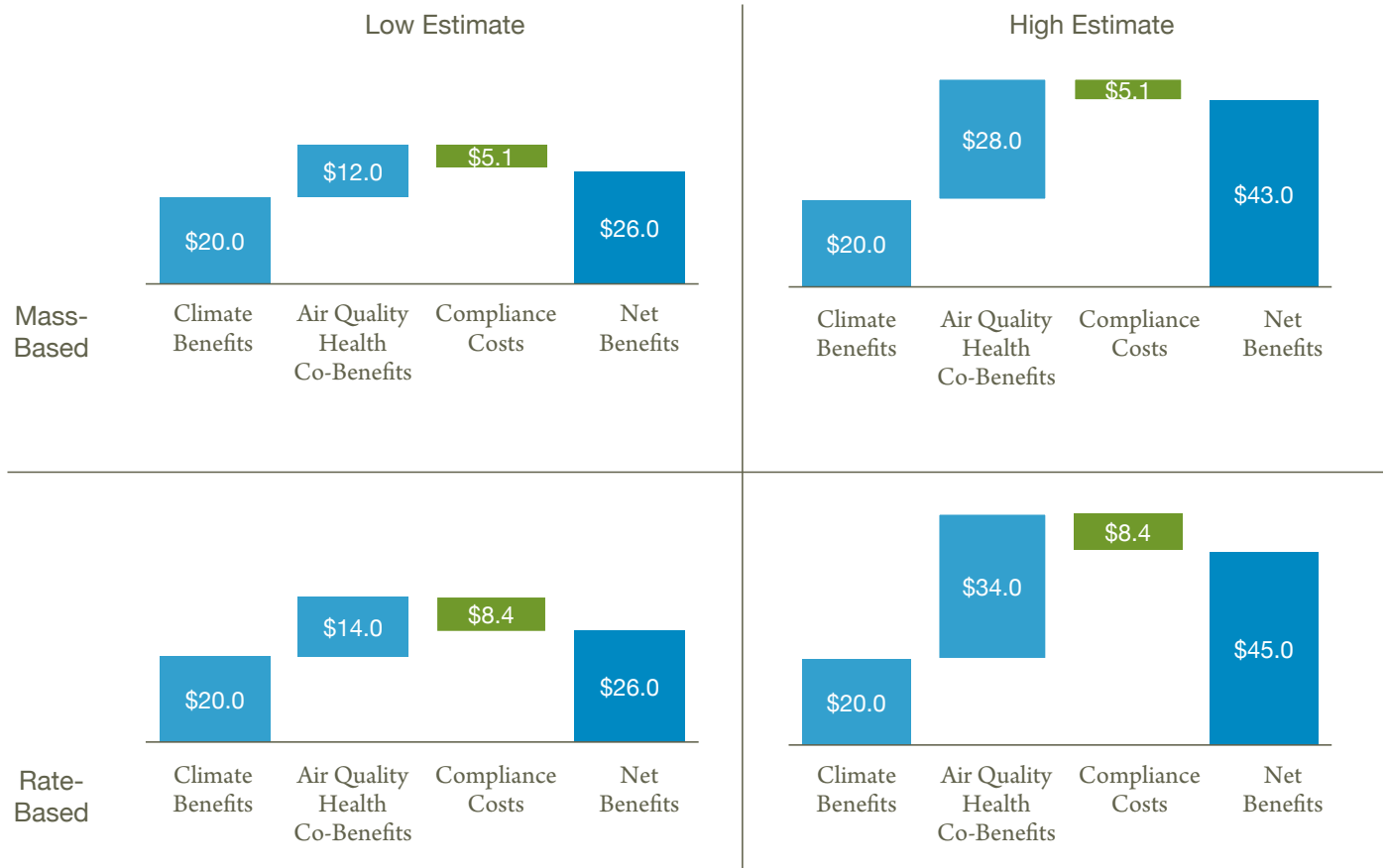
[20] CPP RIA, *supra* note 4, tbl.ES-7 (explaining that health co-benefits estimates reflect a "range based on adult mortality functions" from the scientific literature).

[21] *See id.* at tbl.ES-7 & tbl.ES-8.

[22] The RIA also included estimates of climate benefits at discount rates of 2.5% and 5% and estimates of health co-benefits at a discount rate of 7%. *Id.* at tbl.ES-9 & tbl.ES-10. Under all rates, the CPP's benefits outweighed its costs.

[23] *Id.* at tbl.ES-9 & tbl.ES-10.

Figure 1: EPA Estimates of Annual Benefits and Costs in 2030 at a 3% Discount Rate (billion 2011$)[24]

Low Estimate

High Estimate

Mass-Based

Climate Benefits $20.0	Air Quality Health Co-Benefits $12.0	Compliance Costs $5.1	Net Benefits $26.0

Climate Benefits $20.0	Air Quality Health Co-Benefits $28.0	Compliance Costs $5.1	Net Benefits $43.0

Rate-Based

Climate Benefits $20.0	Air Quality Health Co-Benefits $14.0	Compliance Costs $8.4	Net Benefits $26.0

Climate Benefits $20.0	Air Quality Health Co-Benefits $34.0	Compliance Costs $8.4	Net Benefits $45.0

In addition to the monetized climate and health co-benefits summarized above, EPA identified additional benefits that it was not able to quantify or monetize as part of its analysis. These additional benefits included: climate impacts from changes in non-CO_2 greenhouse gases, such as methane and aerosols; climate impacts from changes in black carbon and ozone; health impacts of reductions in exposure to mercury; and ecosystem impacts from improved visibility and reductions in acid rain.[25]

Recent Energy Sector Developments Relevant to the Clean Power Plan

EPA established the CPP's CO_2 emission guidelines based "in large part on already clearly emerging growth in clean energy innovation, development and deployment."[26] These trends continue to reshape the electric power system in the United States, moving the sector closer to the CPP's emission targets, even though implementation of the rule has been suspended since February 2016.[27]

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[24] All estimates are rounded to two significant figures, so numbers may not sum.
[25] CPP RIA, *supra* note 4, tbl.ES-6.
[26] 80 Fed. Reg. at 64,662.
[27] The U.S. Supreme Court stayed the rule pending resolution of certain legal challenges. West Virginia v. EPA, 136 S. Ct. 1000 (2016) (mem.).

