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Analysis of the Bingaman Clean Energy Standard Proposal

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RESOURCES FOR THE FUTURE

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Abstract

A clean energy standard (CES) is a flexible approach to encouraging a cleaner technology mix for electricity production. The most recent federal CES proposal from Senator Bingaman would transform the way electricity is produced and result in substantial reductions in CO_2 emissions with small national average electricity price effects through 2025. After 2025, electricity prices would increase substantially. The alternative compliance payment (ACP) for clean energy credit will be binding, and thus actual deployment of clean energy will fall short of the intended targets and cumulative emissions reductions by 2035 will be 12 percent smaller than they would be without an ACP. The small utility exemption from the CES requirements equates to roughly $29 billion in avoided electricity expenditures by the customers of exempted utilities in 2035 alone. Excluding power generated by existing nuclear and hydroelectric facilities from CES compliance responsibility raises electricity prices in competitive regions to the benefit of owners of existing nuclear and hydro capacity.

Key Words: climate, clean energy standards

JEL Classification Numbers: Q42, Q48, Q54, Q58

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Introduction

Global climate change is one of the more compelling environmental problems of our time, and policies to address this problem have been an important focus of environmental policy debates in Washington for well over a decade. Several pieces of federal legislation that address greenhouse gas emissions in the United States have been proposed or formally introduced in the US Congress. Many of these proposals have sought to either cap or tax emissions of CO2, either from the electricity sector or more broadly. One economywide cap-and-trade bill, HR 2454, sponsored by Representatives Waxman (D-CA) and Markey (D-MA), was passed by the House of Representatives in 2009, but the Senate failed to take up the measure and it did not become law. Since that time, there has been little appetite among federal legislators for policies that restrict carbon emissions directly. Instead, several members of Congress as well as the Obama administration have been looking for more targeted approaches to encouraging use of clean energy, investments in end-use energy efficiency, and development of clean energy technologies.

One approach that has been proposed to help reduce emissions from the electricity sector is a clean energy standard. A clean energy standard (CES) sets a minimum threshold on the share of generation that must come from clean sources, and that threshold grows over time. Like a renewable portfolio standard (RPS), the CES is a portfolio standard and can be satisfied by generation from a variety of clean energy sources, encompassing a broader range of generation technologies than just renewables alone. This broad range typically includes other nonemitting sources such as nuclear and hydroelectric and also generation from certain types of natural gas plants. Senator Graham (R-SC) introduced a CES bill, S 20, in 2010. This bill would have required 30 percent of electricity generation to be clean by 2030, with clean defined as renewables, new nuclear or hydroelectric plants, coal with carbon capture and storage, and demand-side efficiency improvements. More recently, President Obama in his 2011 State of the Union address discussed a CES that would require 80 percent of electricity to be clean by 2035, crediting natural gas combined cycle as a partially clean technology.

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This analysis focuses on the most recent proposal, sponsored by Senator Bingaman (D-NM), which is the Clean Energy Standard Act of 2012, or S 2146.[1] This CES bill sets the clean energy requirement at 24 percent in 2015, rising by 3 percent per year to 84 percent in 2035. The CES obliges any nonexempt retail utility to hold a fraction of a clean energy credit equal to the requirement for each MWh of retail electricity sales. Generators designated as clean, and therefore qualified to receive clean energy credits for electricity production, are those that are renewable, natural gas, hydro, nuclear, or qualified waste-to-energy facilities that were placed in service after 1991. Generators qualifying as clean receive 1-(*X*/0.82) credits per MWh of generation, where *X* is the carbon intensity of a generator in metric tons of CO_2 per MWh.[2] Thus renewables with no CO_2 emissions will receive a full credit, while generators with CO_2 emissions rates above zero but less than 0.82 metric tons of CO_2 per MWh of generation, such as natural gas combined cycle units or coal with CCS, will receive partial credits.[3] Credits may be banked for use in future years. Retail utilities have the option of paying an alternative compliance payment (ACP) of $30/MWh in 2015,[4] rising by 5 percent per year in real dollars in lieu of purchasing clean energy credits, and thus the ACP imposes a ceiling on the price of credits. Small utilities are exempt from compliance obligation, and the threshold defining small utilities is 2 million MWh of sales per year in 2015, falling by 100,000 MWh per year to 1 million MWh of sales per year in 2025. The threshold is constant after 2025. Any electricity sales generated by a nuclear or hydro facility placed in service before 1992 (almost all of them) are also exempt from the standard.

This analysis looks at the effects of the CES on generation, retail prices, and CO_2 emissions from the electricity sector. We analyze the effects of different aspects of the policy, as well as how the policy performs under different assumptions about natural gas prices and new

[1] For prior analyses of CES policies, see Mignone et al. (2012), Paul et al. (2011), Palmer et al. (2010). For a discussion of the merits of an intensity based approach to a CES, see Aldy (2011).

[2] From our reading of the bill, the only coal boilers eligible to receive credits for biomass cofiring are those built after 1991. There are fewer than 20 GW of such capacity, and to receive credits, a generator must achieve a carbon intensity below 0.82 metric tons CO_2 per MWh. Even if the secretary of energy assigns an emissions rate of zero for biomass, it is still unlikely that many of the 20 GW of potentially eligible capacity could reach 0.82. And if the technical limit on cofiring is 10 percent of heat input, then at most 2 GW could cofire. We make the simplifying assumption that cofiring is not credited.

[3] We also assume that renewable generators who get credit under a state RPS program may also earn credits under the federal CES program. This assumption means that generators located in states that have more aggressive RPS policies than that implied by the federal CES policy are able to export CES credits to utilities located in other states for compliance with the federal policy.

[4] $30/MWh in 2015 dollars is approximately equal to $26/MWh in 2009 dollars, which are used for this analysis.

environmental regulations of mercury and toxics specified in the Mercury and Air Toxics Standards (MATS). Our results suggest that the CES leads to substantial reductions in CO_2 emissions from the electricity sector. The CES will have a modest effect on the national average retail electricity price for the first 10 years, followed by important increases after 2025. The alternative compliance payment for clean energy credit will be binding, and thus actual deployment of clean energy will fall short of the intended target. The exemption granted to small utilities is extremely valuable to their customers, especially by 2035, when wholesale electricity prices across the country will be substantially lower than they would be without the policy. The exclusion of nuclear and hydroelectric capacity built before 1992 is valuable to those generators if they sell power into competitive markets and costly for retail customers in those markets. The detailed results are discussed below.

Model and Scenarios

This analysis uses RFF's Haiku electricity market model (Paul et al. 2009) to look at the implications of the details of the Clean Energy Standard Act of 2012. The Haiku model contains dynamic, price-responsive modules for electricity demand and supply that are calibrated to the Energy Information Adminstration's (EIA) forecasts in its reference case projections, but which can vary from these forecasts according to information and policies represented in the model. The model simulation horizon is the year 2035. The assumptions underlying the baseline and policy scenarios are described below.5

One core and two alternative baseline scenarios underpin this anlysis. The scenario labeled *Baseline* is the core baseline. It includes all of the major environmental policies affecting the US power sector, including the SO_2 trading program under Title IV of the Clean Air Act, the Clean Air Interstate Rule (CAIR), the Regional Greenhouse Gas Initiative (RGGI), the federal renewable energy production and investment tax credit programs, and all of the state RPS and renewable tax credit programs. The *Baseline* scenario is calibrated to the EIA's Annual Energy Outlook (AEO) 2011.

