January 2017

Basis for Denial of Petitions to Reconsider and Petitions to Stay the CAA section 111(d) Emission Guidelines for Greenhouse Gas Emissions and Compliance Times for Electric Utility Generating Units

Appendix 2 — Power Sector Trends

U.S. Environmental Protection Agency

CONTENTS

Petitions for Reconsideration

Appendix X – Power Sector Trends

This appendix includes an updated assessment of power sector trends that demonstrate overall industry movement toward cleaner energy resources, which is consistent with the Clean Power Plan (CPP). In addition, new information and data show that the CPP goals will be less impactful on the generation mix of the industry and considerably less costly to implement than previously thought. This appendix includes updated analysis about industry-wide developments along with specific examples that support the Environmental Protection Agency's (EPA) conclusion that the CPP is a trend-following air pollution rule that builds upon actions and developments occurring in the power sector.

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1. Introduction

This appendix includes information, data, and analyses published since the release of the final CPP in August 2015. This new information demonstrates that the trends toward low- and zero-emitting energy, upon which the CPP builds, continue unabated, and in this manner, reinforces the fact that the CPP is trend following. Ultimately, this information demonstrates that much of the emissions reductions that the final Rule was designed to achieve will be achieved as a matter of business-as-usual, and as a result, the final Rule will be less impactful on the generation mix of the industry and considerably less costly to implement now than the Environmental Protection Agency (EPA) anticipated at the time of promulgation.

Section 2 of this appendix describes how sources covered by the CPP are well on their way toward meeting the carbon dioxide (CO_2) emission reductions that EPA projected would occur under the CPP. When EPA finalized the CPP in August 2015, the Agency projected that, by 2030, the power sector would reduce its CO_2 emissions 32 percent below 2005 levels. In 2012, CO_2 emissions from sources covered by the CPP were 19 percent below 2005 levels.[1] By the end of 2015, several months after

[1] EPA data show 2,171 million short tons of CO_2 emissions in 2012 from sources covered by the CPP. The CO_2 Emission Performance Rate and Goal Computation Technical Support Document for CPP

the CPP was finalized, those sources already had achieved CO_2 emission levels 24 percent below 2005 levels.[2] Indeed, the level of 2015 emissions is roughly equivalent (only 0.05% difference) to the level contemplated by the CPP for 2022—the first year of the compliance period—for all states collectively.[3] For 24 states, emissions from their sources in 2015 were *lower* than the 2022 level. These trends have continued through 2016: for the period from January through September 2016, power plants reported CO_2 emissions to EPA that were about 8 percent less than emissions during the same 9-month period in 2015.[4] These emission trends demonstrate that while the CPP guarantees significant emission reductions by 2030, at the present time, states and sources are already well on their way to achieving CPP requirements—5 years before the beginning of the compliance period in 2022.

Section 2 of this appendix also provides an update on the ongoing power sector trends that have driven these emissions reductions, focusing in particular on recent developments in fuel and technology costs as well as generation shifts. These trends include declines in coal-fired generation and capacity—with no new coal-fired capacity without carbon capture and sequestration (CCS) being added to the grid since 2012—and significant countervailing increases in natural gas-fired generation and capacity. At the same time, renewable energy has continued to be the fastest growing form of utility-scale electric-generating capacity and is expected to account for the largest share of all new capacity in 2016. In addition, electricity demand is only slowly rising, due in part to the continued development of energy efficiency (EE) standards and programs. Slowly growing electricity demand (an annual average growth rate of 0.8% from 2010 to 2015 and 0.1% between 2012 to 2015)[5] puts additional economic pressures on older and less-efficient technologies (like many coal-fired plants), which struggle to compete with the newer capacity coming online that generally has lower operating costs. The data show that these shifts in

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Final Rule is available at https://www.epa.gov/sites/production/files/2015-11/documents/tsd-cpp-emission-performance-rate-goal-computation.pdf.

[2] EPA data show 2,047 million short tons of CO_2 emissions in 2015 from sources covered by the CPP for the 47 states and 3 Indian Tribes that were covered by the CPP. Data available at Air Markets Program Data, https://ampd.epa.gov/ampd/.

[3] The mass goal for all 47 states and tribes was 2,046 million short tons in 2022 (Goal Computation Data File, Appendix 5).

[4] Air Markets Program Data, at https://ampd.epa.gov/ampd/.

[5] EIA, Retail sales of electricity (Electricity Data Browser, http://www.eia.gov/electricity/data/browser/).

the power sector have been significant. Technological advances in the natural gas industry have led to an abundance of natural gas that is, and is projected to remain, low-cost. The costs of renewable generation have similarly fallen due to technological advances, improvements in performance, and local, state, and federal incentives such as the recent extension of federal tax credits.[6]

Section 2 of this appendix also discusses the factors that are driving these emission-reducing shifts in the power sector. Natural-gas costs have fallen and are projected to remain low; and costs of renewable generation have similarly fallen due to several factors, including declines in technology costs, improvements in performance, and local, state and federal incentives (*e.g.*, extension of federal tax credits). Meanwhile, coal has not seen a commensurate reduction in price. Other developments also are driving these shifts: The nation's fleet of coal-fired power plants—91 percent of which were built more than a quarter-century ago—is aging and as a result, continues to experience retirement pressures. The slow pace of electricity demand growth due in part to EE programs puts further pressure on sources of generation like coal that are already becoming less competitive. Those cost trends and these other developments have served as the main drivers for pronounced, ongoing changes in the nation's generation mix.

These changes in the generation mix away from coal and toward lower- and zero-emitting generation are significantly more pronounced than EPA projected when it finalized the CPP.[7] This allows the states to meet their goals and, ultimately, the

[6] As part of the 2016 Consolidated Appropriations Act enacted in December 2015 (H.R. 2029), Congress extended the qualifying deadlines for the production tax credit (PTC) and investment tax credit (ITC) for renewable generation technologies. The deadline for PTC-eligible technologies to receive the full production credit was extended by 2 years.

[7] The impact of these trends on the nation's generation mix is significantly greater than the impact of the CPP on the generation mix, which confirms that the CPP is trends following. To illustrate, when EPA promulgated the CPP, EPA projected that generation from coal-fired generators would comprise almost 33% of total generation in 2030 without the Rule, and about 27% to 28% with the Rule (RIA 3-27, Table 3-11). This difference is smaller than the change observed over the 10-year timeframe from 2002 to 2012 when the percentage of the generation mix provided by coal-fired generators declined from 50% to 37% (RIA 2-5, Table 2-2). By the same token, at the time EPA finalized the Rule, EPA projected that natural-gas fired generation would provide 31% of total generation in 2030 without the Rule, and 32% with the Rule; and EPA projected that renewables would provide 18% of total generation in 2030 without the Rule, and 20% with the Rule (RIA 3-27, Table 3-11). These projected shares for coal and natural gas-fired generation without the CPP have already been achieved, in 2015. In addition, the increase percent share for renewables projected in the final rule (compared to a reference case) was considerably less that the increase already achieved since 2010. As a result, CPP-driven shifts in generation by 2030 can be expected to be correspondingly lesser, given current and projected trends.

sources to meet their standards, with less planning burden, at significantly less cost, and with less impact on the sector.

Section 3 of the appendix looks at recent reports and assessments regarding the extent to which these power sector trends are likely to continue into the future. The materials covered include reports by the U.S. Department of Energy (particularly the U.S. Energy Information Administration); updated power-sector modeling produced by EPA for other air pollution rules; the stated plans and intentions of companies and leaders across the power sector itself; and analyses produced by a wide variety of research organizations, think tanks, and consulting firms.

Specifically, reports and analyses by experts outside EPA indicate that the cost trends discussed in section 2 will continue. The price of natural gas is expected to remain relatively low for the next 10 to 15 years as improvements in drilling technologies and techniques continue to reduce the cost of extraction. In addition, the coal-fired fleet of power generators is aging, and no new coal-fired generation is being planned. The declining costs of renewable energy technologies, particularly for wind and solar generation, and the extension of tax incentives for these technologies, ensure that renewable energy generation will continue to increase. Many power plant generators have announced that they expect to continue to change their generation mix away from coal-fired generation and toward natural-gas fired generation, renewables, and more deployment of EE measures, as discussed below.

Section 3 of this appendix discusses several modeling studies that project future generation mix and emissions *without* the CPP. The bottom-line conclusions of these studies show that many states already have achieved their required CPP reductions through the first several years of the program, even based solely on actions that have occurred within their state (and without reliance on interstate trading). Further, the studies suggest that if states choose to participate in interstate regional trading, it is likely that all states could comply without needing to make any additional CPP-related reductions until the mid-2020s. In addition, these studies show that business-as-usual changes in the generation mix (i.e., changes irrespective of the CPP) will allow from more than one-third to a majority of the states to meet their 2030 goals without requiring any further reductions from their sources. The common thrust of these studies' bottom-line conclusions is bolstered by the fact that they arrived at similar conclusions despite using different models and employing different assumptions. Taken together, the bottom-line conclusions of these studies provide robust evidence that the CPP is a trend-following air pollution rule that builds upon actions and developments occurring in the relevant source category.

When all these trends and changes in the power sector are accounted for, the modeling and analysis indicate that the CPP continues to drive emission reductions, but a lower amount at a much lower cost than EPA projected at the time it finalized the CPP. At the time EPA finalized the CPP, it estimated the highest marginal cost of compliance in any state in 2030 to be \$26/ton of CO_2, an average marginal cost of \$11/ton of CO_2, and that 7 states would have no marginal costs. EPA's updated analysis estimated the highest marginal cost of compliance in any state in 2030 to be \$17/ton of CO_2, an average marginal cost of \$4/ton of CO_2, and that 18 states would have no marginal costs.

In addition, recent analyses show that while states have a number of pathways for implementing the CPP, some pathways—in particular, interstate mass-based trading—have low costs. A number of modeling studies make this clear. For example, modeling by the Bipartisan Policy Center (June 2016) identifies the cost of CPP compliance for the plausible scenario of mass-based state plans with interstate trading at approximately \$1 billion per year.[8] Recent modeling by Duke University's Nicholas Institute for Environmental Policy Solutions identifies total policy costs for the U.S. power sector under a scenario of mass-based state plans with interstate trading at approximately \$1.9 billion through 2040.[9] The models used in the various studies discussed in section 3 have different formats and assumptions and analyze different scenarios (trading, no trading, rate-based, mass-based, etc.); as a result, their bottom-line conclusions, taken together, are robust.

2. Electricity Sector Trends Driving Reductions in CO_2 Emissions, Including Post-CPP Promulgation

CO_2 emissions in the power sector have steadily declined in recent years, and this trend has continued since release of the final CPP. This historic reduction in power sector CO_2 emissions is the result of industry trends away from coal-fired generation and toward low- and zero-emitting sources (*i.e.*, natural gas and

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[8] Bipartisan Policy Center, (June 2016), Modeling the Evolving Power Sector and Impacts of the Final Clean Power Plan, http://cdn.bipartisanpolicy.org/wp-content/uploads/2016/06/BPC-Energy-Clean-Power-Plan-Modeling.pdf.

[9] Martin Ross et al., (July 2016), Ongoing Evolution of the Electricity Industry: Effects of Market Conditions and the Clean Power Plan on States, pp. 23–24, Nicholas Institute for Environmental Policy Solutions, https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_16-07_final.pdf. Projecting costs on a cumulative, not annual, net present value basis.

renewable sources) that can produce the same electricity product as coal, but with 59 to 100 percent fewer CO_2 emissions.[10] There are also significant trends toward EE. All of these industry trends began well before EPA finalized the CPP.

These industry trends have continued in the year and a half since EPA finalized the CPP and, in many cases, accelerated during that time. As explained in section 3 below, the changes are now significantly more pronounced than EPA initially projected at the time it finalized the CPP. These trends—including both recent and projected changes to the country's generation mix—mean that a number of states will be able to develop satisfactory state plans and their sources will be able comply with those plans, essentially by following business-as-usual scenarios.

2.1. Decline in Electricity Sector CO_2 Emissions

CO_2 emissions in the power sector have steadily declined in recent years, and this trend has continued since release of the final CPP. As explained in the CPP preamble, "the final guidelines are based on, and reinforce, the actions already being taken by states and utilities to upgrade aging electricity infrastructure with 21st century technologies."[11] In 2012, the affected energy-generating units (EGUs) in jurisdictions covered by the CPP emitted 2,170,903,759 short tons of CO_2—putting them 19 percent below 2005 levels.[12] By 2015, reported CO_2 emissions from the same category of EGUs had dropped to 2,047,272,685 short tons—or 24 percent below 2005 levels.[13] Figure 1 below plots historic electricity sector CO_2 emissions using EPA data, showing a dramatic decline from 2005 through 2015.

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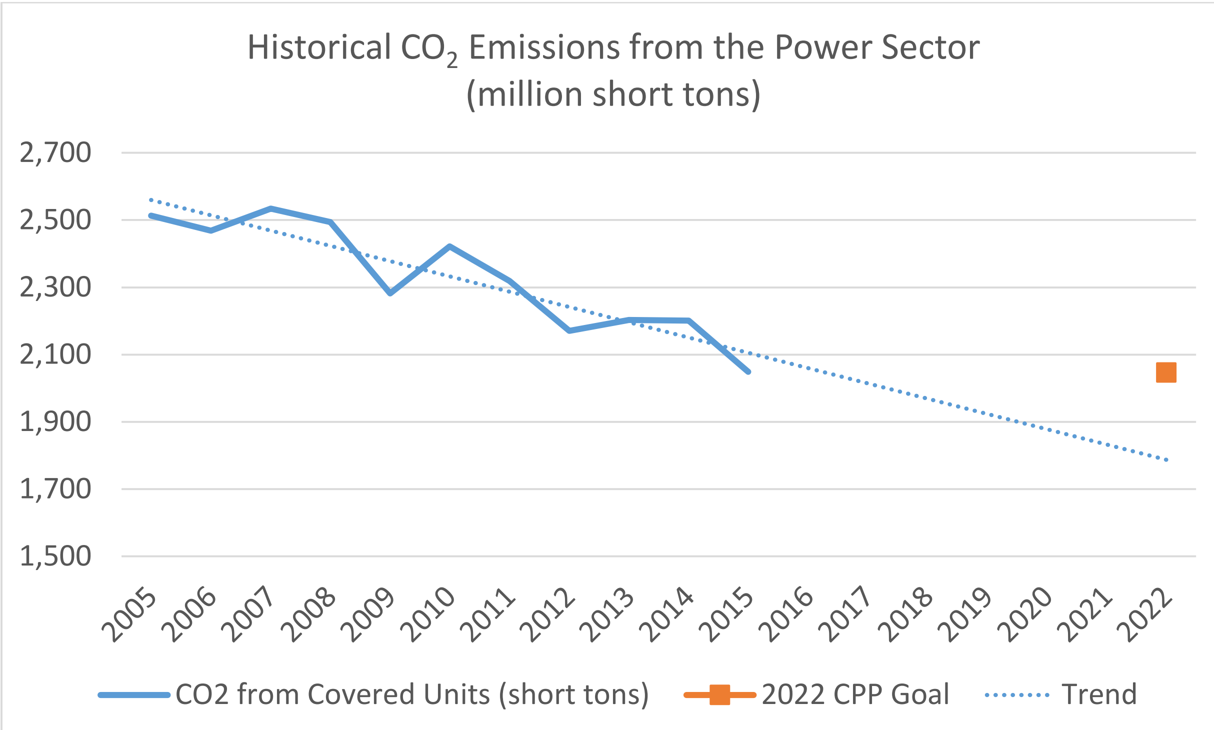
[10] U.S. EPA, GHG Mitigation Technical Support Document, pp. 3–4.

[11] 80 Federal Register (FR) 64678.

[12] Air Markets Program Data, at https://ampd.epa.gov/ampd/. This figure only includes affected EGUs in the 47 states and 3 Indian Tribes covered by the Clean Power Plan.

[13] *Ibid.*

Figure 1. Historical Electricity Sector CO_2 Emissions



This decline in power sector CO_2 emissions has continued since release of the final CPP in August 2015. From January through September 2016, power plant CO_2 emissions reported to EPA were down about 8 percent compared to the same 9-month period in 2015.[14] According to the Energy Information Administration (EIA), U.S. energy-related CO_2 emissions totaled 2,530 million metric tons in the first 6 months of 2016. This was the lowest emissions level for the first 6 months of the year since 1991, as mild weather and changes in the fuels used to generate electricity contributed to the decline in energy-related emissions. EIA's "Short-Term Energy Outlook" projects that energy-associated CO_2 emissions will fall to 5,179 million metric tons in 2016, the lowest annual level since 1992.[15]

As discussed in more detail in Section 3, the reductions in CO_2 emissions that have already occurred (and future reductions projected to occur without the CPP)

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[14] *Ibid.*
[15] U.S. EIA, *Today in Energy,* (October 12, 2016), http://www.eia.gov/todayinenergy/detail.php?id=28312.

indicate the CPP is readily achievable with modest costs—less than EPA projected at the time of the final Rule. For the 47 states and tribes covered by the CPP, the sum of their mass-based levels contemplated by the CPP for the year 2022 is 2,046,199,910 short tons.[16] That is only 0.05 percent below what their sources already achieved in 2015.[17] Indeed, on a state-by-state basis, 24 states actually had *lower* emissions in 2015 than their individual mass-based levels contemplated by the CPP for 2022 .[18]

This historic reduction in power sector CO_2 emissions is the result of industry trends toward low- and zero-emitting electricity resources, as explained in sections 2.2 and 2.3 below. The electricity sector has experienced a reduction in coal-fired generation and capacity. At the same time, there has been an increase in generation from natural gas-fired and renewable energy resources, as well as an increase in demand-side EE.

2.2. Reduction in Coal-Fired Power Generation and Capacity

2.2.1. Decrease in Coal-Fired Generation

For over a decade, coal's share of total U.S. electricity generation has been declining, while generation from natural gas and renewables has increased. Table 1 and Figure 2 illustrate this dramatic, industry-wide shift.

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[16] Goal Computation Data File, Appendix 5

[17] See file in docket named "CPP Goals and Historical Emissions for States and Tribes_Docket."

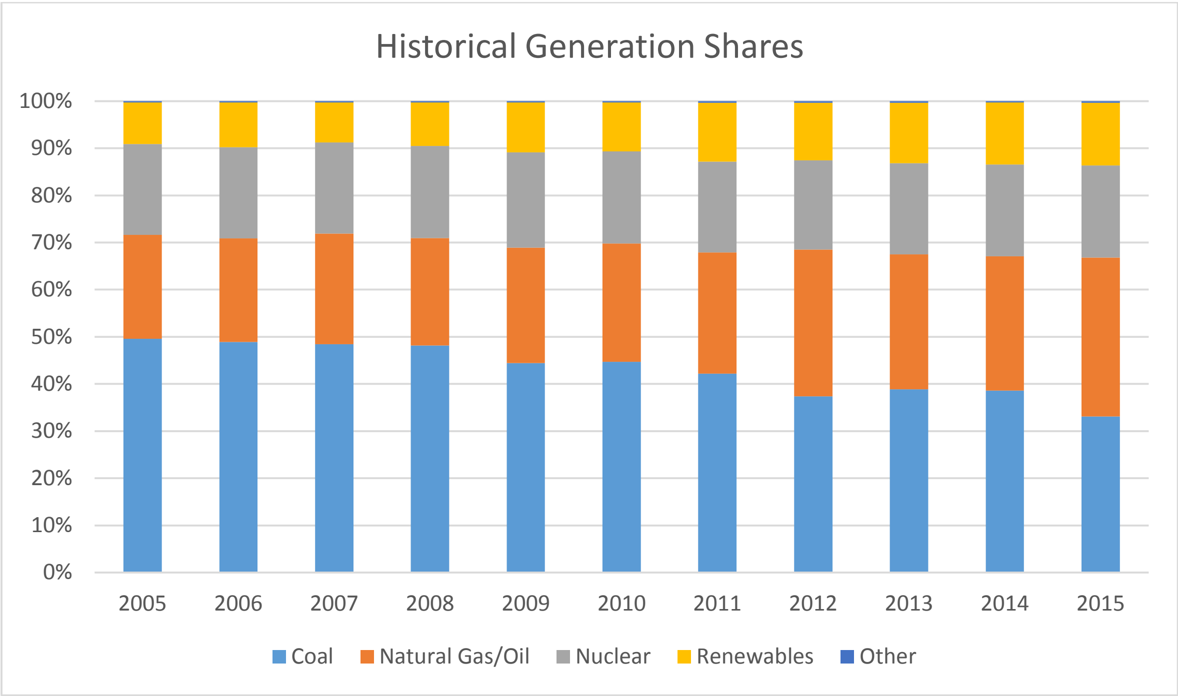
[18] In addition to facilitating CPP compliance, the decline in power sector CO_2 emissions this century demonstrate that emission reductions are compatible with economic growth. The Brookings Institute reports that the U.S. economy expanded without increased emissions for the first time in 2001. That occurred again in 2006, between 2010 and 2012, and in 2015. Moreover, 33 states plus the District of Columbia collectively managed to expand their economies by 22%, while carbon emissions declined 12%, from 2000 to 2014. Devashree Saha & Mark Muro, (December 8, 2016), Growth, carbon, and Trump: State progress and drift on economic growth and emissions 'decoupling', https://www.brookings.edu/research/growth-carbon-and-trump-state-progress-and-drift-on-economic-growth-and-emissions-decoupling/.

Table 1. U.S. Electricity Generation by Source[19]

	Coal	Natural Gas	Renewables
2005	51.0%	17.5%	8.1%
2006	50.4%	18.8%	8.8%
2007	49.9%	20.3%	7.8%
2008	49.5%	20.2%	8.7%
2009	45.7%	22.1%	10.1%
2010	46.0%	22.7%	9.9%
2011	43.5%	23.5%	12.0%
2012	38.6%	29.1%	11.7%
2013	40.2%	26.4%	12.3%
2014	39.8%	26.2%	12.7%
2015	34.2%	31.6%	12.9%

[19] EIA Electric Power Annual with Data for 2015 (November 21, 2016), Tables 3.2.A and 3.3.A

Figure 2. U.S. Historical Generation Shares[20]



This trend away from coal-fired electricity continued in 2016. Coal consumption was 18 percent lower in the first 6 months of 2016 than it had been over the same period in 2015.[21] By contrast, zero-emitting renewable sources *increased* by 9 percent across the same period, with nearly half the growth coming from wind energy alone.[22] In part because of these shifts, the EIA, an independent statistical agency within the Department of Energy (DOE), projects that the U.S. electricity sector will emit less CO_2 in 2016 than it has in any year since 1992—nearly a quarter-century ago.[23]

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[20] Martin Ross et al., (July 2016), Ongoing Evolution of the Electricity Industry: Effects of Market Conditions and the Clean Power Plan on States, p. 7, Nicholas Institute for Environmental Policy Solutions, https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_16-07_final.pdf.
[21] EIA, (October 12, 2016), Energy-related CO_2 emissions for first six months of 2016 are lowest since 1991, http://www.eia.gov/todayinenergy/detail.php?id=28312.
[22] *Ibid.*
[23] *Ibid.*

2.2.2. Capacity Retirements

At the same time that implementation of the CPP has been stayed, market forces have contributed to the retirement—and accelerated the planned retirements of—older and less-efficient coal-fired EGUs.[24] Coal's share of total U.S. electricity generating capacity has been declining for over a decade, in part as a natural consequence of the aging coal fleet and competition from low-cost natural gas. From 2012 to 2014, there were more gigawatts (GW) of retired generating capacity from coal-fired power plants than from any other source, resulting in a net loss of approximately 14 GW of coal-fired generation capacity.[25] (By contrast, the net capacity of natural gas-fired and renewable resources increased by about 40 GW over 2012-2014, representing over 90 percent of the total new capacity added.[26]) The following year, 2015, saw a record high in coal capacity retirements—about 14.6 GW—and no new coal-fired capacity added. The average age of the approximately 44 GW of coal capacity that has retired since 2010 has been over 56 years old, as shown in Table 2.

Table 2. Profile of Retired Coal-Fired Generating Capacity[27]

Year	Total Capacity Retired (MW)	Average Age (years)	Capacity Over 50 Years Old (MW)	Capacity b/w 40 and 50 Years Old (MW)	Capacity b/w 30 and 40 Years Old (MW)	Capacity under 30 Years Old (MW)
2010	1,398	54.4	1,032	56	110	200
2011	2,466	61.8	2,215	251	0	0
2012	9,061	53.3	4,876	3,514	597	74
2013	6,070	53	2,343	3,562	12	153
2014	4,025	56.5	3,116	779	98	33
2015	14,596	57.7	10,246	4,090	260	0
2016*	6,630	55.7	4,986	479	1,043	122
2010–2016*	44,245	56.1	28,813	12,731	2,120	581

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[24] Fitch Ratings, (December 9, 2016), 2017 Outlook: Energy Infrastructure North America, http://www.eenews.net/assets/2016/12/12/document_ew_01.pdf.
[25] Preliminary Monthly Electric Generator Inventory (based on Form EIA-860M as a supplement to Form EIA-860) (November 29, 2016), https://www.eia.gov/electricity/data/eia860m/
[26] *Ibid.*
[27] Preliminary Monthly Electric Generator Inventory (based on Form EIA-860M as a supplement to Form EIA-860) (November 29, 2016), https://www.eia.gov/electricity/data/eia860m/.

*Note that 2016 reflects only retirements that occurred through September 2016, and does not include the final quarter of 2016.

Retirements of old and less-efficient plants are likely to continue as a result of the existing coal-fired EGUs continuing to age and market conditions. For example, the Edison Electric Institute stated that the industry has announced the retirement of 82 GW of coal plants between 2010 and 2024.[28] In 2016, the average coal-fired EGU in operation was 43-years-old.[29] By 2030, accounting for planned retirements, the average coal-fired EGU is expected to be approximately 56-years-old—the same age as EGUs that have retired in recent years.[30]

These retirements have a particularly significant impact on the ability of states and operating sources to implement the CPP. Because EPA calculated state goals using a 2012 baseline, all post-2012 retirements can be used for compliance purposes and will contribute to the achievement of CPP emission reduction requirements. Indeed, a notable amount coal capacity has retired since promulgation of the CPP, providing more compliance flexibility to sources remaining in operation to comply with the CPP.