When it finalized the CPP in 2015, EPA expected the rule to reduce annual electric sector CO_2 emissions to 32 percent below 2005 levels by 2030. Without the rule, EPA expected 2030 emissions to be only 17 percent below 2005 levels.[28]

By 2016, power sector emissions were already down to 25 percent below 2005 levels (see Figure 2),[29] and current modeling suggests that, in the absence of the CPP, emissions in 2030 could be between 22 and 28 percent below 2005 levels, depending on the price of natural gas.[30] Thus, although the CPP is still expected to achieve significant CO_2 reductions beyond those that the market would achieve on its own, the gap between projected emissions with the CPP and projected emissions without the CPP has narrowed since 2015.[31]

Figure 2: Carbon Dioxide from Electric Sector: Historic Emissions and EPA Target (billion short tons)
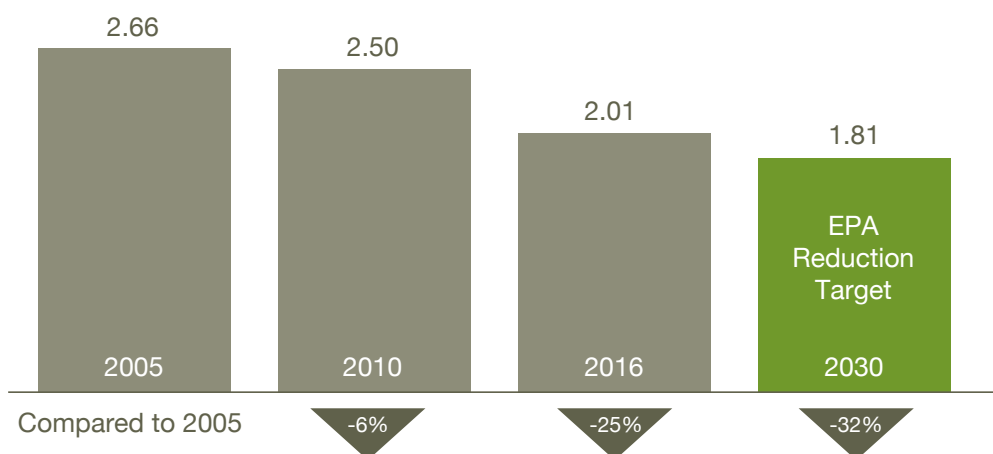
Note: The EPA reduction target shown here is calculated as 32% below 2005 electric sector emissions as reported by EIA.

One of the key factors driving recent emission reductions has been a decline in coal-fired power generation, primarily caused by low natural gas prices.[32] Although this trend was already occurring when EPA developed the CPP, price forecasts for natural gas have continued to decline. In its RIA, EPA used estimates developed by the Department of Energy's Energy Information Administration (EIA) for its Annual Energy Outlook (AEO) in 2015.[33] Since the RIA was published, however, EIA's natural gas price forecast for 2030 has dropped by more than 12 percent.[34]

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[28] CPP RIA, *supra* note 4, tbl.ES-4.

[29] U.S. Energy Info. Admin., Monthly Energy Review June 2017 tbl.12.6 (2017), *available at* https://www.eia.gov/totalenergy/data/monthly/archive/00351706.pdf.

[30] *See* U.S. Energy Info. Admin., Annual Energy Outlook 2017, Energy-Related Carbon Dioxide Emissions by Sector and Source: Reference Case Without Clean Power Plan, https://www.eia.gov/outlooks/aeo/tables_side.php; *id.*, Energy-Related Carbon Dioxide Emissions by Sector and Source: High Resource Without Clean Power Plan, https://www.eia.gov/outlooks/aeo/supplemental_case.php.

[31] Importantly, no matter how small the gap between projected business-as-usual emissions and emissions under the CPP becomes, the CPP provides certainty regarding future reductions that market trends alone cannot.

[32] *See, e.g.,* Trevor Houser et al., Columbia SIPA Center on Global Energy Policy, Can Coal Make a Comeback? (2017) (estimating that "49 percent of the decline in domestic US coal consumption was due to the drop in natural gas prices, 26 percent was due to lower than expected electricity demand, and 18 percent was due to growth in renewable energy").

[33] CPP RIA, *supra* note 4, at 3-5.

[34] Compare U.S. Energy Info. Admin., Annual Energy Outlook 2015 tbl.A1 (2015), https://www.eia.gov/outlooks/archive/aeo15/pdf/tbla1.pdf (projecting a natural gas price of $5.69 per MMBtu in 2030 under reference case), *with* U.S. Energy Info. Admin., Annual Energy Outlook 2017, tbl.A1 (projecting a price of $5.00 per MMBtu in 2030 under reference case).

