

Appendix B: Representing H.R. 2454 in the National Energy Modeling System

Emissions Modeling

The analysis of energy sector and economic impacts of the various greenhouse gas (GHG) emission reduction measures in the American Clean Energy and Security Act of 2009 (ACESA) is based on the Energy Information Administration's (EIA) National Energy Modeling System (NEMS) which is used for projections in the *Annual Energy Outlook 2009 (AEO2009)*, including an updated Reference Case that reflects provisions of the American Recovery and Reinvestment Act (ARRA) and recent changes in the economic outlook.¹⁷ The updated *AEO2009* Reference Case is used as the baseline for the analysis in this report.

The projection horizon for NEMS extends to 2030, while the emissions policies in the bill extend to 2050 and beyond. As a result, this analysis is limited to addressing the bill's impacts through 2030; however, some expectations of post-2030 changes affect the modeling, such as assumed allowance banking behavior through 2030 and an assumed continuance of allowance price trends beyond 2030 when simulating electric power capacity decisions through 2030.

NEMS endogenously calculates changes in energy-related carbon dioxide (CO₂) emissions in the analysis cases. The cost of using each fossil fuel includes the costs associated with the GHG allowances needed to cover the emissions produced when they are used. These adjustments influence energy demand and energy-related CO₂ emissions. The GHG allowance price also determines the reductions from projected baseline emissions of other covered GHGs based on assumed abatement cost relationships, as well as the potential supplies of domestic and international offsets. With emission allowance banking, NEMS solves for a starting allowance price and trend such that cumulative emissions match the cumulative emissions target, including cumulative bank allowances, with a constant-growth trend in allowance prices consistent with the average cost of capital to the electric power sector.

The NEMS Macroeconomic Activity Module (MAM), which is based on the IHS Global Insight U.S. Model, interacts with the energy supply, demand, and conversion modules of NEMS to solve for an energy and economy-wide equilibrium. In an iterative process within NEMS, MAM reacts to changes in energy prices, energy consumption, and allowance revenues, solving for the effect on macroeconomic and industry level variables such as real gross domestic product (GDP), the unemployment rate, inflation, and real industrial output.

Title III Cap-and-Trade Provisions

Title III of ACESA modifies the Clean Air Act by adding Titles VII and VIII to limit emissions of most GHGs through an allowance cap-and-trade system (Title VII) and to impose and modify emissions standards affecting other GHGs (Title VIII). Title III of ACESA also establishes various financial regulations on allowance markets. EIA's modeling of Title III provisions was limited to the allowance cap-and-trade system. EIA's analysis does not reflect a separate cap-and-trade system on certain hydrofluorocarbons (HFCs) used primarily as substitutes for ozone-

¹⁷ Energy Information Administration, *Annual Energy Outlook 2009*, DOE/EIA-0383(2009)(Washington, DC, February 2009), web site www.eia.doe.gov/oiaf/aeo/index.html, and *An Updated AEO2009 Reference Case Reflecting Provisions of the American Recovery and Reinvestment Act and Recent Changes in the Economic Outlook*, DOE/EIA-SR-OIAF/2009-03 (Washington, DC, April 2009).

depleting substances. Nor does it address the emission standards on other GHG sources not covered by the cap-and-trade system, such as methane emissions for landfills and coal mines.

Establishing the Cap and Coverage Assumptions

Sec. 721 establishes the overall cap on GHGs by specifying the number of allowances to be created each year under certain assumptions about overall 2005 emissions and the coverage fractions in 2012, 2014, and 2016 as additional coverage is phased in. The yearly allowance quantities are based on specific percentage reductions in 2012, 2020, 2030, and 2050 relative to the applicable emissions from covered sources in 2005. The bill sets the reductions targets at 3 percent in 2012, 17 percent in 2020, 42 percent in 2030, and 83 percent in 2050. See Table B1.