2.2.3. New Coal-Fired Units

The United States is unlikely to see a wave of new, high-emitting coal-fired capacity. At least for the near term (roughly 5–10 years), while natural gas prices are expected to remain at or near their current low levels and tax incentives for new renewables continue, the most likely scenario is that no new coal-fired power plants will be constructed.[31] One possible exception is a single plant (the Texas Clean Energy Project) that is already, for business reasons, planning to include full carbon capture.

As discussed below, there are several alternatives to new coal-fired generating capacity that can meet customers' needs for energy services, not only in a more environmentally sustainable manner but also more economically, including demand-side EE, incremental renewable energy generation, and incremental

[28] E&E News, (December 19, 2016), "Electric utility leaders see no change in trajectory with Trump," http://www.eenews.net/energywire/2016/12/19/stories/1060047387.
[29] *Ibid.*
[30] *Ibid.*
[31] Recent AEO projections (AEO 2014, 2015, and 2016) show that new capacity additions are anticipated to be mostly gas-fired and new renewable, with no new unplanned conventional coal being built through 2030.

natural gas combined-cycle generation. The greater attractiveness of these alternatives has caused the U.S. power sector to shift away almost entirely from coal as a fuel for new electricity generating capacity. In 2014, the year before finalization of the CPP, about 17 GW of new electricity-generating capacity was installed in the United States.[32] Less than 1 percent of that was new conventional coal steam generation.[33] EPA is not aware of any new coal-fired power projects proposed in the United States since at least 2010, before the 2012 publication of EPA's first proposal to establish New Source Performance Standards (NSPS) for greenhouse gas emissions from new power plants.[34]

The recent history of development of new coal capacity demonstrates how little appetite there is for new coal generation. To EPA's knowledge, only one of the coal-fired power projects that is currently under development but was not actively under construction in 2010 has made substantial construction progress: the Kemper County integrated gasification combined cycle (IGCC) project in Mississippi, which is currently testing its coal gasification components and is expected to shift from natural gas-fired to coal-fired operation in the near future.[35] Unlike the existing coal fleet, however, the Kemper project is designed to use CCS technology.

The EPA sees little likelihood that the broad trend away from coal-fired generation will reverse in the foreseeable future. At present, even without EPA's greenhouse gas (GHG) NSPS, the levelized cost of a new conventional coal-fired power plant is roughly 40 percent higher than that of a new combined-cycle natural gas plant.[36] Many prominent industry participants appear to have come to a view that, in general, based on current projections of relative costs, new coal plants are not competitive with alternative potential resources for meeting customers' electricity requirements. For example, Gerry Anderson, the CEO of DTE Energy,

[32] Preliminary Monthly Electric Generator Inventory (based on Form EIA-860M as a supplement to Form EIA-860) (November 29, 2016), https://www.eia.gov/electricity/data/eia860m/.
[33] *Ibid*. The remaining 99 percent of installed capacity consisted of approximately 52 percent new renewable capacity and 47 percent new natural gas capacity.
[34] 77 FR 22392 (April 13, 2012).
[35] "Mississippi Power issues statement regarding Kemper County energy facility schedule", December 2, 2016, press release, http://mississippipowernews.com/2016/12/02/mississippi-power-issues-statement-regarding-kemper-county-energy-facility-schedule-2/.
[36] Levelized Cost and Levelized Avoided Cost of New Generation Resources, EIA (2015 and 2016) (projected for 2020 in AEO 2015 for conventional coal, and projected in 2022 for advanced combined cycle in AEO 2016).

explained that his company's plans to retire eight coal-fired EGUs by 2030 would proceed "regardless" of the CPP.[37] Like many coal-fired EGUs across the country, DTE Energy's fleet is "old and aging" and, according to the CEO, the company is thus "on [the] path" to phasing out coal from its portfolio entirely.[38] "On pure economics you would build natural gas today . . . . I don't know anybody in the country who would build another coal plant." [39]

DTE Energy's perspective is far from unique. As discussed below, electric utilities across the country are shifting their generation mixes. This trend away from new coal-fired generation is of course subject to change based on changes in economic drivers, such as projected future prices of natural gas and coal and improvements in various technologies. It is still common for companies to consider new coal generating capacity as a resource option in their integrated resource planning processes, even if it is uncommon at present for that option to be selected as part of the ultimate resource plan, and the industry generally continues to view fuel diversity as desirable, which in some circumstances could be a factor weighing in favor of new coal capacity.[40] With those caveats, the trend away from coal generation currently appears to be occurring across all manner of companies throughout the country.

2.2.4. Coal Production

The decline in coal-fired generation is further reflected in the reduced coal production from mining. Between 2012 and 2013 alone, the total number of U.S. mines producing coal dropped by 14 percent.[41] The coal industry idled or closed 271 mines in 2013 and began production at fewer new (or reactivated) coal mines that year than at any time in at least a decade.[42] There were fewer active coal mines in

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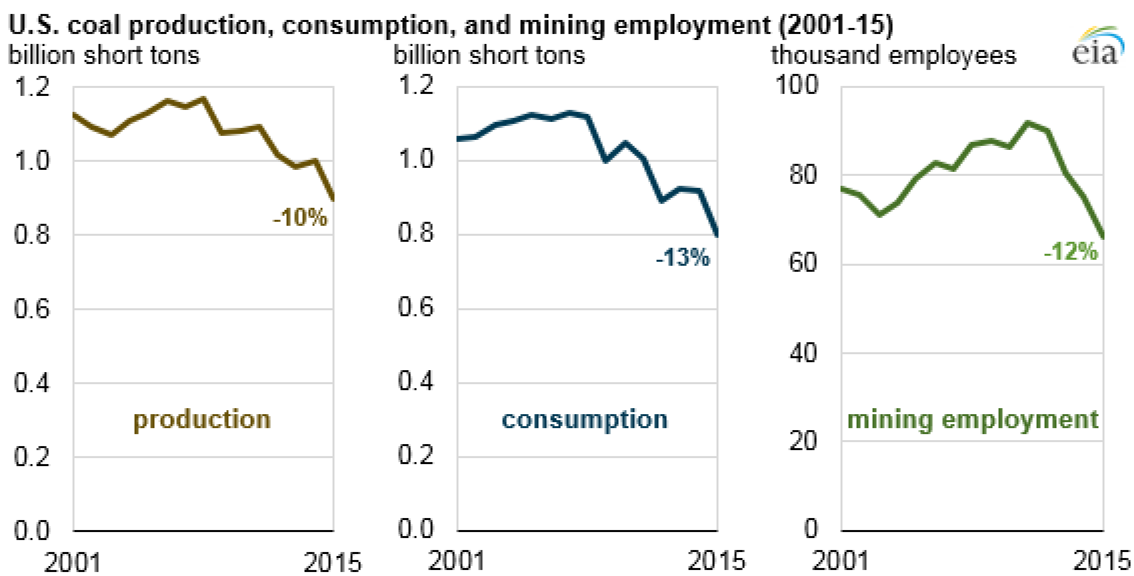
[37] Emily Lawler, *Michigan's biggest electric provider phasing out coal, despite Trump's stance*, MLive, November 25, 2016 (9:47am), updated November 28, 2016 (12:51 pm), http://www.mlive.com/news/index.ssf/2016/11/michigans_biggest_electric_pro.html.
[38] *Ibid.*
[39] *Ibid.*
[40] *See* 80 FR at 64526-27. *See also* comments of Utility Air Regulatory Group at 111-113 (EPA-HQ-OAR-2013-0495-9666) (arguing that EPA underestimates the competitiveness of new coal EGUs, and concluding that coal will "surely" be favored by EGU developers in some applications).
[41] *Ibid.*
[42] *Ibid.*

2013 than have ever been recorded.[43] According to the EIA, "The declining number of new mines reflects reduced investment in the coal industry, strong competition from natural gas, stagnant electricity demand, a weak coal export market, and regulatory and permitting challenges"[44]—all of which preceded the CPP.

These impacts show no sign of abating. In 2015, United States coal production dropped another 10 percent, to the lowest production level since 1986.[45] Production declined in every major coal-producing region, mirroring the 13 percent reduction in coal consumption for electric power generation, industrial, and other uses (Figure 3).[46] That decline continued into 2016: the first quarter of 2016 had the lowest quarterly level of coal production since the second quarter of 1981—a time when the industry was experiencing a major coal strike.[47] As of October 29, 2016, coal production in 2016 was down 20 percent from the comparable period in 2015.[48]

Figure 3. U.S. Coal Production, Consumption, and Mining Employment (2001–2015).



[43] *Ibid*. While preliminary mining data from 2014 shows a small increase in production and in the number of new and reactivated mines, the levels will remain below recent highs.
[44] *Ibid*.
[45] *Today in Energy November 10, 2016* http://www.eia.gov/todayinenergy/detail.php?id=28732
[46] *Ibid*.
[47] *Today in Energy June 10, 2016* http://www.eia.gov/todayinenergy/detail.php?id=26612
[48] *Today in Energy November 10, 2016* http://www.eia.gov/todayinenergy/detail.php?id=28732

2.3. Natural Gas, Renewables, and Demand-Side Energy Efficiency Are Rising

The shift away from coal-fired electricity generation has been coupled with corresponding shifts toward natural gas, renewable sources, and demand-side EE.

2.3.1. Natural Gas Trends

Just as coal experienced a significant boom at the turn of the 19th century, the turn of the 20th century has seen enormous growth in lower-emitting natural gas generation, largely displacing coal-fired generation. Between 2000 and 2015, net electricity generation from natural gas-fired power plants more than doubled in the United States.[49] From 2005 to 2014, net natural gas generation increased by nearly one third.[50] By 2015, coal and natural gas were neck-and-neck as the leading sources of electricity in the United States, comprising 33 percent and 32.5 percent of generation respectively.[51] In April 2015, for the first month in American history, the United States generated more electricity from natural gas than it did from coal.[52] Natural gas surpassed coal another six times in 2015—in July, August, September, October, November, and December.[53] These trends have continued since EPA finalized the CPP in August 2015.

According to the EIA, consumption of natural gas for electricity generation has been "very high throughout 2016" and broke historical records for the most natural gas consumed on a single day: 40.9 billion cubic feet on July 21, 2016.[54] (Nine of the 10 days in history with the most natural gas burned for power occurred in July 2016,

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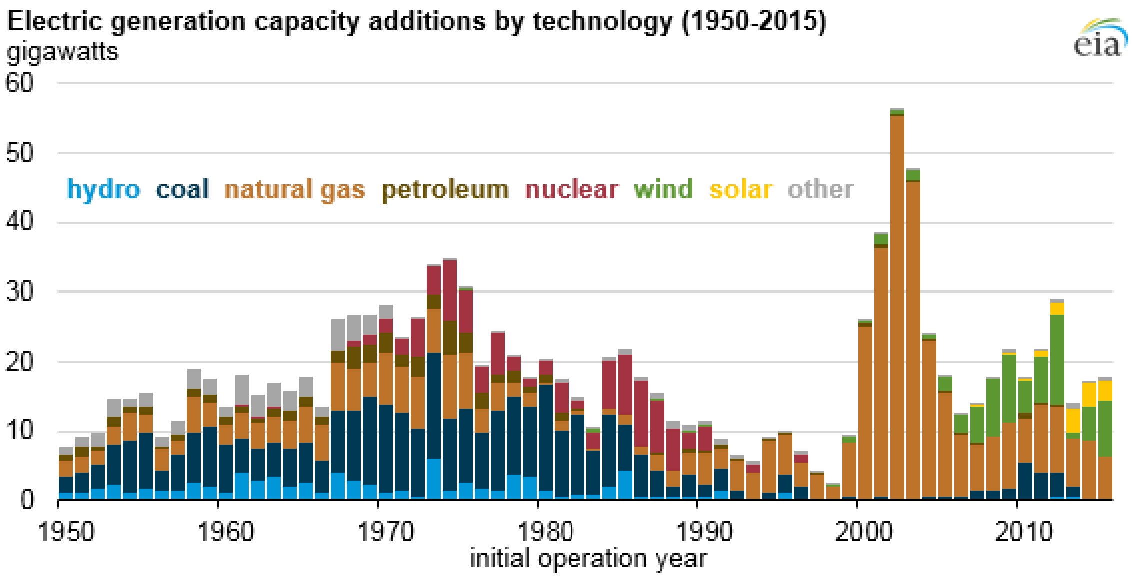
[49] EIA, Net generation from all sectors (natural gas), http://www.eia.gov/electricity/data/browser/ (view "net generation" data set by "annual").
[50] 80 FR at 64694–96.
[51] NREL 2015 Renewable Energy Data Book, p. 12. http://www.nrel.gov/docs/fy17osti/66591.pdf
[52] EIA, Nationwide, Electricity Generation from Coal Falls While Natural Gas Rises, *Today In Energy,* Oct. 7, 2015, http://www.eia.gov/todayinenergy/detail.cfm?id=23252.
[53] http://www.utilitydive.com/news/eia-gas-topped-coal-fired-generation-in-seven-months-last-year/414732/
[54] *Natural Gas Weekly Update* August 4, 2016. https://www.eia.gov/naturalgas/weekly/archivenew_ngwu/2016/08_04/index.cfm.

with the other in July 2015.)[55] In fact, EIA anticipates that natural gas is "expected to surpass coal" in the mix of fuel used for U.S. power generation in 2016.[56]

These recent trends toward natural gas-fired generation reflect the dominance of low- and zero-emitting resources when it comes to the construction of new capacity. Over the past 20 years, new electric generating capacity has been mostly natural gas-fired, with new renewables becoming a larger share of new capacity over the past 10 years (Figure 4).[57] For 2016, about 8 GW of new natural gas-fired capacity is expected to be added, slightly above the 7.8 GW average annual additions over the previous 5 years (Figure 5).[58]

Figure 4. Electric Generation Capacity Additions by Technology (1950–2015)



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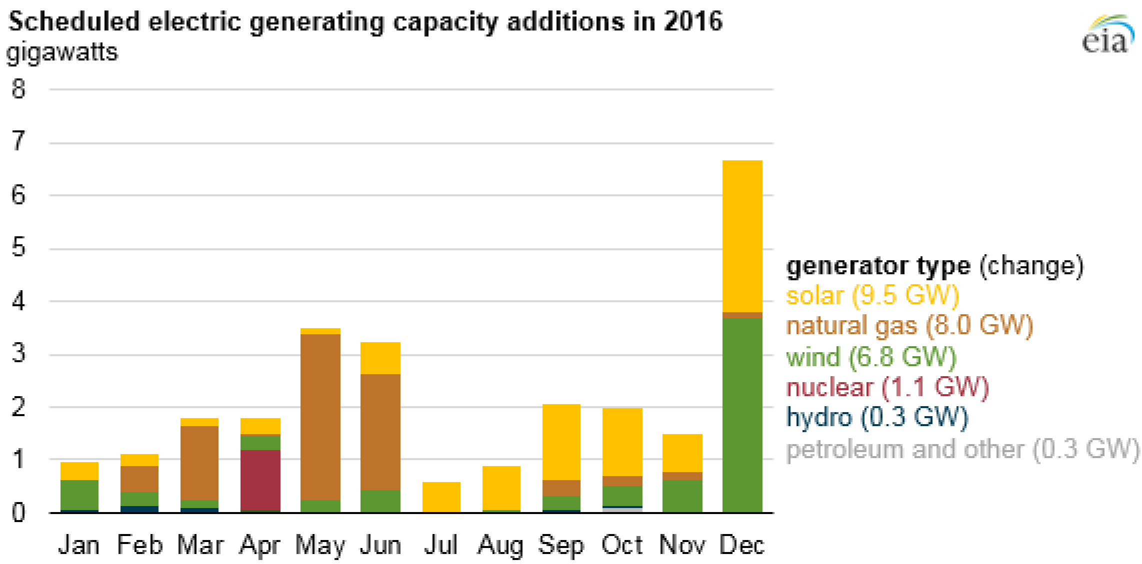
[55] *Natural Gas Weekly Update* August 4, 2016 (citing PointLogic data)https://www.eia.gov/naturalgas/weekly/archivenew_ngwu/2016/08_04/index.cfm.
[56] Today in Energy (March 16, 2016), from EIA at http://www.eia.gov/todayinenergy/detail.php?id=25392.
[57] Today in Energy (March 18, 2016), from EIA, http://www.eia.gov/todayinenergy/detail.php?id=25432
[58] Today in Energy (December 19, 2016), from EIA, http://www.eia.gov/todayinenergy/detail.php?id=21172

Figure 5. Scheduled Electric Generating Capacity Additions in 2016



The primary factors driving an increase in summer use of natural gas have been the relatively low prices of natural gas and growth in the natural gas power infrastructure.[59] But this increased reliance on natural gas is not limited to the high-demand summer months; consumption has also risen in the winter.[60] Indeed, 2016 is on track to be the first full year in American history that natural gas exceeds coal as the leading source for electricity generation.[61]

Shifts in annual average capacity factors for combined-cycle generators further illustrate these dramatic shifts. In 2005, the average capacity factors for combined-cycle EGUs was 35 percent.[62] In 2012, the average capacity factor for natural gas combined cycle EGUs was 46 percent.[63] By 2015, average capacity factors had risen

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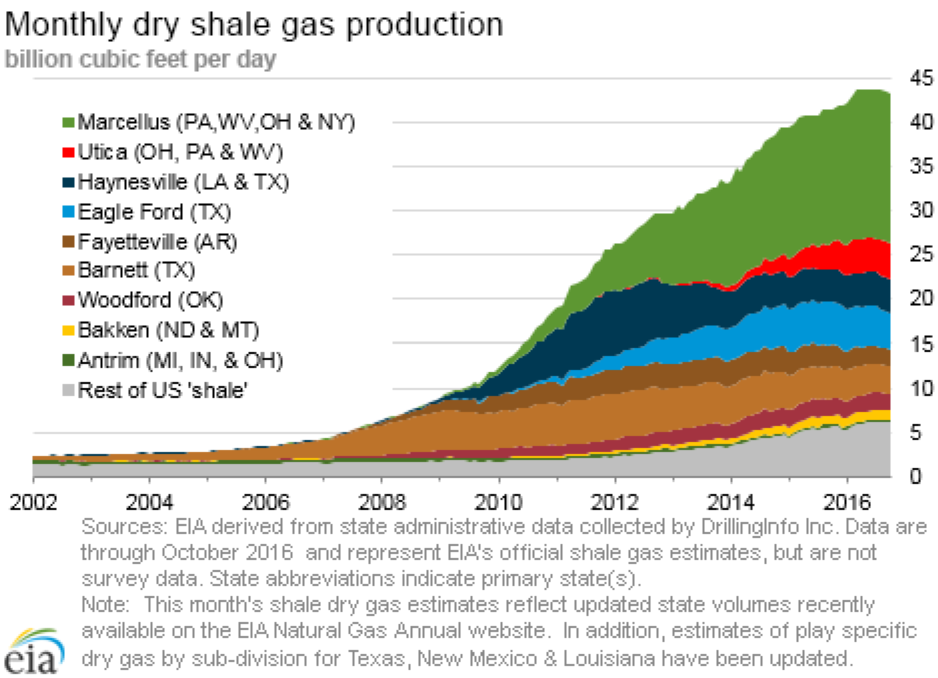
[59] *Natural Gas Weekly Update* August 4, 2016 (citing PointLogic data), https://www.eia.gov/naturalgas/weekly/archivenew_ngwu/2016/08_04/index.cfm.
[60] *Ibid.*
[61] NREL *2016 Standard Scenarios Report: A U.S. Electricity Sector Outlook* p.16 http://www.nrel.gov/docs/fy17osti/66939.pdf
[62] *Ibid.* (citing EIA 2016b)
[63] EPA Greenhouse Gas Mitigation Measures TSD (Docket ID No. EPA-HQ-OAR-2013-0602), using EIA Form 860 and 923 data

to approximately 55 percent,[64] as generators increasingly prioritized the dispatch of natural gas units ahead of coal. As one DOE research laboratory explained, these "recent changes are arguably the greatest [changes] in the modern history of the U.S. generation mix."[65] These trends toward natural gas generation are also reflected in the growth of natural gas production. EIA estimates that in November 2006, an average of approximately 4.15 billion cubic feet of dry shale gas was produced each day. A decade later, by November 2016, that production had risen to 43.08 billion cubic feet per day—a more than 900 percent increase.[66] Figure 6 illustrates this tremendous growth.[67]

Figure 6. Monthly Dry Shale Gas Production (2001–2016).



[64] Calculated using EIA Form 860 and 923 data, 2015
[65] *Ibid.* p.16 & fig. 16
[66] https://www.eia.gov/naturalgas/weekly/img/shale_gas_201611.xlsx
[67] Chart from EIA *Natural Gas Weekly Update* November 30, 2016. https://www.eia.gov/naturalgas/weekly/ (Accessed Dec 20, 2016)

2.3.2. Renewable Energy Trends

Renewable energy is the fastest growing form of utility-scale electric generating capacity. With respect to wind and solar energy in particular, the growth in recent years has been unprecedented.[68] In 2015, solar electricity generation increased by a staggering 35.7 percent—a growth of 11.7 terawatt hours (TWh).[69] Wind electricity generation experienced similar growth in overall generation that year (9.3 TWh), amounting to a 5.1 percent increase over the previous year's levels of wind generation.[70]

These trends began before the CPP was finalized. Between 2005 and 2015, total wind and solar electricity generation increased by approximately 1,200 percent,[71] while annual coal-fired electricity generation declined by 33 percent[72] (Figure 7).

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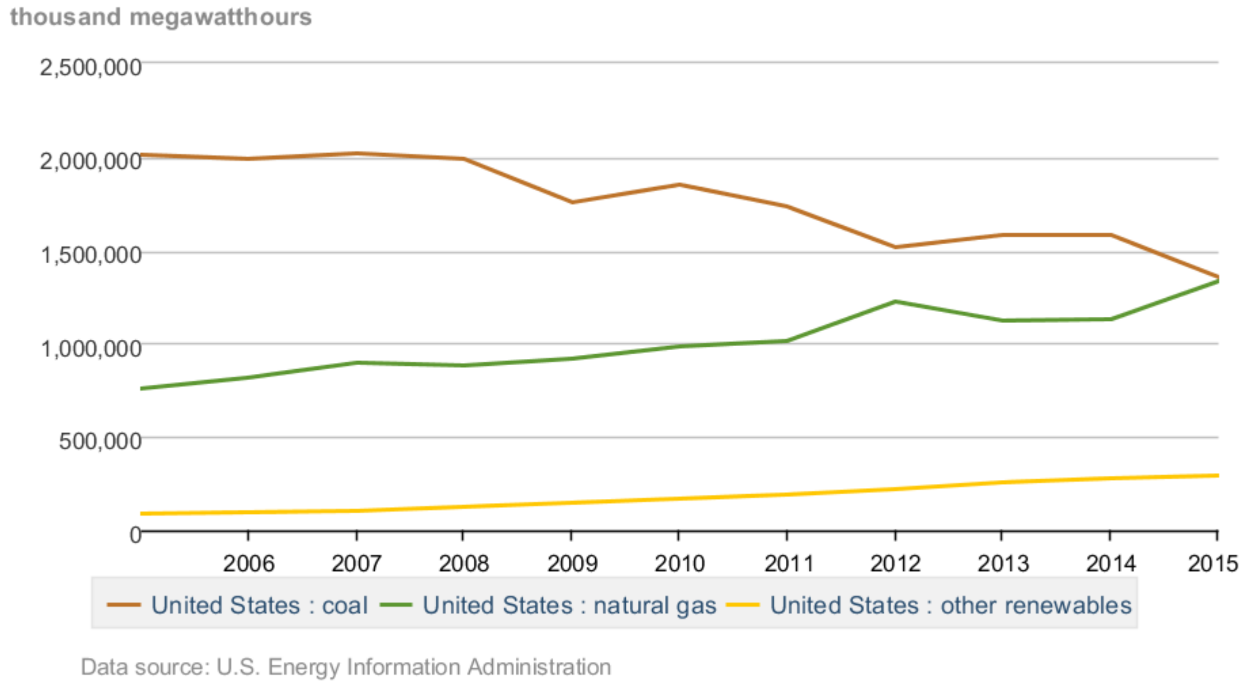
[68] RFF at 11 http://www.rff.org/files/document/file/RFF-DP-16-21.pdf
[69] 2015 Renewable Energy Data Book, p18 http://www.nrel.gov/docs/fy17osti/66591.pdf
[70] *Ibid.*
[71] 2015 Renewable Energy Data Book, p18 http://www.nrel.gov/docs/fy17osti/66591.pdf)
[72] Historical Net Generation by Energy Source, EIA at http://www.eia.gov/electricity/annual/html/epa_03_01_a.html

Figure 7. Annual Net Generation for All Sectors



These trends have continued unabated since EPA finalized the CPP. From January through October 2016 (the last month for which there is currently available, consistent data), the level of monthly renewable electricity generation surpassed levels from the corresponding month in 2015.[73] During the first 6 months of 2016, wind electricity accounted for 5.6 percent of U.S. electric power generation, more than its share in 2015 (4.7 percent), and more than double its share in 2010 (2.3 percent, Figure 8).[74] EIA data through July 2016 indicate that 12 states covered by the CPP were projected to generate at least 10 percent of their total electricity from wind energy in 2016.[75]

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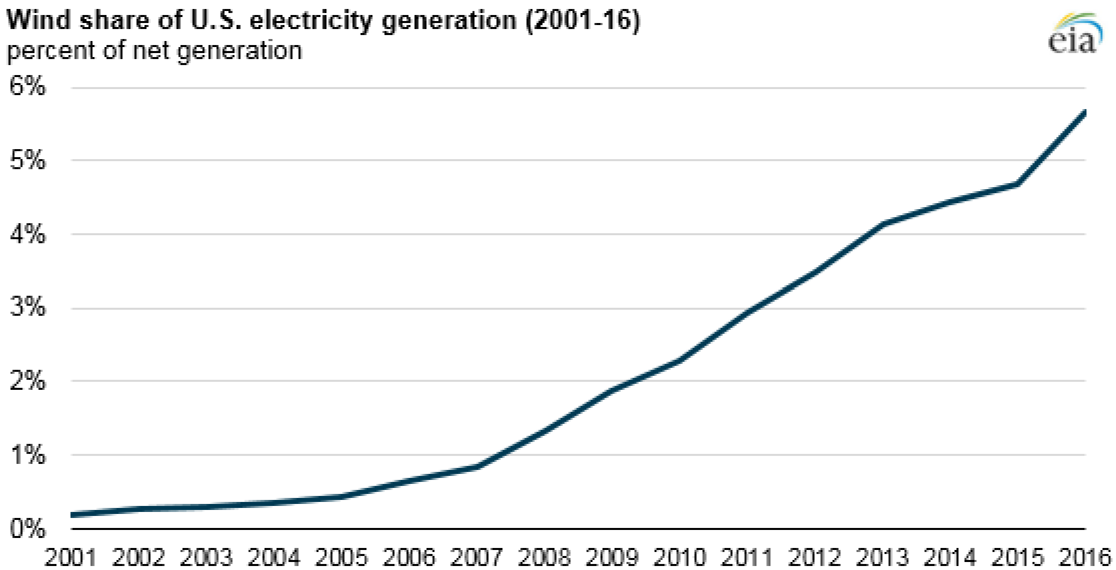
[73] EIA, "Electric Power Monthly", December 23, 2016 https://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_1_01_a

[74] *Today in Energy October 26, 2016* http://www.eia.gov/todayinenergy/detail.php?id=28512

[75] *Ibid*. Those states are Iowa, South Dakota, Kansas, Oklahoma, North Dakota, Minnesota, Idaho, Colorado, Oregon, Maine, Texas, and New Mexico. Vermont is also projected to exceed 10% electricity generation from wind sources in 2016.