Coinciding with the start of the shale gas revolution, coal generation peaked in 2007, at which time it was responsible for 50 percent of total generation in the United States.[35] By 2014, the year before EPA completed its modeling, coal's share of generation had declined to 40 percent.[36] And in 2016, coal generation dropped to 31 percent of the nation's total.[37] That same year, natural gas overtook coal as the nation's largest source of electricity for the first time since EIA began collecting data (see Figure 3).[38] Coal-fired power plants have continued to retire from the system in 2017.[39]

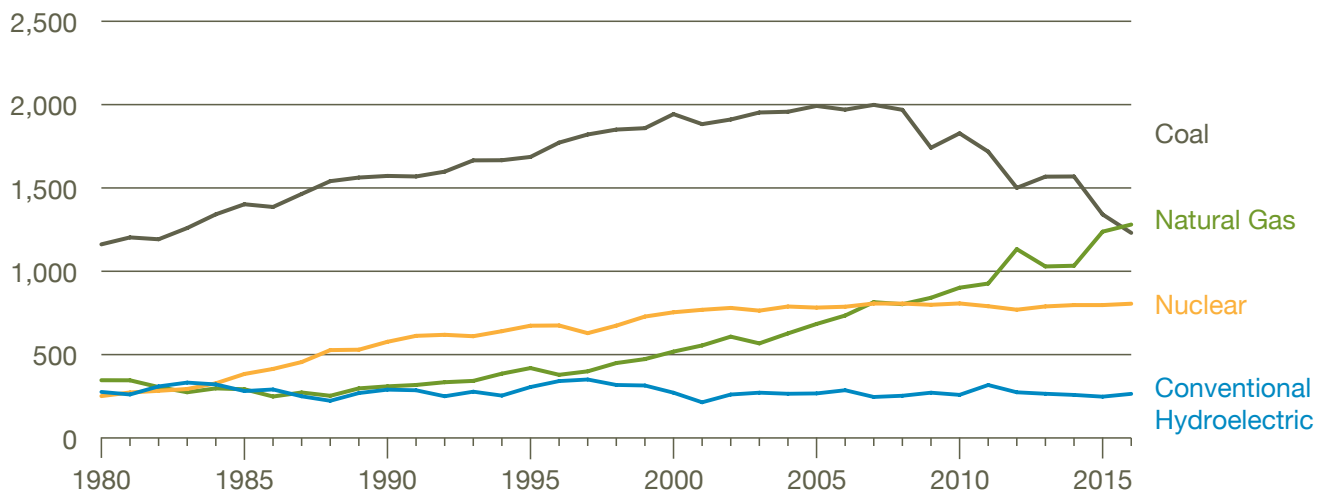Figure 3: Historic Generation Trends of Select Fuel Types (terawatt hours)

Photo © Fletcher6

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[35] U.S. Energy Info. Admin., Monthly Energy Review June 2017 tbl.7.2b (2017), *available at* https://www.eia.gov/totalenergy/data/monthly/archive/00351706.pdf.

[36] *Id.*

[37] *Id.*

[38] *Id.*

[39] *See Factbox: U.S. coal-fired power plants scheduled to shut*, Reuters (May 16, 2017), https://www.reuters.com/article/us-usa-coal-retirement-factbox/factbox-u-s-coal-fired-power-plants-scheduled-to-shut-idUSKCN18C2C5 (noting that "U.S. power companies expect to retire or convert from coal to gas nearly 8,000 megawatts of coal-fired plants in 2017").

Meanwhile, renewable energy development has continued to surge. Together, wind and solar accounted for 63 percent of utility-scale capacity additions in 2016.[40] The U.S. solar industry alone added over 10 gigawatts (GW) of solar capacity in 2016, a new annual record and double the capacity added in 2015.[41] Wind energy has experienced similar record growth and now has an installed capacity of more than 80 GW.[42] A number of factors are driving deployment of renewable energy:

1. The economics of wind and solar continue to improve;[43]

2. Congress extended tax incentives for renewable energy at the end of 2015;[44] and

3. 29 states (and the District of Columbia.) have renewable portfolio standards and an additional 8 states have renewable portfolio goals.[45]

Additionally, large consumers of electricity are pursuing renewable energy options. For example, 111 companies—including leading U.S. corporations like Apple, Coca-Cola, Facebook, General Motors, Google, Microsoft, Nike, and Starbucks—have committed to 100 percent renewable electricity through an initiative called RE100.[46] These companies are entering into direct agreements for renewable energy. For example, General Motors recently purchased 50 megawatts of wind in Texas to equal the electricity needs of 16 of its U.S. facilities.[47]

A final factor contributing to emissions reductions is continued investment in energy efficiency programs by states and consumers. In 2015, state energy efficiency programs saved more than 26 million megawatt hours—almost twice the amount saved in 2010.[48] Those savings were equivalent to almost one percent of total U.S. electric demand for 2015.[49]

If EPA were to revisit its 2015 CPP modeling with updated assumptions reflecting these recent changes in the electric power system, it would find that the costs of compliance are significantly lower than previously anticipated. First, ongoing market trends are reducing electric sector emissions, narrowing the gap between business-as-usual emissions and the

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[40] U.S. Energy Info. Admin., *Renewable generation capacity expected to account for most 2016 capacity additions*, Today in Energy (Jan. 10, 2017), https://www.eia.gov/todayinenergy/detail.php?id=29492.

[41] U.S. Energy Info. Admin., *U.S. electric generating capacity increase in 2016 was largest net change since 2011*, Today in Energy (Sept. 27, 2017), https://www.eia.gov/todayinenergy/detail.php?id=30112 (noting that solar industry added 7.7 GW of utility-scale capacity and 3.4 GW of distributed capacity in 2016); U.S. Energy Info. Admin., *Wind adds the most electric generation capacity in 2015, followed by natural gas and solar*, Today in Energy (Mar. 23, 2016), https://www.eia.gov/todayinenergy/detail.php?id=25492 (showing that the solar industry added just over 5 GW of total capacity in 2015).

[42] U.S. Energy Info. Admin., *U.S. wind generating capacity surpasses hydro capacity at the end of 2016*, Today in Energy (Mar. 6, 2017), https://www.eia.gov/todayinenergy/detail.php?id=30212.