Table B1. Revisions to the GHG Cap for Emissions Accounting and Limitations in Modeling Detail

(million metric tons CO₂-equivalent)

	Assumed in Bill		As Modeled	
	Emission Level	Percentage of Total	Emission Level	Percentage of Total
2005 Total Emissions	7206	100.0	7303	100.0
2005 Covered emissions, 2012 coverage	4770	66.2	4975	68.1
2005 Covered emissions, 2014 coverage	5455	75.7	5589	76.5
2005 Covered emissions, 2016 coverage	6089	84.5	6128	83.9
Year	Specified Cap	Percentage of 2005 Covered Emissions	Revised Cap as Modeled	Percentage of 2005 Covered Emissions
2012	4627	97.0	4826	97.0
2013	4544	95.3	4739	95.3
2014	5099	93.5	5225	93.5
2015	5003	91.7	5128	91.8
2016	5482	90.0	5515	90.0
2017	5375	88.3	5408	88.3
2018	5269	86.5	5301	86.5
2019	5162	84.8	5194	84.8
2020	5056	83.0	5086	83.0
2021	4903	80.5	4933	80.5
2022	4751	78.0	4780	78.0
2023	4599	75.5	4627	75.5
2024	4446	73.0	4474	73.0
2025	4294	70.5	4320	70.5
2026	4142	68.0	4167	68.0
2027	3990	65.5	4014	65.5
2028	3837	63.0	3861	63.0
2029	3685	60.5	3708	60.5
2030	3533	58.0	3554	58.0
2050	1035	17.0	1042	17.0

The bill establishes a procedure for revising the cap based on any changes in the emissions accounting affecting the relative emissions by covered entities or the total 2005 emissions. Accordingly, EIA has revised the assumed cap slightly to conform to EIA GHG accounting practices and the level of emissions accounting incorporated into NEMS, while adhering to the percentage targets for 2012, 2020, and 2030 set forth in the bill. Targets for intervening years

are established by using a uniform annual decline in the amount of emissions between the years specified. Table B1 presents the original and revised caps as assumed in this analysis through 2030.

The bill phases in the allowance requirements for some emission sources. Emissions from petroleum combustion and electric power companies are covered at the onset of the program starting in 2012. In 2014 and 2015, it is estimated that approximately 72 percent of the natural gas used in the industrial sector is subject to the allowance holding requirement. The allowance obligation for local distribution companies (LDCs) supplying natural gas to non-covered entities begins in 2016. It was assumed that CO₂ emissions from natural gas that is not consumed by covered industrial and electric power companies will be supplied by LDCs. Therefore all CO₂ emissions from natural gas are assumed to be covered beginning in 2016. By 2016, all energy-related CO₂ emissions, other than those attributed to a small amount of residential and commercial sector coal usage, are assumed to be covered.

A small amount of emissions from other industrial emissions are also subject to the allowance holding requirement. These gases include nitrous oxide from adipic acid and nitric acid production, non-energy process emissions of carbon dioxide, and emissions of fluorinated gases other than those HFCs used as substitutes for ozone-depleting substances (a separate cap on the latter group of gases is established in the bill but is not treated in the modeling conducted for this report). Due to model limitations, the coverage of emissions of these gases is programmed to begin in 2012, rather than in 2014 as required in the bill.

Limits on Offset Credits

H.R. 2454 establishes an overall limit on international and domestic offset credits of 2 billion metric tons (BMT) of the allowance requirements, with each source limited to half the total. The domestic and international offset limits are applied on a pro-rata basis on individual covered entities. The pro-rata limit is a maximum percentage of the allowance obligation that can be met using offsets. The pro-rata limit can therefore restrict offset usage independently of the overall 2-BMT limit. The pro-rata limit is calculated as follows:

$$\text{MaxOffsetPct}_y = 100 * (2000 / (2000 + \text{CAP}_y)), \text{ where}$$

MaxOffsetPct_y is the maximum percentage of the allowance obligation that can be met through offsets in year y, and

CAP_y is the emissions cap, or number of allowances issued, for year y, in million metric tons CO₂-equivalent.