Figure 8. Wind Share of U.S. Electricity Generation (2001–2016).[76]



In 2016, renewable energy is expected to set historical records domestically. In fact, new utility-scale solar capacity is expected to double year over year, with a compound annual growth rate of 60 percent over the past decade.[77] For 2015, wind capacity was the largest share of new capacity with over 8 GW installed, with natural gas and solar second and third, respectively (Figure 9).[78] According to EIA, solar capacity is expected to have been the largest form of new, utility-scale generating capacity installed in 2016, at roughly 9.5 GW.[79] Looking beyond just utility-scale capacity, more than 21 GW of wind and solar capacity are projected installed in 2016; roughly 68 percent of all new U.S. generating capacity.[80]

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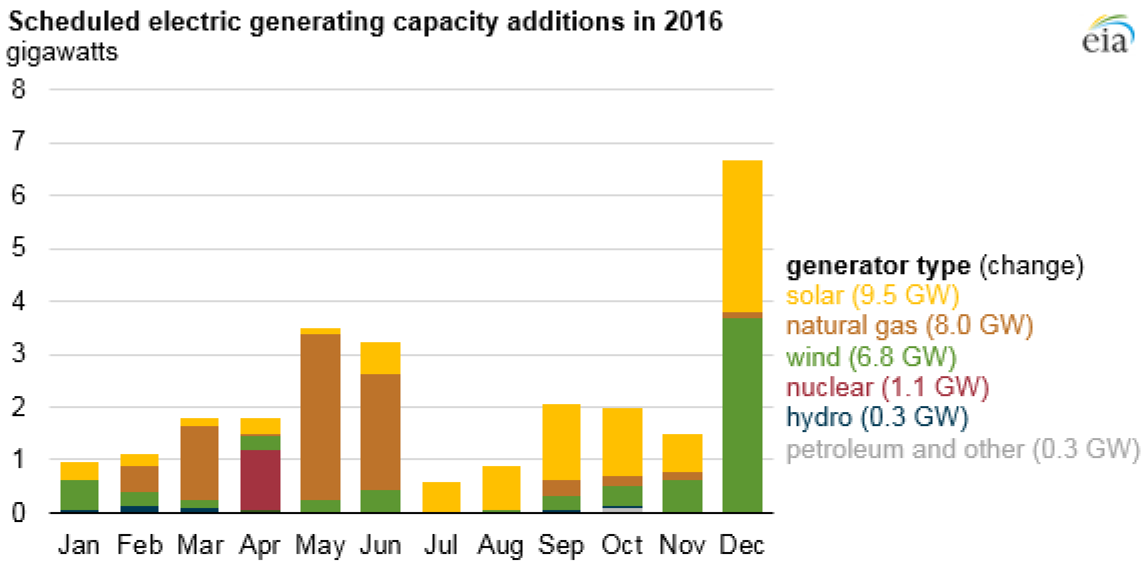
[76] *Ibid.*
[77] Solar Market Insights 2016 Q4, Solar Energy Industries Association.
[78] Today in Energy, March 23, 2016, from EIA, http://www.eia.gov/todayinenergy/detail.php?id=25492.
[79] Today in Energy, March 1, 2016, from EIA, http://www.eia.gov/todayinenergy/detail.php?id=25172.
[80] Pam Kiely & Charlie Jiang, "2016 Wrap-Up: States, Power Companies Lead in Cutting Carbon; Election Not Slowing Expected 2017 Progress" (Jan. 4, 2017, revised Jan. 6, 2017) http://blogs.edf.org/climate411/2017/01/04/2016-wrap-up-states-and-power-companies-led-the-way-to-cut-carbon/ (citing studies by FERC, SNL Energy, EIA, and SEIA/GTM Research).

Figure 9. Scheduled Electricity Generating Capacity Additions in 2016.



Annual renewable energy consumption has been steadily increasing for many years now (Figure 10). According to EIA, during the first 6 months of 2016 alone, the consumption of renewable fuels increased 9 percent compared with the same period in 2015. Wind energy, which also saw the largest electricity generating capacity additions of any technology in 2015,[81] accounted for nearly half the increase. Hydroelectric power, which has increased with the easing of drought conditions on the West Coast,[82] accounted for 35 percent of the increase in consumption of renewable energy. Solar energy accounted for 13 percent of the increase and is expected to have comprised the largest capacity additions of any fuel in 2016.[83]

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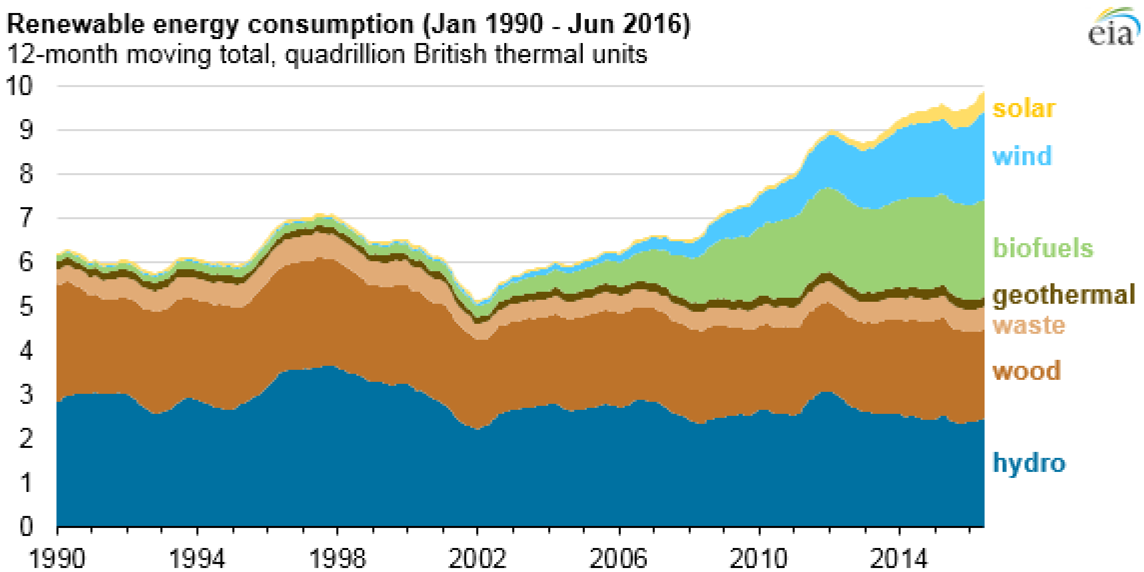
[81] EIA Today in Energy, March 1, 2016, http://www.eia.gov/todayinenergy/detail.cfm?id=25172
[82] EIA Today in Energy, May 20, 2016, http://www.eia.gov/todayinenergy/detail.cfm?id=26332
[83] EIA Today in Energy, October 12,2016, http://www.eia.gov/todayinenergy/detail.php?id=28312

Figure 10. Renewable Energy Consumption (Jan 1990–Jun 2016)



These trends toward zero-emitting renewable energy are reflected in the long-term investments that companies are making in new renewable capacity. Indeed, the majority of all new U.S. capacity additions in the past 3 years has been non-hydroelectric renewable sources.[84] Total U.S. renewable electricity capacity increased by 6.8 percent in 2014 and increased another 8 percent in 2015.[85] These rates of growth in 2014 and 2015 are faster than the compound annual growth rate for installed renewable capacity in 2005–2015 (6.7 percent),[86] suggesting that renewable capacity continues to increase (Figure 8). In total, since 2005, this growth represents a 91 percent increase in cumulative installed renewable energy capacity.[87] Of the approximately 17 GW of new generating capacity installed in 2015, about 67 percent was renewables and 32 percent was natural gas.[88] Coal constituted zero percent of new generating capacity in 2015;[89] down from less than

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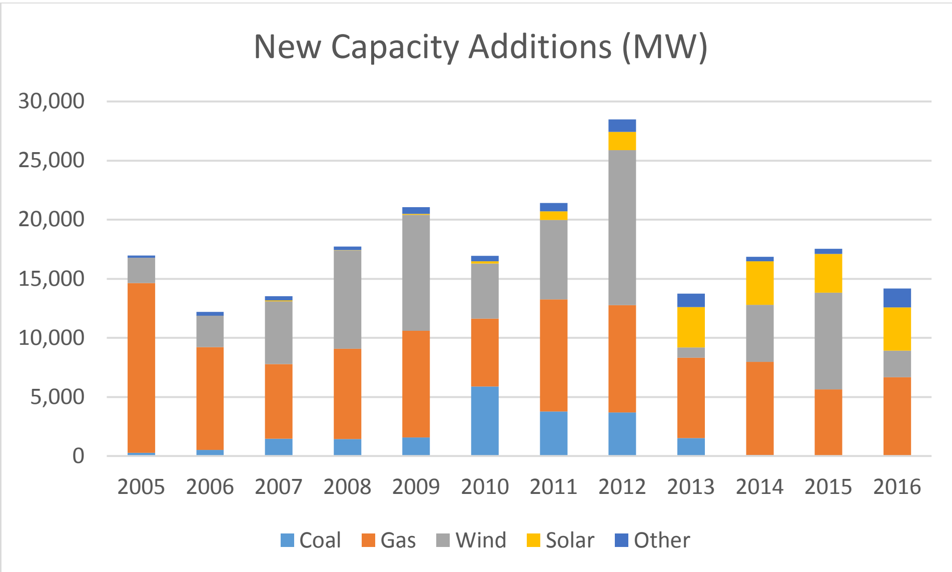
[84] Today in Energy, "Monthly U.S. renewable electricity generation in 2016 surpasses previous years" August 25, 2016 http://www.eia.gov/todayinenergy/detail.php?id=27672
[85] 2015 Renewable Energy Data Book, p18 http://www.nrel.gov/docs/fy17osti/66591.pdf
[86] *Ibid.*
[87] *Ibid.*
[88] Preliminary Monthly Electric Generator Inventory (based on Form EIA-860M as a supplement to Form EIA-860) (November 29, 2016), https://www.eia.gov/electricity/data/eia860m/
[89] *Ibid.*

1 percent of new generating capacity in 2014 (Figures 11–13).[90] (In 2015, coal-fired generation accounted for about 67 percent of total capacity retirements.)[91]

The statistics for 2016 tell a similar story. Of the more than 26 GW of utility-scale capacity planned to be added in 2016, approximately 67 percent was solar or wind capacity.[92] Planned solar capacity additions accounted for the most additions of any energy source.[93] Combined, planned solar, wind, and natural gas account for 93 percent of all utility-scale generation planned for 2016.[94]

Figure 11. Capacity Additions since 2005[95]



*Note that 2016 reflects only new capacity that began operating through September 2016, and does not include any new capacity that began operating in the final quarter of 2016.

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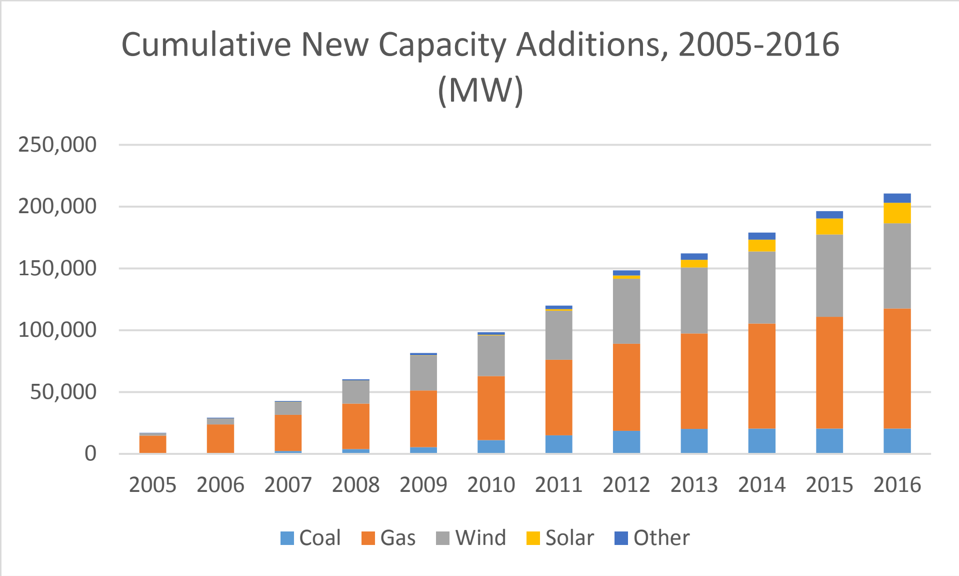
[90] Preliminary Monthly Electric Generator Inventory (based on Form EIA-860M as a supplement to Form EIA-860) (November 29, 2016), https://www.eia.gov/electricity/data/eia860m/.
[91] *Ibid.*
[92] Today in Energy, "Solar, natural gas, wind make up most 2016 generation additions," https://www.eia.gov/todayinenergy/detail.php?id=29212
[93] *Ibid.*
[94] *Ibid.*
[95] Preliminary Monthly Electric Generator Inventory (based on Form EIA-860M as a supplement to Form EIA-860) (November 29, 2016), https://www.eia.gov/electricity/data/eia860m/.

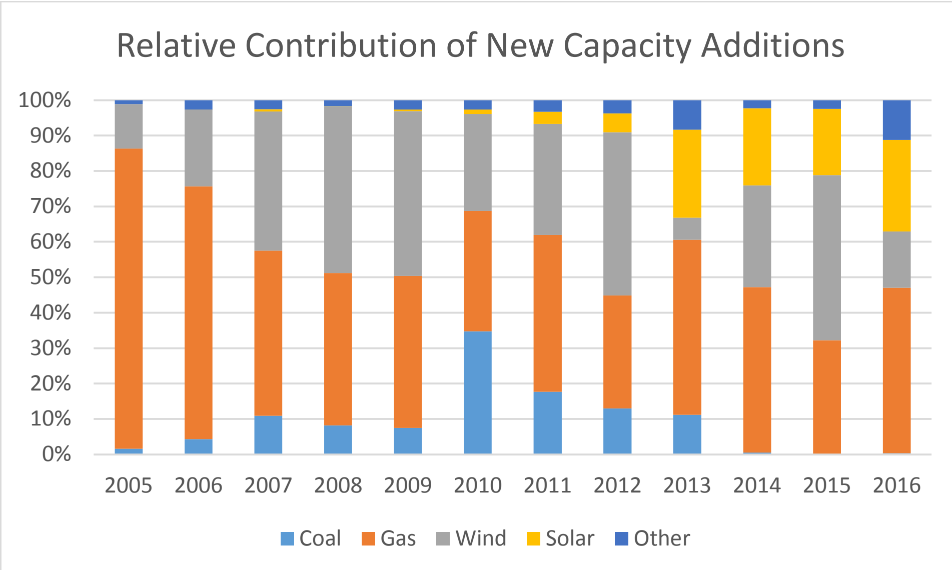
Figure 12. Cumulative New Capacity Additions since 2005[96]



*Note that 2016 reflects only new capacity that began operating through September 2016, and does not include any new capacity that began operating in the final quarter of 2016.

[96] Preliminary Monthly Electric Generator Inventory (based on Form EIA-860M as a supplement to Form EIA-860) (November 29, 2016), https://www.eia.gov/electricity/data/eia860m/.

Figure 13. Relative Contribution of Generation Types in Annual Capacity Additions [97]



*Note that 2016 reflects only new capacity that began operating through September 2016, and does not include any new capacity that began operating in the final quarter of 2016.

2.3.3. Demand-Side Energy Efficiency Trends

The historic supply-side shifts discussed above regarding low- and zero-emitting electricity generation have been complemented by a strong demand-side trend toward increasing EE.

EE investments and associated reductions in electricity demand have been increasing for many years prior to EPA finalizing the CPP in 2015. On the federal level, two statutes—the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007—created new EE standards (including for household appliances like dishwashers, refrigerators, and freezers), required improvement of lighting efficiency by more than 70 percent by 2020, and required strict EE measures for federal buildings (including for public and assisted housing). In addition, the 2009 federal economic stimulus bill (i.e., the American Recovery and

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[97] Preliminary Monthly Electric Generator Inventory (based on Form EIA-860M as a supplement to Form EIA-860) (November 29, 2016), https://www.eia.gov/electricity/data/eia860m/

Reinvestment Act) provided funding for state EE programs. As a result of DOE rulemakings, federal legislation, and consensus standards, more than 50 types of commercial and residential equipment have become subject to minimum energy standards.[98] States also have heavily promoted demand-side EE. As of 2015, there were 24 states with fully funded specific energy savings targets,[99] and 15 states (plus the District of Columbia) with appliance efficiency standards stricter than federal requirements[100]—driving further advances in the national and global appliance industries. Budgets for electric efficiency programs totaled $5.9 billion in 2012, following rapid growth in funding for EE programs,[101] and rose to $6.3 billion in 2013.[102]

The combination of federal, state, and local programs and market forces have resulted in real-world advances in EE that have driven down demand for electricity. For example, U.S. homes built since 2000 use only 2 percent more energy than older homes, despite being an average of 30 percent larger.[103] From 1980 to 2009, energy use decreased by about 50 percent for new central air conditioners, about 65 percent for new refrigerators, and about 70 percent for new washing machines.[104] Over the same period, in the industrial sector, the amount of energy necessary to produce the same value of an average product dropped almost 40 percent.[105] Although U.S. electricity demand continues to increase, it is currently growing at its slowest rate

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[98] Consensus process provides alternate approach to energy efficiency standard development, *Today in Energy,* July 21, 2015. http://www.eia.gov/todayinenergy/detail.cfm?id=22152.

[99] American Council for an Energy-Efficient Economy, *State Energy Efficiency Resource Standards* (April 2015), http://aceee.org/sites/default/files/eers-04072015.pdf. The count of 24 includes 22 with a stand-alone policy and two that count energy efficiency toward their renewable energy standards; it does not include Ohio or Indiana, which have eliminated their policies.

[100] Center for Climate and Energy Solutions, *Appliance Efficiency Standards*, http://www.c2es.org/us-states-regions/policy-maps/appliance-energy-efficiency.

[101] 80 FR 64694–96, citing Annie Downs *et al.,* American Council for an Energy Efficient Economy, The 2013 State Energy Efficiency Scorecard (Nov. 2013), http://aceee.org/sites/default/files/publications/researchreports/e13k.pdf.

[102] *See* Demand-Side Energy Efficiency TSD at 18 & tbl. 2.

[103] U.S. Energy Info. Admin., *Newer U.S. homes are 30% larger but consume about as much energy as older homes*, TODAY IN ENERGY (Feb. 12, 2013), http://www.eia.gov/todayinenergy/detail.cfm?id=9951.

[104] Steven Nadel, Neal Elliott, and Therese Langer, American Council for an Energy-Efficient Economy*, Energy Efficiency in the United States: 35 Years and Counting (June 2015)*, p. 7 http://aceee.org/sites/default/files/publications/researchreports/e1502.pdf.

[105] *Ibid.* p. vi,

in decades—in large part due to policies improving EE in homes, businesses, and technological devices.[106]

Since the CPP was finalized, updated data for 2014 and 2015 show similar levels of spending—$5.9 billion and $6.3 billion per year, respectively.[107] The overall U.S. share of electricity costs from these investments has increased slightly, from 0.66 percent of retail demand in 2013 to 0.71 percent in 2015.[108] In addition, four states covered by the CPP reported annual electricity savings of more than 1.5 percent in 2015.[109]

These trends have continued since EPA finalized the CPP. For example, a number of additional federal standards have been promulgated that significantly reduce energy demand, including standards for commercial cooling equipment, commercial furnaces, residential boilers, commercial water heaters, fluorescent lamps, commercial pumps, and commercial ice makers and beverage vending machines.[110] Since the beginning of 2014, in addition to these recent federal appliance and equipment standards, EPA has finalized an additional 20 ENERGY STAR product specifications addressing clothes washers, windows/doors/skylights, water heaters, central air conditioners/heat pumps, ventilation fans, televisions, clothes dryers, room air conditioners, dish washers, light fixtures, displays, commercial ovens, commercial fryers, light bulbs, large network equipment, dehumidifiers, set-top boxes, commercial refrigeration, and commercial coffee makers. These new federal standards and ENERGY STAR specifications will lead to significant additional reductions in U.S. electricity demand in the years leading up to and including the compliance period for the CPP.[111]

2.4. Reasons for Industry Trends

The industry trends discussed above result from many interdependent factors, namely technology improvements and financial incentives that have shifted the relative costs of generation to different types of generation resources. This section explains some of these factors, such as historically low natural gas prices, advances

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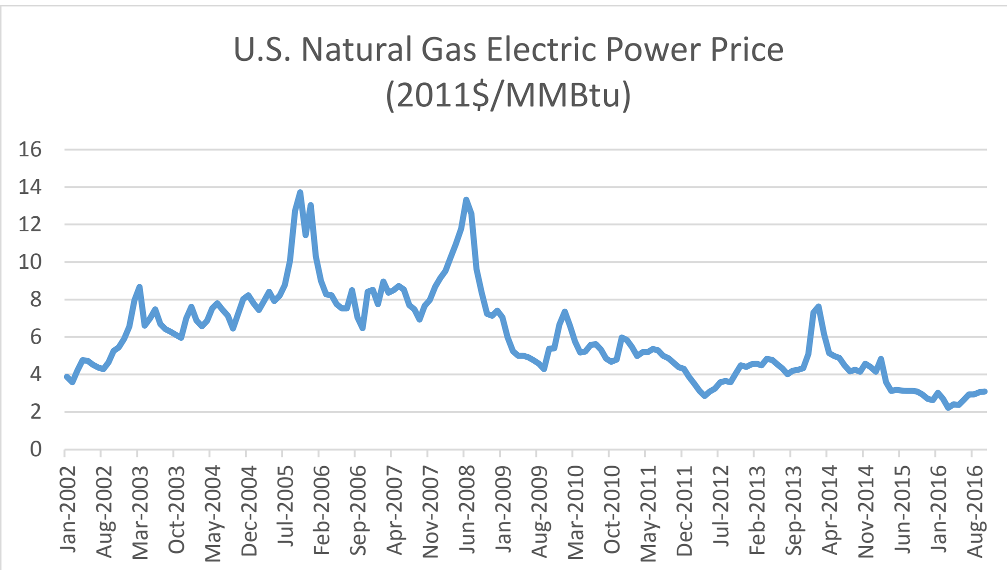
[106] DOE, Quadrennial Technology Review (Sept. 2015), p. 17, http://energy.gov/sites/prod/files/2015/09/f26/QTR2015-01-Challenges.pdf.
[107] American Council for an Energy-Efficient Economy (ACEEE), "The 2016 State Energy Efficiency Scorecard," September 2016, Report U1606. http://aceee.org/research-report/u1606.
[108] *Ibid*.
[109] *Ibid*. Those states are Rhode Island, Massachusetts, California, and Maine. Hawaii and Vermont also achieved reductions greater than 1.5%, although they are not addressed by the CPP.
[110] EIA, "Annual Energy Outlook 2016: With Projections to 2040," August 2016. http://www.eia.gov/outlooks/aeo/pdf/0383(2016).pdf.
[111] www.energystar.gov/productdevelopment.

in renewable energy technologies coupled with financial incentives, and the aging of coal-fired resources.