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[5] The bill contains provisions for combined heat and power, carbon capture and sequestration (CCS), and potentially funding for end-use energy efficiency programs through the use of alternative compliance payment revenue that are not fully captured by the Haiku model. The only provision among these three that is captured at all is that on CCS. Haiku simulates new investments in CCS equipment in conjunction with construction of new coal-fired integrated gasification combined cycle generators, but not CCS retrofit at existing coal boilers.

The scenario labeled *Low Gas Supply* is identical to the *Baseline* except that the natural gas supply module is calibrated to AEO 2009 instead of 2011. The AEO 2009 was much less optimistic than the 2011 version regarding natural gas supply, so the *Low Gas Supply* scenario is a high natural gas price scenario. The scenario labeled *MATS* is identical to the *Baseline*, but with the Environmental Protection Agency's (EPA) proposed MATS rule imposed.

The central policy case for this analysis, which corresponds to the text of the bill, is labeled *CES*. This scenario captures all of the features of the bill described in the introduction. The scenario labeled *CES w/o ACP* is identical to the *CES* scenario, but without the alternative compliance payment provision. The *CES w/o SUE* scenario is identical to *CES*, but without the small utilities exemption. The scenario labeled *CES w/o ACP or SUE* is *CES* without either ACP or SUE. The two scenarios labeled *CES w/ Low Gas Supply* and *CES w/ MATS* represent the bill as written, but with alternative assumptions about natural gas supply and the presence of MATS. The scenario labeled *CES w/o Nuke/Hydro Excluded* is identical to *CES*, but without the provision that excludes from compliance obligation all sales from generation at pre-1992 nuclear and hydroelectric generators, and with the CES requirement adjusted to maintain a constant share of generation from clean sources across the two scenarios.[6] Note that almost all existing nuclear and hydroelectric generation capacity was constructed before 1992, so henceforth this document will refer in this context to existing nuclear and hydroelectric capacity without making the pre 1992 distinction.

A scenario labeled *Carbon Tax* is included in the analysis. This scenario finds a carbon tax trajectory that begins in 2015, rises at 5 percent per year in real dollars, and achieves cumulative CO_2 emissions by 2035 that are equivalent to those under the *CES* scenario.

[6] If generation from existing nuclear and hydroelectric capacity were not excluded from compliance obligation, then if the CES requirement is as specified in the bill, the credit prices would rise (if there were no ACP) in response to increased demand for credits. To isolate the effect of excluding existing nuclear and hyrdroelectric generators while maintaining an approximate equivalence in environmental outcomes, the CES requirement is adjusted from 24 percent in 2015 and 84 percent in 2035 to 16 percent in 2015 and 61 percent in 2035.

Results

All dollar values are in 2009 dollars.

CO_2 Emissions

The proposed CES legislation would reduce CO2 emissions substantially. Figure 1 shows the emissions trajectories for the Baseline and CES scenarios and for alternative approaches to CO2 emissions mitigation. CES would achieve 11.4 billion tons of cumulative CO2 emissions reductions by 2035, or 21 percent of cumulative Baseline emissions. In 2035 alone, CES would achieve 1.1 billion tons of reductions, or 41 percent of annual emissions in Baseline. The United States has pledged, as part of the United Nations climate change conferences in Copenhagen and Cancun, to reduce economy-wide CO2 emissions to 83 percent below 2005 levels by 2050. To be on a linear path to meet this goal, the United States would have to reduce total CO2 emissions in 2035 by roughly 4.1 billion tons from 2005 levels, so CES would contribute 27 percent of the United States' pledged CO2 emissions reductions in 2035.

Figure 1. Annual CO_2 Emissions (billion tons)

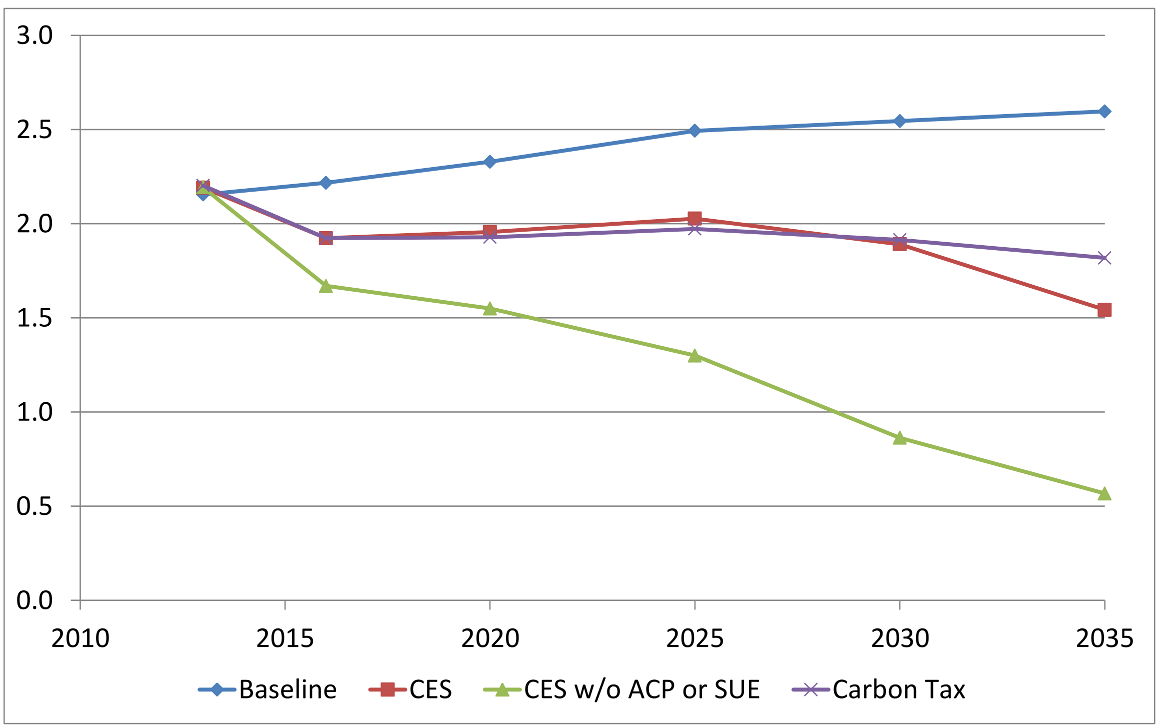


Table 1. CO_2 Emissions (billion tons)

	Annual Emissions in 2035	% Change from Baseline	Cumulative Emissions by 2035	% Change from Baseline
Baseline	2.6		55.5	
CES	1.5	–41%	44.1	–21%
CES w/o ACP	0.9	–65%	37.3	–33%
CES w/o SUE	1.4	–44%	43.3	–22%
CES w/o ACP or SUE	0.6	–78%	29.7	–46%
CES w/o Nuke/Hydro Excluded	1.6	–40%	44.2	–20%
MATS	2.6	–1%	54.9	–1%
CES w/ MATS	1.4	–45%	41.8	–25%
Low Gas Supply	2.7	3%	57.9	4%
CES w/ Low Gas Supply	1.7	–35%	48.7	–12%
Carbon Tax	1.8	–30%	44.7	–20%

The ACP provision of the bill is important because, in this deterministic analysis, it binds at all times. Expressed in 2009 dollars, the ACP starts out at $26/MWh in 2015 and rises by 5 percent per year in real dollars to $68/MWh in 2035. Without an ACP, the clean energy credit price would reach $36/MWh in 2015 and $92/MWh in 2035 (*CES w/o ACP* scenario). Indeed, the binding ACP will prevent the fraction of power supplied by clean sources in the *CES* scenario from reaching the requirements specified in the bill. The elevated credit prices in the *CES w/o ACP* would engender a greater fraction of generation from clean sources and more emissions reductions, amounting to an additional 12 percent of cumulative emissions reductions by 2035 beyond those reductions projected under the *CES* scenario.

