Projected Greenhouse Gas Emissions Reductions from the Power Sector under the Clean Energy Standard Act of 2012, S. 2146

As Introduced by Senator Bingaman on March 1, 2012

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This analysis provides an assessment of the projected power sector greenhouse gas (GHG) emissions reductions from S. 2146, the Clean Energy Standard Act of 2012 (CESA), introduced by Senator Bingaman and eight cosponsors on March 1, 2012.[i] CESA establishes a standard for clean energy generation in the United States through 2035.[ii] In 2035 covered utilities must supply 84 percent of their total annual sales of electricity from clean sources. CESA defines "clean" on the basis of a generator's greenhouse gas emissions intensity, and thus can drive significant reductions in emissions.

Findings

- **CESA can reduce GHG emissions from the power sector approximately 12-18 percent (295-428 million metric tons CO_2e) below 2005 levels in 2020 and 49-56 percent (1,194-1,357 mmtCO_2e) below 2005 levels in 2035**, assuming that affected utilities meet their obligations under the program by generating electricity from clean sources or purchasing credits from other clean sources (see Figure 1).[iii] The figure also compares the projected reductions from CESA to the power sector reductions that were predicted to occur under the American Clean Energy Security Act[iv] (ACESA, or Waxman-Markey), which is the only comprehensive climate bill to pass either house of Congress and would have reduced total U.S. GHG emissions (i.e., economy-wide) 17 percent below 2005 levels in 2020.[v]

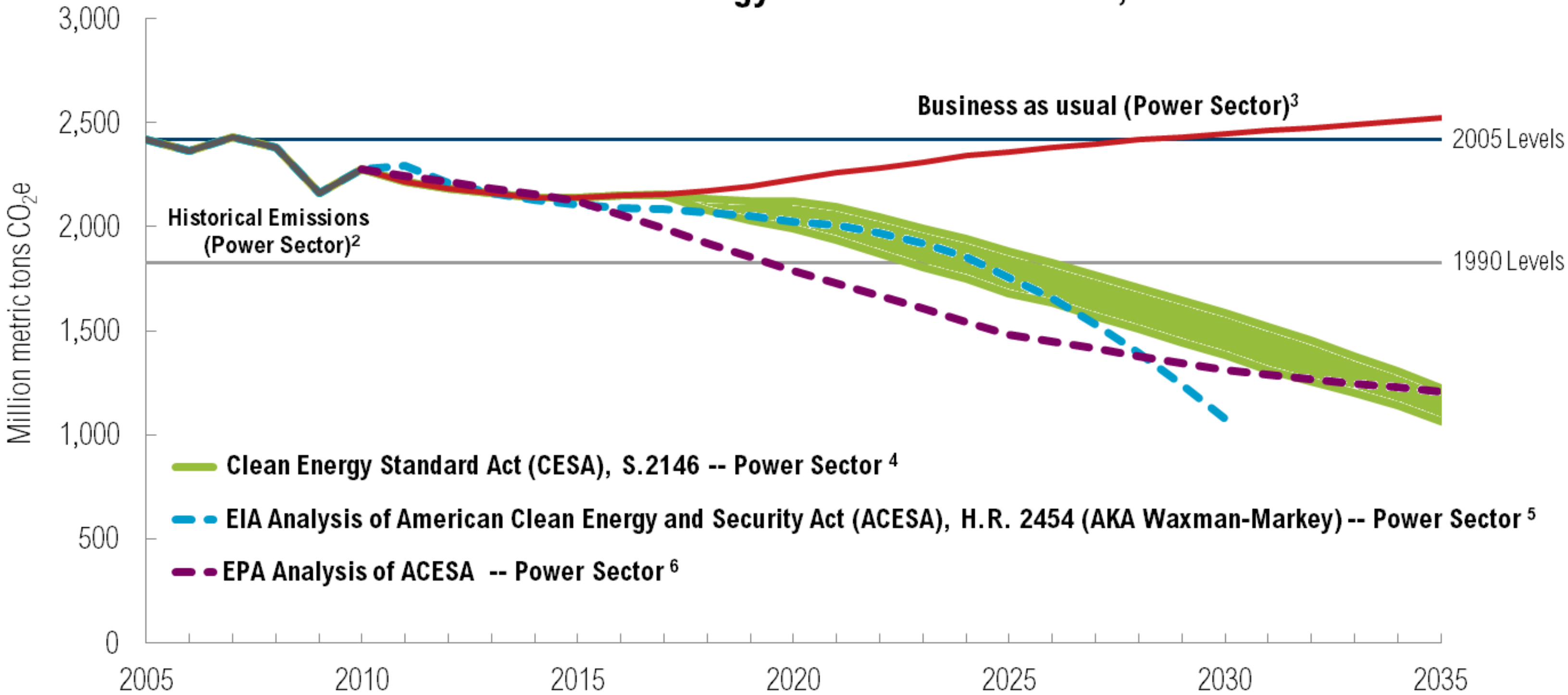
- **The GHG reductions from CESA are significant, but not sufficient to reduce U.S. economy-wide GHG emissions 17 percent below 2005 levels in 2020 without ambitious greenhouse gas abatement measures from other sectors** (see Figure 2).[vi]