2.4.1. Natural Gas Prices and Supply

A main driver of these trends has been the continued low price of natural gas. Abundant low-cost natural gas has catalyzed unprecedented changes in the U.S. power generation mix over the past decade. Since 2010, significant advances in drilling technology and techniques have greatly reduced the costs of drilling for—and increased the efficiency of extracting—natural gas. As a result, producers have been able to access and bring to market large amounts of relatively inexpensive natural gas, primarily from shale resources. While the average monthly price of natural gas delivered to the electric power sector reached a high of about $14 per million Btu (MMBtu; $2011) in 2005 and 2008, the average monthly delivered price has remained approximately $2 to $3 per MMBtu ($2011) since August 2015 (Figure 14).[112]

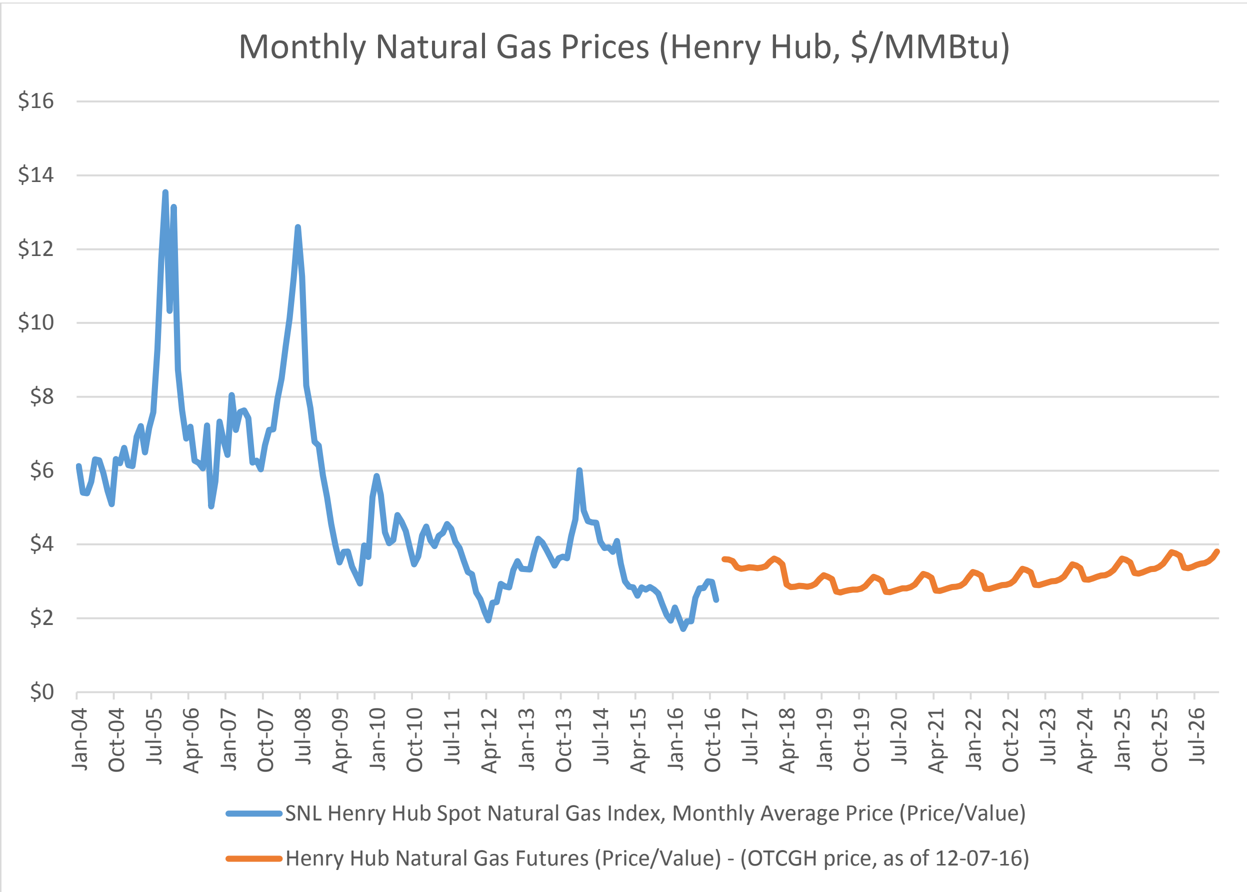
Figure 14. U.S. Natural Gas Electric Power Price



[112] EIA, Natural Gas Prices. http://www.eia.gov/dnav/ng/hist/n3045us3m.htm. Converted to 2011 dollars using BEA Implicit Price Deflators for Gross Domestic Product, and converted to $/MMBtu using 1,032 Btu/cf.

In the 12 months before the CPP was finalized (July 2014 to July 2015), the monthly average price of natural gas at Henry Hub, a major gas trading point, declined nearly 30 percent—from $4.14 to $2.91 per MMBtu (Figure 15).[113] As of November 2016, average natural gas prices were lower still, at $2.55 per MMBtu.[114]

Figure 15. Monthly Natural Gas Prices at Henry Hub



The low cost of natural gas makes it challenging for coal to compete in the marketplace. For example, in the month before the CPP was finalized, the average wholesale price of natural gas in New York City ($2.06/MMBtu) was less than the

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[113] EIA, "Nationwide, electricity generation from coal falls while natural gas rises," http://www.eia.gov/todayinenergy/detail.php?id=23252
[114] http://www.eia.gov/dnav/ng/hist/rngwhhdm.htm

average wholesale price of Central Appalachian coal ($2.31/MMBtu)—even *before* accounting for the fact that natural gas power plants generate more electricity per MMBtu than coal-fired plants do.[115] Over the past year, natural gas has continued to be a competitive fuel source relative to coal; the per-megawatt-hour (MWh) price of natural gas in New York City, for example, remained below the price of Central Appalachian coal for the eighth consecutive month in October 2016.[116]

According to most experts, these fundamental shifts in the natural gas market are not a temporary phenomenon; they are a permanent recalibration of the market based upon major advances in drilling techniques.[117] Most of the increased natural gas production has come from shale gas plays, with a notable amount of that increase from the Marcellus region covering Pennsylvania, West Virginia, and Ohio. Natural gas production from shale resources is expected to increase over the coming decades, with prices remaining stable (Figure 16).[118] Shale gas production accounted for more than half of U.S. natural gas production in 2015 and is projected to more than double from 37 billion cubic feet per day (Bcf/day) in 2015 to 79 Bcf/day by 2040—70 percent of total U.S. natural gas production in the AEO 2016 reference case by 2040.[119]

EIA states that "the recent decline in the generation share of coal, and the concurrent rise in the share of natural gas, was mainly a market-driven response to lower natural gas prices that have made natural gas generation more economically attractive."[120]

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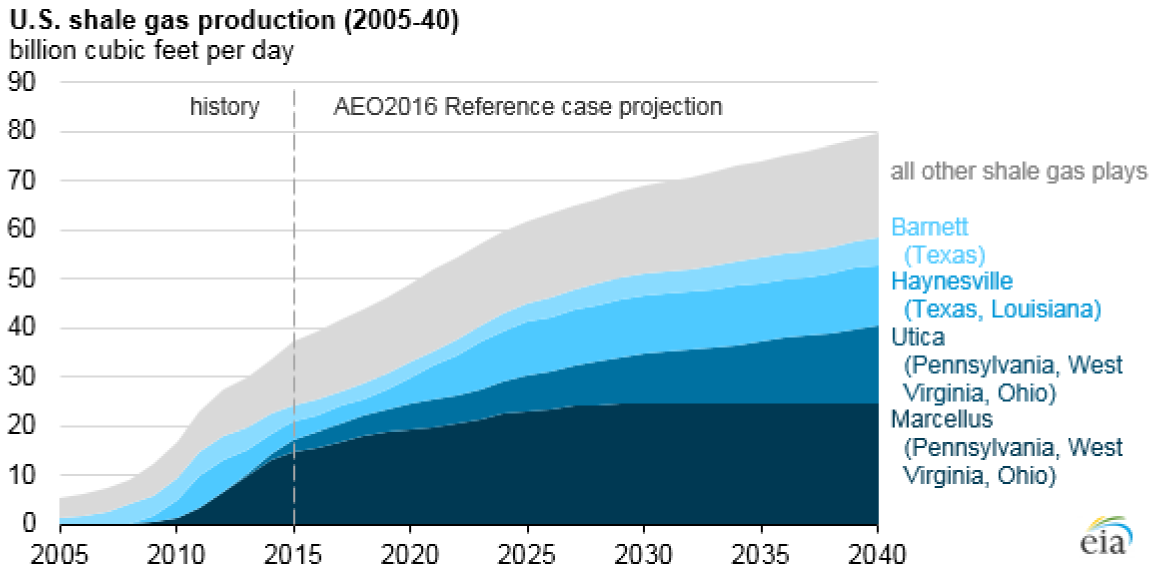
[115] EIA, "Nationwide, electricity generation from coal falls while natural gas rises," http://www.eia.gov/todayinenergy/detail.php?id=23252
[116] EIA, "Electricity Monthly Update, with Data for October 2016" https://www.eia.gov/electricity/monthly/update/resource_use.cfm#tabs_spot-2
[117] See Comparison of Natural Gas Projections, AEO 2016 that show increased natural gas use, and stable prices through 2030. These include BP, ExxonMobil, IHS Global Insight, ICF International who believe that the natural gas market has undergone inherent structural shifts (http://www.eia.gov/outlooks/aeo/section_comparison.cfm).
[118] EIA AEO 2016 reference case.
[119] http://www.eia.gov/todayinenergy/detail.php?id=27512
[120] Today in Energy (December 22, 2016), from EIA at http://www.eia.gov/todayinenergy/detail.php?id=29272

Figure 16. U.S. Shale Gas Production (2005–2040)



2.4.2. Renewable Energy Prices and Federal Tax Credits

In recent years, the cost of wind and solar electricity has dropped considerably.[121] Larger and less expensive wind turbines are reducing costs and improving project performance, leading to a 25 percent decline in overall project costs from 2009 to 2015.[122] These trends have lowered the average levelized long-term price from wind power sales agreements from $70/MWh to $20/MWh over the same timeframe. Improvements in solar photovoltaic (PV) system pricing for 2016, meanwhile, have reinforced longer-term trends, with declines across all market segments driven by continued reductions in module, inverter, and structural balance of system prices.[123] Costs for utility-scale PV dropped from $1.78 per Watt of direct current (Wdc) in the first quarter of 2015 to $1.42/Wdc in the first quarter of 2016, down from $4.46/Wdc in 2009.[124] Between 2009 and 2014, the cost of PV systems decreased by 15 percent

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[121] Today in Energy, "Monthly U.S. renewable electricity generation in 2016 surpasses previous years" August 25, 2016http://www.eia.gov/todayinenergy/detail.php?id=27672
[122] DOE, "2015 Wind Technologies Market Report" August 2016 https://emp.lbl.gov/sites/all/files/2015-windtechreport.final_.pdf
[123] Solar Energy Industries Association, "U.S. Solar Market Insight Q4 2016" http://www.seia.org/sites/default/files/H7D82HD9F238SMI2016Q4.pdf
[124] National Renewable Energy Laboratory, "U.S. Solar Photovoltaic System Cost Benchmark: Q1 2016" September 2016 http://www.nrel.gov/docs/fy16osti/66532.pdf

per year, and has decreased even in comparison to wind power and natural gas-fired plants.[125]

These trends are expected to continue into the future, particularly in light of policy developments that occurred after EPA finalized the CPP. In December 2015, the federal government extended the U.S. wind power production tax credit (PTC) and solar investment tax credit (ITC). The wind PTC (extended to 2020) provides a $23-per-MWh subsidy—approximately one third of the total revenue that can be expected from a typical new wind generator.[126] The solar ITC (extended to 2022) covers 30 percent of the up-front investment costs for new solar electricity generation systems.[127]

These tax credits are projected to significantly increase renewable capacity and generation relative to the baseline that EPA assumed when developing and evaluating the CPP. For example, the DOE's National Renewable Energy Laboratory (NREL) estimates that the tax-credit extensions could increase renewable energy capacity by more than 50 GW in 2020, easing the compliance costs of the CPP by avoiding more than 500 million metric tons of CO_2 on a cumulative basis from 2016–2030.[128] Similarly, Bloomberg New Energy Finance projects that these tax credits will lead to an increase in capacity from wind and solar PV projects of 37 GW by 2021.[129]

State utility regulations like renewable portfolio standards also incentivize new renewable installations and have the indirect effect of driving technological developments. A comprehensive review from the Environmental Defense Fund surveying clean energy developments in 2016 (particularly the final months of 2016) discusses many of the steps that state policymakers have taken to push forward

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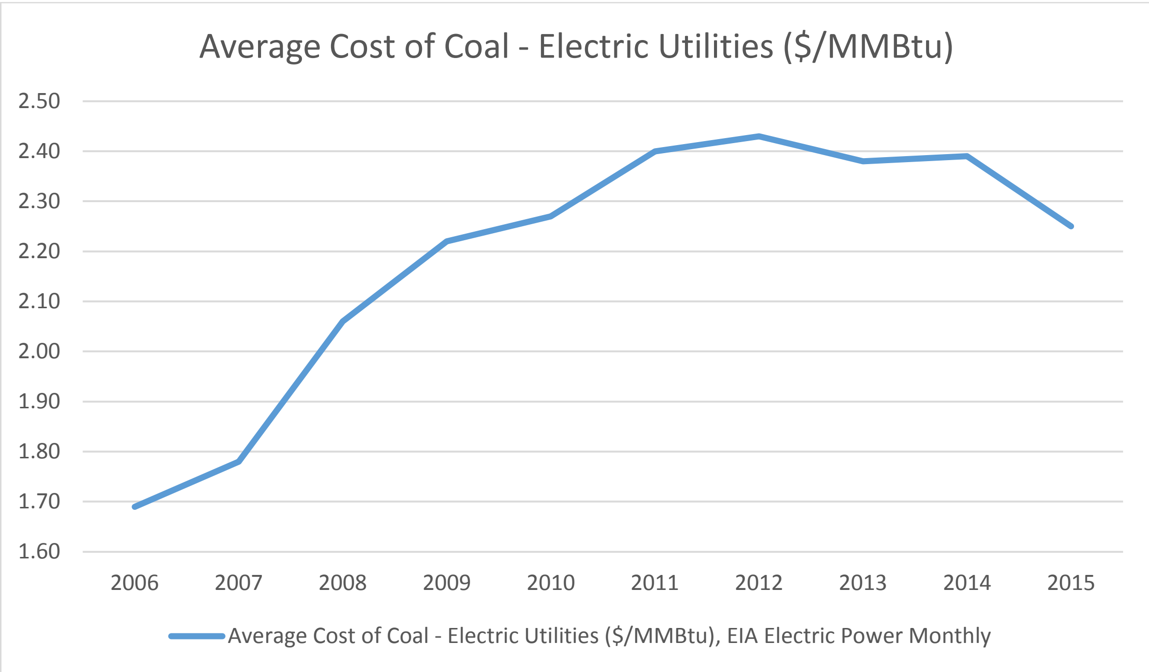
[125] RFF. An Economic Assessment of the Supreme Court's Stay of the Clean Power Plan and Implications for the Future p.14 http://www.rff.org/files/document/file/RFF-DP-16-21.pdf
[126] *Ibid.* p.13
[127] *Ibid.* p.14
[128] "Impacts of Federal Tax Credit Extensions on Renewable Deployment and Power Sector Emissions," Mai, et al., National Renewable Energy Laboratory, February 2016, http://www.nrel.gov/docs/fy16osti/65571.pdf
[129] "Impact of Tax Credit Extensions for Wind and Solar," Grace, et al., Bloomberg New Energy Finance, December 2015, https://data.bloomberglp.com/bnef/sites/4/2015/12/2015-12-16-BNEF-US-solar-and-wind-tax-credit-impact-analysis.pdf

with regulatory programs reducing the CO_2 emissions from the power sector, including by encouraging further investment in renewable energy.[130]

2.4.3. Coal Prices

The average cost of coal in 2015 to electric utilities remained elevated by historical standards at $2.25/MMBtu, exceeding its 10-year average of $2.19/MMBtu despite a 7 percent decline from 2012 (Figure 17).[131]

Figure 17. Average Cost of Coal to Electric Utilities



Average prices have fallen since 2012, largely a function of reduced demand—coal consumption fell 13.1 percent in 2015 to 738 million short tons, the lowest level since 1987, while U.S. annual coal production dropped 10.3 percent in 2015 to a 30-year low. The recent price declines, driven primarily by increased competition from high-efficiency natural gas combined cycle (NGCC) units bolstered by low natural gas prices, have been partially offset by longer-term production cost trends that

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130 *See* Pam Kiely & Charlie Jiang, "2016 Wrap-Up: States, Power Companies Lead in Cutting Carbon; Election Not Slowing Expected 2017 Progress" (Jan. 4, 2017, revised Jan. 6, 2017) http://blogs.edf.org/climate411/2017/01/04/2016-wrap-up-states-and-power-companies-led-the-way-to-cut-carbon/.

131 http://www.eia.gov/electricity/monthly/

have made coal reserves costlier to mine, particularly in the Appalachian region. This trend is reflected in the continuing closure of smaller mines and reduction in productive capacity of U.S. coal mines overall (down 6.3 percent from 2014 for a fourth straight year).[132]

2.4.4. Aging Coal Fleet

Another driver of CO_2 emission reductions in the power sector is the fact that many of the nation's existing coal-fired power plants are retiring due to age, amongst other market factors.[133] In the nearly 5 years preceding the CPP, the average age of a retiring coal plant was 55 years.[134] Since 2008, coal production and the number of coal-mining jobs have fallen by approximately 15 percent, and 20 percent of coal-fired capacity has or will soon retire.[135]

Ninety-eight coal-fired EGUs closed in 2015, accounting for nearly 15 GW of capacity, and these EGUs were built starting in 1944 with an average age of 58 years. [136] Over the next 5 years, coal plants representing an additional 23 GW of capacity are scheduled for retirement.[137] These retirements are anticipated even in the absence of the CPP.[138] As of 2015, 91 percent of existing U.S. coal-fired power

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[132] https://www.eia.gov/coal/annual/pdf/acr.pdf

[133] Martin Ross et al., Nicholas Institute for Environmental Policy Solutions, Ongoing Evolution of the Electricity Industry – Effects of Market Conditions and the Clean Power Plan 3 (July 2016), https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_16-07_final.pdf (noting that many coal plants have retired in the past decade because of age).

[134] This is the average age at retirement of the approximately 28 GW of coal steam capacity that reported retirement to U.S. Energy Information Administration during this period. U.S. Energy Info. Admin., Form 860, 2014 Early Release, Table 3-1 (Generator, Operable, Retired and Cancelled), http://www.eia.gov/electricity/data/eia860/; U.S. Energy Info. Admin., *Electric Power Monthly,* Table 6.4, (June 2015) http://www.eia.gov/electricity/monthly/current_year/june2015.pdf.

[135] Joshua Linn et al., Resources for the Future, An Economic Assessment of the Supreme Court's Stay of the Clean Power Plan and Implications for the Future 7 (June 2016), http://www.rff.org/research/publications/supreme-court-s-stay-clean-power-plan-economic-assessment-and-implications.

[136] Preliminary Monthly Electric Generator Inventory (based on Form EIA-860M as a supplement to Form EIA-860) (November 29, 2016), https://www.eia.gov/electricity/data/eia860m/.

[137] Mark Chediak, *Why Coal Burners Don't Totally Hate Obama's Climate Plan*, Bloomberg Business (Nov. 14, 2015), http://www.bloomberg.com/news/articles/2015-11-13/why-coal-burners-don-t-totally-hate-obama-s-climate-plan (last visited Nov. 25, 2015).

[138] Joshua Linn et al., Resources for the Future, An Economic Assessment of the Supreme Court's Stay of the Clean Power Plan and Implications for the Future 7 (June 2016), http://www.rff.org/research/publications/supreme-court-s-stay-clean-power-plan-economic-

plants were built in the 1980s or earlier, and 71 percent have construction dates before 1980.[139] More retirements are likely as these plants continue aging.

2.5. Electricity Prices

Nationwide average electricity prices are relatively stable and have risen a few percent per year recently (roughly 6 percent from 2012 to 2015, in nominal terms; Figure 18). In 2015, the national average price was about 12.6 cents/kilowatt-hour (kWh).[140] When electricity prices are held constant in real terms, electricity prices have been flat since 2010 (Figure 19). This timeframe coincides with the notable shift in generation mix away from coal, toward significant increases in the use of natural gas and generation from renewables.

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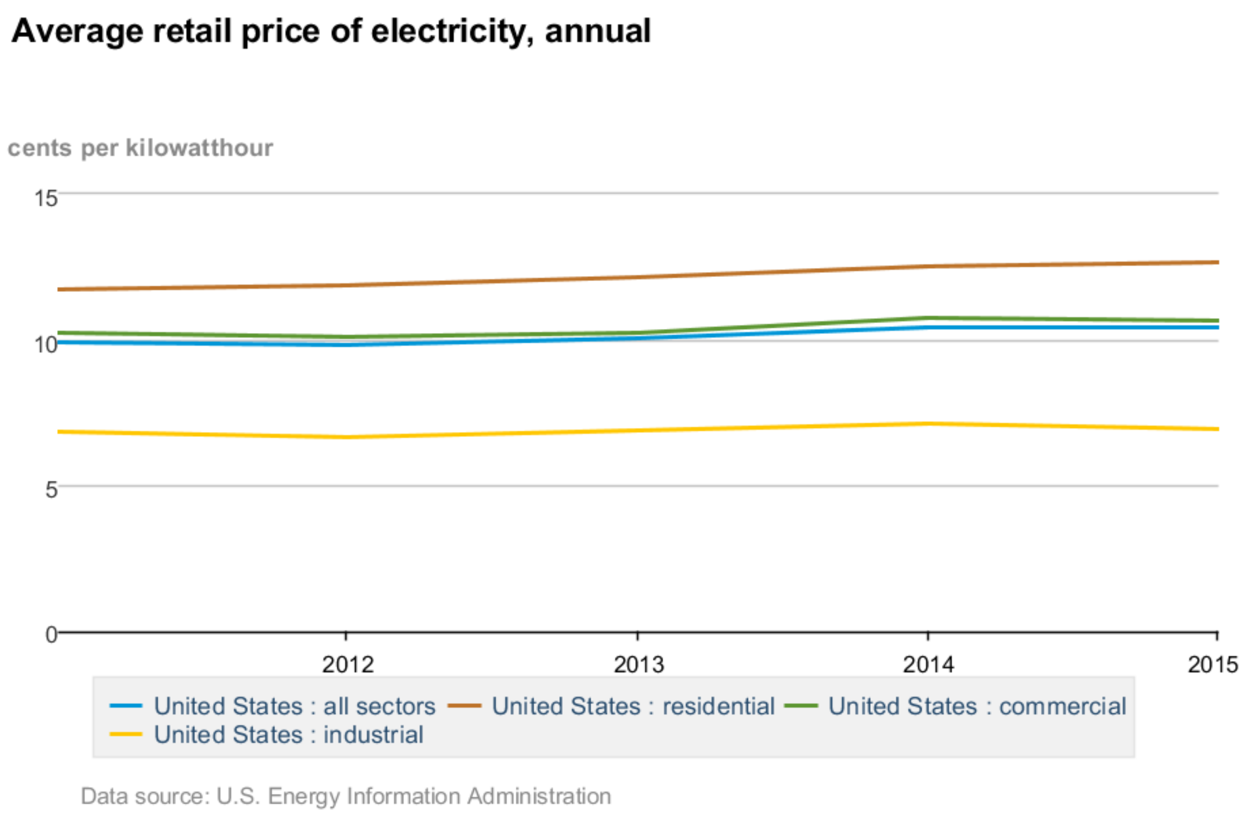
assessment-and-implications (explaining that many future coal plant retirements would occur independent of the CPP).

139 Jack Fitzpatrick, *Coal Plants Are Shutting Down, With or Without Clean Power Plan*, Morning Consult, May 3, 2015, https://morningconsult.com/2016/05/03/coal-plants-shutting-without-clean-power-plan/.

140 EIA, Electric Power Monthly (Table 5.3, Average Price of Electricity to Ultimate Consumers).

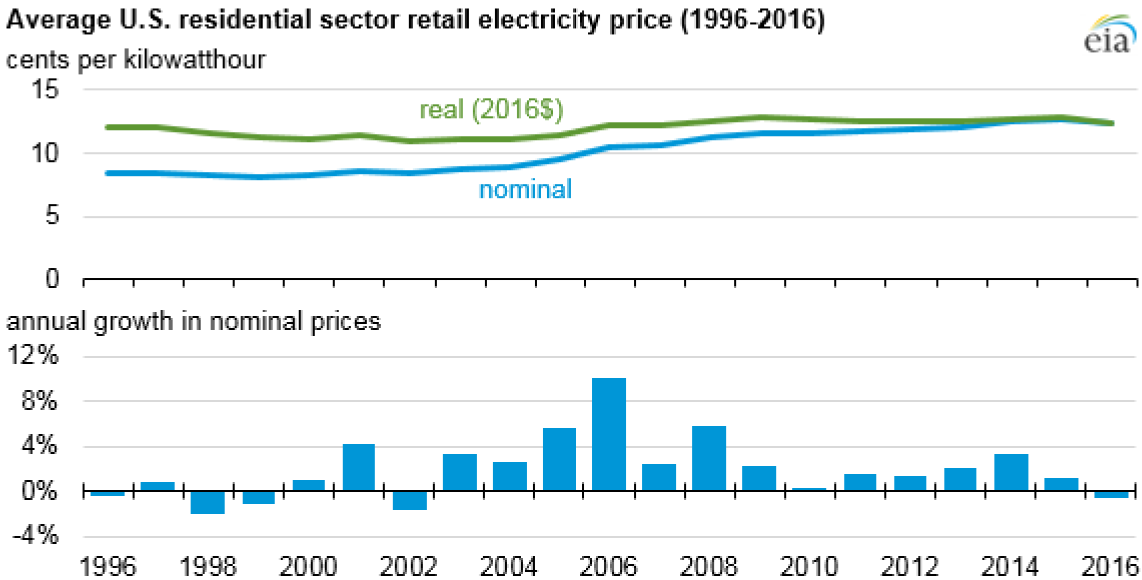
Figure 18. Annual Average Retail Price of Electricity



In 2016, EIA anticipates that residential electricity prices will have declined for the first time in many years (Figure 19).[141] This is largely due to declining fuel costs, especially for natural gas. Over the first 6 months of 2016, the weighted average cost of natural gas delivered to electricity generators was $2.58/MMBtu, 28 percent lower than in the first half of 2015.

[141] Today in Energy (October 6, 2016) from EIA, https://www.eia.gov/todayinenergy/detail.php?id=28252

Figure 19. Average U.S. Residential Sector Retail Electricity Price (1996–2016)



3. Projected Continuation of Power Sector Trends and Achievability of CPP

Since EPA finalized the CPP in August 2015, a wide variety of federal agencies, research organizations, think tanks, consulting firms, and private companies have conducted analyses on industry trends as they relate to the CPP. These analyses are designed, in large part, to help stakeholders and states understand current industry trends and the potential impacts of various approaches to implementing the CPP. While the analyses sometimes use different assumptions and models, they generally show consistent findings:

- The power sector will continue transitioning toward low- and zero-emitting generation with or without the CPP;
- This transition and its corresponding emission reductions allow states and sources to implement the CPP and achieve its goals more readily than originally projected;
- In many scenarios, the CPP is functionally nonbinding in the early years of implementation; and
- To the extent the CPP becomes binding in later years, it can be implemented at very low costs.

This section summarizes key findings and conclusions of recent reports, including those by the EIA, the EPA, power sector companies, and leading research organizations.

The price of natural gas and continued trend toward lower costs of new renewable forms of electric generation confirm the cost effectiveness of implementing building blocks 2 and 3 of the CPP. Specifically, the prices and supply framework used to support building block 2 (which entailed shifting coal-fired generation to NGCC generation) included higher natural gas prices than what is observed today (by roughly an order of two) and higher than the projected natural gas prices shown in the EIA Annual Energy Outlook (AEO) 2016. EIA is now projecting delivered gas prices on the order of approximately $4.40–$4.70/MMBtu (2011$), which is lower than the prices of roughly $5.00–$6.00/MMBtu (2011$) that EPA projected at the time it promulgated the CPP. Similarly, the costs of new renewable energy (RE) have continued to decline, consistent with the trajectory EPA used to support building block 3. In addition, tax provisions for new RE were extended since promulgation of the CPP .