Another important provision of the bill is the small utilities exemption (SUE), which, like the ACP, will prevent the fraction of electricity produced by clean sources from reaching the levels specified in the bill. Because of the presence of the ACP, the SUE has only a small effect on emissions, though the economic consequences are not small, as will be subsequently shown. In the absence of both ACP and SUE (*CES w/o ACP or SUE* scenario), cumulative emissions reductions of 46 percent relative to *Baseline* would be achieved, an additional 25 percent beyond the reductions projected under the bill. Without these two provisions, the policy would contribute approximately half of the United States' pledged CO_2 emissions reductions in 2035, as discussed above.

The exclusion of generation from existing nuclear and hydroelectric capacity from compliance responsibility is another aspect of the bill with evident consequences. Special treatment for these technologies is born from the fact that even though many such facilities have very low variable costs, and would therefore produce an identical amount of power under *CES* regardless of whether their production receives clean energy credit, this will not hold for all facilities. For facilities that would reduce production under *CES* without any credit, exclusion from compliance obligation will reverse this effect, keeping that clean production on line.

The CO_2 emissions consequences of the exclusion for existing nuclear and hydroelectric capacity are revealed by comparing the *CES w/o Nuke/Hydro Excluded* scenario to the *CES*. Until 2035, less than 10 TWh of annual generation by existing nuclear facilities is preserved by the exclusion provision, but 29 TWh (3 percent of total generation from existing nuclear facilities) are preserved in 2035. This change in generation would not be accompanied by a change in capacity, and 17 TWh of the generation that would be lost without the exclusion are made up by additional generation at new nuclear facilities. Since most of the existing nuclear generation that is preserved by the exclusion provision is offset by reductions in new nuclear generation, the emissions effects of the provision are small.

Natural gas price uncertainty is an important consideration in projecting the future of the electricity sector under any policy scenario. CO_2 emissions under the AEO 2009 assumptions for natural gas supply (*Low Gas Supply* scenarios) are substantially different from their AEO 2011 counterparts (*Baseline* and *CES* scenarios). The relatively high natural gas prices in the *Low Gas Supply* scenarios lead to a substitution between coal and gas that results in greater cumulative emissions under both baseline and CES conditions. However, the difference is greater under a CES policy, resulting in fewer cumulative emissions reductions from *CES* if low gas supply conditions prevail.

The existence of EPA's MATS regulation (*CES w/ MATS* scenario) would compound the CO_2 emissions reductions of CES, achieving an additional 4 percent cumulative reductions from *Baseline*. Another way to think of this is that *CES* would set up MATS to achieve 4 percent cumulative reductions as an ancillary benefit of the EPA regulation.

The *Carbon Tax* scenario has cumulative emissions by 2035 that closely match those of the *CES* scenario, but the trajectory is somewhat different, with more reductions occurring in the short run and fewer occurring later in the simulation horizon. The CO_2 tax trajectory that engenders these emissions would start at $10/ton in 2015 and reach $23/ton in 2035. Further results will speak more to the differences between *Carbon Tax* and *CES*.

Retail Electricity Prices

The retail electricity price effects of a CES will be substantial in the long run, but prices would be affected only moderately in the first decade of the policy. In the initial years of the program, the *CES* credit prices and credit requirements will be relatively low, yielding virtually no effect on electricity prices. During the same initial period, the CES policy will encourage expanded investment in and averted retirement of natural gas capacity. Coal capacity will be retired under a CES, but during this initial period the increase in natural gas capacity will exceed the decrease in coal capacity. In the *CES* scenario in the year 2020, the change relative to *Baseline* in natural gas capacity exceeds that of coal capacity, resulting in 20 GW more total capacity under *CES* than under *Baseline*. Most of this capacity expansion occurs in the regions of the country that price electricity in competitive markets, which are the regions where capacity expansion tends to drive down electricity prices because marginal costs determine prices. In these regions, the price dampening effect of capacity expansion is approximately offset by the small increase in prices that follows from the obligation to hold clean energy credits. The net effect is approximately no change in retail prices under a *CES* in competitive regions in the short run. In cost-of-service regions, where prices are governed by average (or total) costs, the small short-run increase in prices resulting from credit requirements is offset by small reductions in costs resulting from a net export of credits to competitive regions. These countervailing effects of *CES* yield approximately no short-run electricity price impacts for the nation as a whole. In the long run, the cost of the credit obligation increases as both the credit price and requirement rise, trumping all other factors affecting electricity prices. By 2035, the national average retail electricity price under *CES* would exceed that of the *Baseline* scenario by $16/MWh (18 percent).

Figure 2. National Average Electricity Prices ($/MWh)

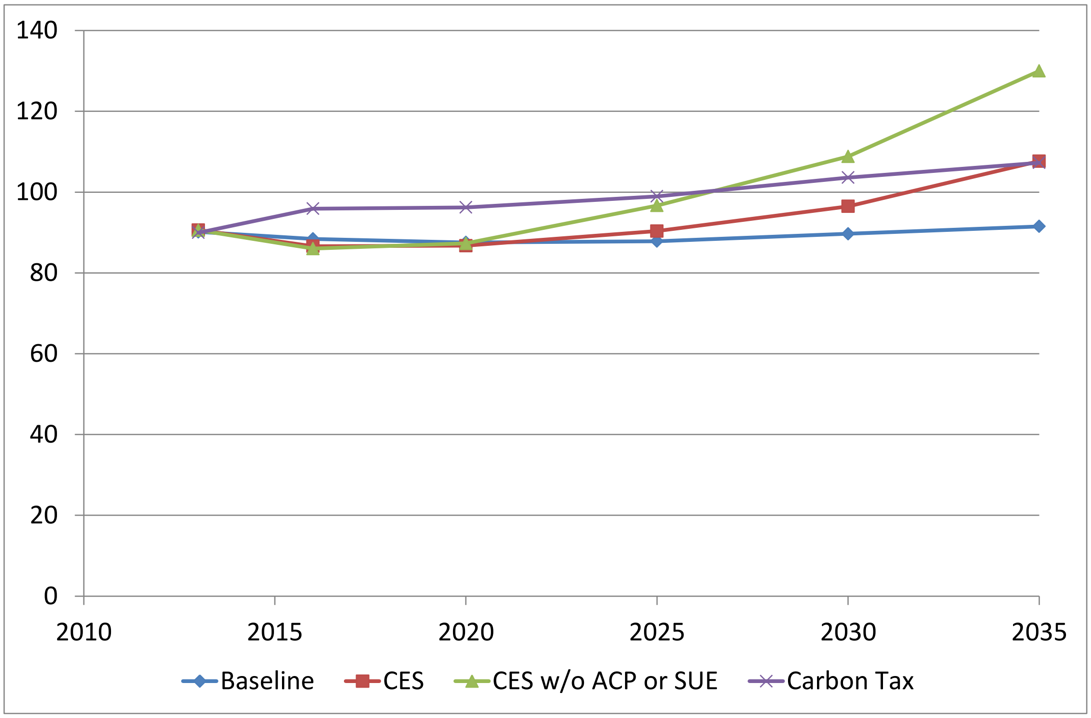


Table 2. Average Electricity Prices in 2035 ($/MWh)