[43] *See, e.g.*, Ran Fu et al., Nat'l Renewable Energy Lab., U.S. Solar Photovoltaic System Cost Benchmark: Q1 2016 (2016) (showing a 20% decline in the cost of utility-scale photovoltaics between 2015 and 2016).

[44] Armando Gomez et al., *Congress Extends Renewable Energy Tax Credits*, Skadden, Dec. 21, 2015, https://www.skadden.com/insights/publications/2015/12/congress-extends-renewable-energy-tax-credits.

[45] Renewable Portfolio Standard Policies, Database of State Incentives for Renewables & Efficiency (Feb. 2017), http://ncsolarcen-prod.s3.amazonaws.com/wp-content/uploads/2017/03/Renewable-Portfolio-Standards.pdf.

[46] Companies, RE100, http://there100.org/companies (last visited Sept. 27, 2017).

[47] Press Release, General Motors, GM Makes its Largest Green Energy Purchase to Date (Nov. 16, 2016), http://media.gm.com/media/us/en/gm/news.detail.html/content/Pages/news/us/en/2016/nov/1116-green.html.

[48] Compare U.S. Energy Info. Admin., Form 861, Electric Power Sales, Revenue, and Energy Efficiency (2015), (energy efficiency savings in column I of "Energy_Efficiency_2015"), with U.S. Energy Info. Admin., Form 861, Electric Power Sales, Revenue, and Energy Efficiency (2010) (energy efficiency savings in column K of "file 3_2010").

[49] U.S. Energy Info. Admin., Electric Power Annual tbl.1.1 (2016), https://www.eia.gov/electricity/annual/ (showing total sales of 3.76 billion megawatt hours in 2015).

CPP targets, meaning that fewer total tons of CO_2 would need to be abated to meet the CPP targets.[50] Second, lower renewable energy costs and natural gas prices mean that the emissions that need to be abated under the CPP can be reduced more cheaply than EPA first projected.[51]

More Recent Estimates of the Clean Power Plan's Costs

After EPA finalized the CPP and published its modeling, a number of organizations conducted additional modeling to better understand compliance options and to explore the impact of market and policy developments that occurred after EPA finalized its own data inputs. The key changes captured in the more recent modeling were Congress's extension of tax credits for electricity generated from wind and solar resources and lower natural gas price and renewable technology cost forecasts. In all cases where direct comparison to EPA's results is possible, independent analyses that incorporated these market and policy developments estimated significantly lower compliance costs than EPA did in its 2015 analysis.

Estimates Using the Same Electric Sector Model as EPA

A number of independent modeling efforts used IPM, the same model of the electric sector that EPA employed in its analysis of the CPP. These IPM studies, with key assumptions and results summarized in Table 2, are particularly useful for highlighting the effect of the changes that occurred after EPA completed its own modeling. The table focuses on mass-based compliance scenarios. Independent analyses tended to favor this compliance option, so it provides a consistent regulatory approach across model runs.

There is some variability in how the CPP was modeled across these cases. In particular, EPA modeled a mass-based scenario in which only existing sources were covered by the rule.[52] However, although the CPP's emission guidelines apply only to existing sources, the rule requires states relying on mass-based implementation to adopt measures preventing emission "leakage"—that is, the potential for power producers to respond to limits on existing sources by increasing emissions from newly constructed sources.[53]

One option for addressing such leakage is for the state to include both new and existing sources in its mass-based trading system.[54] The other model runs in Table 2 assume that states would choose this leakage-prevention strategy and include both new and existing sources under their emission caps. All else being equal, this raises projected compliance costs when compared to a compliance scenario that covers existing sources only and does not include other measures to prevent shifting of generation to new sources. In other words, had the independent groups looked only at existing sources, as EPA

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50   To be clear, lower business-as-usual emissions reduce both the costs and the benefits of the CPP (because if fewer tons are being abated to meet the CPP targets, fewer climate and health benefits are attributable to the CPP). Because benefits do not decline *more* than costs, however, the benefits of the rule continue to significantly outweigh the compliance costs.

51   Unlike the downward adjustment to business-as-usual emissions, the decline in per-ton abatement costs reduces the costs of the CPP without also reducing its benefits.

52   CPP RIA, *supra* note 4, at 3-7.

53   80 Fed. Reg. at 64,823.

54   *Id.* at 64,888.

did in its original modeling, their compliance cost estimates would have been even lower than shown here. Indeed, API *did* perform an existing-only run and estimated that, under that scenario, the CPP would impose no incremental costs in 2030.[55] Similarly, the Bipartisan Policy Center (BPC) estimated average annual costs of only $1 billion for an existing-only compliance scenario.[56]

Table 2: Annual Incremental Cost Estimates and Key Assumptions for CPP Modeling

| CPP Scenario	Modeling Entity	Report Date	Incremental Cost of the CPP (billion 2011$)	Natural Gas Price Forecast	Renewable Tax Credit Extension	Energy Efficiency Assumption
Mass-based (existing only)	EPA	2015	$5.1 in 2030	AEO 2015 Reference Case	No	Increasing to 1% of demand per year
Mass-based (existing + new)	MJB&A	2016 (Jan)	$7.4 in 2030	AEO 2015 Reference Case	No	1% or greater savings rate per year
		2016 (June)	$0.8 in 2030	AEO 2015 avg. of RC and High Oil and Gas Resource	Yes	1% or greater savings rate per year
	BPC	2016	≈$5.4 annual average (2022-2032)	AEO 2015 avg. of RC and High Oil and Gas Resource	Yes	No incremental EE
	API	2016	Less than $3.0 in 2030 ("market forces" scenario)	AEO 2015 High Oil and Gas Resource	No	No incremental EE

Figure 4 illustrates the differing slopes of the three natural gas price forecasts cited in Table 2. EPA's modeling used the AEO 2015 Reference Case, shown in blue, as did MJB&A's January 2016 modeling. But MJB&A's June 2016 modeling and BPC's June 2016 modeling used an average of the AEO 2015 Reference Case and the AEO 2015 High Oil and Gas Resource case, shown as a dotted line. In an October 2016 analysis, API used the AEO 2015 High Oil and Gas Resource Case, shown in green, to reflect expectations of lower natural gas prices. The alternative forecasts used by MJB&A and BPC are closer to current expectations of future natural gas prices, as reflected in EIA's AEO 2017 Reference Case, shown in yellow. The forecast used by API is lower than EIA's current expectation of future natural gas prices.