3.1. U.S. Energy Information Administration

One of the most important efforts to help elected officials, government agencies, industries, and the public understand the potential future energy system in the United States is the Annual Energy Outlook (AEO), produced by the U.S. EIA. EIA is an independent and impartial agency within the DOE that collects, analyzes, and disseminates energy information and data to the public in order to further the understanding of the relationship between energy, the economy, and the environment. EIA's data are a vital resource to many stakeholders.

Every year, EIA releases a new AEO, which updates EIA's projections based on the most current information and outlines important factors expected to shape U.S. energy markets in the future. These projections provide a basis for examination and discussion of energy market trends and serve as a starting point for analysis of potential changes in U.S. energy policies, rules, and regulations, as well as the potential role of advanced technologies. The information provided in the AEO is used extensively and provides a relatively conservative baseline projection of future conditions under a variety of assumptions. The following sections summarize the results of recent AEO projections, with a particular focus on scenarios that do not include CPP requirements to illustrate how these industry trends are expected to advance, irrespective of the CPP.

The annual projections from the AEO show a progression and evolution of various power sector market outcomes to reflect the most current and up-to-date assumptions and dynamics of the sector, consistent with real-world trends. Importantly, the AEO reflects only existing laws and regulations, and it is generally a conservative reflection of future conditions, as it does not reflect major technology shifts or new policy. The AEO instead largely relies upon the prevailing energy market conditions that are known today and in the near future. Each AEO update, over time, shows the aforementioned trends playing out in the modeled projections, with EIA incorporating updates to the modeling framework and modeling outputs that further refine projections with the most up-to-date information, regulatory frameworks, and economics. The scenarios provided in the AEO are not forecasts or predictions of the future, but rather projections of a range of outcomes or possibilities that help deepen the public's understanding of the energy system.

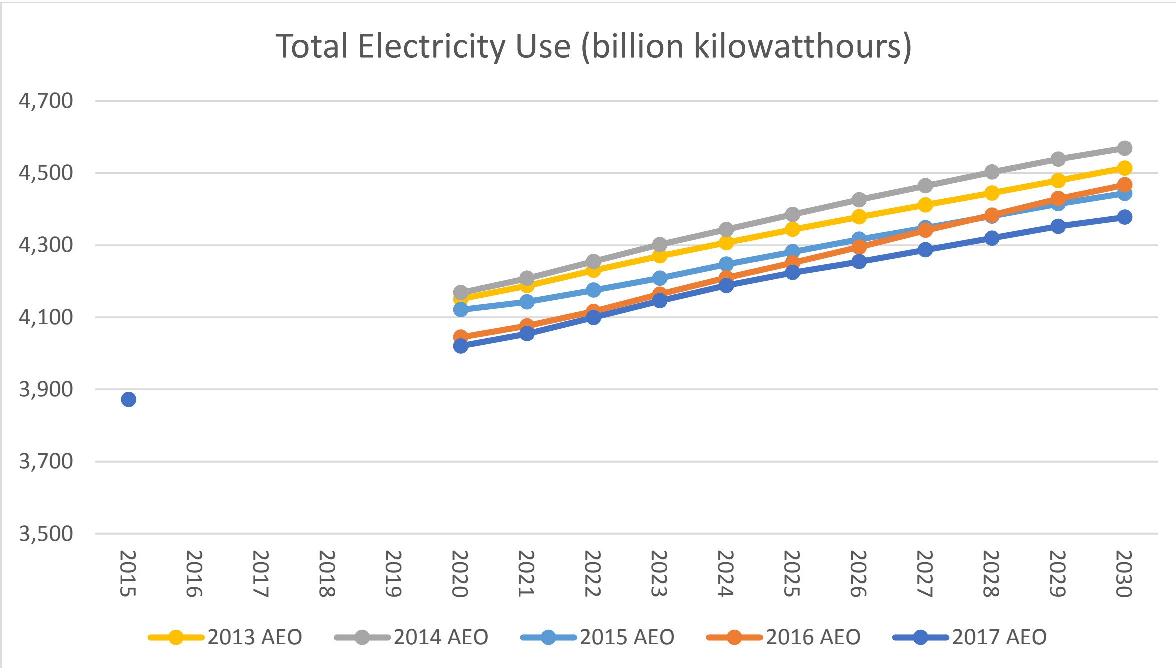
Recently, EIA released the AEO for 2017, and key projections from that outlook (for the electric power sector) are shown and summarized below. Alongside the AEO 2017 projections is the same data for previous AEOs, to illustrate how they have changed over time. It is important to note that the scenarios shown below are from AEO scenarios *without the CPP*, thus illustrating the changes that are occurring in the power sector independent of the changes that might be driven by the CPP.[142]

3.1.1. Electric Demand

One of the key drivers of the AEO's electric sector outcomes is the projected total future electric demand, which EIA evaluates based upon a number of factors, including domestic economic activity, population growth, and technology change and turnover. Over time, the U.S. economy has become less energy intensive, and electric demand-growth projections have generally been lowered in each subsequent AEO, to reflect the trend. The AEO 2016 (no CPP case) shows a 1 percent average rate of growth from 2020 to 2030, similar to average growth rates from past AEOs.[143] Over time, EIA has revised its AEO projections to account for changes in the economy that are driving lower electric demand trends (Figure 20). Compared to previous AEOs, AEO 2017's projections indicate that total electric demand will be less than previously expected for most of the CPP implementation phase. In particular, the electric growth rate in AEO 2017 (no CPP) averages 0.7% from 2025 to 2030.

[142] AEO 2016 and 2017 include the CPP in the "reference case," and have a side case for a scenario without CPP, shown here. Previous AEOs did not include CPP in the reference case.
[143] AEO 2015 projected a lower rate of growth from 2020 to 2030, but a higher level of demand in 2020.

Figure 20. AEO Projections for Total Electricity Use



3.1.2. Generation Mix

EIA forecasts that the industry-wide shifts in electricity generation that have already occurred prior to and following finalization of the CPP (discussed above in Section 2) will continue into the future. These trends show that natural gas-fired generation and renewable energy will constitute an increasing share of the electric generation mix into the future, while coal is expected to remain at levels similar to today (irrespective of the CPP).

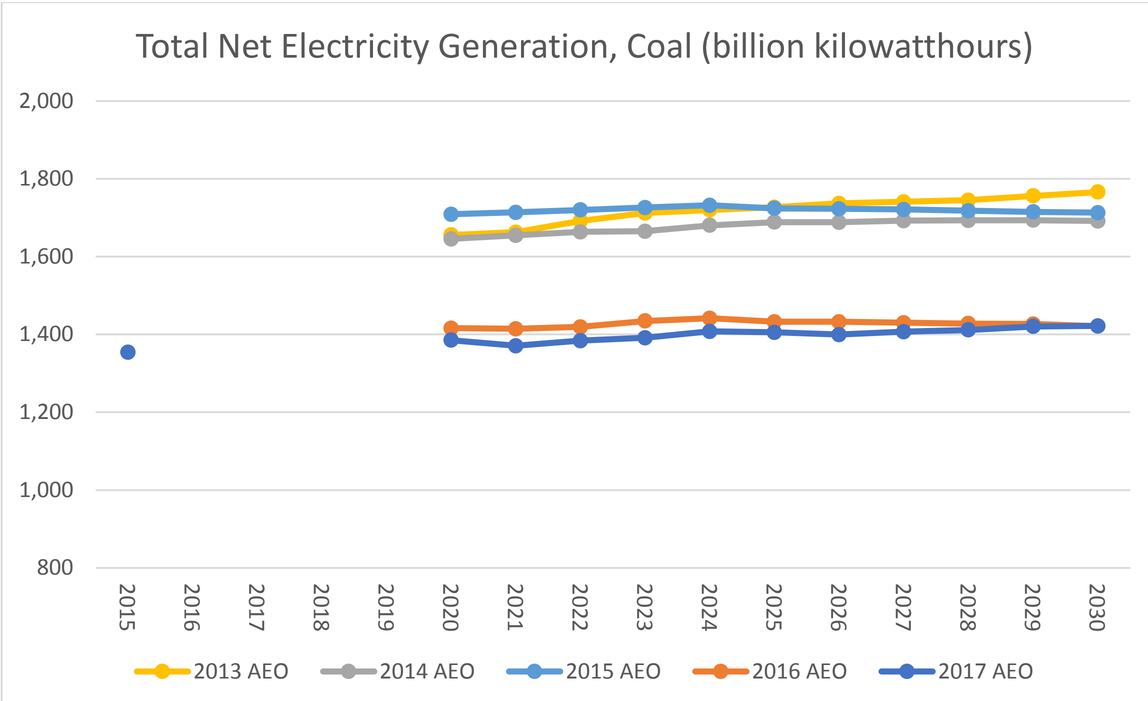
3.1.3. Coal-Fired Generation

With respect to coal-fired generation, EIA has concluded that even "[w]ith no Clean Power Plan (CPP), coal-fired generation shows little change from 2015 level" in the AEO 2016 and 2017 (no CPP) cases.[144] In 2015, coal provided roughly 33 percent of total electric generation, the same level that the AEO 2016 (no CPP) case shows for 2030. The total level of generation for coal-fired power plants is very similar, although slightly above, the historical 2015 level versus the AEO 2016 and 2017 (no CPP) projections (Figure 21). In the updated AEO 2017 (no CPP), generation from

[144] EIA's AEO 2016 (no CPP) case, at http://www.eia.gov/outlooks/aeo/MT_electric.cfm#cap_natgas.

coal-fired power plants is about 2 to 3 percent lower than the AEO 2016 from 2020 to 2027, and identical by 2030.

Figure 21. AEO Projections for Total Net Electricity Generation, Coal

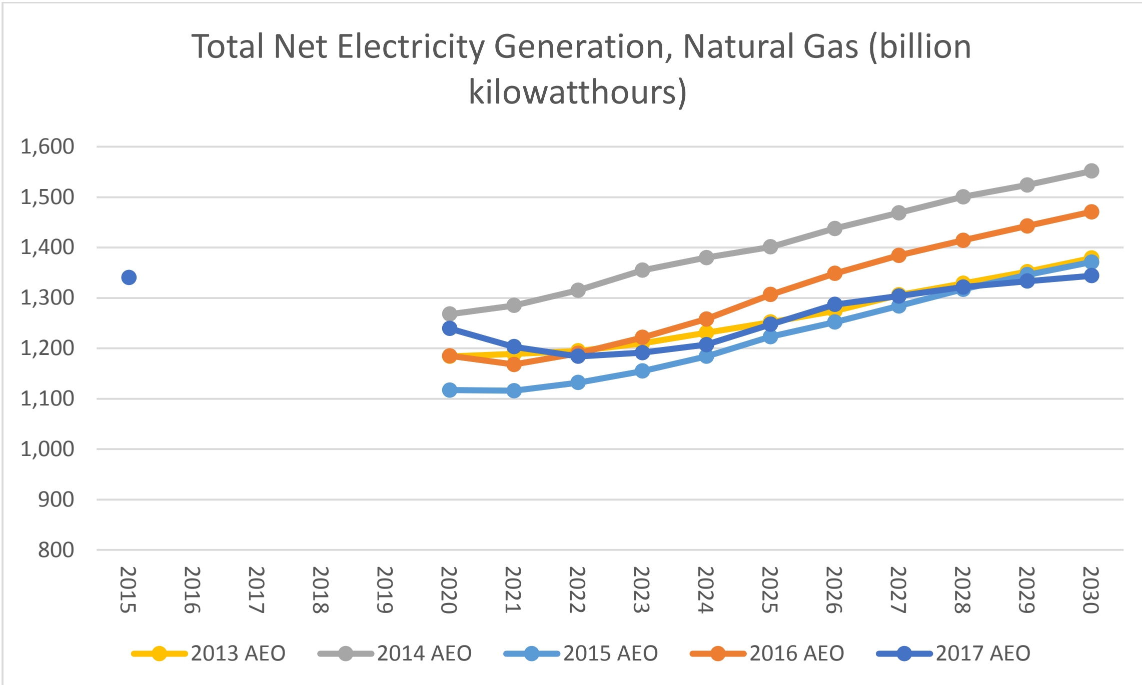


3.1.4. Natural Gas-Fired Generation

In 2015, natural gas-fired and coal-fired sources of generation each supplied approximately 33 percent of total utility-scale electricity generation, and EIA expects that by the end of 2016 natural gas will have surpassed coal's share of the market (33% versus 32%).[145] Natural gas will likely continue to be the predominant source of utility-scale electricity generation into 2017, even as natural gas prices are projected to increase. Recent editions of the AEO have shown gas-fired generation increasing over time due to the relatively abundant supply (Figure 22). More specifically, the AEOs show that generation from gas-fired power plants will be lower than 2015 levels in the earlier years and rise over time.

[145] EIA's Today in Energy (December 22, 2016) and EIA Short Term Energy Outlook (November 8, 2016). http://www.eia.gov/outlooks/steo/ (Accessed Dec 6, 2016)

Figure 22. AEO Projections of Total Net Electricity Generation, Natural Gas



In the updated AEO 2017 (no CPP), generation from gas-fired power plants is expected to be lower compared to projections in AEO 2016 (no CPP), and to be below 2015 generation levels until 2030. During those intervening years, the AEO 2017 shows large amounts of new renewables being built (discussed in subsequent sections).

EIA's AEO 2016 (no CPP) case projects that the price of natural gas in 2030 will be $1.08/MMBtu less than EIA had projected a year earlier in the AEO 2015 reference case.[146] These even lower prices will continue to ensure that natural gas remains highly competitive relative to higher-emitting sources of generation. In the AEO 2017 (no CPP), natural gas prices are generally lower than the AEO 2106 (no CPP) until about 2030, and very similar thereafter.

The price of natural gas is expected to remain relatively low for the next 10 to 15 years, as improvements in drilling technologies and techniques continue to reduce

[146] Jennifer Macedonia et al., *Modeling the Evolving Power Sector and Impacts of the Final Clean Power Plan*, Bipartisan Policy Center 17 (June 2016), http://cdn.bipartisanpolicy.org/wp-content/uploads/2016/06/BPC-Energy-Clean-Power-Plan-Modeling.pdf

the cost of extraction. Other sub-agencies of the DOE agree. According to NREL, this sustained low-price environment is expected to provide "substantial opportunity" for natural gas-electricity to grow its share of the power sector.[147]

NREL analyzed eight scenarios—with varying costs for natural gas and renewables, differences in demand, and other factors—and from 2020 to 2050 every scenario projected considerable growth for natural gas-fired generation (average annual growth rates of 1 percent to 3 percent).[148] Short-term increases in natural gas prices are only projected to cause slight declines in natural gas generation, and only prior to 2020.

3.1.5. Renewable Energy

Renewable energy (predominantly wind and solar energy) is the fastest growing form of electric generating technology. Both 2015 and 2016 saw record levels of new capacity coming online, and the trend will continue due to the increasing cost-competitiveness and the extension of various federal tax incentives for renewable energy technologies.[149] Generation from renewable forms of energy has increased in AEO annual updates over time, and in the AEO projections (2020 to 2030), the updated AEO 2016 and 2017 (no CPP) scenarios shows the effect of the renewable energy cost declines and the tax extension (Figure 23). EIA's projected levels of renewable generation for 2020 to 2030 increased by 22 percent, on average, between AEO 2015 and AEO 2016. In the updated AEO 2017 (no CPP), generation from renewable technologies further increases another 6 percent from AEO 2016 (no CPP), on average, for the period 2020 to 2030.

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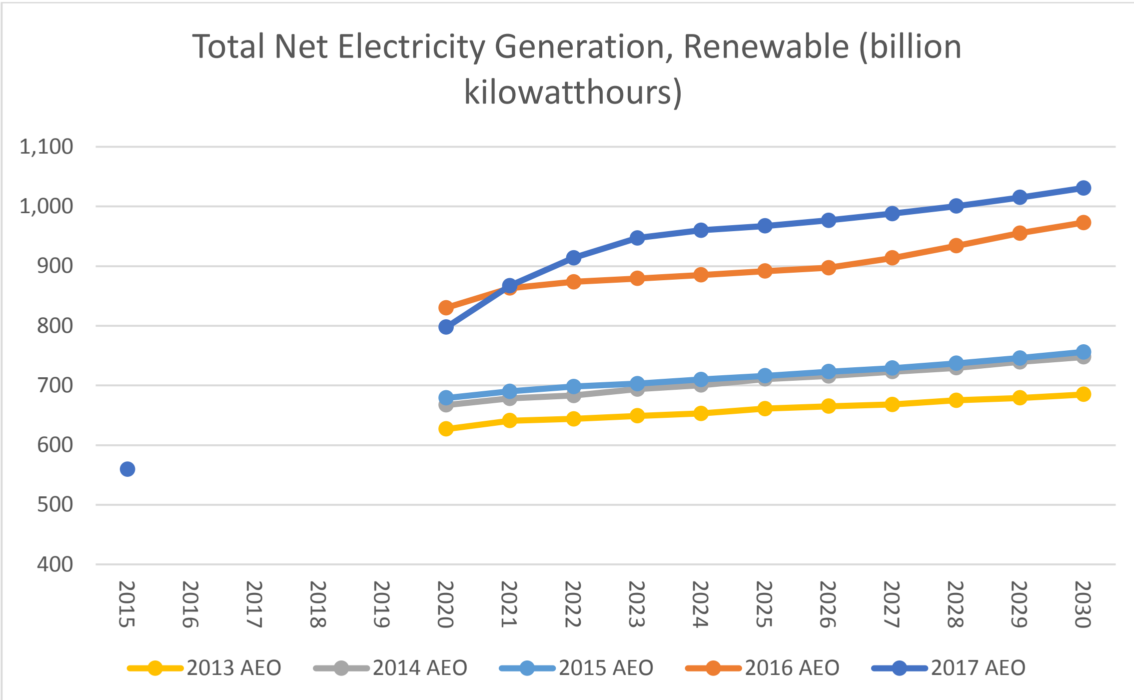
[147] NREL, 2016 Standard Scenarios Report: A U.S. Electricity Sector Outlook 17 (Nov. 2016), *available at* http://www.nrel.gov/docs/fy17osti/66939.pdf.
[148] *Id.*
[149] As part of the 2016 Consolidated Appropriations Act enacted in December 2015 (H.R. 2029), Congress extended the qualifying deadlines for the production tax credit (PTC) and investment tax credit (ITC) for renewable generation technologies. The deadline for PTC-eligible technologies to receive the full production credit was extended by 2 years.

Figure 23. AEO Projections of Total Net Electricity Generation, Renewable Energy

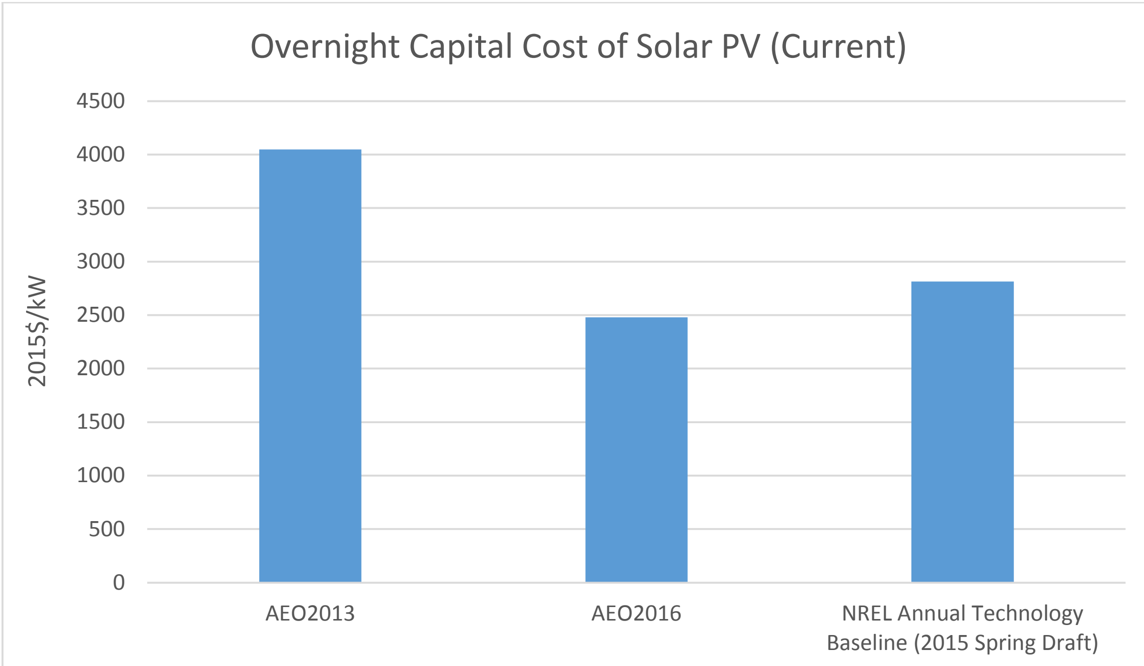


With respect to renewable capacity, EIA similarly revised its projections upward. Primarily as a result of continuing cost declines in utility-scale wind (9% decline) and solar photovoltaics (32% decline), coupled with extended tax credits (discussed below), the AEO 2016 reference case (no CPP) is projected to deploy 49 GW more renewable capacity by 2020 than the AEO 2015 reference case.[150]

A notable update in AEO 2016 was the continued improvement assumed for the cost and performance characteristics of new utility-scale solar PV technologies, producing estimates that are now similar to those which EPA relied on for the final CPP. Figure 24 shows a comparison of overnight capital costs from AEO 2013 (the estimates the agency relied upon for the proposed rule), the NREL Annual Technology Baseline Spring 2015 Draft (the estimates the agency relied upon for the final rule), and AEO 2016. The figures represent total overnight capital cost estimates for the current year of the publication.

[150] Cara Marcy, U.S. Energy Information Administration, "Higher renewable capacity additions in AEO 2016 reflect policy changes and cost reductions" (June 2016), http://www.eia.gov/todayinenergy/detail.php?id=26492; *see also* AEO 2015 (no CPP) case; AEO 2016 "Cost and Performance Characteristics," available at: https://www.eia.gov/outlooks/archive/aeo16/assumptions/pdf/table_8.2.pdf

Figure 24. Comparison of Capital Cost Assumptions for Solar Photovoltaic



Although total electricity generation from all utility-scale plants is expected to grow by only 0.7 percent in 2017, renewables are expected to increase their share of generation to almost 24 percent in 2030 (AEO 2017, no CPP), from roughly 15 percent in 2015.

3.1.6. New Capacity Additions

Recent AEO projections have shown that unplanned capacity additions[151] over time to be dominated by new NGCC technology and new renewables, primarily wind and solar. The AEO 2016 and 2017 updates, reflecting the aforementioned renewable cost declines and tax extensions, has shifted the balance of new capacity additions significantly toward new renewables, with less new NGCC capacity projected than in previous editions of the AEO (Figures 25 and 26). In addition, the mix of renewable capacity additions has changed in AEO 2016 and 2017, with solar capacity becoming a much larger share of the total.

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[151] Unplanned capacity additions are what are chosen economically within the model itself, based on prevailing market conditions and considering existing laws and regulations. Planned capacity additions are known projects that are under construction, and are a separate category not shown here. Planned capacity additions are also dominated by renewable projects in AEO 2016.