The pro-rata limit would restrict the aggregate use of offsets below the overall 2-BMT limit unless covered emissions exceeded the cap by 2 BMT, assuming all covered entities used the maximum allowable percentage. As with the overall limit, domestic and international offsets under the pro-rata limit can each be no more than half the total, with one exception which can be triggered by the Environmental Protection Agency (EPA) Administrator. If the EPA Administrator expects the availability of domestic offset credits to be less than 900 million metric tons (MMT) in any year given expected allowance prices, the maximum percentage of

international offsets is increased, and the domestic offset percentage decreased. The maximum offset percentage is changed to reflect an increase in the international offsets by an amount equal to 1,000 MMT less the expected domestic offset availability, up to an increase of 500 MMT of additional international offsets.

Domestic offset credits substitute for allowances on a 1-for-1 basis. International offset credits are exchanged for allowance requirements on a 1-for-1 basis through 2017. Beginning in 2018, 1.25 international offset credits are required to substitute for one allowance.

Assumptions for Non-CO₂ Emissions Abatement and Offset Supplies

Assessing ACESA requires an analysis of energy-related CO₂ emissions and non-CO₂ GHG emissions. NEMS represents U.S. energy markets and the associated CO₂ emissions and abatement opportunities endogenously. Non-CO₂ GHG emissions and international offsets are represented using exogenous baseline emissions projections and schedules of abatement opportunities over time and by price. To reflect the reduction in non-energy-related GHG emissions, EIA relies on these assumed economic relationships to quantify the potential emissions abatement and offset supplies that would occur over a range of allowance or offset prices.

To a great extent, EIA bases abatement and offset supply assumptions on research and analysis by EPA. EPA has provided EIA with estimates of baselines and domestic and international “marginal abatement cost curves,” or MACs, for various sources of GHG emissions and biogenic carbon sequestration. The MACs reflect the estimated economic GHG abatements that could be achieved from emission reduction projects, given a price or value on GHG emissions reductions. Such estimates tend to reflect the technical potential for emissions reductions with positive rates of return and do not reflect institutional and market factors affecting adoption of abatement and offset options. As a result, EIA has incorporated discounting and market penetration assumptions to reflect these factors. Such estimates are naturally subject to a great deal of uncertainty, particularly with regard to international offsets.

The availability and price of international offsets from energy- and non-energy-related projects will depend on the global supply of and demand for emission reductions. The U.S. demand for offsets will compete with the demand for emissions abatement outside the United States, which, in turn, will depend on the emissions reduction commitments undertaken by other countries. Under ACESA, covered entities can submit project-level or sector-level offsets from developing countries that have established agreements with the United States to ensure that requirements for monitoring and verification are fulfilled. Under Sec. 728, covered entities may also submit allowances from approved countries that have established cap-and-trade systems of comparable stringency and scope. Allowances supplied under Sec. 728 do not count against offset limits and are not subject to any quantitative limits initially.

The potential supply of offset credits and allowances to the United States is derived based on the excess supply of potential abatement for the world, relative to the assumed demands for abatement based on stated or assumed emissions reduction commitments. Given that the capped sources of emissions under ACESA are primarily energy-related CO₂, the supply of CO₂ abatement from the Group 1 developed countries would potentially qualify as a source of

comparable allowances. However, countries having equally stringent caps could face similar compliance costs at the margin, possibly limiting the potential for international allowance trading. Therefore, no net trade in international allowances was assumed.

International abatement supply is based on EPA-provided MACs for CO₂, other GHGs, and forestry/agriculture. In processing the MACs to obtain offset supply, EIA applies discounts and market penetration assumptions to reflect the market response to the technical abatement potential. EPA has disaggregated GHG abatements into two regional categories: Group 1 nations (Europe, Canada, Japan, Australia, and New Zealand) and Group 2 nations (the rest of world, excluding United States).