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[55] *See infra* Table 4.
[56] Jennifer Macedonia et al., Bipartisan Policy Center, Modeling the Evolving Power Sector and Impacts of the Final Clean Power Plan 28 (2016), https://bipartisanpolicy.org/wp-content/uploads/2016/06/BPC-Energy-Clean-Power-Plan-Modeling.pdf.

Figure 4: AEO 2015 Natural Gas Henry Hub Spot Prices Used for Modeling and AEO 2017 for Comparison (2013$/MMBtu)
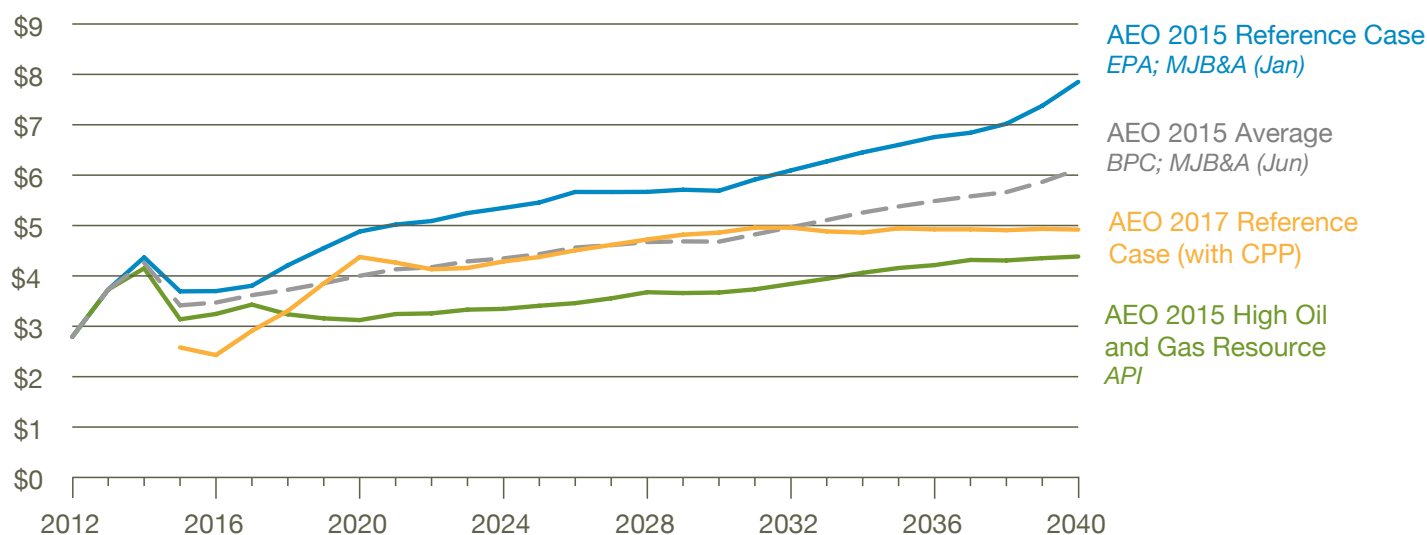
Note: Reference Case used in EPA and January 2016 MJB&A modeling. Average used in June 2016 MJB&A and BPC modeling. High Oil and Gas Resource used in API modeling.

M.J. Bradley & Associates

MJB&A published two rounds of IPM modeling of the final CPP, first in January 2016 and again in June 2016. The January 2016 modeling used the same natural gas price forecast as EPA's analysis and, like EPA's analysis, did not incorporate the congressional extension of renewable energy tax credits.[57] The June 2016 modeling, by contrast, incorporated the tax credits and used a natural gas price forecast based on the average of the AEO 2015 Reference Case and High Oil and Gas Resource Case, to approximate expected updates to the natural gas price forecast.[58]

A side-by-side comparison of these two sets of results provides a particularly clear illustration of the extent to which taking into account recent energy sector developments, while holding other key assumptions constant, reduces expected CPP compliance costs.

[57] M.J. Bradley & Assocs., EPA's Clean Power Plan: Summary of IPM Modeling Results 5 (Jan. 2016), http://www.mjbradley.com/sites/default/files/MJBA_CPP_IPM_Summary.pdf.
[58] M.J. Bradley & Assocs., EPA's Clean Power Plan: Summary of IPM Modeling Results with ITC/PTC Extension 5 (June 2016), http://www.mjbradley.com/sites/default/files/MJBA_CPP_IPM_Report_III_2016-06-01_final_0.pdf.