Figure 25. Cumulative Unplanned Additions from NGCC Sources from the AEO

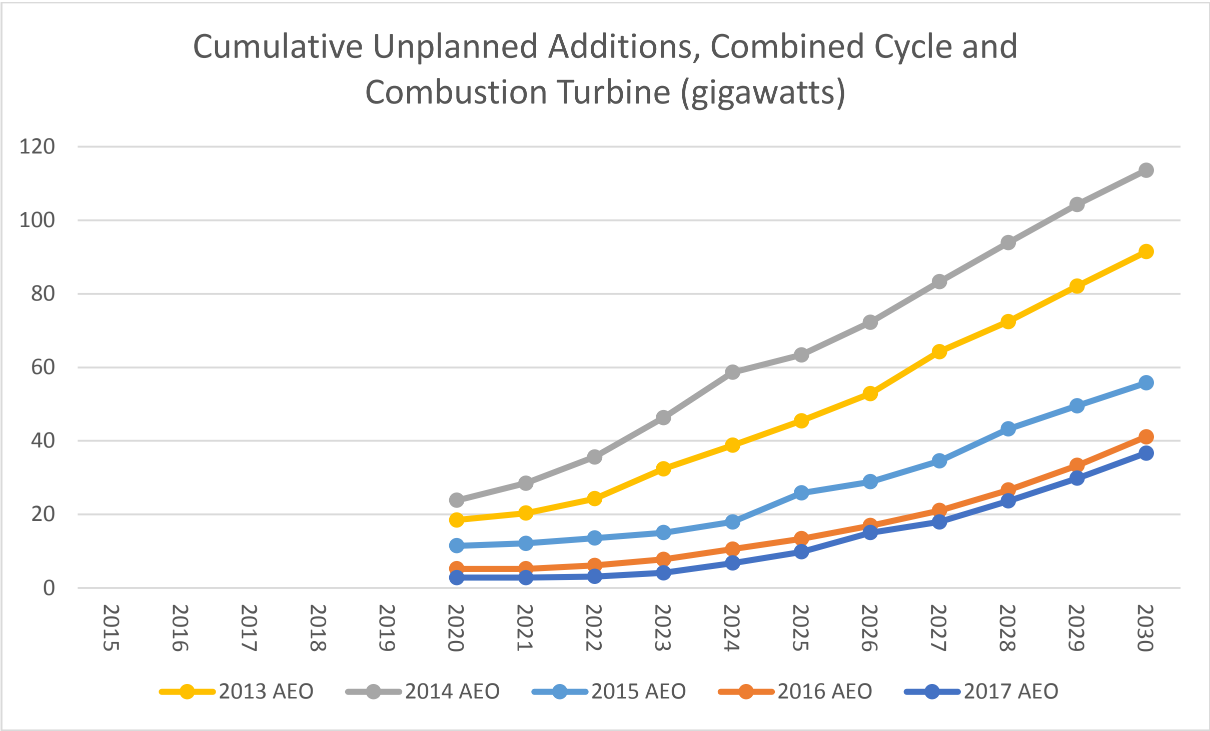
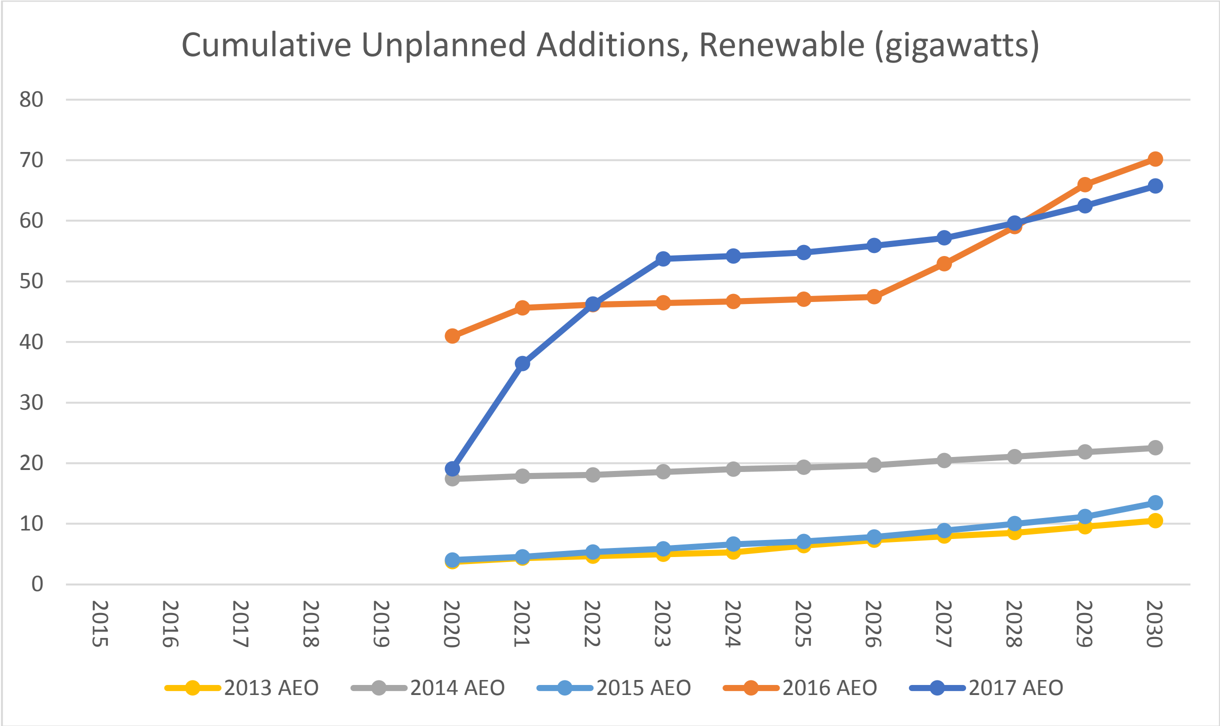


Figure 26. Cumulative Unplanned Additions from Renewable Sources from the AEO



3.1.7. Demand-Side Energy Efficiency Projections

EE measures affect two aspects of the economic analysis of the CPP: (1) the underlying electricity demand forecast, which is foundational to the reference case analysis; and (2) the cost and scale of the EE measures available as a compliance option in EPA's illustrative compliance scenarios. For each of these aspects, EE measures have the effect of placing additional economic pressures on older, less efficient means of generation.

Recent AEO projections have shown electric demand growth to be roughly 1 percent per year to 2030. The recent AEO 2017 (no CPP) shows an annual electric growth rate of 0.9% from 2020 to 2030, falling to about 0.6% in 2030. This compares to recent historical averages of 0.1 percent from 2012 to 2015 (Table 3).

Table 3. Historical Retail Sales of Electricity, Annual (EIA) (all sectors, million kilowatt hours)

Year	*GWh*	*Annual Growth*	*Avg. Growth*			
2001	3,394,458		***2002-2015***			
2002	3,465,466	2.1%				
2003	3,493,734	0.8%				
2004	3,547,479	1.5%		***2005-2015***		
2005	3,660,969	3.2%				
2006	3,669,919	0.2%				
2007	3,764,561	2.6%				
2008	3,733,965	-0.8%				
2009	3,596,795	-3.7%			***2010-2015***	
2010	3,754,841	4.4%				
2011	3,749,846	-0.1%				***2012-2015***
2012	3,694,650	-1.5%				
2013	3,724,868	0.8%				
2014	3,764,700	1.1%				
2015	3,758,992	-0.2%	0.8%	0.6%	0.8%	0.1%

Aside from the AEO, other estimates and projections indicate that EE investments and associated electricity demand reductions demonstrated in recent years will continue and likely increase into the future. Recent and observed trends have been driven by state and federal policies as well by private sector response to electricity and EE market economics. As addressed in the EE Technical Support Document (TSD) for the final CPP, key areas of EE investment have included utility customer-funded EE programs, energy service performance contracting (ESPC) through energy service companies (ESCOs), federal and state appliance and equipment energy standards, and building energy codes (with model federal energy codes for commercial and residential buildings established by DOE and adopted through state and local governments). In addition, new technological advances are further accelerating the potential electricity savings from EE, such as information and communications technology (ICT), "smart grid technology," and the "internet of things" (IoT).[152]

The EE TSD presented information from a Lawrence Berkeley National Laboratory (LBNL) study of the ESCO market projecting an increase in ESCO revenues from $5.3 billion in 2011 to about $6.4 billion in 2013. However, a 2016 LBNL study updates the prior data and projections of ESCO markets. The more recent study projects an average annual growth rate of the ESCO market of approximately 13 percent per year from 2015 to 2017, culminating in projected revenues of $7.6 billion in 2017.[153] Associated electricity savings are expected to grow in proportion to these increases in ESCO market size.

Another area of projected growth for EE is building energy codes. Building energy codes establish minimum efficiency requirements for new and renovated residential and commercial buildings, locking in long-term energy savings at a low cost during the building design and construction phases. Model building energy codes are developed at the national or international level, may be adopted at the state or local level, and generally are administered and enforced locally. An evaluation by the Pacific Northwest National Laboratory (PNNL) in October 2016 provides an updated estimate of the potential energy impacts of building energy codes in the United States through 2040 and accounts for the most recent information on code adoption and enforcement, including efforts since the final CPP. The results from this analysis indicate that annual energy savings in the commercial and residential sectors in 2030 are projected to be 0.25 quadrillion BTUs and 3.06 quadrillion cumulative BTUs saved from 2010 to 2030.[154]

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[152] Deloitte Center for Energy Solutions (https://dupress.deloitte.com/dup-us-en/focus/internet-of-things/iot-in-electric-power-industry.html).

[153] Lawrence Berkeley National Laboratory, U.S. Energy Service Company (ESCO) Industry: Recent Market Trends (October 2016), *available at*, https://emp.lbl.gov/sites/all/files/esco_recent_market_trends_30sep2016.pdf.

[154] Pacific Northwest National Laboratory, Impacts of Model Building Energy Codes (October 2016), *available at* https://www.energycodes.gov/sites/default/files/Impacts%20of%20Model%20Building%20Energy%20Codes%20Public%20Review%20Draft.pdf.

Still another area of EE growth concerns adoption of new EE technologies and strategies in the electric power sector itself. The U.S. electricity sector is in the midst of major transformation through the adoption of ICT. The adoption of ICT strategies and more traditional technology advancements in electricity-consuming devices have the potential to drive ongoing improvements in EE that will further reduce already declining projections of electricity demand growth. These savings are largely beyond those projected from past evaluations of cost-effective EE potential. A recent study by the American Council for an Energy-Efficient Economy (ACEEE) provides a midrange estimate of electricity savings from the adoption of new EE technologies and strategies (several based on new ICT deployment) equal to 22 percent of projected U.S. electricity sales in 2030.[155] Numerous other studies (including from The Brattle Group, Electric Power Research Institute, and PNNL) have also documented substantial electricity savings potential from the deployment of strategies related to ICT, smart grid technology, and the IoT.[156] The deployment of these technologies and strategies are expected to continue to increase energy savings from EE and put downward pressure on electricity demand growth over the next several decades.

3.1.8. CO_2 Emissions

Due to the increasing competitiveness of natural gas and renewable forms of electric generation, the projections from AEO 2016 (no CPP) case indicate that coal-fired generation will remain at levels similar to 2015, and overall CO_2 emissions are expected to be relatively flat in the future and similar to today's levels, absent the CPP. For example, the 2015 CO_2 emissions from affected sources were essentially identical to the collective levels contemplated by the CPP for 2022, the first year of the interim performance period (discussed further in Section 2). EIA's projections for AEO 2017 (no CPP) indicate that CO_2 emissions from the power sector as a whole will remain lower than 2015 levels for the entire period from 2020 to 2030 (Figure 27), and are lower than the AEO 2016 (no CPP) forecast. In addition, the CO_2 emissions that AEO 2017 (no CPP) projects for 2020 through 2030 are an average of 14 percent lower than EIA had projected in AEO 2012. The trends towards lower CO_2, as a result of increases in cleaner energy, show an emissions

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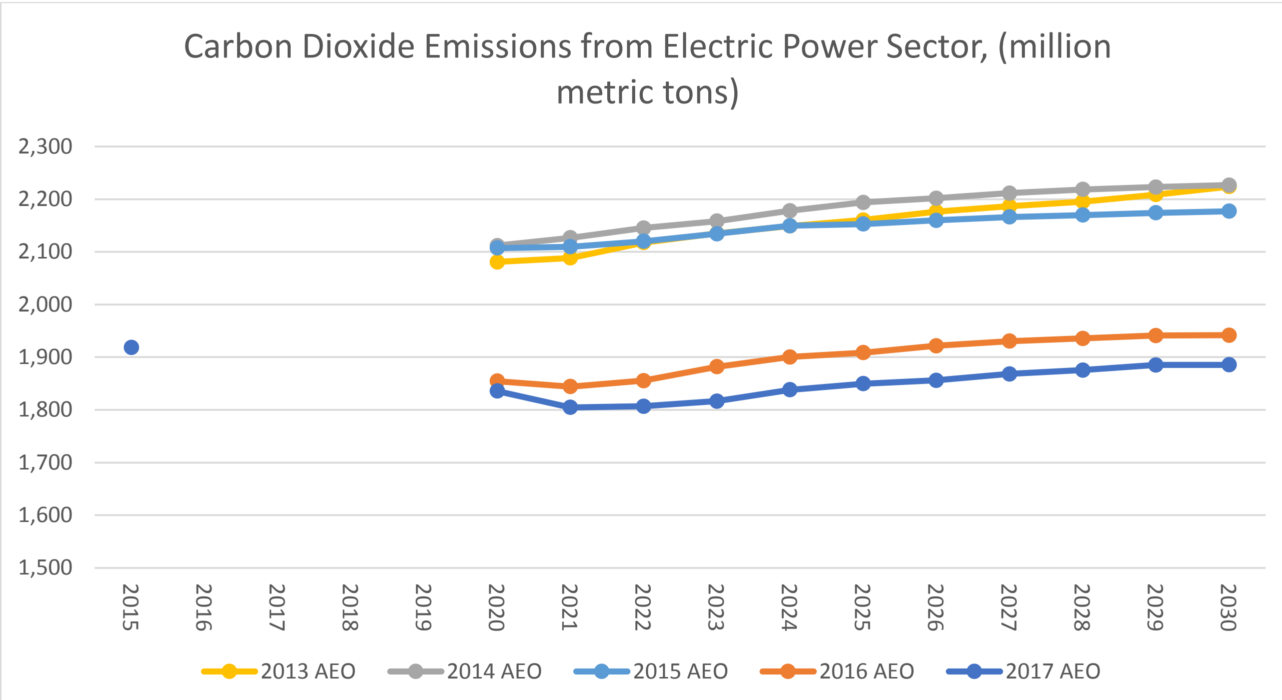
[155] American Council for an Energy-Efficient Economy, "New Horizons for Energy Efficiency: Major Opportunities to Reach Higher Electricity Savings by 2030" (September 2015), Report Number U1507, http://aceee.org/research-report/u1507.
[156] *See, e.g.,* Hledik, Ryan, The Brattle Group, "How Green Is the Smart Grid," The Electricity Journal (April 2009); Electric Power Research Group, "Estimating the Costs and Benefits of the Smart Grid" (2011); Pacific Northwest National Laboratory, "The Smart Grid: An Estimation of the Energy and CO2 Benefits" (January 2010), PNNL-19112.

level in the AEO 2017 (no CPP) projection that are considerably lower than projected in AEO 2012, 2013, and 2014.

Figure 27. AEO Projections of Carbon Dioxide Emissions from Electric Power Sector



3.1.9. Achieving the CPP Goals

The AEO data show that the industry's trends away from coal-fired generation and toward cleaner generation have accelerated since the record for the CPP closed. As a result of these trends, the CPP is projected to have a modest impact on the generation mix, one that is less than EPA projected at the time of the final Rule. The measures that would meet the required CO_2 emission reductions under the CPP are already occurring and will continue into the future. *See generally* AEO 2017, no CPP case, *supra*. In particular, lower projected future electric demand and much higher levels of new renewable deployment (compared to previous AEO projections) demonstrate that the incremental actions needed to meet the requirements of the CPP are less than previously projected and likely at lower cost.

3.2. Updated EPA CPP Base Case Modeling for Interstate Ozone Transport

Recent EPA power-sector modeling released in December 2016 for a different air pollution rule indicates that (1) the marginal costs of reducing CO_2 emissions from the power sector have dropped considerably since EPA finalized the CPP in August 2015, and (2) more states than previously projected can meet CPP requirements with no marginal costs.

Recently, EPA conducted an updated power sector scenario and produced interstate ozone transport modeling data to share with states and other stakeholders for purposes of addressing the Clean Air Act's interstate transport requirements.[157] EPA uses the Integrated Planning Model (IPM) to analyze the potential impacts of environmental regulations on the power sector.[158,159] This scenario includes updates to key assumptions that reflect more recent information than was available when EPA finalized the CPP,[160] such as:

- Changes to the inventory of existing electric generating units, reflecting planned/committed units and planned/announced retirements;
- Updates to natural gas supply;
- Updates to coal supply;
- Inclusion of the extension of federal tax incentives for renewable energy;

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[157] *See generally* U.S. EPA, Notice of Availability of the Environmental Protection Agency's Preliminary Interstate Ozone Transport Modeling Data for the 2015 Ozone National Ambient Air Quality Standard (NAAQS)," Docket ID No. EPA-HQ-OAR-2016-0751 (signed December 28, 2016).

[158] IPM is a peer-reviewed, dynamic linear programming model that projects power sector behavior under future conditions and examines prospective air pollution control policies for the electric power system of the contiguous United States. IPM provides forecasts of least-cost capacity expansion, electricity dispatch, and emission control strategies used to meet energy demand while satisfying environmental, transmission, dispatch, and reliability constraints.

[159] Note that these projections include a change in operation occurring as early as 2020, which is the first year of the 25-year horizon over which EPA's model is optimizing. EPA's modeling adopts the assumption of perfect foresight, which implies that agents know precisely the nature and timing of conditions in future years (*e.g.*, future natural gas supply, future demand) that affect the ultimate cost of decisions along the way. With this perfect foresight, the model looks throughout the entire modeling horizon and selects the overall lowest cost solution for the power sector over that time. Modeling that EPA performed for the CPP and included in the CPP Regulatory Impact Analysis, which included projections from 2016 through 2050, identified change in operation of numerous units in 2016 due to this perfect foresight assumption. For that modeling, EPA explained perfect foresight and why such projections in change in operation during the first year of a model's analysis are a function of normal limitations in complex modeling and overstate such changes. *See generally West Virginia et al. v. EPA*, No. 15-1363, Reid Harvey Decl. (D.C. Cir. filed Dec. 3, 2015) (included in the docket for this action); West Virginia et al. v. EPA, No. 15A773, Suppl. Decl. Reid Harvey (S. Ct. filed Feb. 3, 2016) (included in the docket for this action).

[160] EPA Base Case v.5.16 for 2015 Ozone NAAQS Transport NODA Using IPM Incremental Documentation, *available at* https://www.epa.gov/airmarkets/incremental-documentation-epa-base-case-v516-2015-ozone-naaqs-transport-noda-using-ipm-0.

- Updates to state rules and laws; and
- Updated nuclear costs (fixed and variable operating costs).

The scenario employs essentially the same implementation of CPP as set forth in the Regulatory Impact Analysis (RIA) for the final rule,[161] including significant electricity savings in each model run-year that reflect demand-side EE improvements that are assumed to occur in response to the CPP.[162] That analysis took a conservative view of CPP implementation and required that each state meet its state-specific goal, with flexibility to meet the emission goal on a purely intrastate basis, without employing interstate compliance measures. However, the analysis did allow for flexible operation of the electric system and dispatch across sources in order to achieve state-level CPP targets in the most cost-effective manner while meeting electric demand across the system.

The updated modeling shows that the trends currently under way in the industry will continue, with more use of natural gas-fired generation and increased deployment of RE due to their increased availability and cost-competitiveness. These factors indicate that the CPP will have a more modest impact and at lower cost than projected at the time the CPP was finalized. This can be demonstrated by comparing updated shadow prices against the shadow-price results from when the final rule was promulgated in August 2015.

The analysis of the illustrative mass-based implementation of CPP (both in the RIA and the updated scenario) include shadow prices for the CO_2 limitation that was applied to the 47 affected states. These prices reflect the marginal cost of meeting the mass-based state goals. While they do not necessarily show the precise cost in each state of sources meeting the requirements, they provide a meaningful basis for demonstrating the relative stringency of the program and the cost of reducing the last ton of emissions to implement the CPP.[163] These prices are also conservative

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[161] Due to an update in the modeling allowing for more resolution of years between 2020 and 2030, the new scenario allows banking of compliance instruments for future use. Banking is authorized under the CPP, but was not modeled in the final rule, due to structure of modeled years at the time, which have since been changed to reflect more intervening years between 2022 and 2030.
[162] The quantification of these data is explained in the Demand-Side Energy Efficiency TSD for the CPP.
[163] The shadow prices do not necessarily reflect the cost of end-use energy efficiency, which was exogenously incorporated into the CPP modeling. Therefore, the marginal costs in some states may be understated in both the RIA and the updated modeling. However, because the treatment of EE did not change, EPA attributes the considerable decrease in marginal costs between the two analyses to the recent updates, demonstrating that these recent trends make compliance with the CPP significantly less costly.

because they are based upon intrastate trading rather than interstate trading, which generally reduces compliance costs.

In summary, the present updates to IPM have the combined effect of demonstrating that CO_2 emissions reductions will be significantly less costly to achieve, as demonstrated by the shadow prices (Table 4). The Final CPP RIA modeling showed a highest marginal cost at $26/ton of CO_2, with average marginal costs of $11/ton of CO_2 nationwide, and a total of seven states where the CPP requirements did not result in any marginal costs. By contrast, the updated analysis found the highest marginal cost had dropped to $17/ton of CO_2, the average marginal cost had dropped to $4/ton of CO_2, and 18 states where the CPP requirements are not expected to result in any marginal costs in 2030. The updated analysis, therefore, indicates that CPP requirements are more modest and can be achieved at significantly lower cost than EPA projected when it finalized the CPP in 2015.

Table 4. Shadow Prices under the Illustrative CPP, from IPM

For 2030	CPP (v5.15/RIA)	CPP (v5.16 update)
Average	$11	$4
High	$26	$17
# of States with $0/ton	7	18

3.3. Individual Companies: Recent and projected generation shifts

The broad trends away from coal-fired generation and toward lower-emitting generation and EE are reflected in the recent actions and recently announced plans of many power plants across the industry—spanning all types of companies in all locations. Furthermore, as noted in a comprehensive review of clean energy developments in 2016 produced by the Environmental Defense Fund, executives from dozens of power companies have announced their companies' commitment to moving toward cleaner energy, including in the last months of 2016.[164] Attachment A to this appendix describes the intentions of several utilities in their integrated resource plans (IRPs) to increase their investments in low- and zero-emitting sources of electricity, as well as EE measures.

[164] Pam Kiely & Charlie Jiang, "2016 Wrap-Up: States, Power Companies Lead in Cutting Carbon; Election Not Slowing Expected 2017 Progress" (Jan. 4, 2017, revised Jan. 6, 2017) http://blogs.edf.org/climate411/2017/01/04/2016-wrap-up-states-and-power-companies-led-the-way-to-cut-carbon/.

3.3.1. Large Utilities

For strategic business reasons, a number of the country's major utilities plan to increase their renewable energy holdings and continue reducing CO_2 emissions. Comparing electricity generation data from 2010 and 2015 shows that many companies have already undergone substantial shifts away from coal generation. We identified the 10 companies with the greatest amount of coal generation in 2010, and compared their generation mixes for 2010 and 2015. Between 2010 and 2015, each of these companies shifted their generation away from coal (Table 5). Over that 5-year period, 8 of the 10 companies reduced the shares of their overall generation attributable to coal by at least 10 percent, and 4 companies reduced coal's share by over 20 percent.

Table 5. Shifts in Coal Generation of the 10 Owner-Operators with the Most Coal-Fired Generation in 2010 in the United States[165, 166]

Company	Percentage Generation from Coal (2010)	Percentage Generation from Coal (2015)	Difference
American Electric Power	83%	71%	**–12%**
Duke Energy	56%	34%	**–22%**
NRG Energy	78%	56%	**–22%**
Southern Company	58%	34%	**–24%**
FirstEnergy	73%	58%	**–15%**
Tennessee Valley Authority	50%	38%	**–12%**
Berkshire Hathaway	63%	51%	**–12%**
Dynegy	71%	50%	**–21%**
Energy Future Holdings	70%	67%	**–3%**
Xcel Energy	61%	56%	**–5%**

In 2016, Duke Energy, NextEra Energy, Southern Company, and AEP each announced plans to acquire more renewable capacity over the coming years. Their

165 Data compiled from ABB: Velocity Suite, December 2016.

166 EPA developed this list of current owner-operators of U.S. coal-fired generating units by aggregating 91 entities to the parent-entity level. The list omits over 100 entities—primarily municipal and cooperative but also some investor-owned—that own shares of, but do not operate, any coal-fired units. The list also omits various private equity investors that own or have share of approximately 40 plants, which were not traced to the parent-entity level.

plans to increase RE generation result from a combination of factors, including extended federal tax credits, state renewables policies, and declining technology costs for wind and solar.

Duke Energy's generation portfolio in 2015 included almost 4,400 MW of renewables, "with 49 percent coming from wind, 39 percent from solar and 12 percent from biomass."[167] The company recently announced plans to command 8,000 MW of renewables by 2020, citing the move to renewables making "good business sense"; this target is one-third more renewable capacity than the company projected just a few years ago.[168] Duke Energy's Third Quarter 2016 Earnings Review and Business Update explained to investors shifts planned to increased fuel diversity, estimating that—even without the CPP—its generation portfolio will drop from 35 percent coal in 2015 to 23 percent coal in 2030.[169] By contrast, Duke Energy expects to increase its generation portfolio's share of renewable resources from 4 percent in 2015 to 10 percent by 2030—again, without the CPP.[170] By the end of 2016, Duke Energy Renewables had announced its acquisition of a 13-MW solar power project in Colorado, "the 50th solar project in our growing U.S. renewables footprint."[171]

Southern Company expects capital spending at its subsidiary Southern Power Co. to exceed forecasts in 2017 and 2018, with an emphasis on acquiring wind assets in light of federal tax credits.[172] Since 2012, Southern Company has added more than 4,000 MW of renewables.[173] In June 2016, Southern Power Company indicated its expectation that additional wind and solar projects would be the company's "primary growth vehicle" over the next several years.[174] Southern Power CEO Buzz Miller touted the company's acquisition of a 100 MW solar project in late 2016, saying that the acquisition "underscores Southern Power's growing success in acquiring and developing utility-scale solar across the United States," and that the

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[167] Michael Copley, SNL, Major utilities planning big boosts to renewables investments (May 6, 2016), https://www.snl.com/InteractiveX/article.aspx?CDID=A-36395177-11561&KPLT=4.
[168] *Ibid.*
[169] Third Quarter 2016 Earnings Review/Business Update, Nov. 4, 2016, (see slide 24), https://www.duke-energy.com/our-company/investors.
[170] *Ibid.*
[171] https://news.duke-energy.com/releases/releases-20161208
[172] Michael Copley, SNL, Major utilities planning big boosts to renewables investments (May 6, 2016), https://www.snl.com/InteractiveX/article.aspx?CDID=A-36395177-11561&KPLT=4.
[173] Southern Company, Renewable Resources, http://www.southerncompany.com/what-doing/corporate-responsibility/energy-innovation/building-renewable-resources.cshtml.
[174] http://s2.q4cdn.com/471677839/files/Southern-Power-Fixed-Income-Update.pdf (see slide 14).

project itself "aligns with our business model as we strategically develop our renewable portfolio."[175]

NextEra anticipates adding three times more wind capacity in the next couple of years than it previously projected."[176] Company executives have stated that the renewable energy market is the strongest it has ever been, in light of tax credits, state incentives, expected carbon regulations, and declining technology costs.[177] Accordingly, NextEra expects to add 4,100 MW of renewables by 2018, including three times as much wind capacity as it previously forecasted.[178]

American Electric Power continues to produce about 60 percent of its generation from coal, but has reduced CO_2 emissions 39 percent from 2000 levels. It anticipates coal-fired generation shrinking to 45 percent by 2026 as the company moves toward natural gas-fired and renewable energy generation.[179] The company plans to expand its zero-emission generation with almost 9,000 MW of additional renewables (approximately 5,500 MW of wind and 3,000 MW of solar) by 2025.[180]

Iowa-based MidAmerican Energy, a subsidiary of Berkshire Hathaway, is in the process of shifting its fleet from 70 percent coal generation in 2004 to 100 percent renewable energy.[181] In August 2016, the Iowa Utilities Board approved MidAmerican's $3.6 billion project to add 2,000 MW of wind. Claimed to be the "largest wind energy project in US history," it will generate 85 percent of the electricity needed to meet MidAmerican Energy's customer demand.[182] NV Energy, another Berkshire Hathaway subsidiary, is similarly shifting its fleet toward RE. In

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[175] http://www.southerncompany.com/news/2016-11-17-boulder-solar.cshtml
[176] Michael Copley, SNL, Major utilities planning big boosts to renewables investments (May 6, 2016), https://www.snl.com/InteractiveX/article.aspx?CDID=A-36395177-11561&KPLT=4 .
[177] *Ibid.*
[178] *Ibid.*
[179] American Electric Power, Power Generation, https://www.aep.com/about/MajorBusinesses/PowerGeneration/ (last visited Jan. 3, 2017); American Electric Power, Climate Change, https://www.aep.com/environment/climatechange/ (last visited Jan. 3, 2017).
[180] Martha Roberts, Environmental Defense Fund, Power Companies and States—On Track to Meet Clean Power Plan Goals (Sept 14, 2016), http://blogs.edf.org/climate411/2016/09/14/power-companies-and-states-on-track-to-meet-clean-power-plan-goals/.
[181] MidAmerican Energy, Our 100% Renewable Vision, https://www.midamericanenergy.com/our-renewable-energy-vision.aspx (last visited Jan. 3, 2017).
[182] Leanna Garfield, Business Insider, The largest wind farm in US history just got the green light (Sept. 1, 2016), http://www.businessinsider.com/american-iowa-wind-farm-approval-2016-9.