The alternative compliance payment (ACP) provisions in the bill were not included in this analysis. While use of this provision would allow affected utilities to produce or purchase less electricity from cleaner sources, the majority of funds provided through the ACP would be distributed to state energy efficiency programs. Depending on the cost and effectiveness of those programs, the resulting reduction in electricity demand could result in GHG emission reductions similar to, or in some cases exceeding, those achieved through direct compliance with CESA.

See page six for a discussion of how these results compare to those released on May 2, 2012 by the U.S. Energy Information Administration (EIA).

Figure 1.

Estimates of Greenhouse Gas Emissions from the Power Sector under the Clean Energy Standard Act of 2012, S.2146[1]



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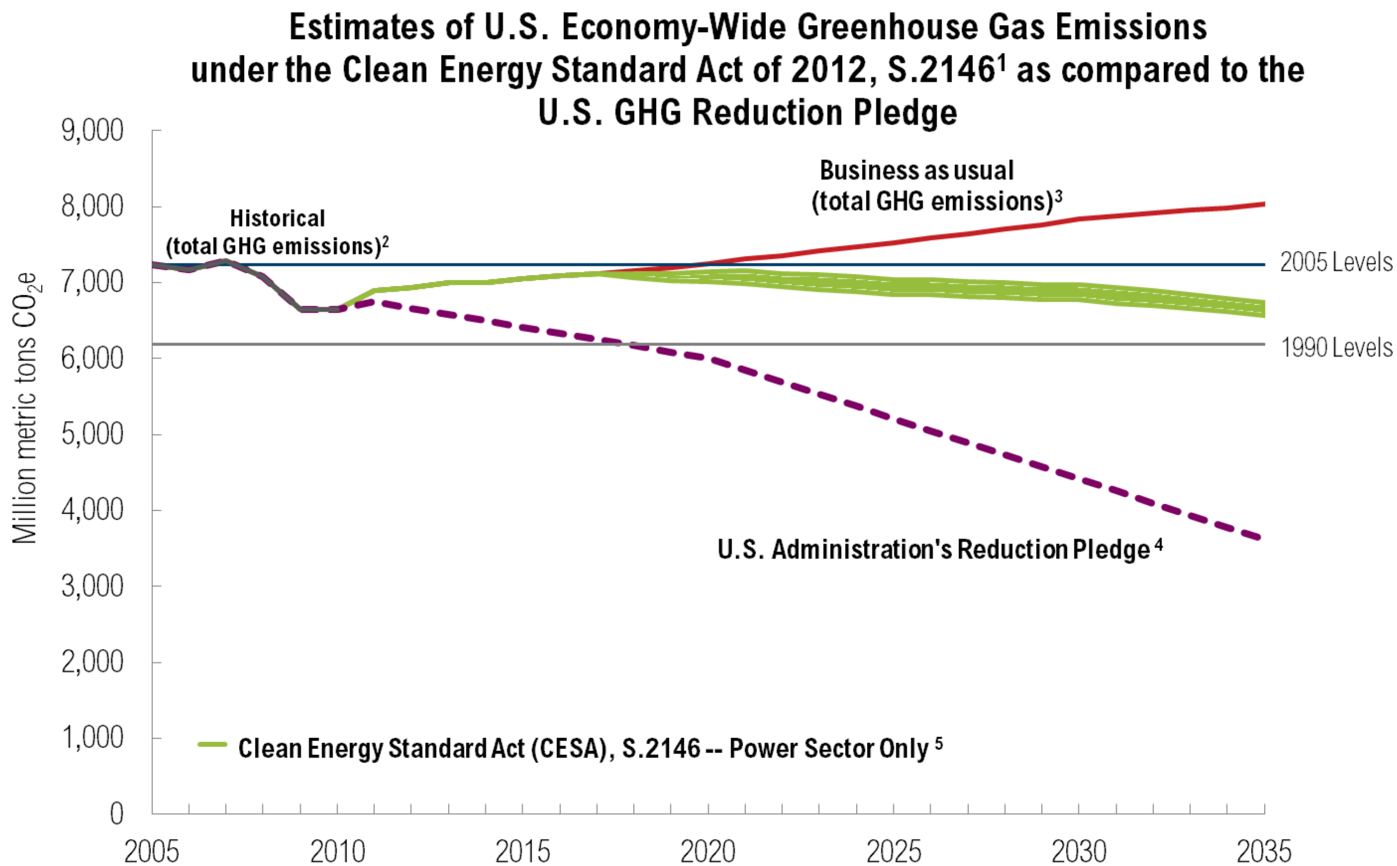
[1] Most proposals in the 111th Congress were economy-wide in scale. CESA covers the power sector only.
[2] Historical emissions (2005-2010) are from EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2010.
[3] "Business as usual" emission projections are from EIA's 2011 Annual Energy Outlook Reference Case Scenario.
[4] Projections of GHG emissions under S. 2146 represent a range of emissions reductions that can be expected, assuming that the alternative compliance payment is unused. 75% of ACP payments and civil penalties will be distributed to states to implement energy efficiency programs. Energy savings from these programs will lower the baseline of total electricity sales, making the CESA target more achievable in subsequent compliance periods
[5] Represents EIA's Basic Case of "Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009" from 2011-2030. EIA's modeling relied on an older version of the Annual Energy Outlook which only projected out through 2030. The emissions path is directional and provided for illustrative purposes. Only GHG emissions occuring in the power sector due to the ACESA are included in the chart above.
[6] Represent's EPA's Adage modeling run of H.R. 2454, the American Clean Energy and Security Act of 2009