Table 3: MJB&A Estimates of Annual Incremental Compliance Costs in 2030 (billion 2012$)[59]

Compliance Scenario Description	2030	
	January 2016 Runs	June 2016 Runs
Mass-based (existing + new), Intra-state trading, Energy efficiency increased to 1% per year	$7.4	$0.8
Mass-based (existing + new), Interstate trading, Extend current energy efficiency	$8.2	$2.3
Mass-based (existing + new), Interstate trading, Energy efficiency increased to 1% per year	$7.0	$1.5
Mass-based (existing + new), Interstate trading, Energy efficiency increased to 2% per year	$4.5	$2.2
Rate-based, Interstate trading, Energy efficiency increased to 1% per year	$5.7	$3.7

The first scenario in Table 3 (Mass-based (existing + new), Intra-state trading, Energy efficiency increased to 1% per year) is the most comparable to the mass-based compliance scenario in EPA's 2015 regulatory impact analysis. The major difference is that the MJB&A case includes both new and existing sources in the compliance program while EPA included only existing sources, and this difference likely explains why MJB&A's January 2016 estimate of a $7.4 billion cost for this scenario is higher than EPA's $5.1 billion estimate for its mass-based compliance scenario. After MJB&A updated its assumptions in June 2016 to include renewable energy tax credits and lower natural gas price forecasts, however, its estimated costs for this scenario declined by almost 90 percent to $0.8 billion—a level far below EPA's projection, even with new sources included.

The final scenario in Table 3 (Rate-based, Interstate trading, Energy efficiency increased to 1% per year) is the closest to EPA's rate-based scenario. One significant difference is that, unlike EPA, the MJB&A case did not include states with existing mass-based trading programs (California and the Regional Greenhouse Gas Initiative states) in the rate-based framework.[60] This is likely part of the reason that MJB&A's January 2016 estimate of a $5.7 billion cost for this scenario is lower than EPA's $8.4 billion estimate for its rate-based compliance scenario. As with the mass-based scenario, however, once MJB&A updated its assumptions in June 2016 to reflect renewable energy tax credits and lower natural gas price forecasts, its estimated costs for the rate-based scenario fell substantially—in this case, by more than 30 percent.

Bipartisan Policy Center
In June 2016, the Bipartisan Policy Center (BPC) released an IPM-based analysis of the CPP.[61] The BPC modeling included the congressional extension of the renewable energy tax credits and natural gas prices that anticipated reductions in forecast prices by averaging the AEO 2015 Reference Case and the AEO 2015 High Oil and Gas Resource Case.[62]

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[59] M.J. Bradley & Assocs., Supplemental Data: System Costs, Average Bills, and Emissions (2016), http://mjbradley.com/sites/default/files/MJBA_IPM_Results_TotalUS.xlsm.

[60] M.J. Bradley & Assocs., EPA's Clean Power Plan: Summary of IPM Modeling Results with ITC/PTC Extension 6 (June 2016).

[61] Jennifer Macedonia et al., Bipartisan Policy Ctr., Modeling the Evolving Power Sector and Impacts of the Final Clean Power Plan (2016), https://bipartisanpolicy.org/wp-content/uploads/2016/06/BPC-Energy-Clean-Power-Plan-Modeling.pdf.

[62] *Id.* at 14.

BPC found that many states were already on track to meet CPP targets in the initial years of the program (i.e., beginning in 2022) without any incremental compliance expenditures, given the low price of natural gas, the extension of the tax credits, and state-specific policies (e.g., renewable portfolio standards).[63] BPC estimated that, due to these factors, carbon emissions would continue declining even in the absence of the CPP. However, BPC concluded that the CPP would accelerate the decline in emissions and encourage increased investment in renewables.[64]

Unlike EPA's and MJB&A's estimates, the BPC results were presented in terms of average annual compliance costs, rather than as a 2030 compliance cost.[65] The analysis estimated that a mass-based existing-only approach would cost an average of $1 billion (2012$) per year across the compliance period (i.e., from 2022–2032).[66] Adding new sources to BPC's mass-based scenario raised estimated costs to an average of $5.5 billion per year.[67] Finally, BPC projected that a rate-based scenario would cost an average of $9 billion per year.[68]

BPC's runs included significantly less energy efficiency than EPA. While EPA assumed energy efficiency would grow to about one percent of electricity sales per state per year, BPC assumed energy efficiency would not be used for compliance in its primary policy runs.[69] This assumption removes a low-cost compliance option that was included in EPA's analysis.[70] Despite this, with the updated assumptions, BPC found average annual compliance costs for its existing plus new mass-based scenario that were comparable to EPA's 2030 estimates for an existing-only scenario. And BPC's projected average annual costs for an existing-only scenario are significantly lower than EPA's 2030 estimate, even without EPA's higher energy efficiency assumptions.

American Petroleum Institute

In October 2016, API published an IPM-based analysis of the CPP.[71] The analysis estimated costs for three compliance pathways: mass-based for existing sources, mass-based for existing and new sources, and rate-based.[72] API used the AEO 2015 High Oil and Gas Resource Case for its natural gas price forecast.[73] This forecast results in the lowest natural gas prices of any of the modeling efforts described here, as shown in Figure 4. The modeling did not include the congressional extension of the renewable energy tax credits.[74] Each compliance pathway was then modeled assuming three different scenarios:

- Compliance based on the model's least-cost compliance solution;

- Compliance based on a combination of state-specific energy efficiency targets and the model's least-cost compliance solutions; and

- Compliance based on a combination of state-specific renewable energy targets and the model's least-cost compliance solutions.[75]

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[63] *Id.* at 5.
[64] *Id.*
[65] *Id.* at 28.
[66] *Id.*
[67] *Id.*
[68] *Id.*
[69] *Id.* at 59–60.
[70] *Id.* (noting that cost projections for all scenarios decrease when incremental energy efficiency is assumed).
[71] Am. Petroleum Inst., EPA Clean Power Plan Compliance Pathways—Modeled Generation, Capacity and Costs (2016), http://www.api.org/~/media/Files/Policy/Natural-Gas-Solutions/CPP_National_Results.pdf.
[72] *Id.* at 3.
[73] *Id.* at 11.
[74] *Id.* at 14.
[75] *Id.* at 4.