To reflect world competition for offset supplies, the international abatement market is assumed to establish a floor price, above which excess abatement supplies can penetrate the U.S. market in the form of offset credits from developing countries and, potentially, allowances from countries assumed to have comparable caps in place. A floor price, or international GHG abatement price excluding the United States, is estimated by combining annualized abatement supplies and abatement demand and solving for the market price each year. This approach allows the U.S. market for allowances to be treated somewhat independently from the world market and allows offset supplies to the United States to be restricted to developing countries, as specified in the bill.

The assumed international abatement demand is defined as international baseline emissions minus stated or hypothetical commitments to various emissions levels (Table B2). The reference emissions baseline shown is based on estimates originally provided by EPA and used in several previous EIA studies, but the non-U.S. energy-related CO₂ growth rates through 2030 have been updated to reflect the CO₂ projections in the EIA *International Energy Outlook 2009 (IEO2009)* Reference Case, which does not reflect any international commitments to cap GHGs.

Table B2. Assumed International Abatement Demand, Excluding the United States
(million metric tons carbon dioxide equivalent)

	Reference Emissions		Policy Assumption		Cap		Abatement		
	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Group 1	Group 2	Total
1990	8188	16268	Reference	Reference	8188	16268	0	0	0
1995	8403	18002	Reference	Reference	8403	18002	0	0	0
2000	8619	19736	Reference	Reference	8619	19736	0	0	0
2005	8848	21535	Reference	Reference	8848	21535	0	0	0
2010	8697	24778	5.0% below 1990	No Policy	7778	24778	919	0	919
2015	8851	27069	8.3% below 1990	No Policy	7508	27069	1343	0	1343
2020	9051	29503	16.6% below 1990	No Policy	6828	29503	2223	0	2223
2025	9089	31942	16.6% below 1990	2020 levels	6828	29503	2260	2439	4699
2030	9118	34303	26.6% below 1990	2020 levels	6010	29503	3108	4799	7908
2035	9214	36720	26.6% below 1990	2020 levels	6010	29503	3204	7217	10421
2040	9340	39196	36.6% below 1990	2020 levels	5191	29503	4149	9693	13842
2045	9471	41470	36.6% below 1990	2020 levels	5191	29503	4280	11967	16246
2050	9601	43743	46.6% below 1990	2020 levels	4372	29503	5229	14240	19470

Under ACESA, allowable sources of international offset credits are from developing countries that have established bilateral or multilateral agreements with the United States to ensure the offset requirements of the bill are fulfilled. For this analysis, it is assumed that the Group 2 countries will be deemed developing countries and that their participation will increase gradually over time as reflected by imposing a gradual market penetration function to their offset supplies. In the case of offsets from reduced deforestation, the bill specifies substantial additional regulatory requirements, such as agreements on national baselines, technical capacity to monitor, measure, report, and verify forest carbon fluxes, and institutional capacity to reduce deforestation, such as strong forest governance. These requirements will likely reduce the potential sources of forestry offsets to a subset of Group 2 countries. As a result, the technical potential of forestry-related abatement from Group 2 countries as provided by EPA has been discounted by 50 percent and a slower rate of market penetration has been applied than with other offset abatement supply sources.

Table B3 displays the assumed supply schedule of international offset credits, given these considerations. Both the gross Group 2 offset supply and the supply net of international abatement demand are shown, given the estimated international floor price for GHG abatement. The latter schedule (net supply) represents the supplies assumed to be available to the United States.

Depending on how international offsets are regulated and how fast the requisite international agreements or arrangements are formed, the potential availability of low-cost international offsets could be substantially different (greater or smaller) than assumed. In the ACESA High Offsets Case, the maximum allowable quantity of international offsets was assumed to be available in every projection year at the allowance price of that year.

Allowance Banking and Borrowing

To reflect banking incentives and trading arbitrage, allowance prices escalate at a rate no higher than 7.4 percent per year in real terms during intervals when allowance balances are held. This rate reflects the average cost of capital in the electric power sector, where a significant share of emissions reduction investments is expected to occur.