Figure 2.



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[1] Most proposals in the 111th Congress were economy-wide in scale. CESA covers the power sector only.

[2] Historical emissions (2005-2010) are from EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2010.

[3] "Business as usual" GHG emission projections represent a combination of energy CO_2 emissions projections from EIA's 2011 Annual Energy Outlook Reference Case Scenario and non-energy CO_2 and non-CO_2 emissions projections from the reference case from EPA's Analysis of H.R. 2454 in the 111th Congress, the American Clean Energy and Security Act of 2009. Note, the projection of non-CO_2 emissions from natural gas systems does not take into account the recent update to methodologies and data sources associated with this emission source. These updates are taken into account in the historical GHG emission estimates. Refer to Section 10.1 http://epa.gov/climatechange/emissions/downloads11/US-GHG-Inventory-2011-Complete_Report.pdf

[4] Projections of GHG emissions under S. 2146 represent a range of emissions reductions that can be expected in the power sector, assuming that the alternative compliance payment is unused. 75% of ACP payments and civil penalties will be distributed to states to implement energy efficiency programs. Energy savings from these programs will lower the baseline of total electricity sales, making the CESA target more achievable in subsequent compliance periods

[5] The U.S. Administration's Reduction Pledge commits the United States to reducing GHG emission 17 percent below 2005 levels in 2020 and notes that post 2020 emissions reductions will follow a pathway consistent with 83% reductions from 2005 levels in 2050.

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Table 1. Estimates of Power Sector Greenhouse Gas Emissions Under the Clean Energy Standard Act (CESA), S. 2146

Absolute Emissions (mmtCO_2e)				
Year	**2020**	**2025**	**2030**	**2035**
Business-as-usual	2,225	2,360	2,444	2,526
CESA *	1,990 to 2,123	1,681 to 1,879	1,382 to 1,584	1,061to 1,225
EIA's Projected Power Sector Emissions Under ACESA (AKA Waxman-Markey)**	2,026	1,757	1,074	-
EPA's Projected Power Sector Emissions Under ACESA (AKA Waxman-Markey)**	1,788	1,483	1,309	1,206
Percent change from 2005				
Business-as-usual	-8%	-2%	1%	4%
CESA*	-12% to -18%	-22% to -30%	-35% to -43%	-49% to -56%
EIA's Projected Power Sector Emissions Under ACESA (AKA Waxman-Markey)**	-16%	-27%	-56%	N.A.
EPA's Projected Power Sector Emissions Under ACESA (AKA Waxman-Markey)**	-26%	-39%	-46%	-50%
Percent change from 1990				
Business-as-usual	22%	29%	34%	38%
CESA*	9% to 16%	3% to -8%	-13% to -24%	-33% to -42%
EIA's Projected Power Sector Emissions Under ACESA (AKA Waxman-Markey)**	11%	-4%	-41%	N.A.
EPA's Projected Power Sector Emissions Under ACESA (AKA Waxman-Markey)**	-2%	-19%	-28%	-34%

*See Appendix B for details on calculating the upper and lower range of GHG emissions reductions achievable under CESA.
**EPA's and EIA's modeling for Waxman-Markey relied on an older version of the Annual Energy Outlook, which only projected emissions through 2030. While both analyses were conducted using an older Reference Case, they can provide a useful reference point when attempting to evaluate the ambition of policies for the power sector.