	National Average	Change from Baseline	Competitive Average	Change from Baseline	Regulated Average	Change from Baseline
Baseline	92		106		85	
CES	108	16	116	9	104	19
CES w/o ACP	111	20	122	16	106	21
CES w/o SUE	115	23	120	14	112	27
CES w/o ACP or SUE	130	38	141	35	125	40
CES w/o Nuke/Hydro Excluded	103	12	100	-6	105	20
MATS	92	1	106	0	86	1
CES w/ MATS	108	17	115	9	105	20
Low Gas Supply	96	4	117	11	87	2
CES w/ Low Gas Supply	112	20	122	16	107	22
Carbon Tax	107	16	117	11	103	18

The ACP and SUE provisions of the bill both serve to dampen any electricity price increases resulting from CES. If both provisions were struck from the policy (*CES w/o ACP or SUE* scenario), national average prices would reach $130/MWh by 2035, or 42 percent above *Baseline*, which is 24 percentage points higher than the 18 percent effect of *CES*. Especially effective in reducing average price impacts is the SUE, which causes prices to be only 18 percent above *Baseline* in 2035, as opposed to 25 percent above *Baseline* without the SUE. Without the ACP, prices increase by only an additional 4 percent above *CES* for a total price effect of 22 percent over *Baseline*.

The benefits to consumers of a reduced electricity price due to the SUE accrue exclusively to those consumers who buy electricity from utilities that qualify for the SUE. Based on the 2009 distribution of utility sizes, we determined the fraction of regional consumption that would be exempted under each level of the threshold. By 2025 and thereafter, the SUE is projected to exempt 12.5 percent of national electricity consumption under *CES* from any compliance obligation. This means that the benefits of the $7/MWh difference in national average prices in 2035 between *CES* and *CES w/o SUE* is concentrated in the hands of the consumers of only 12.5 percent of total sales. With the SUE under the *CES* scenario, consumers served by the exempted utilities pay an average retail electricity price of only $52/MWh in 2035 (assuming these utilities have the regional average mix of generating technologies), while the remaining consumers pay an average price of $116/MWh. Regional differences cause an even greater discrepancy between retail prices across the country. For example, consumers of exempted utilities in the Northwest pay only $12/MWh in 2035, but consumers on Long Island, where the SUE exempts no consumers, pay $175/MWh. Under the *CES w/o SUE* scenario, however, consumers served by utilities that would have been exempted by the SUE face an average retail price of $109/MWh, and all other consumers still pay an average of $116/MWh. In other words, the SUE allows consumers of 12.5 percent of total sales to enjoy an average retail electricity price reduction of $57/MWh, while consumers of the remaining 87.5 percent see no benefit at all. This price difference, applied to the 12.5 percent of 4,085 TWh of national consumption in 2035 under *CES* that are exempted by the SUE, amounts to an electricity expenditure savings of $29 billion.

If there were no ACP, the SUE would reduce the consumption basis for the CES, which would in turn reduce the total amount of clean energy required by the policy, the credit price, and electricity prices for all consumers. However, for both of these scenarios, the ACP is binding, so clean energy generation is unchanged. Instead, the effect of the SUE is to reduce the ACP revenues received by state governments for end-use energy efficiency programs. In the absence of a rationale for an SUE provision on efficiency grounds, it is unclear why the substantial redistribution of wealth embodied in the SUE is desirable for other than political reasons.

The exclusion for existing nuclear and hydroelectric generators is effectively innocuous for the regions of the country that price electricity by cost-of-service regulation. In the competitive-pricing parts of the country, the exclusion amounts to a wealth transfer from consumers to the owners of existing nuclear and hydroelectric generators. In some states, like New York, where some hydroelectric capacity is publicly owned, the ratepayers presumably will recapture part of the wealth transfer, but that does not occur in these model results. In other cases, especially with respect to nuclear capacity, the transfer will remain with utility shareholders.

The scenarios covering alternative assumptions about gas supply and the existence of MATS yield little of interest in terms of electricity price effects. Less supply of natural gas tends to raise prices and tends to do so at a rate that is largely independent of the presence of *CES*. MATS tends to raise prices, though by only a small percentage, and this effect is also largely independent of the presence of *CES*.

The *Carbon Tax* scenario reveals an electricity price trajectory that is uniformly greater than the prices under *CES* until 2035. These higher prices have the potential to facilitate cost-effective CO_2 emissions reductions, since they account for the social cost of emissions, but ultimately cost-effectiveness hinges on the allocation of tax revenues. Further analysis of this issue is beyond the scope of this paper.[7]

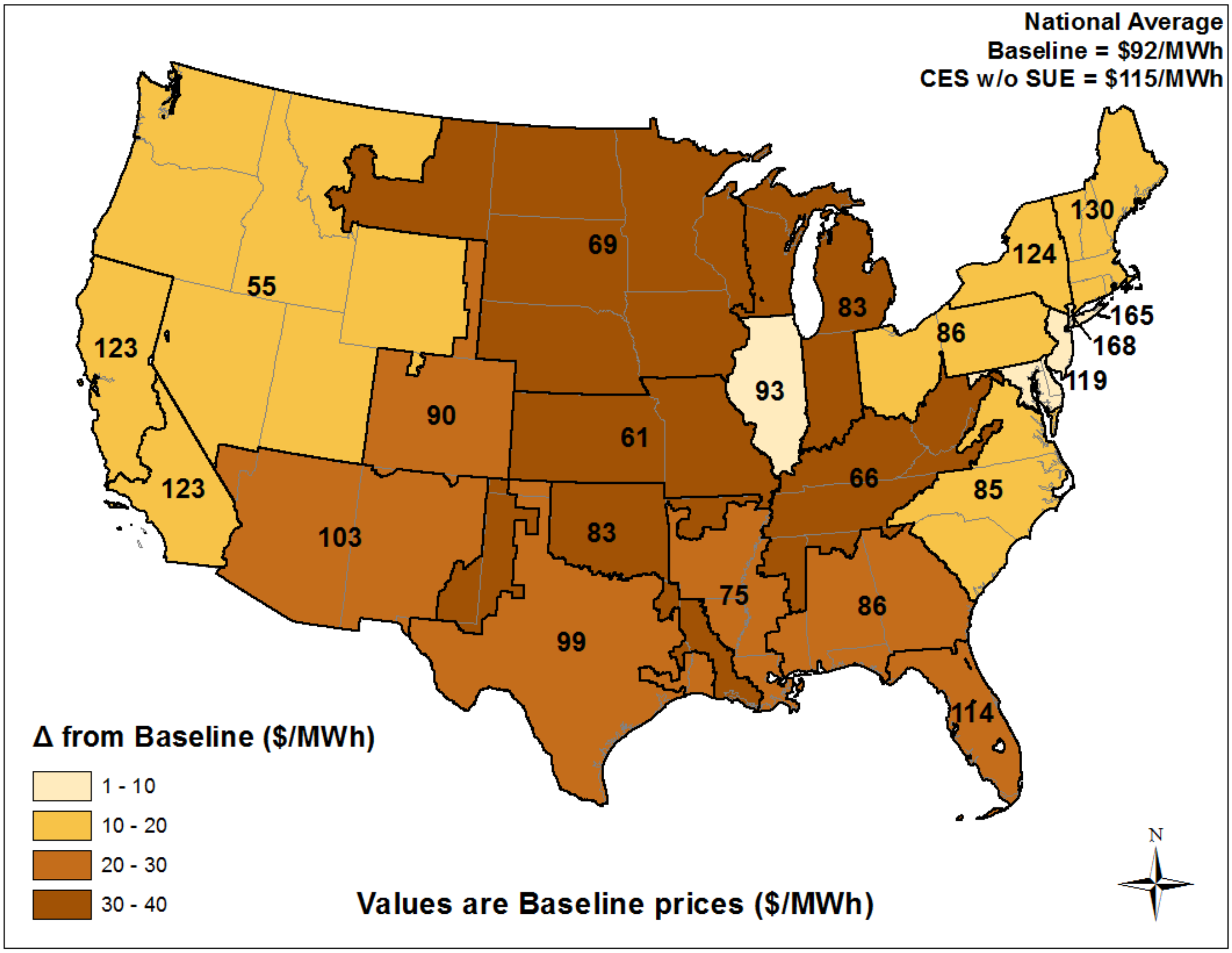
In the case of a CES policy, an analysis of national average prices alone is insufficient because the national averages obscure substantial regional variation in the effects. This variation is brought about by the aforementioned regulatory regimes for electricity pricing (market-based versus cost-of-service), the composition of the existing generation fleet, and the size of local utilities with respect to the threshold for the small utility exemption.