Assuming a mass-based compliance scenario, covering existing sources only and with compliance determined by market forces (i.e., assuming that states adopted no renewable energy or energy efficiency mandates beyond those already on the books), API estimated that the CPP would impose no incremental compliance costs in 2030.[76] Adding new sources raised the projected annual cost to $3 billion, and switching to rate-based compliance brought the expected annual cost to $8 billion (see Table 4).[77]

API found higher costs under compliance scenarios with increased state mandates for energy efficiency and renewable energy.[78] But the CPP does not require any state to adopt such mandates. Additionally, API did not include the Congressional extension of the renewable energy tax credits, which would lower the projected costs of renewable deployment.

Table 4: API Estimates of Annual Incremental Compliance Costs in 2030 (billion 2012$)*

Compliance Scenario	Market Forces	Increased Energy Efficiency Mandates	Increased Renewables Mandates
Mass-based (existing only)	$0	$11	$16
Mass-based (existing + new)	$3	$12	$16
Rate-based	$8	$12	$16
*Dollar values estimated based on a graphic on slide 20 of API's published results			

Estimates Using Alternative Electric Sector Models

In addition to the modeling completed using ICF's IPM, a number of other groups have modeled the CPP using in-house models. Those groups include the Nicholas Institute for Environmental Policy Solutions at Duke University (Nicholas Institute), the Rhodium Group, Synapse Energy Economics, and NERA Economic Consulting. It is more difficult to draw direct comparisons between the cost indicators in these analyses and those in EPA's original RIA, but they do provide alternative projections of compliance costs based on models other than IPM.

Nicholas Institute for Environmental Policy Solutions

In July 2016, the Nicholas Institute published a working paper on the impact of the CPP on the electric sector.[79] The working paper included the results of a series of model runs using the Nicholas Institute's Dynamic Integrated/Economy/Energy/Emissions Model to evaluate the impact of the CPP on generation mix, emissions, and industry costs.[80] The analysis focused on three compliance scenarios: mass-based for existing sources, mass-based for existing and new sources, and rate-based.[81] The Nicholas Institute created a "Standard Assumptions" set of model runs that included similar inputs to other studies completed since EPA's 2015 analysis, including natural gas prices at an average of EIA's Reference Case and High Oil and Gas Resource Case (consistent with the MJB&A and BPC assumption in Figure 4) and the extensions of the renewable energy tax credits.[82]

[76] *Id.* at 20.

[77] *Id.*

[78] *Id.*

[79] Martin T. Ross et al., *Ongoing Evolution of the Electricity Industry: Effects of Market Conditions and the Clean Power Plan on States* (Nicholas Institute, Working Paper NI WP 16-07, 2016), https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_16-07_final.pdf.

[80] *Id.* at 1.

[81] *Id.* at 16.

[82] *Id.* at 12, 14.

Nationally, the Nicholas Institute calculated cumulative compliance costs through 2040 of $12.1 billion under a mass-based approach that covered new and existing sources, $15.4 billion under a rate-based approach, and $1.9 billion under a mass-based approach that covered only existing sources, as shown in Table 5.[83] While the Nicholas Institute did not publish costs for 2030 or an annualized equivalent of costs, the researchers did estimate costs as a percentage increase in generation costs through 2040.[84] As summarized in Table 5, none of the scenarios increases total generation costs by more than one percent. In 2030, EPA estimated that a rate-based program would increase total power sector generating costs, including costs associated with energy efficiency, by about 4 percent and that a mass-based existing-only program would increase total power sector generating costs, including energy efficiency by 2.5 percent.[85]

To better understand the sensitivity of results to gas prices, renewable costs, and demand growth, the researchers also completed runs that varied these assumptions. The results of these sensitivities suggested that low gas prices could reduce policy costs to almost zero under rate- or mass-based scenarios.[86]

Table 5: Nicholas Institute Estimates of Cumulative Compliance Costs as Change in Present Value to 2040

Compliance Scenario	Compliance Cost (billion $)	Compliance Cost (% increase in generation costs)
Mass-based (existing)	$1.9	0.1%
Mass-based (existing + new)	$12.1	0.5%
Rate-based	$15.4	0.7%

Rhodium Group

In May 2016, the Rhodium Group, supported by the Center for Strategic & International Studies, released an assessment of the CPP.[87] Rhodium modeled two compliance scenarios—a rate-based scenario and a mass-based scenario that included both existing and new sources—using an in-house version of the EIA's National Energy Modeling System (NEMS) model called RHG-NEMS.[88] Rhodium Group used the same AEO 2015 natural gas price forecast as EPA, but, unlike EPA, included the extension of the renewable energy tax credits.[89]

Rhodium Group projected that cumulative system costs during the compliance period (2022-2030) would be 8 percent higher under the rate-based compliance scenario compared to the reference case, but only 2 percent higher under the mass-based compliance scenario compared to the reference case.[90] Rhodium Group did not publish its cost estimates; it reported only the cumulative percentage increase relative to its reference case. As a result, its estimates of the CPP's costs cannot be compared with EPA's estimates.

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83 *Id.* at 23-26.
84 *Id.* at 3-4.
85 Calculated as 2030 incremental costs divided by 2030 base case costs. CPP RIA, *supra* note 4, tbl.3-9.
86 *Id.* at 26.
87 John Larsen et al., Ctr. for Strategic & Int'l Studies / Rhodium Grp., Assessing the Final Clean Power Plan: Energy Market Impacts (2016), http://rhg.com/wp-content/uploads/2016/05/AssessingCleanPowerPlan_EMI.pdf.
88 *Id.* at 3.
89 *Id.*
90 *Id.* at 5.