Table 2. Estimates of U.S. Economy-Wide Greenhouse Gas Emissions Under the Clean Energy Standard Act (CESA), S. 2146

Absolute Emissions (mmtCO_2e)				
Year	**2020**	**2025**	**2030**	**2035**
Business-as-usual	7,251	7,527	7,836	8,035
CESA, Power Sector Only*	7,017 to 7,150	6,848 to 7,046	6,774 to 6,976	6,570 to 6,734
U.S. Administration's Reduction Pledge	6,008	5,212	4,415	3,619
Percent change from 2005				
Business-as-usual	0%	4%	8%	11%
CESA, Power Sector Only*	-1 to -3%	-3 to -5%	-4 to -6%	-7 to -9%
U.S. Administration's Reduction Pledge	-17%	-28%	-39%	-50%
Percent change from 1990				
Business-as-usual	17%	22%	27%	30%
CESA, Power Sector Only*	13% to 16%	11% to 14%	9% to 13%	6% to 9%
U.S. Administration's Reduction Pledge	-3%	-16%	-29%	-42%

*See Appendix B for details on calculating the upper and lower range of GHG emissions reductions achievable in the power sector under CESA.

Methods & Limitations

Greenhouse gas emissions reductions associated with the Clean Energy Standard Act (CESA) were estimated using an Excel-based model that used publicly available data. This is not an economic analysis; instead we developed two scenarios intended to capture the range of reductions that might be achieved if reductions were obtained entirely through purchases of clean energy. We used the 2011 Annual Energy Outlook as the starting point for this analysis.

We assume that electric demand remains unchanged from the baseline projections in the 2011 Annual Energy Outlook, and so the new clean generation that comes online to meet CESA displaces generation that would have come from other, non-credited sources. Both scenarios assume that first step toward compliance for the power sector is to avoid building new, unplanned[vii] coal units that do not qualify for clean energy credits under CESA, and the second step is to retire existing plants. In the first (high emissions reduction) scenario, the first units retired were coal units with the highest emissions rates. In the second (low emissions reduction) scenario, the first units retired were those that do not qualify for credits that have the lowest CO_2 emission rate. We assumed that all units that were shut down were replaced with 100 percent greenhouse gas-free power. Alternatively, the power sector could build more natural gas combined cycle units or other low-carbon emitting generation, but that scenario would require shutting down additional coal-fired units in order to meet the emission targets in the bill. The GHG benefit should be the same in both scenarios because crediting is based on actual CO_2 emissions intensity.[viii]

Key Modeling Assumptions and Considerations:

1. Electricity demand does not change as a result of compliance costs associated with CESA. If demand decreases in response to higher electricity rates, then GHG emissions from the power sector will decrease further.
2. Electricity sales by utility for 2010 are indicative of utility sales in subsequent years, and thus projections of the total sales covered by CESA do not change due to utilities reducing sales or dividing their operations in order to fall below the applicability threshold.
3. The EIA 2011 Annual Energy Outlook Reference Case provides a reasonable estimate of electric generation by energy source in the absence of a Clean Energy Standard.[ix]
4. Utilities comply with CESA by generating electricity from clean sources or purchasing credits from clean generators and not by paying a fee, known as an alternative compliance payment.
5. Due to the banking provisions, annual emissions may be higher or lower than the projections in any given year.

In this analysis, we did not model the effect of utilities opting to meet their obligations by making alternative compliance payments instead of producing more electricity from cleaner sources. CESA requires that seventy-five percent of ACP payments be distributed to states to implement energy efficiency programs. Energy savings from these programs will reduce CO_2 emissions by reducing demand for electricity from CO_2 emitting generation sources. How those emission reductions compare to those from purchasing cleaner energy is difficult to predict. In inflation adjusted dollars, the level of the ACP (in dollars per MWh) is higher than ACEEE's current estimated average cost of energy savings starting in 2018. This means that in some instances utilization of the ACP could drive greater reductions in electricity demand and thus GHG emissions than are achieved through purchases of clean energy to comply with CESA.[x] However, this is unlikely to be the case across the board. Some state energy efficiency programs are already more expensive than ACEEE's estimated average cost of energy savings[xi] and heavy investment in energy efficiency could cause the cost of additional energy efficiency investments to increase as the projects with the greatest return on investment are completed first.[xii]