Figure 3 displays the regional price effects of the *CES w/o SUE* scenario in 2035, which allows for an examination of the price effect of the CES due to regulatory structure and the regional variation of the existing generation fleet without the regional effects of the SUE. The value label in each region shows the average retail electricity price in the *Baseline* scenario, and the color of each region represents the regional price effect of *CES w/o SUE*. In general, the

[7] Parry and Williams (2011) discuss the efficiency implications of the use of carbon tax revenues.

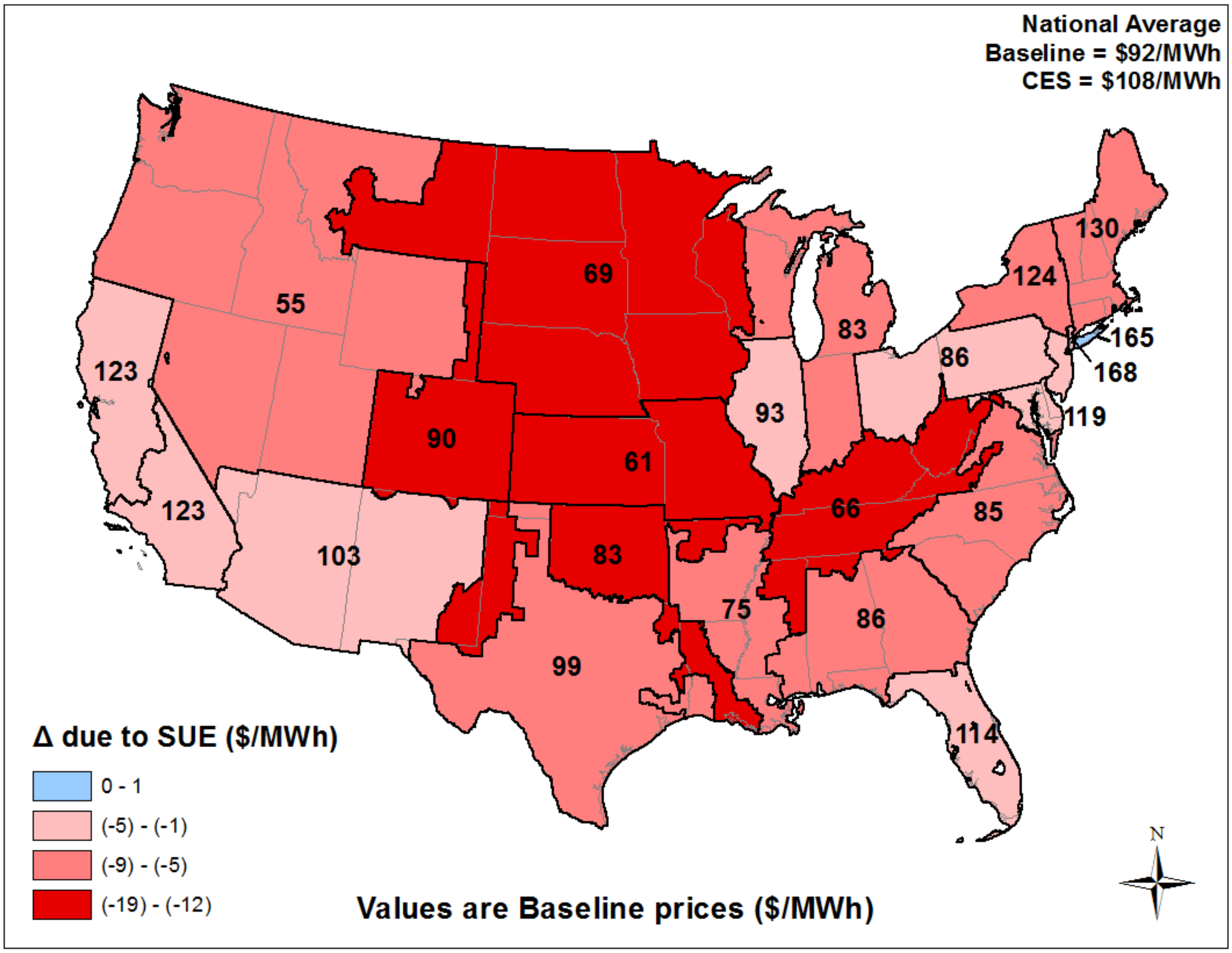
regions that would otherwise enjoy the lowest-priced electricity will endure the largest price increases under the bill, with the Pacific Northwest a notable exception. However, the regional variation in the baseline is big enough that these low-price regions that endure the largest price increases would still tend to pay among the lowest prices in the country, generally still below the national average. The regions that have the highest *Baseline* prices would tend to see small price increases, and still pay prices above the national average. Overall, *CES w/o SUE* would tend to reduce the regional variation in electricity prices that would otherwise exist under *Baseline*.