Synapse Energy Economics

In March 2016, Synapse published an update to a January 2016 report entitled "Cutting Electric Bills with the Clean Power Plan: EPA's Greenhouse Gas Reduction Policy Lowers Household Bills."[91] Synapse conducted its analysis with an adapted version of the National Renewable Energy Laboratory's Regional Energy Deployment System (ReEDS) model.[92] Like EPA, Synapse relied on natural gas price forecasts from the AEO 2015 Reference Case, but, unlike EPA, its modeling incorporated the renewable energy tax credit extensions.[93] Synapse examined three scenarios for the U.S. electric sector: (1) a reference case; (2) a "Synapse-CPP" case that emphasized cost-effective energy efficiency and renewables as a compliance pathway; and (3) a "Low-EE-CPP" case that emphasized renewables and expansion of natural gas generation as a compliance pathway.[94]

The Synapse Report assesses the relative compliance costs of its two compliance pathways, finding that total system costs in 2030 are 10 percent higher in the Low-EE-CPP case than in the Synapse-CPP case that includes more energy efficiency measures.[95] It does not, however, report total system costs for either scenario relative to its reference case. As a result, its estimates of the CPP's costs cannot be compared with EPA's estimates.

NERA Economic Consulting

In November 2015, NERA Economic Consulting released an economic analysis of the CPP that relied on NERA's in-house NewERA model.[96] NERA used the same forecast of natural gas prices as EPA (AEO 2015 Reference Case) and higher assumptions for the cost of renewable energy and energy efficiency than EPA.[97] In addition, NERA did not include the extension of the renewable energy tax credits, which Congress approved after NERA published its modeling. These key assumptions, along with the way that NERA accounts for emissions allowances and energy efficiency costs, result in significantly higher estimated costs than found by EPA or the other analyses discussed here.[98]

NERA reported its estimated costs as the net present value of the change in energy sector expenditures from 2022 to 2033 (calculated using a discount rate of five percent).[99] Under a massed-based program. NERA estimated a cumulative increase in expenditures of $220 to $292 billion ($2015), with average annual expenditures of $29 to $39 billion.[100] Under a rate-based scenario, NERA estimated a cumulative energy sector expenditure increase of $192 billion.[101]

In addition to assuming higher costs for compliance strategies (i.e., costlier natural gas, renewable energy, and energy efficiency), NERA also included costs paid for emissions allowances as part of its estimate of total energy sector

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[91] Allison P. Knight et al. Synapse Energy Economics, Inc., Cutting Electric Bills with the Clean Power Plan: EPA's Greenhouse Gas Reduction Policy Lowers Household Bills: March 2016 Update (2016), http://www.synapse-energy.com/sites/default/files/cutting-electric-bills-cpp-march2016.pdf.

[92] *Id.* at 10.

[93] *Id.* at 14.

[94] *Id.* at 1.

[95] *Id.* at 8.

[96] David Harrison et al., NERA, Energy and Consumer Impacts of EPA's Clean Power Plan (2015), http://www.nera.com/content/dam/nera/publications/2015/NERA_ACCCE_CPP_Results_Nov72015.pdf.

[97] *Id.* at 3; Noah Kaufman & Eleanor Krause, *The Economic Impacts of the Clean Power Plan: How Studies of the Same Regulation Can Produce Such Different Results* 3–5 (World Res. Inst. Working Paper, Jan. 2017) (showing that NERA's estimates of energy efficiency and renewable costs are significantly higher than those used by EPA and other organizations).

[98] Kaufman & Krause, *supra* note 97, at 8 ("The NERA study uses mostly pessimistic assumptions . . . and arrives at highly pessimistic results . . . .").

[99] Harrison et al., *supra* note 96, at 6.

[100] *Id.*

[101] *Id.*

expenditures.[102] If allowances are freely allocated to generators, however, allowance sales are merely a means of efficiently distributing emission-reduction costs among participants in the electric sector (because any losses incurred by allowance purchasers are entirely offset by corresponding gains for allowance sellers). They do not result in any additional expenditure by the electric sector as a whole, and adding them to emission-reduction investments overstates total compliance costs.

If allowances were auctioned by state governments, the money paid for the allowance might represent an additional expenditure by the energy sector, above and beyond its total investment in actual emission reductions. But the CPP does not require states to include auctions as part of their implementation of the rule.[103] Accordingly, EPA's own modeling assumed that allowances would be freely allocated to generators.[104] Furthermore, even if a state did choose to auction allowances, the money paid by plant owners to the state government in exchange for allowances would not, under longstanding White House guidance on cost-benefit analysis, qualify as a regulatory "cost." Instead, it would be considered a "transfer payment" that should be discussed in a separate analysis of the rule's distributional effects.[105]

Using NERA's data, removing the allowance value from the compliance cost estimate reduces the estimated cumulative expenditures by more than 50 percent, from $292 billion to $141 billion, implying an annual cost of about $19 billion. Updates to other inputs and assumptions would further reduce the estimated expenditures.

Conclusion

Developments in the electric sector since the EPA estimated the costs and benefits of the Clean Power Plan have accelerated the shift to a cleaner generation mix. As a result, multiple analyses conducted by independent, non-governmental entities subsequent to EPA's original assessment have found that the rule's emission targets could be achieved for significantly less than the agency projected in 2015.
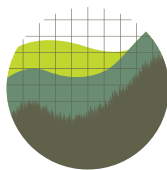
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[102] *Id.* at 24.

[103] Auctions can, however, increase the efficiency of allowance trading programs. *See* Dallas Burtraw et al., *The Effect of Allowance Allocation on the Cost of Carbon Emission Trading* (Resources for the Future Discussion Paper 01-30, 2001).

[104] CPP RIA, *supra* note 4, at 3-36.

[105] *See* Office of Mgmt. & Budget, Circular A-4, p. 38 (2003) ("You should not include transfers in the estimates of the benefits and costs of a regulation. Instead, address them in a separate discussion of the regulation's distributional effects. Examples of transfer payments include the following: . . . Indirect taxes and subsidies.").