EIA recently published the Annual Energy Outlook 2012 Early Release. However, we used the AEO 2011 because our analysis required detailed outputs for coal, oil, and natural gas units, which are not yet available for the 2012 Early Release. The AEO 2012 Early Release predicts that CO_2 emissions from the power sector will be 6 percent lower in 2035 under business as usual conditions than is predicted by the AEO 2011. This is driven by lower electric demand (2 percent below the AEO 2011 projections for 2035), lower coal generation, and increased generation using natural gas, nuclear, and renewable resources. This means that fewer additional clean resources are needed to meet the CESA requirements. If electricity demand does fall below the projections found in the AEO 2011, then GHG emissions would also be predicted to fall lower than what was projected in our analysis.

On May 2, 2012, EIA published modeling results on the effects of CESA as requested by Senator Bingaman.[xiii] EIA's results are within the range of our projections. EIA predicts lower GHG emissions from the power sector through 2021, and greater GHG emissions in 2030 and from 2032 through 2035. Some of the reasons for this disparity are:

- EIA predicts greater GHG reductions at the start of the program, resulting in over-compliance with the standard. This leads to banked credits, which allow for fewer reductions in later years. The higher reductions in the early years largely result from a rapid ramp-up in natural gas generation.
- EIA uses an updated Reference Case, building off the AEO 2012 Early Release reference case, while ours builds off the AEO 2011 reference case due to our model's reliance on detailed outputs not yet publicly available for the Early Release.
- EIA predicts that some affected utilities will take advantage of the Alternative Compliance Payment beginning in 2031. For modeling purposes they assume that those payments do not result in electricity savings and thus GHG emissions reductions.

APPENDIX

Appendix A. Summary of Key Design Features of CESA[xiv]

- Beginning in 2015, each utility covered under CESA must obtain a certain percentage of electricity from "clean" sources (see table in Appendix B). That obligation increases each year, so that in 2035 covered utilities must supply 84 percent of their total annual sales (in MWh) of electricity from clean sources.
- Covered utilities can generate electricity from clean sources to meet the electricity demands of their consumers, or they can purchase tradable credits from other clean sources through an established trading program.
- Credits are awarded in proportion to the carbon intensity of the net electricity produced.[xv] Facilities producing electricity without producing greenhouse gas (GHG) emissions receive full credit per MWh of electricity generated. Facilities producing electricity with some GHG emissions (e.g., natural gas-fired power plants or coal plants equipped with carbon capture and storage) are credited based on how much lower their carbon intensity is than 0.82 metric tons of CO_2e / MWh, which was chosen to reflect the carbon intensity of a new supercritical coal facility.
- The level of crediting to low-emitting units is affected by when the unit is built. All generation built after the enactment of CESA is eligible for credits as long as its carbon intensity is lower than 0.82 metric tons of CO_2e / MWh, including qualified combined heat and power.
- Some types of units can receive credit for units placed in service after December 31, 1991, including:
    - Renewable energy, including: solar, wind, ocean, current, wave, tidal, geothermal, hydropower, and qualified renewable biomass;[xvi,xvii]
    - natural gas, including coal mine methane;
    - nuclear power; and
    - qualified waste-to-energy facilities.[xviii]
- Electricity from hydropower and nuclear power facilities placed into service in the United States before 1992 is deducted from the total sum of the utility's annual electricity sales, reducing the utility's clean energy obligation.
- Additional generation at nuclear and hydro plants built before 1992 is considered clean if it is the direct result of efficiency improvements and capacity additions that take place after December 31, 1991.
- In 2015 the standard applies to all utilities that have at least 2,000,000 MWh of sales. The applicability threshold declines by 100,000 MWh per year for the next ten years, so that in 2025 the standard applies to all utilities that have at least 1,000,000 MWh of electricity sales. The threshold remains at 1,000,000 MWh of electricity sales in 2026 and every year thereafter. The determination of whether a utility meets the threshold is made annually based on the previous year's sales data.
- The Clean Energy Standard Act does not apply to electric utilities located in Alaska or Hawaii.
- Covered utilities that do not generate electricity from clean sources or purchase credits from other clean sources may also comply by paying a fee, known as an alternative compliance payment. That payment starts at 3 cents/kWh in 2015 and annually increases by 5 percent plus the rate of inflation. Seventy-five percent of the funds collected as alternative compliance payments or civil penalties are to be used to fund state energy efficiency programs.