December 2016, the Nevada Public Utilities Commission voted to expedite the 2017 retirement of a 51-year-old coal-fired power unit at the Reid Gardner Generating Station and to approve a long-term contract for a 100-MW solar farm as a replacement. The 25-year, $40.62-per-MWh contract between Techren Solar LLC and NV Energy is the lowest price for a utility-scale solar project in the United States, commissioners said. Commission Chairman Joe Reynolds even commented, "When I read something like this, I just go, 'Yes. This is where the future should be.'"[183] "Our customers want more renewable energy," said CEO Bill Fehrman, "and we couldn't agree more."[184]

Minnesota's largest electric utility, Xcel Energy, also is in the process of slashing its CO_2 emissions. Its 2015 Integrated Resource Plan includes a CO_2 emission target of 60 percent from 2005 levels by 2030.[185] On a percentage basis, this is almost double the 32 percent emission reduction that the CPP was projected to achieve nationally during the same period. Xcel Energy plans to achieve these deep reductions by generating 63 percent of its electricity from non-emitting sources in 2030.[186] Similarly, Westar Energy, which serves Kansas, expects its CO_2 emissions to decline 36 percent below 2005 levels by 2017.[187] In that vein, in 2016 Xcel Energy secured regulatory approvals for up to 1,800 MW of new wind and 1,4000 MW of new solar capacity in Minnesota, as well as approval for 600 MW of utility-scale wind in Colorado.[188]

In June 2016, DTE Energy Chairman and CEO Gerry Anderson explained that, "The way DTE generates electricity will change as much in the next 10 years as any other period in our history. We will replace 11 aging coal-fired generating units at

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183 Benjamin Storrow, *Nev. Restores net metering in win for solar industry*, E&E News PM (Dec. 22, 2017), http://www.eenews.net/eenewspm/2016/12/22/stories/1060047639.
184 Press release, *MidAmerican Energy announces $3.6 billion investment in renewable energy* (April 14, 2016), https://www.midamericanenergy.com/news-article.aspx?story=777.
185 Bloomberg New Energy Finance, State energy factsheet: Minnesota (July 2016), http://www.bcse.org/images/2016%20MN/2016%20BCSE%20BNEF%20Minnesota%20Energy%20Factsheet.pdf.
186 *Ibid.*
187 Westar Energy, 2015 Annual Report 86, http://phx.corporate-ir.net/External.File?item=UGFyZW50SUQ9NjI3MzU5fENoaWxkSUQ9MzMwMDcwfFR5cGU9MQ==&t=1.
188 Pam Kiely & Charlie Jiang, "2016 Wrap-Up: States, Power Companies Lead in Cutting Carbon; Election Not Slowing Expected 2017 Progress" (Jan. 4, 2017, revised Jan. 6, 2017) http://blogs.edf.org/climate411/2017/01/04/2016-wrap-up-states-and-power-companies-led-the-way-to-cut-carbon/

three facilities built in the 1950s and 1960s with a mix of newer, more modern, and cleaner sources of energy generation such as wind, natural gas, and solar."[189] DTE's spokesperson further explained that, "Many of Michigan's power plants have either shut down or are scheduled to be shut down prior to 2025. This phenomenon is occurring across Midwest states, due to the age of the coal fleet, existing environmental regulations and the competitive advantages of low-priced natural gas."[190]

3.3.2. Smaller, Municipally-Owned, and Cooperative Electric Utilities

This trend is not unique to the largest owner-operators of coal-fired generation; smaller utilities have seen similar shifts. The Central Iowa Power Cooperative shifted from 63 percent coal-fired generation to 53 percent during the same 2010–2015 period.[191] In Missouri, Columbia Water & Light shifted from 83 percent coal-fired generation to 49 percent.[192] In South Carolina, SCANA's coal-fired generation has declined from 65 percent in 2008 to 39 percent in 2015.[193] In the western U.S., Black Hills Corporation's coal-fired generation shifted from 98 percent in 2010 to 65 percent in 2015.[194] In the northeast, Eversource Energy's coal-fired generation has declined from 84 percent in 2010 to 46 percent in 2015.[195] Table 6 shows changes in coal-fired generation at several cooperatives between 2010 and 2015. Table 7 shows changes during the same period for several municipal utilities.

Table 6. Shifts in coal-fired generation at several cooperatives*[196]*

Utility	Percentage Generation	Percentage Generation	Difference

[189] http://newsroom.dteenergy.com/index.php?s=26817&item=137044#sthash.EEm065kr.dpbs
[190] DTE won't build any more coal plants, CEO says, December 6, 2016, www.snl.com.
[191] ABB: Velocity Suite, December 2016
[192] *Id.*
[193] South Carolina Electric & Gas Co., Form 10-K, (March 1, 2010), at 19, http://www.scana.com/investors/sec-filings (Annual report for 2009); South Carolina Electric & Gas Co., Form 10-K, (February 26, 2016), at 9, http://www.scana.com/investors/sec-filings (Annual Report for 2015). With the addition of two nuclear units currently under construction, SCANA "will retire up to six coal-fired generating units, reducing its coal-fired capacity by more than 700 megawatts." SCANA, Power Generation, https://www.scana.com/about/power-generation (last visited Dec. 12, 2016).
[194] ABB: Velocity Suite, December 2016.
[195] *Id.*
[196] *Id.*

	from Coal (2010)	from Coal (2015)	
Central Iowa Power Cooperative	63%	53%	**–10%**
Corn Belt Power Cooperative	69%	61%	**–8%**
PowerSouth Energy Cooperative	57%	23%	**–34%**
Basin Electric Power Cooperative	97%	88%	**–9%**

Table 7. Shifts in coal-fired generation at several municipal utilities[197]

Utility	Percentage Generation from Coal (2010)	Percentage Generation from Coal (2015)	Difference
Willmar Municipal Utilities	83%	74%	**–9%**
JEA	84%	67%	**–17%**
Salt River Project	64%	48%	**–16%**

Wholesale providers of electricity have similarly shifted away from coal-fired generation in recent years. Basin Electric Power Cooperative and American Municipal Power both generated 97 percent from coal in 2010; by 2015, they had reduced the percentage of their generation from coal to 88 percent and 83 percent respectively.[198] The Wabash Valley Power Association demonstrated a particularly dramatic shift from 79 percent coal-fired generation in 2010 to only 32 percent in 2015.[199]

Generators across the electric power sector have clearly shown intentions to continue these trends away from coal and toward low- and zero-emitting generation.

Most electric cooperatives are already making direct investments in the types of measures that reduce CO_2 emissions from electricity generation. The National Rural Electric Cooperative Association (NRECA) represents hundreds of not-for-profit, consumer-owned electric cooperatives that provide service to millions of people in 47 states. NRECA CEO Jim Matheson has explained that electric cooperatives are already "investing heavily in renewables and energy efficiency." Mr. Matheson noted that more than 95 percent of electric cooperatives provide electricity generated from renewable sources, and 82 percent offer their members

[197] *Id.*
[198] *Id.*
[199] *Id.*

some type of EE program, including rebates for efficient appliances and other incentives.[200]

One example is the Wabash Valley Power Association, an electric cooperative and wholesale electricity provider, providing a diverse electricity mix to 23 locally owned distribution cooperatives.[201] Wabash Valley owns coal, natural gas, and landfill gas generation. It purchases wind and biogas generation and is adding solar energy to its portfolio.[202,203]

In early 2016, the Central Iowa Power Cooperative announced the launch of what it called “Iowa’s largest utility based solar project.” The cooperative’s CEO, Dennis Murdock, called the solar project a continuation of the cooperative’s ongoing “commitment to providing a well-balanced generation portfolio,” noting that more than half of the cooperative’s generation is carbon-free.[204]

Dairyland Power Cooperative provides wholesale electricity to 25 member-distribution cooperatives and 17 municipal utilities and owns and operates a mix of generating resources, including coal-fired, natural gas, and renewables. Dairyland also purchases RE from several sources, and grows its share of renewable resources each year.[205] In a November 2016 news release, Dairyland announced agreements for three new utility-scale solar generation projects bringing its total to 15 solar installations. Dairyland has power purchase agreements with the projects’ developers who will own, operate, and maintain the solar installations. Barbara Nick, Dairyland’s president and CEO, said, “Dairyland is celebrating our 75th anniversary this year and the 15 solar projects are an exciting example of our commitment to providing safe, reliable and sustainable energy far into the future. The current amount of solar generation in Wisconsin will nearly double through our expanding solar initiative.”[206]

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[200] http://www.electric.coop/statement-by-nreca-ceo-jim-matheson-on-clean-power-plan-oral-arguments/
[201] https://www.wvpa.com/who-we-are/fast-facts/
[202] https://www.wvpa.com/power-supply-diversity/renewable-energy/
[203] https://www.wvpa.com/power-supply-diversity/future-sources/
[204] Central Iowa Power Cooperative (CIPCO), release dated March 2016, http://www.cipco.net/content/cipco-launches-iowas-largest-utility-based-solar-project.
[205] http://www.dairylandpower.com/energy_resources/renewable_resources.php
[206] http://www.dairylandpower.com/dcontent/article/DPCannouncesadditionalsolarcontracts.pdf

Minnesota's Great River Energy—one of the nation's largest generation and transmission cooperatives, serving 28 distribution cooperatives (with an energy mix of more than 70 percent coal)—has undertaken numerous steps to shift the way it produces electricity toward zero-emitting renewable sources. In a December 2016 interview, Board Chairman Mike Thorson explained, "We have our strategy set, we're staying the course, and we intend to be on the right side of history."[207]

By shifting from coal-fired generation to low- and zero-emitting means of producing electricity, companies across the electricity-generating sector are producing meaningful reductions in CO_2 emissions. As a result of these trends, the CPP is projected to have a modest impact on the generation mix, one that is less than EPA projected at the time of the final Rule.

3.4. Policy Centers

3.4.1. Bipartisan Policy Center

In June 2016, the Bipartisan Policy Center (BPC) released an extensive analysis of the evolving market dynamics for the electric power sector, including an assessment of potential CPP impacts.[208] BPC conducted power sector modeling using the same tool as EPA (IPM), with different assumptions and parameters where BPC thought appropriate. The analysis concludes that "many states are currently on track to comply with the CPP" because of significant power sector trends, such as "state energy policies, falling natural gas prices, and the extension of the federal tax incentives for renewables."[209] In particular, it finds that emissions for the power sector under the reference case (which does not include the CPP) are lower than the mass-based levels the CPP contemplates for 2022 to 2025.

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[207] Michael Noble, *Partnering with Great River Energy on our path to electrify the economy*, Fresh Energy (Dec. 7, 2016), http://fresh-energy.org/2016/12/partnering-with-great-river-energy-on-our-path-to-electrify-the-economy/.

[208] *See* Jennifer Macedonia et al., *Modeling the Evolving Power Sector and Impacts of the Final Clean Power Plan*, BIPARTISAN POLICY CENTER (June 2016), http://cdn.bipartisanpolicy.org/wp-content/uploads/2016/06/BPC-Energy-Clean-Power-Plan-Modeling.pdf. BPC also produced interactive graphs supplementing the primary analysis. Bipartisan Policy Center, Interactive: Impacts of the Final Clean Power Plan, http://bipartisanpolicy.org/clean-power-plan-analysis-interactive/.

[209] *Ibid.*

As a result of these business-as usual emission reductions, "the CPP is not binding in the early years."[210] The analysis concludes, however that though the CPP does not mandate CO_2 reductions beyond reference case levels in the early years, under multiple policy cases it is economic for sources to reduce emissions below CPP levels during this period in order to bank allowances and reduce compliance costs in later years.[211] The CPP is thus non-binding in the early years but nevertheless achieves significant emission reductions.

The analysis further shows that industry trends and compliance flexibilities result in very modest compliance costs through 2030. For example, the system-wide compliance costs with the mass-based goals for existing sources are slightly more than $1 billion annually (average for 2022–2032), well below EPA's annual cost estimates in the RIA.[212] This is largely a result of industry trends that are already anticipated to reduce emissions considerably. In addition to national cost estimates, the analysis provides cost estimates for the three electric system interconnections (East, West, and the Electric Reliability Council of Texas (ERCOT) regions), the same regions that EPA used to calculate performance standards for existing sources. Using costs from a scenario that includes mass-based implementation for existing sources, the annual average costs for 2022–2030 are reported to be $0 for the East, roughly $500 million for ERCOT, and less than $600 million for the West. These costs are a small fraction of the annual revenues of the power sector from generating, transmitting, and distributing electricity, which total more than $390 billion.[213]

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[210] *Ibid.*

[211] *See Ibid.* at 24, 26 (illustrating that banking creates an incentive for emission reductions beyond CPP requirements through 2025 when the policy case covers only existing units and both existing and new units). "Although business-as-usual emissions are projected to comply with the CPP in most states in 2022, the policy drives additional reductions." *Ibid.* at 24. "At the U.S. level and in the majority of states, if only existing-fleet CO_2 is considered [as CPP does], business as usual (BAU) emissions remain below CPP mass goals through much of the interim period, building a bank of allowances for use in 2030 and beyond." *Ibid.* at 26.

[212] Bipartisan Policy Center, Interactive: Impacts of the Final Clean Power Plan, http://bipartisanpolicy.org/clean-power-plan-analysis-interactive/ (view U.S. Average Annual Compliance Costs graph).

[213] EIA, http://www.eia.gov/electricity/annual/html/epa_02_03.html.

3.4.2. M.J. Bradley & Associates

In June 2016 M.J. Bradley & Associates (MJB) published its updated CPP modeling results, which reflect recent power sector developments, such as the extension of federal tax credits for wind and solar, new natural gas price forecasts, and declining solar cost forecasts.[214] Overall, results indicate that CPP targets are less-costly to achieve than MJB originally projected in January 2016; they are achievable "under a range of scenarios and assumptions;"[215] and compliance costs, if any, are low across a range of scenarios.

MJB's June 2016 report highlights the recent significant decline in CO_2 emissions from the electricity sector, identifying a 20 percent reduction from 2005 to 2015. This trajectory puts the sector well on its way to achieving the 33 to 34 percent reduction from 2005 levels that MJB projects would result from implementing a mass-based trading program covering existing and new sources.[216] Moreover, the June 2016 report shows that in light of current trends, CPP requirements are even less-costly for states to achieve than MJB projected in January 2016.[217] For instance, the June 2016 report projects business-as-usual (BAU) sector emission levels 3.2% lower by 2020 and 6.4% by 2030 than MJB originally projected.[218]

MJB concludes that the CPP achieves meaningful reductions at low cost. MJB compares total electricity system costs under various CPP policy scenarios to two BAU cases (distinguished by different levels of demand-side energy efficiency). When compared to the first BAU case (labeled "RCa"), which includes no EE beyond that reflected in the AEO 2015 demand forecast, CPP compliance costs in almost

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[214] MJ Bradley & Assoc., EPA's Clean Power Plan: Summary of IPM Modeling Results with ITC/PTC Extension 5 (June 2016), http://www.mjbradley.com/reports/updated-modeling-analysis-epas-clean-power-plan.
[215] *Ibid.* at 3.
[216] *Ibid.* at 10.
[217] MJ Bradley & Assoc., EPA's Clean Power Plan: Summary of IPM Modeling Results (Jan. 2016), http://mjbradley.com/sites/default/files/MJBA_CPP_IPM_Summary.pdf.
[218] MJ Bradley & Assoc., System Costs, Average Bills, and Emissions (June 2016), http://mjbradley.com/sites/default/files/MJBA_IPM_Results_TotalUS.xlsm (percent change calculated by comparing RCb BAU emission projections across the June 2016 and January 2016 reports).

every policy scenario are negative in 2025 and in 2030. [219] This means total system costs are *lower* with the CPP than without it.

When compared to the second BAU case (labeled "RCb"), which includes current levels of EE, CPP policy costs in 2025 are either negative or minimal. For example, in mass-based state-by-state compliance scenarios (i.e., no interstate trading), compliance costs across the power sector in 2025 range from about $400 million to a *savings* of $225 million, depending on levels of demand-side energy efficiency.[220] In 2030, compliance costs in the state-by-state compliance scenarios range from $775 million to $1.4 billion.[221] In mass-based interstate trading scenarios, compliance costs in 2025 range from $2 billion to *negative* $1 billion.[222] In 2030, the highest compliance-cost scenario for mass-based trading is $2.76 billion.[223] To put these figures in context, average compliance costs across 2030 mass-based scenarios are only about 0.8% higher than projected BAU costs for 2030.[224]

In terms of allowance prices as a cost metric, mass-based policy runs with interstate trading project modest prices throughout the program and indicate that prices can be moderated downward even further through increases in demand-side EE.[225] More specifically, the four mass-based interstate trading scenarios show a $0 allowance price in 2025 and allowances prices between $0 and $6.05 by 2030. Increases in the level of EE reduce allowance prices significantly, potentially resulting in an allowance price of $0.[226] This range of allowance prices translates into either a slight increase in residential electricity bills (1 to 2 percent above BAU levels) or a decrease in residential bills (2 to 7 percent below BAU levels), depending

[219] *Ibid.* (select June 2016 tab and then Total System Cost; refer to columns H through N for the years 2025 and 2030).
[220] *Ibid.* (select June 2016, Total System Cost, and the year 2025; refer to columns Q and R).
[221] *Ibid.* (select June 2016, Total System Cost, and the year 2030; refer to columns Q and R).
[222] *Ibid.* (select June 2016, Total System Cost, and the year 2025; refer to columns S through V).
[223] *Ibid.* (select June 2016, Total System Cost, and the year 2030; refer to column U).
[224] *Ibid.* (comparing average 2030 compliance costs on tab June 2016 in scenarios represented in columns Q through V to total 2030 system costs for RCb in column B).
[225] MJ Bradley & Assoc., EPA's Clean Power Plan: Summary of IPM Modeling Results with ITC/PTC Extension 13 (June 2016), *available at* http://www.mjbradley.com/reports/updated-modeling-analysis-epas-clean-power-plan.
[226] *Ibid.*

upon the level of EE.[227] In addition, the report projects significant increases in RE generation, especially solar, due to the extension of federal tax credits.[228]

3.4.3. Regional Transmission Organizations and Independent System Operators

A number of regional transmission organizations (RTOs) and independent system operators (ISOs), tasked with ensuring efficient and reliable electric delivery and reliability, have conducted modeling and analysis of their systems to ensure that stakeholders and policymakers have adequate information and data to ensure the continued reliable operation of the electric grid. This is a central part of their mission and routine analysis these entities perform on an ongoing basis.

The PJM interconnection recently examined the compliance pathways for CPP using a reference scenario and alternative scenarios reflecting a range of possible future conditions.[229] One scenario included in the report was a "low gas price" scenario, which is similar to the natural gas trends already under way. As PJM described it, the scenario reflects "a continuation of the current trend in gas prices in which gas production remains on its current trajectory…". This scenario used standard projections from the consultancy IHS CERA from its central case forecast, where natural gas prices continue to rise at 0.4 percent per year in real terms over the next 20 years. When these natural gas trends are incorporated into the PJM analysis, emission levels in the PJM system are below the CPP goals even without the CPP. When the CPP was included in the scenario, the price of reducing CO_2 emissions was $0—*i.e.*, no cost at all. As PJM stated, "The level of CO_2 emissions observed in the low gas price sensitivity render the study of this sensitivity for CPP compliance unnecessary."

The Midcontinent ISO (MISO) analysis of the final CPP reports that compliance through the mid-2020s follows current industry trends, so that "early compliance

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[227] *Ibid.* at 14.
[228] *Ibid.* at 15.
[229] EPA's Final Clean Power Plan - Compliance Pathways Economic and Reliability Analysis, PJM Interconnection (September 1, 2016), http://pjm.com/~/media/library/reports-notices/clean-power-plan/20160901-cpp-compliance-assessment.ashx.

targets can be met through existing renewable portfolio standards and coal-to-gas re-dispatch."[230]

ERCOT also conducted an analysis of the CPP. When updating its analysis for the final CPP, ERCOT found the impacts of the final rule to be notably lower than the proposed rule, and itself noted that ERCOT has successfully integrated significant amounts of RE into the grid and deployed new transmission while managing retirements of older and higher emitting units. Modeling results also indicate more moderate impacts on retirements compared to the prior study—from 5,000-MW incremental retirements under the CPP in 2029 for the prior study of the proposed rule, compared to 4,000-MW incremental retirements in 2030 from the CPP in ERCOT's updated study.[231]

3.4.4. Nicholas Institute for Environmental Policy Solutions at Duke University

In July 2016, Duke University's Nicholas Institute for Environmental Policy Solutions published its latest CPP modeling results.[232] The paper explores how ongoing power sector trends are likely to shape the industry in the coming decades. It also explores how the CPP may interact with these trends.[233] Overall, the report concludes that the CPP achieves emission reductions under "standard" assumptions and that under a low natural gas price scenario, the CPP is nonbinding in early years. Further, the modeling used to develop the report shows that across multiple compliance scenarios, the CPP will have minimal impact on total system costs—in the range of 0.1 to 1.0 percent.[234] For example, if natural gas prices remain low or

[230] MISO's Analysis of EPA's Final Clean Power Plan Study Report, July 2016, available at: https://www.misoenergy.org/Library/Repository/Meeting%20Material/Stakeholder/PAC/2016/20160720/20160720%20PAC%20Item%2002a%20Clean%20Power%20Plan%20Study%20Report.pdf

[231] ERCOT Analysis of the Impacts of the Clean Power Plan Final Rule Update, October 16, 2015 http://www.ercot.com/content/news/presentations/2015/ERCOT_Analysis_of_the_Impacts_of_the_Clean_Power_Plan-Final_.pdf.

[232] Martin Ross et al., Nicholas Institute for Environmental Policy Solutions, Ongoing Evolution of the Electricity Industry – Effects of Market Conditions and the Clean Power Plan (July 2016), https://nicholasinstitute.duke.edu/sites/default/files/publications/ni_wp_16-07_final.pdf.

[233] *Ibid.* at 2.

[234] *Ibid.* at 1. "Policy costs encompass all costs associated with delivering electricity to meet grid demands in a particular state or region. Among these costs are those directly related to generating electricity in an area: capital costs of new construction or retrofits (these are typically annualized for cost-reporting purposes); fixed operations and maintenance (O&M) costs that represent annual maintenance expenditures; variable O&M costs, which vary with the level of generation; and fuel costs." *Ibid.* at 22.

the cost of renewables continues to decline, the industry could meet CPP requirements "without additional adjustments."[235]

The Nicholas Institute, like others, observes that the electricity sector is changing dramatically, irrespective of the CPP. As a result, the CPP secures meaningful emission reductions over time at low cost. More natural gas-fired units are coming online as coal plants retire due to market forces, age, and other factors—*e.g.*, the Mercury and Air Toxics Standard (MATS).[236] Between 2002 and 2012, the share of generation from coal in the electricity sector dropped from 55 percent to less than 40 percent, while generation from natural gas and non-hydro renewables increased significantly. The report observes that these trends are expected to persist in the coming decades because "natural gas prices are expected to remain relatively low on a historical basis" and RE costs are forecast to decline further.[237] Even without new policies such as the CPP, "the [Nicholas Institute modeling] estimates that by 2030, coal generation will represent only one-third of all electricity."[238] Natural gas generation will increase to the point of parity with coal generation, and generation from renewables will double from 2012 levels in response to state policies and utility decisions to install new capacity based on economics.[239] BAU cases in the modeling indicate that if natural gas prices remain below $4/MMBtu for the next 20 years, CO_2 emissions will continue to decline. Even under moderate natural gas prices ($4.50/MMBtu), emissions stay the same.[240] As a result, the modeling "indicates that future industry trends are likely to make CPP compliance relatively inexpensive, with cost increases of 0.1 percent to 1.0 percent."[241]

Under a range of CPP policy scenarios, modeling shows low industry compliance costs. For example, under the model's "standard" assumptions (*e.g.*, natural gas price of $4.70/MMBtu in 2030), a mass-based policy case for existing units leads to "extremely modest" national net costs of $1.9 billion (present value) through 2040 (not annually).[242] In a low natural gas price scenario ($3.60 MMBtu to $3.74/MMBtu between 2020 and 2030), the CPP is nonbinding through the "first

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235 *Ibid.* at 1.
236 *Ibid.* at 3.
237 *Ibid.* at 6.
238 *Ibid.*
239 *Ibid.*
240 *Ibid.* at 3.
241 *Ibid.* at 1.
242 *Ibid.* at 23.

few years of the policy."[243] Costs under an existing-unit only policy case with low natural gas prices are "essentially zero."[244] Under a policy case covering existing and new units, policy costs would be approximately 0.1 percent.[245] This suggests that "the Clean Power Plan is non-binding and that its emissions goals can be met without significant adjustments if gas prices are sufficiently low."[246]

The Nicholas Institute's modeling also shows that the CPP does not drive dramatic reductions in coal generation. Under a range of CPP policy cases, "coal generation declines slightly by 2030." The CPP's impact on coal generation is minimal because baseline coal capacity decreases significantly (225 GW) by 2022 in response to low natural gas prices and other environmental regulations.[247]

3.4.5. Resources for the Future

Modeling results from Resources for the Future (RFF) in 2016 support conclusions similar to those of other organizations: The power sector experienced significant generation shifts and emission reductions in recent years, these trends are projected to continue reducing sector CO_2 emissions irrespective of the CPP, and projected emissions reductions make CPP targets more achievable.