Figure 3. Regional Retail Electricity Price Effects of *CES w/o SUE* in 2035 ($/MWh)



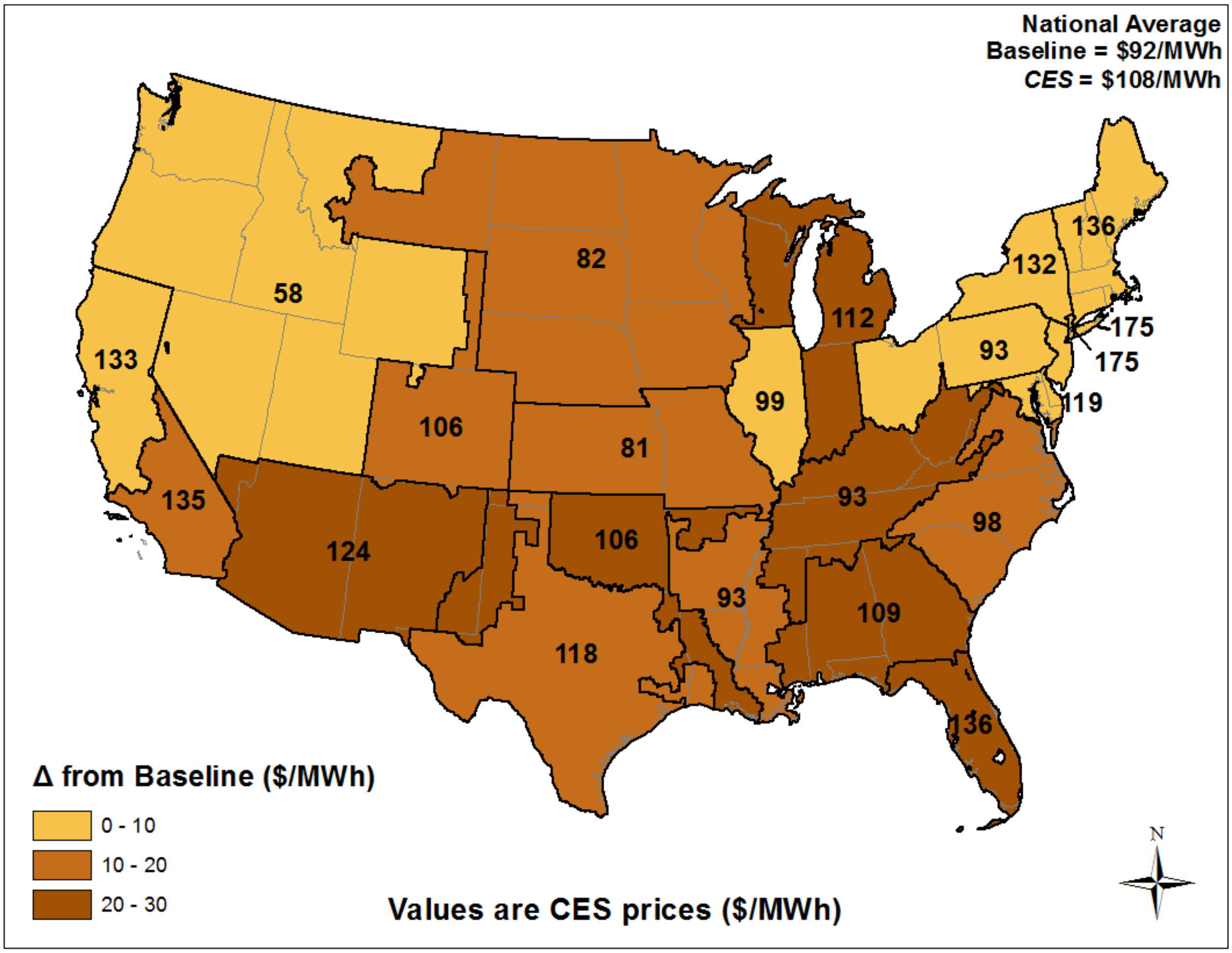
Since the country is heterogeneous in the size of local utilities, the regional impact of the SUE is also heterogeneous. Figure 4 shows the price impacts of the SUE in 2035. The color and labeling scheme for this figure is unlike that of the last. Here, the color intensity indicates the price effect of the SUE relative to *CES*, with red indicating a price decrease due to the SUE and blue indicating a price increase, and the value labels within each region are the projected *Baseline* prices. In general, the SUE provision of the CES tends to increase regional variation in retail electricity prices under CES. Most of the regions that have the lowest electricity prices in *Baseline*, including the Northwest, Plains, and Appalachia, would experience moderate to large price decreases due to the SUE. On the other hand, most of the regions that have the highest prices in *Baseline*, including California, the Northeast, and Florida, would experience small to moderate price decreases.

Figure 4. Regional Retail Electricity Price Effects of the SUE in 2035 ($/MWh)



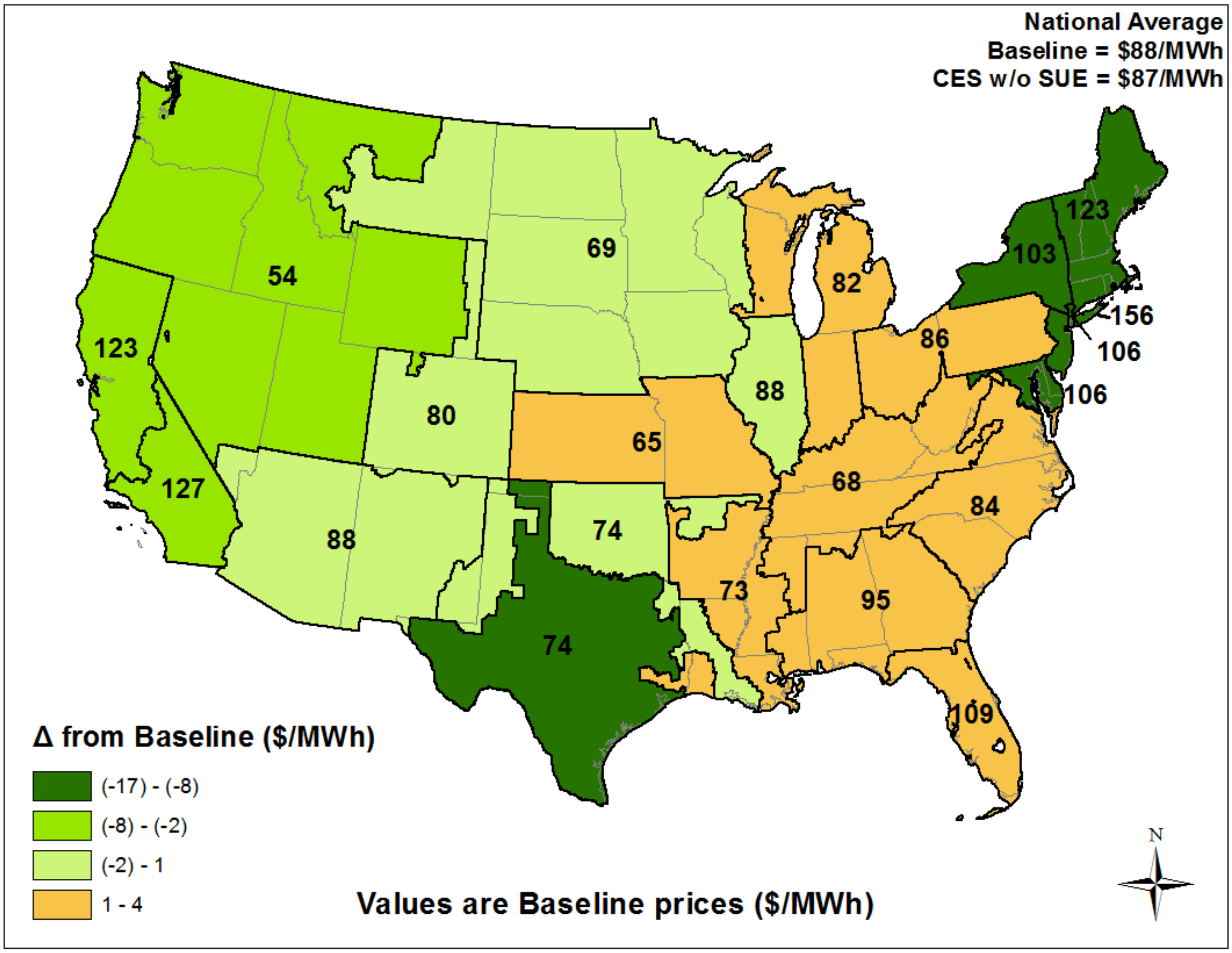
The net price impact of *CES* in 2035, due to the combination of these regional effects, is shown in Figure 5. Much of the leveling effects of the non-SUE regional differences (seen in Figure 3) are undone by the inclusion of the SUE provision (seen in Figure 4). The result is that the regions with a relatively clean mix of generators or a relatively high proportion of small utilities would experience a relatively small average retail price increase due to the *CES*, while most of the rest of the country would experience larger increases.