Appendix B. Detailed Overview of Methods

This is not an economic analysis. We instead developed scenarios intended to capture the range of reductions that might be achieved if reductions were obtained entirely through purchases of clean energy. Modeling followed the following five step process.

1. Determine the amount of electric generation covered under CESA
2. Calculate the clean energy requirement
3. Calculate credits that would be awarded for clean energy built under the business-as-usual scenario
4. Develop scenarios for how the power sector meets CESA
5. Calculate the GHG benefit associated with the two compliance scenarios

This model builds on a variety of data from EIA's Annual Energy Outlook (AEO) 2011 and Form EIA-861 as well as EPA's Clean Air Markets Database (CAMD) and eGRID 2010. We used the 2011 AEO instead of the 2012 Early Release due to our use of detailed outputs for coal, oil, and natural gas units, which are not yet available for the 2012 Early Release.

Step 1. Determine the amount of electric generation covered under CESA

The amount of electric generation covered under CESA was determined by examining historical sale records. We subtracted generation from hydropower and nuclear facilities built before 1992, as CESA does not count their generation towards covered utility's annual electricity sales (thus reducing their compliance obligation).

We used the AEO 2011 projections for total electricity sales, as well as electricity generated by fuel source through 2035. We used applicability threshold percentages as calculated by EIA (see Table B-1).[xix] For modeling purposes, we assumed that coverage based on 2010 utility sales would remain constant in subsequent years and that program coverage does not change due to utilities reducing sales or dividing their operations in order to fall below the applicability threshold. We also assumed that total electricity sales remain unchanged from the AEO 2011 projections. Estimated coverage ratios can be found in the table below in the column labeled "Percent Total U.S. Sales."

Table B-1. Applicability Threshold, Affected Sales, and Clean Energy Requirement under CESA

Year	Applicability Threshold (MWh Electricity Sales)	Percent Total U.S. Sales*	Percent of Electricity from Clean Sources
2015	2,000,000	83%	24%
2020	1,500,000	85%	39%
2025	1,000,000	88%	54%
2030	1,000,000	89%	69%
2035	1,000,000	89%	84%

***** Affected sales as calculated by EIA, which determined applicability at the holding company level instead at the subsidiary level through independent research and private data sets purchased by EIA.

We assumed that all clean energy, including electricity produced by nuclear and hydro-powered units built before 1992, is used to help meet covered utilities' compliance obligations.

Average historical hydro generation was calculated by facility online year using data from eGRID for the years 2004, 2005, and 2007 (eGRID2006, eGRID2007, and eGRID2010). We assumed that hydropower facilities built before 1992 would continue operating through 2035, and that any upgrades would only get credit for the incremental hydropower generation above and beyond historical production. We assumed nuclear facilities would run for 60 years and then shut down, which is consistent with the assumptions used in EPA's Integrated Planning Model (IPM) runs.[xx]

Step 2. Calculate the clean energy requirement

To determine the total amount of clean energy required under CESA in 2015 through 2035, we multiplied the percentage of required clean energy required (last column in Table B-1) by the covered generation (as calculated in step 1 above).

Step 3. Calculate credits that would be awarded for clean energy built under the business-as-usual scenario

We determined the quantity of credits that would be awarded for qualified clean energy built under the reference case for EIA's Annual Energy Outlook 2011 by using a variety of publicly available outputs and historical emissions data from eGRID.

CESA only rewards clean energy built after 1991. These facilities are credited based on how much lower their carbon intensity is than 0.82 metric tons of CO_2e/MWh. We estimated generation built before 1992, using reported facility age and average annual generation in eGRID for the years 2004, 2005, and 2007 (similar to the hydro and nuclear calculations described above).

In accordance with CESA, we awarded full credit to electricity produced with no GHG emissions and proportional credit to electricity produced with some GHG emissions (i.e., natural gas, oil, and qualified coal units) based on the CO_2 emission rate.[xxi] We compared this to the amount of clean energy needed under CESA (as described above) to determine the incremental amount of clean energy required above what EIA projects will be generated between 2015 and 2035.

Step 4. Determine how the power sector meets CESA

We developed two scenarios in order to estimate the range of likely emissions reductions possible under CESA. Both scenarios assume that the power sector first does not build new, unplanned coal units with emissions rates >0.82 metric tons of CO_2e/MWh, and then shuts down existing plants.

Scenario 1 estimates the upper end of reductions achievable under CESA by shutting down the coal units with the highest emissions rates first (4th quartile).[xxii] Any remaining clean energy requirement is met by shutting down the 3rd quartile units, and so on.