RFF describes transformational changes, such as emission reductions and generation shifts, that have occurred in the electricity sector over the last decade, which have been driven by fuel costs, technology advancements, and policies designed to improve air quality and to support the use of natural gas and renewable resources for electricity generation.[248] "After rising steadily for decades, electricity sector CO_2 emissions peaked in 2007 and decreased 15 percent by 2013."[249] This decline in emissions is a result of factors such as the 2008 recession, the decline in natural gas prices after 2008, the increased cost of coal generation relative to other

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[243] *Ibid.* at 3.
[244] *Ibid.* at 26.
[245] *Ibid.* at 4.
[246] *Ibid.* at 26.
[247] *Ibid.* at 19.
[248] Joshua Linn et al., Resources for the Future, An Economic Assessment of the Supreme Court's Stay of the Clean Power Plan and Implications for the Future 4 (June 2016), http://www.rff.org/research/publications/supreme-court-s-stay-clean-power-plan-economic-assessment-and-implications.
[249] *Ibid.* at 7-8.

resources, and policies to promote EE and RE.[250] "Since 2008, coal production has fallen 15 percent, coal-mining employment has fallen 14 percent, and 20 percent of the coal-fired generation fleet has retired or will retire."[251] Sector emissions have decreased dramatically, mostly as a result of low natural gas prices, which dropped 60 percent between 2008 and 2012 (Figure 20).[252] RFF finds that the decline in natural gas prices was a predominant cause of the reduction in coal generation and retirement of coal-fired power plants.[253]

RFF further observes that "these trends have caused emissions to decline more quickly in recent years than the CPP will cause in coming years."[254] Between 2007 and 2013, emissions declined by about 3 percent annually (Figure 28). By comparison, RFF analysis indicates the CPP will cause an annual emission decline of less than 1 percent. "In that sense, the CPP continues, to a lesser extent, the emissions trajectory that the US power sector is already on."[255]

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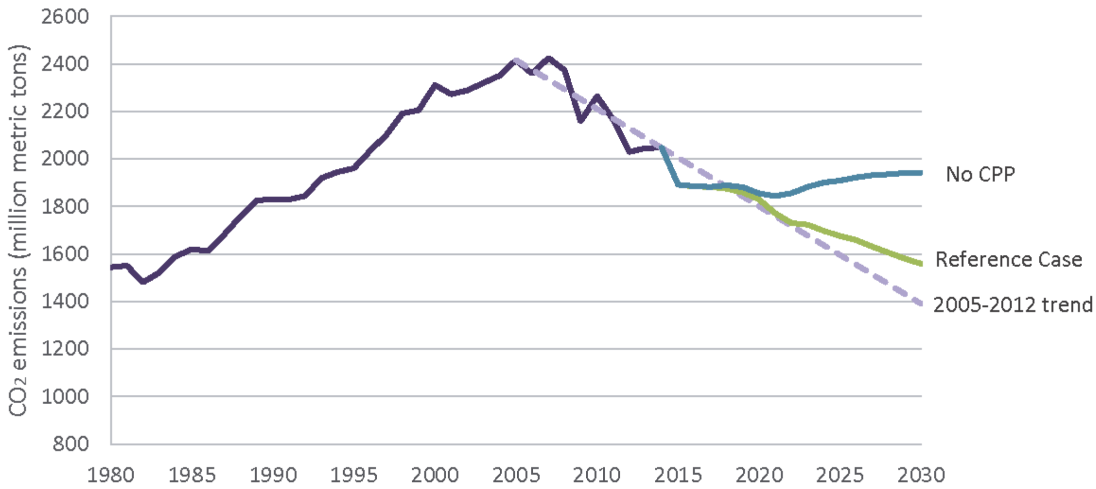
[250] *Ibid.*
[251] *Ibid.*at 4.
[252] Joshua Linn et al., Resources for the Future, Is halting the Clean Power Plan Economically Justified 28 (Sept. 2016), http://www.rff.org/files/document/file/RFF-Resources-193_Feature-Linn.etal_.pdf.
[253] Joshua Linn et al., Resources for the Future, An Economic Assessment of the Supreme Court's Stay of the Clean Power Plan and Implications for the Future 7-8 (June 2016), http://www.rff.org/research/publications/supreme-court-s-stay-clean-power-plan-economic-assessment-and-implications.
[254] *Ibid.* at 8.
[255] *Ibid.*

Figure 28. RFF Electricity Sector CO_2 Emissions[256]



Notes: The figure plots historic CO_2 emissions from the Energy Information Administration (EIA) Monthly Energy Review, April 2016, and projected emissions under the reference case, which includes the mass-based CPP rule, and an alternative case without the CPP (EIA 2016b).

Looking forward, RFF finds that the forces currently transforming the power sector will continue to shift generation away from high-emitting resources. These trends, such as low-cost natural gas, will "overshadow" the importance of the CPP in driving future emission reductions.[257] Market forces will continue shifting generation to low- and zero-emitting resources, and the CPP will not play a role in furthering this shift until "at least the mid-2020s."[258]

Current trends of low-cost natural gas and growth in generation from renewables further imply that the overall costs of the CPP will be low (Figure 29).[259] In light of

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[256] *Ibid.*
[257] *See* Joshua Linn et al., Resources for the Future, Is halting the Clean Power Plan Economically Justified 27 (Sept. 2016), http://www.rff.org/files/document/file/RFF-Resources-193_Feature-Linn.etal_.pdf .
[258] *Ibid.* at 28.
[259] Joshua Linn et al., Resources for the Future, An Economic Assessment of the Supreme Court's Stay of the Clean Power Plan and Implications for the Future 4 (June 2016),

"existing market, technology, and policy trends,[260] overall CPP compliance costs will be close to $0 through 2025 and will be drastically outweighed by public benefits.[261] Further RFF, expects that the CPP will have "a small effect on the profits of operating coal-fired power plants,"[262] though the ultimate cost will depend upon the approach adopted by states.[263]

RFF's modeling also indicates annualized costs of $8.4 billion in 2030, which parallels EPA's 2030 estimate of $5.1 to $8.4 billion,[264] depending upon how states choose to structure their state plans.[265] RFF estimates allowance prices with multistate trading at only $2 by 2025, meaning that existing policies and technology trends alone will reduce emissions almost enough to achieve the CPP reductions contemplated for the first interim step period (2022–2024). By 2030, allowance prices rise to $17 per ton of CO_2. This compares to EPA's estimate of allowance prices ranging from $0 to $14.95 during the same period. RFF expects much lower allowance prices if state plans allow for interstate trading.[266]

In sum, according to RFF, the power sector has been changing because of market forces that predate the CPP, such as innovation in RE technology, sharp declines in natural gas prices, policies that support EE and RE, and the increase in relative costs of coal-fired generation. RFF modeling projects that these trends will play a larger role in future emission reductions than the CPP. Even when the CPP becomes binding in the mid-2020s, compliance costs are expected to be moderate.

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http://www.rff.org/research/publications/supreme-court-s-stay-clean-power-plan-economic-assessment-and-implications .

[260] *Ibid.*

[261] Joshua Linn et al., Resources for the Future, Is halting the Clean Power Plan Economically Justified 28 (Sept. 2016), http://www.rff.org/files/document/file/RFF-Resources-193_Feature-Linn.etal_.pdf.

[262] Joshua Linn et al., Resources for the Future, An Economic Assessment of the Supreme Court's Stay of the Clean Power Plan and Implications for the Future 18 (June 2016), http://www.rff.org/research/publications/supreme-court-s-stay-clean-power-plan-economic-assessment-and-implications.

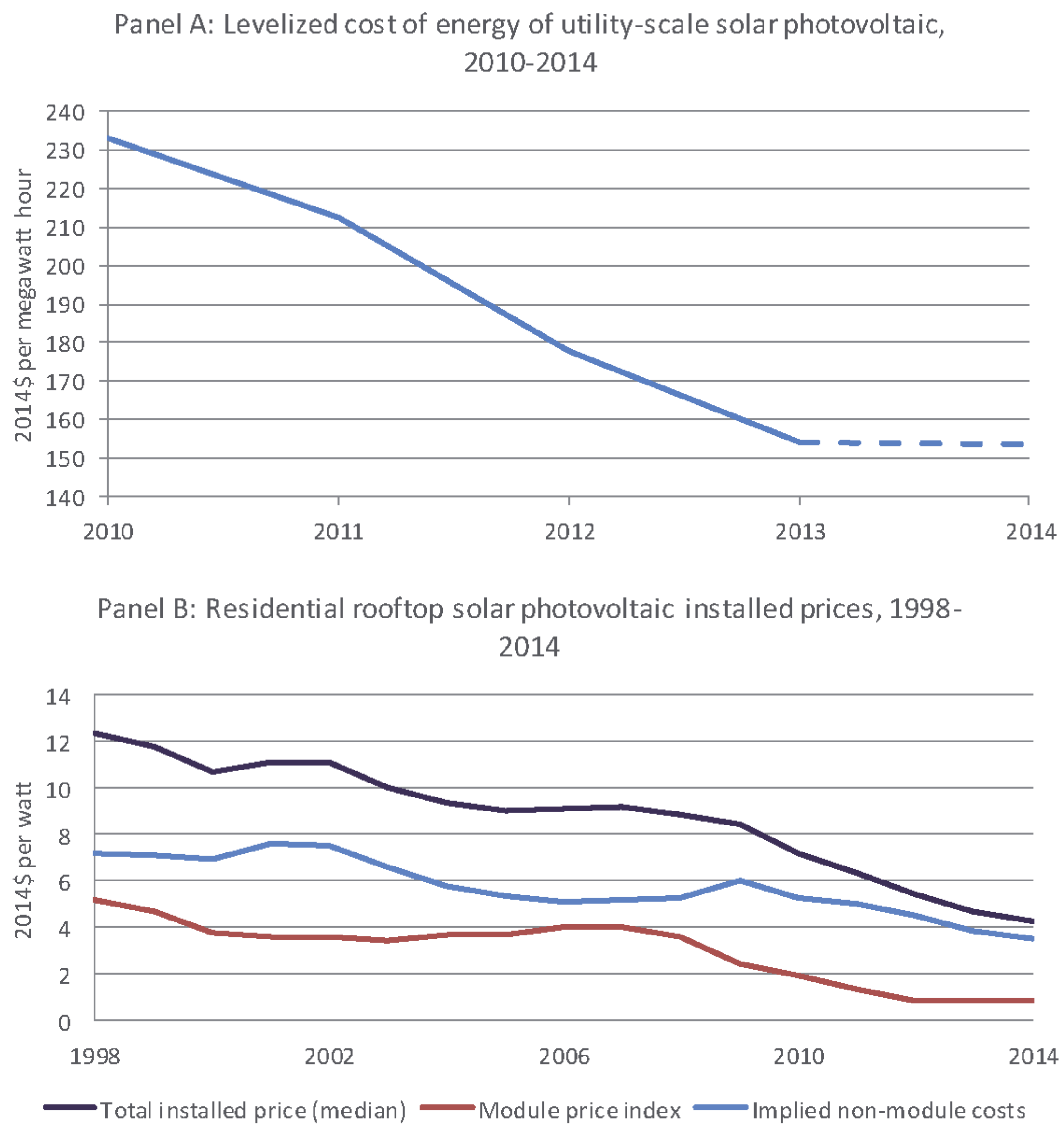
[263] *Ibid.* at 18.

[264] U.S. Environmental Protection Agency, Regulatory Impact Analysis for the Clean Power Plan Final Rule, ES-9 (2015), https://www.epa.gov/sites/production/files/2015-08/documents/cpp-final-rule-ria.pdf.

[265] Joshua Linn et al., Resources for the Future, An Economic Assessment of the Supreme Court's Stay of the Clean Power Plan and Implications for the Future 18 (June 2016), http://www.rff.org/research/publications/supreme-court-s-stay-clean-power-plan-economic-assessment-and-implications ..

[266] *Ibid.* at 19.

Figure 29. Average Costs of Utility-Scale Solar and Installed Prices of Residential Solar[267]

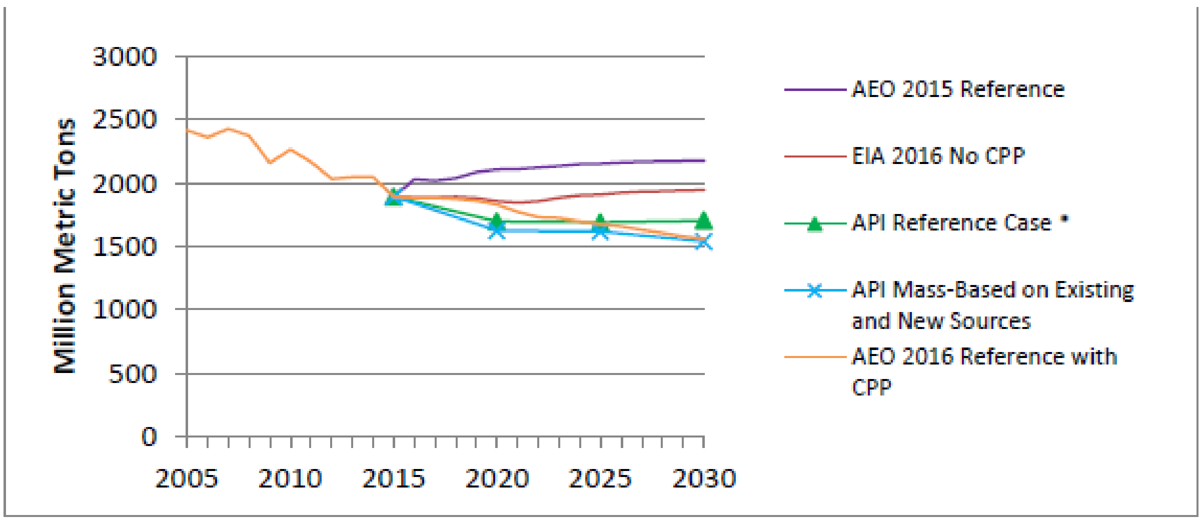


Notes: The levelized cost of energy of utility-scale solar is calculated using the National Renewable Energy Laboratory's 2015 Annual Technology Baseline (NREL 2015; Bolinger and Seel 2015). Because the capacity factor in 2014 is imputed by extrapolating the trend in capacity factors between 2010 and 2013, we indicate the 2014 costs using a dashed line. While the capacity-weighted average installed price of utility-scale solar photovoltaics increased from 2013 to 2014, the median installed price decreased (Bolinger and Seel 2015). The levelized cost is reported in 2014$ per megawatt hour. The installed prices of rooftop solar are from Barbose and Darghouth (2015) and are reported in 2014$ per watt. NREL subsequently reduced its capital cost for solar in its 2015 Annual Technology Baseline by another 20 percent.[15]

3.4.6. American Petroleum Institute

The American Petroleum Institute (API) released two reports that conclude that BAU emissions in 2030 will be on par with the level of emission reduction required by the CPP. API's reference case shows a 30 percent reduction in CO_2 emissions from 2005 levels by 2030, even without the CPP (Figures 30 and 31).[268] The API reference case includes the AEO 2015 high natural gas resource assumptions, which API believes is more realistic than the assumptions for natural gas used in EPA's BAU case.[269] But even under the API reference case, fuel economics and generation shifts lead to emission reduction levels sufficient to achieve CPP requirements under API's modeling scenario for mass-based limits in existing sources.[270] In effect, the CPP requires no additional reductions beyond BAU in this scenario. Additional rate- and mass-based scenarios show the CPP achieving incremental reductions in BAU emissions under the API reference case.

Figure 30. Electric Power Sector CO_2 Emissions[271]

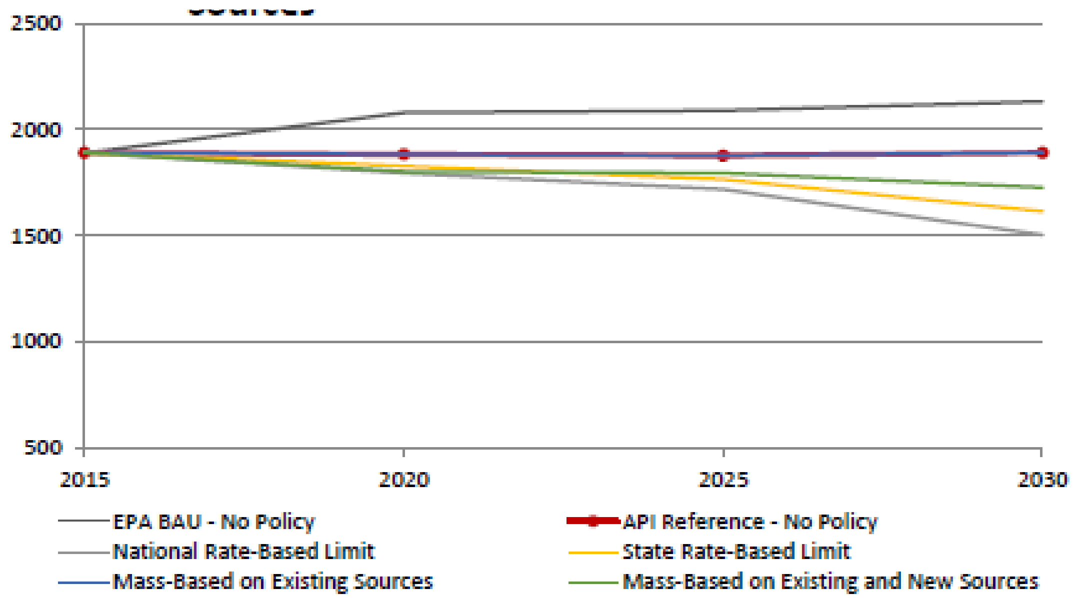


*API Reference Case assumes: no CPP, business as usual load, and is based on AEO 2015 high natural gas resource assumptions

[267] *Ibid.*
[268] American Petroleum Institute, The Natural Gas Solution – Modeling the EPA's Clean Power Plan 1, http://www.api.org/news-policy-and-issues/natural-gas-solutions/api-modeling-of-epa-cpp.
[269] *Ibid.*
[270] American Petroleum Institute, Natural Gas Solutions: Power Generation --- EPA Clean Power Plan Compliance Pathways – Modeled Generation, Capacity and Costs 17, http://www.api.org/~/media/Files/Policy/Natural-Gas-Solutions/CPP_National_Results.pdf.

[271] American Petroleum Institute, The Natural Gas Solution – Modeling the EPA's Clean Power Plan 1, http://www.api.org/news-policy-and-issues/natural-gas-solutions/api-modeling-of-epa-cpp.

Figure 31. Projected U.S. CO2 Emission from Total Covered Sources[272]



3.4.7. Natural Resources Defense Council

A June 2016 report from the Natural Resources Defense Council (NRDC) indicates that transformational generation trends already under way in the power sector will help the sector meet CPP requirements. NRDC concludes that updated analysis of these trends show that CPP requirements are more readily achievable than expected when the CPP was finalized in 2015.

The report highlights the remarkable growth in wind and solar over the past decade, which it attributes to support from state policies and declines in technology costs (Figure 32).[273] "According to the investment firm Lazard, the cost of generating electricity from new onshore wind turbines has fallen 61 percent since 2009; the cost of electricity generated from solar panels has fallen 82 percent in the same time period," the report states.[274] The report further identifies a number of

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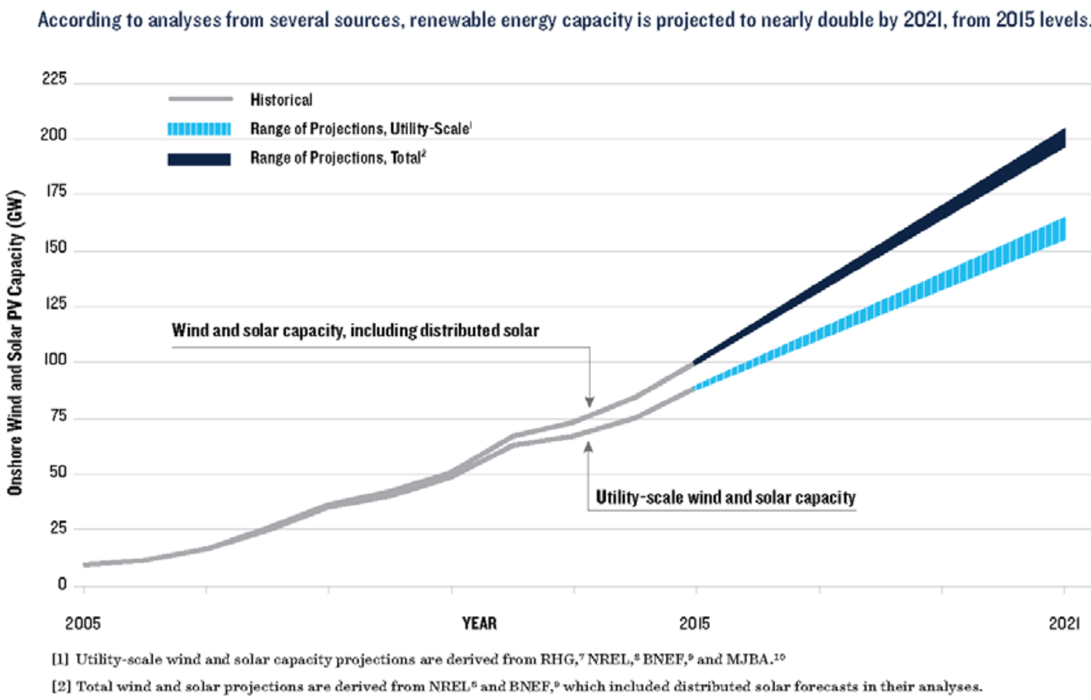
[272] American Petroleum Institute, Natural Gas Solutions: Power Generation --- EPA Clean Power Plan Compliance Pathways – Modeled Generation, Capacity and Costs 17, *available at* http://www.api.org/~/media/Files/Policy/Natural-Gas-Solutions/CPP_National_Results.pdf.
[273] Natural Resources Defense Council, The Clean Power Plan: Keeping Climate Progress on Track (June 2016), https://www.nrdc.org/sites/default/files/clean-power-plan-climate-progress.pdf.
[274] *Ibid.* at 1 (citing Lazard, "Levelized Cost of Energy Analysis 9.0," November 2015, www.lazard.com/perspective/levelized-cost-of-energy-analysis-90/).

industry and governmental analyses that project continued growth in RE, potentially doubling from 2015 levels by 2021, as a result of federal tax credits, stronger state renewables policies, and international demand for renewables. Because of these trends, the power industry will be "in an excellent position to meet—or even exceed—[CPP requirements]."[275] In other words, NRDC found, continuing BAU, "carbon pollution from the power sector will likely be close to the CPP's initial requirements for 2022," and meeting CPP requirements will be less-costly than anticipated a year ago.[276]

Figure 32. NRDC Projected Wind and Solar Capacity[277]



[275] *Ibid.* at 2. "Examining all of these trends, including the extension of the renewable energy tax credits, with varied assumptions and analytical tools, four recent analyses from Rhodium Group (RHG), the National Renewable Energy Laboratory (NREL), Bloomberg New Energy Finance (BNEF), and M.J. Bradley and Associates (MJB) paint a strikingly similar picture: Renewable energy will continue its strong growth for the next six years, with capacity expected to nearly double from 2015 levels by 2021." *Ibid.*

[276] Natural Resources Defense Council, The Clean Power Plan: Keeping Climate Progress on Track 2 (June 2016), https://www.nrdc.org/sites/default/files/clean-power-plan-climate-progress.pdf.

[277] *Ibid.*

3.4.8. Environmental Defense Fund – Market-Driven Decarbonization of the Power Sector

In early 2017, the Environmental Defense Fund issued a report that reviewed recent studies describing the power sector's shift towards cleaner generation.[278] The study concluded that "[t]he power sector is in the midst of a steady move to a low carbon future," and that "[a]s a result the power sector is achieving significant emissions reductions and is on its way to achieving the 2030 targets in the Clean Power Plan."[279]

Among other things, this report states:

> In recent years, new generation has been dominated by low-cost zero-carbon and lower-carbon resources. As a result, carbon dioxide pollution from the power sector declined by 21 percent from 2005 levels by 2015. These trends are expected to continue. Data shows that emissions from the power sector further declined to 25 percent below 2005 levels over the last 12-month period for which data was available (October 2015–September 2016). These rapid declines are being driven by a number of factors, including steadily falling renewable prices, sustained low natural gas prices, consumer preference, and Congress' extension of tax credits for renewable energy resources. As a result the power sector is achieving significant emissions reductions and is on its way to achieving the 2030 targets in the Clean Power Plan (CPP).
>
> Our review of the literature finds that experts expect these trends to continue and that the power sector is already evolving consistent with the best system of emissions reductions contemplated by the U.S. Environmental Protection Agency (EPA) when the Agency developed the Clean Power Plan. Furthermore, there is general consensus that it will be even easier to meet the climate pollution reduction goals of the

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[278] Nicolas Bianco & Martha Roberts, ENVIRONMENTAL DEFENSE FUND, "Experts Agree: The U.S. Power Sector is Rapidly Decarbonizing as a Result of Market Trends" (Jan. 5, 2017), *available at* http://blogs.edf.org/climate411/files/2017/01/CPP-Combined-3.pdf.

[279] *Ibid.* at 1–2.

program than EPA previously predicted, and thus EPA's approach in calculating emission reduction goals was conservative.[280]

Specifically, the report reviews the literature showing that:[281]

1. Emissions of climate pollution from the power sector are falling while states grow their economies;

2. Studies consistently show that the climate pollution goals established under the Clean Power Plan are readily achievable and consistent with current trends, and also that the Clean Power Plan is essential for realizing the sectors emission reduction targets;

3. These trends are equally apparent at the state and company level;

4. Underlying these developments is a surge in renewable development, which is largely driven by increasingly favorable economics;

5. Low natural gas prices continue to drive reductions in emissions of climate pollution as a result of a re-dispatch of the system away from the highest emitting plants; and

6. States and consumers continue to grow their investments in energy efficiency, lowering electric bills while creating jobs and reducing emissions of climate pollution; and,

7. Power generators also have important opportunities to reduce emissions through heat rate improvements and other improvements.

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[280] *Ibid.* at 1 (citations to reports from the Energy Information Administration omitted).
[281] *Ibid.* at 1-2