Figure 5. Regional Retail Electricity Price Effects of *CES* in 2035 ($/MWh)



In 2020, the national average effect of *CES* on electricity prices would be effectively zero, but this obscures some regional variation. Figure 6 shows these regional results, revealing that the regions of the country that rely most on coal-fired generation stand to experience small retail price increases, while the Northeast and Texas stand to pay substantially less for electricity with *CES* than without it.

Figure 6. Regional Retail Electricity Price Effects of *CES* in 2020 ($/MWh)



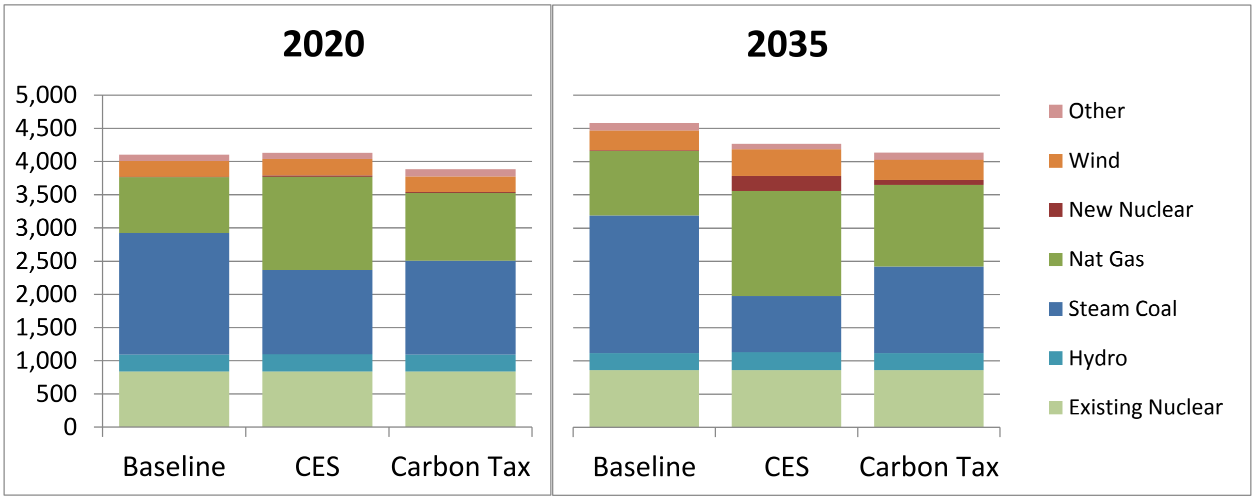
Electricity Supply: Generation Mix, Industry Profits, Market Size

The proposed CES legislation would drastically alter the composition of electricity supply in the long run, with a huge decline in coal-fired generation being the most pronounced effect, as shown in the right-hand panel of Figure 7. The roughly 1,200 TWh decline in coal generation would be offset partially by about a 330 TWh decline in consumption.[8] Offsetting the remainder of the lost coal generation would be a variety of new generation sources. Large growth in natural gas generation (about 600 TWh) would be accompanied by more moderate growth in wind and nuclear generation (about 100 and 140 TWh, respectively). In the short run by 2020, the CES will affect a swap of generation from coal to natural gas of almost 600 TWh.

[8] To be precise, generation declines by 360 TWh because of a smaller decline in consumption. The difference is due to losses in transmission and distribution.

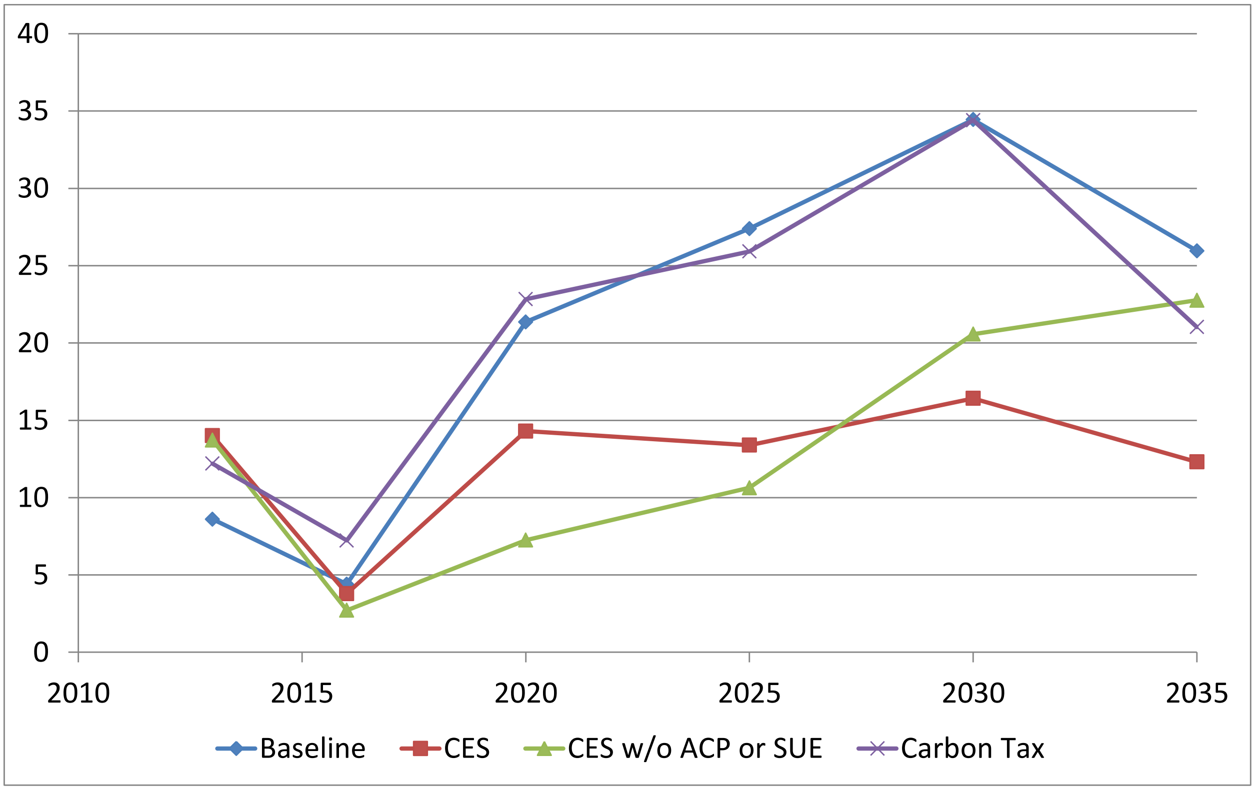
The *Carbon Tax* scenario achieving the same cumulative CO_2 emissions as the *CES* scenario by 2035 would yield a substantially different configuration of the electricity generation fleet than *CES*. The 59 percent decline in coal generation under *CES* would be reduced to 37 percent under *Carbon Tax*. Higher electricity prices under *Carbon Tax* through 2030 than under *CES* would engender slightly lower demand in 2035. These two factors reduce the demand for new sources of generation, with the reduction in new source growth shared among natural gas, wind, and nuclear generation.