Scenario 2 takes the opposite approach compared to Scenario 1. To determine the lower range of emission reductions, we retired fossil units that are not eligible for clean energy credits with the lowest CO_2 emission rate first. These are natural gas and oil units built before 1992[xxiii], which do not receive credit under CESA. Scenario 2 assumes that coal-fired units with the lowest emissions rates (1st quartile) are shut down next. This scenario is not meant to represent a probable case, but instead is meant to help bound the analysis.

Because the quantity of clean energy projected by EIA in 2015 and 2016 is larger than the amount of clean energy required under CESA, a surplus of clean energy credits is created. We assumed all credits were banked and used for compliance purposes in subsequent years. This resulted in no reduction of fossil-fired generation in 2015 and 2016.

In the following years, we assumed that all units that were shut down were replaced with 100 percent greenhouse gas-free power.[xxiv] Alternatively, the power sector could build more gas or other low-carbon emitting generation, but that scenario would require shutting down additional coal-fired units. The GHG benefit should be the same in both scenarios because crediting is based on actual CO_2 emissions.

Step 5. Calculate the GHG benefit associated with the two compliance scenarios
Avoided generation was multiplied by the appropriate emissions rate in order to determine the GHG benefits from CESA.

Note that due to the banking provisions, annual emissions may be higher or lower than the projections in any given year.

Acknowledgements

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[i] http://www.energy.senate.gov/public/index.cfm/files/serve?File_id=b3580f37-ec8c-4698-a635-3e19f9815b9a
[ii] See Appendix A for additional details about CESA.
[iii] Covered utilities that do not generate electricity from clean sources or purchase credits from other clean sources may also comply by paying a fee, known as an alternative compliance payment. See Appendix A for more information about this design feature.
[iv] For a summary of the American Clean Energy Security Act, see http://pdf.wri.org/wri_summary_of_aces_0731.pdf
[v] Modeling of ACESA conducted by the U.S. Energy Information Administration (EIA) and the U.S. Environmental Protection Agency (EPA) found that the cheapest reductions are found in the power sector, and projected that it would provide the majority of the emission reductions from regulated sectors.
[vi] The U.S. Administration's Reduction Pledge commits the United States to reducing economy-wide GHG emission 17 percent below 2005 levels in 2020 and notes that post-2020 emissions reductions will follow a pathway consistent with 83 percent reductions from 2005 levels in 2050. This equates to emissions reductions of 50 percent below 2005 levels in 2035. Assuming that the Administration's target covers all GHGs and all sources, according to EPA's emissions inventory this correlates with reductions of 1,231 $mmtCO_2e$ in 2020 and reductions of 3,619 $mmtCO_2e$ in 2035.
[vii] Unplanned units are new builds projected by the model. Planned units, in contrast, are those that have commenced construction.
[viii] To understand how this works, consider a case where a utility needs 1 MWh of clean generation to meet its compliance obligation. That requirement could either be met through 1 MWh of generation from a qualified zero carbon source or from roughly 2 MWh of generation from a combined cycle natural gas plant (our analysis assumes it would require 1.9 MWh of generation from a combined cycle natural gas plant in 2035). The 1 MWh of zero carbon generation would displace 1 MWh of higher carbon generating electricity, while the 2 MWh of natural gas would displace 2 MWh of higher carbon generating electricity. If one assumes that the displaced electricity in both cases is coal, which for existing plants has an average emissions rate of about 1 ton of CO_2/MWh, then the two scenarios avoid 1 and 2 tons of CO_2 from coal generation, respectively. However, in the scenario where gas generation is used to meet the clean energy standard, there is an additional 1 ton of CO_2 emissions from the

combustion of natural gas (0.5 ton of CO_2/MWh times 2 MWh). Thus, both scenarios lead to the same level of emissions reductions.

[ix] Note that if the projections underestimate generation from renewables, then business-as-usual projections of GHG emissions will be lower and less additional clean generation will need to be built to meet the CES.

[x] The ACP begins at 3 cents per kWh, and annually escalates at 5 percent plus the rate of inflation. States receive 75 percent of the ACP, which equates to 2.25 cents per kWh in 2015. ACEEE has estimated that the average cost of energy savings from energy efficiency programs has been 2.5 cents per kWh (http://www.aceee.org/sites/default/files/publications/researchreports/U092.pdf).