Figure 7. National Generation Mix (TWh)



CES would lead to lower utility profits, as shown in Figure 8, amounting to almost $90 billion in net present value (NPV) terms through 2035. These losses would be borne by utilities selling power into the competitive electricity markets (profits for cost-of-service regulated utilities are zero by construction), but these utilities would remain profitable, accumulating about $140 billion by 2035 in discounted terms. In combination, the ACP and SUE provisions of the bill have little effect on industry profits in discounted terms, with profits about $10 billion greater in NPV under *CES* than they would be without ACP and SUE. This near equivalence in NPV profits is manifest in greater short-run profits under the bill than without ACP and SUE, but fewer profits in the most distant years. A *Carbon Tax* would lead to a small positive effect on industry profits of about $10 billion in NPV terms. This increase results from higher production costs and reduced sales under *Carbon Tax* being offset by higher electricity prices. Indeed, the growth in revenue would much more than offset growth in costs, with the difference being carbon tax revenue collected by the government on top of the $10 billion retained by producers. In the *Carbon Tax* scenario, there are about $300 billion of discounted carbon tax revenues through 2035.

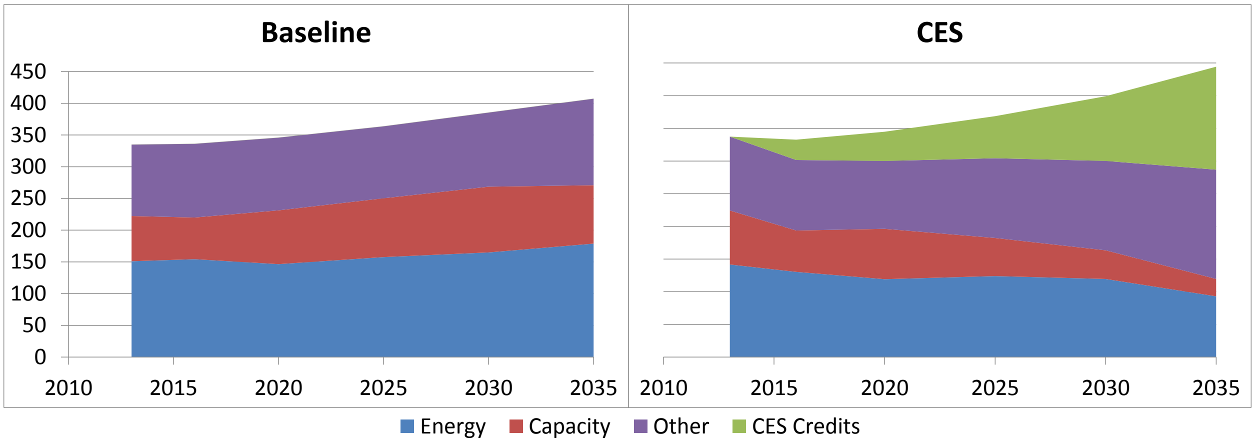
Figure 8. National Electricity Sector Producer Surplus (billion $)



A potentially important aspect of *CES* is that it will transform the composition of the revenue stream received by electricity producers. The change in retail electricity prices under *CES* will be much smaller than, and in the opposite direction from, the change in wholesale prices. Over time *CES* will substantially depress wholesale prices, with the lost revenues to generators in electricity markets being replaced by revenues in clean energy credit markets. Figure 9 shows the components of utility revenue streams under *Baseline* and *CES*.[9] The top portion of the *CES* panel shows revenues from credit sales to electricity retailers and the other portions (blue, red, and purple) show revenues from electricity sales. NPV of electricity sales declines by about $700 billion through 2035 under CES, replaced by about $780 billion of revenues from clean energy credits, with total NPV revenues rising by 1.5 percent. In 2035, 36 percent of industry revenues would come from credit sales.

[9] The “Other” category includes transmission and distribution, taxes, and a calibrator. For cost-of-service regions, the distinction between energy and capacity revenues is a modeling artifact of the ratio between the marginal value of generation and capacity.

Figure 9. Components of Electric Utility Revenue (billion $)



This transformation of the revenue stream for generators means that a growing portion of volatility in electricity prices, which matters to both consumers and electricity sector investors, will come to depend not just on the factors that have historically driven electricity prices, but now also on credit price stability. Considering the relative lack of volatility in historical electricity prices, the threshold for credit price volatility to lead to greater electricity price volatility under CES is not high. Considering the size of the credit market, electricity prices could be highly vulnerable to credit price volatility, though credit price volatility would be partly offset by responsive wholesale electricity prices. The implications of this transformation of the revenue stream under a CES are a ripe topic for further research. A carbon tax would bring about no such transformation in revenue streams.

Conclusion

US federal legislators have not been willing to impose direct limits on emissions of CO2, so those who wish to promote cleaner energy are focusing on alternative approaches. A clean energy standard is a flexible approach to encouraging a transition to a cleaner technology mix for electricity production that has grabbed the attention of energy policy makers and policy watchers. If enacted as written, the most recent federal proposal from Senator Bingaman would transform the way electricity is produced and result in substantial reductions in CO2 emissions and increases in electricity prices after 2025. Price effects in the short-run would be small and potentially negative in some regions. Although the future of this policy is highly uncertain, its effects on electricity consumers and producers in different parts of the country will depend importantly on a few key features of the policy.

One such provision is the alternative compliance payment (ACP), which caps the price of clean energy credits at a level that grows over time. This analysis suggests that the ACP will be binding, which implies that the policy will fall short of its stated goals for clean energy generation, achieving 12 percent fewer cumulative reductions of CO_2 emissions by 2035 than it would in the absence of the ACP. The ACP does help mitigate retail electricity price increases.

Another important provision is the small utility exemption, which exempts utilities with fewer than 2 million MWh of sales initially, and utilities with under 1 million MWh of sales ultimately, from having to comply with the standard. From 2025, the small utility exemption affects roughly 12.5 percent of the electricity sold in the contiguous United States. This provision has a much larger effect on national average retail electricity price than the ACP and in total amounts to an electricity expenditure savings of roughly $29 billion in 2035. Because the ACP is binding, the small utility exemption reduces the amount of ACP revenues that state governments receive for energy efficiency programs. The effect of the exemption on electricity prices also varies substantially across regions of the country, with the consumers of 12.5 percent of national electricity demand collecting the entire value of the exemption.

The exclusion of power generated by existing nuclear and hydroelectric facilities from CES compliance responsibility is a third important provision of the bill. There is almost no effect on emissions from the exclusion, but there is an important wealth transfer from consumers in competitive-pricing parts of the country to the owners of existing nuclear and hydroelectric generators that sell power to those consumers. The average electricity price effect of the exclusion in competitive regions would be $16/MWh in 2035.

Over time, the CES policy will change the way the electric utility industry raises revenue. As the standard gets higher and the ACP increases, the market price of credits rises and generators find themselves getting an increasingly larger share of their revenues from the sale of credits as opposed to electricity per se. By 2035, 36 percent of revenues would be from credit sales. This transformation means that the performance of credit markets will have important implications for the prices that consumers pay for electricity in the future under such a policy.

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