[xi] In the 2009 study, *Saving Energy Cost Effectively: A National Review of the Cost of Energy Saved through Utility-Sector Energy Efficiency Programs*, ACEEE found that the utility-scale energy efficiency programs implemented in 14 states in recent years have seen costs of saved energy range from 1.6 cents per kWh to 3.3 cents per kWh. (http://www.aceee.org/sites/default/files/publications/researchreports/U092.pdf)

[xii] Ultimately, the GHG impact of the ACP is tied to the rate utilities must pay and requirements about how the funds are spent. If the rate was lowered, or a smaller percent is required to be spent on energy efficiency programs, then the ACP could reduce the GHG benefits of the program.

[xiii] http://www.eia.gov/analysis/requests/bces12/

[xiv] Summary of the Clean Energy Standard Act of 2012, S. 2146, As Introduced by Senator Bingaman on March 1, 2012. Nicholas Bianco, Kevin Kennedy, and James Bradbury. World Resources Institute. March 7, 2012 http://www.wri.org/stories/2012/03/wri-summary-clean-energy-standard-act-2012-s-2146

[xv] The Secretary of Energy is directed to consult with the Administrator of the Environmental Protection Agency in determining the carbon intensity of generating facilities. This will be done by dividing the net annual CO_2e emissions of the generator by the annual quantity of electricity generated by the generator.

[xvi] CESA narrowly defines renewable energy to include solar, wind, ocean, current, wave, tidal, and geothermal. CESA does not include hydropower and qualified renewable biomass in the definition of renewable energy, but does allow them to earn clean energy credits under certain circumstances.

[xvii] According to Sec. 6109(b)(5) of CESA, "Qualified renewable biomass means renewable biomass produced and harvested through land management practices that maintain or restore the composition, structure, and processes of ecosystems, including the diversity of plant and animal communities, water quality, and the productive capacity of soil and the ecological system."

[xviii] To qualify, waste-to-energy facilities that commence operation before CESA is enacted must meet the standards for new sources under Clean Air Act sections 112 and 129 that are in effect on the date CESA is enacted (Facilities built after CESA is enacted are already subject to the standards for new sources under Clean Air Act Sections 112 and 129).

[xix] EIA estimated the total quantity of covered sales in each year based on the holding company aggregation using a combination of NEMS growth rates, EIA Form-861 data, independent research, and private data sets purchased by EIA. Since EIA utilized the AEO 2012 Early Release in their modeling efforts, we divided covered sales by the total sales as reported in the AEO 2012 Reference Case. The resulting applicability threshold percentages were used along with the total sales reported in the AEO 2011 Reference Case to determine the total generation covered under CESA.

[xx] EPA's IPM Base Case v.4.10 forces existing nuclear units to retire after they reach 60 years of age. This assumption is based on the U.S. Nuclear Regulatory Commission (NRC) granting 20-year license extensions to the majority of nuclear power plants beyond their initial 40-year operating licenses. Most other plants had announced plans to file for this same extension at the time the EPA Base Case v4.10 was released in September, 2010. No plants had received extensions to operate past age 60. http://www.epa.gov/airmarkets/progsregs/epa-ipm/docs/v410/Chapter3.pdf

[xxi] CO_2 emission rates were calculated by dividing the total CO_2 emitted by the electricity generated from a particular unit type (mtons CO_2 per MWh); Clean energy credits for a particular unit =

[xxii] To calculate the amount of electricity generated by coal-fired units with either high or low emissions rates, we broke up existing coal generation into quartiles, based on unit-level generation reported to the EPA CAMD for 2010. Coal-fired units with the lowest emissions rate that generated 25 percent of total electricity were grouped in

the 1st quartile while the units with the highest emissions rates that generated 25 percent of electricity were grouped in into the 4th quartile. The 2nd and 3rd quartiles each contain 25 percent of electricity generated by units with emission rates larger than the 1st quartile but less than the 4th quartile. The average emissions rate for each quartile was calculated by dividing total CO_2 emissions by generation. This was used to determine the variation from the mean for each quartile. This variation was then applied to the average emissions rate reported in the AEO 2011 for existing coal-fired units between 2015-2035.

[xxiii] The AEO 2011 projects that oil will only contribute roughly 5 percent to total electricity generated by natural gas and oil sources through 2035.

[xxiv] We assumed that the alternative compliance payment (ACP) was unused and that all utilities generated electricity from qualified sources or purchased credits from other clean sources. 75 percent of ACP payments and civil penalties will be distributed to states to implement energy efficiency programs. Energy savings from these programs will lower the baseline of total electricity sales, making the CESA target more achievable in subsequent compliance periods (see http://www.wri.org/stories/2012/03/wri-summary-clean-energy-standard-act-2012-s-2146).