ACESA calls for increasingly stringent emissions caps beyond 2030, the forecast horizon for NEMS. Meeting these post-2030 caps will require significant emission reductions outside the electricity sector, the predominant source of early emissions reductions, and increase future price pressure, absent significant technological breakthrough in transportation and other uses that are dependent on fossil fuels. As a result, EIA assumes that covered entities and traders will amass a substantial allowance bank balance by the end of 2030. Based on recent modeling work by the EPA to evaluate ACESA impacts, an approximate average allowance balance of 13 BMT in 2030 was estimated across various scenarios they considered, an increase of cumulative abatement of roughly 50 percent above the minimum required under ACESA through 2030. This level of allowance banking is consistent with the greater difficulty of complying with the increasingly stringent post-2030 caps under continued growth in population and the economy. While the level of banking would also depend on other economic assumptions, such as the availability and cost of international offsets, the 13-BMT-balance assumption was applied in all but one of the cases analyzed. In the ACESA High Banking Case, where banked allowances

were assumed to rise to 20 BMT, approximating the highest level observed in EPA’s ACESA cases.

Table B3. Assumed Gross and Net Supply Schedule of International Offsets from Developing Countries
(million metric tons CO₂-equivalent)

Gross Group 2 Offset Supply		Potential Gross Quantity of Offsets Supplied (million metric tons CO ₂ equivalent)				
Price (2000 dollars per tonne CO ₂)		2010	2015	2020	2025	2030
	\$0.0	0	0	0	0	0
	\$0.3	71	41	151	264	327
	\$3	131	97	294	684	992
	\$5	185	156	454	1106	1611
	\$8	229	234	622	1762	2630
	\$11	273	335	855	2578	3932
	\$14	322	459	1160	3578	5320
	\$20	388	727	1955	6120	8232
	\$27	455	1083	3062	9384	11361
	\$34	527	1507	4270	12248	14244
	\$41	603	2036	5602	14782	16206
	\$48	685	2680	6951	16922	17760
	\$55	772	3444	8248	18881	19263
	\$61	861	4208	9322	20521	20584
International Floor Price (2000 dollars per tonne CO ₂)		\$13.15	\$12.68	\$11.81	\$10.80	\$15.81
International Abatement Demand at floor price (million metric tons CO ₂ equivalent)		308.3	404.2	937.1	2523.3	6200.3
Offset Supply, Net of International Abatement Demand		Potential Net Quantity of Offsets Supplied (million metric tons CO ₂ equivalent)				
Price (2000 dollars per tonne CO ₂)		2010	2015	2020	2025	2030
	\$0.0	0	0	0	0	0
	\$0.3	0	0	0	0	0
	\$3	0	0	0	0	0
	\$5	0	0	0	0	0
	\$8	0	0	0	0	0
	\$11	0	0	0	55	0
	\$14	14	54	223	1054	0
	\$20	80	323	1017	3596	2032
	\$27	147	679	2125	6861	5161
	\$34	218	1103	3333	9725	8044
	\$41	295	1632	4665	12259	10005
	\$48	376	2276	6014	14399	11560
	\$55	464	3040	7311	16358	13062
	\$61	553	3803	8385	17998	14384

Treatment of Allowance Prices in Energy Prices

Under ACESA, the allowance obligations are imposed on an upstream basis, on producers and importers rather than end users, for all emissions from petroleum and a portion of natural gas sold by LDCs to uncovered entities. Allowance obligations for coal and natural gas covered entities in the industrial and electric power sectors are imposed on a downstream basis. This mixed regulatory approach has implications for how allowance costs are reflected in the modeling of delivered energy prices.

- The allowance holding requirement on covered entities for their coal-related and natural-gas-related CO₂ emissions is an incremental opportunity cost of using coal. For modeling

purposes, the allowance cost was added to the delivered price of coal and natural gas to reflect the opportunity cost faced by these covered entities.

- For petroleum and uncovered natural gas regulated upstream, it is assumed that the allowance costs associated with the related CO₂ emissions are passed through in the delivered prices, with some exceptions.
- CO₂ emissions from refineries' direct fuel combustion of petroleum-based fuels would be subject to the allowance requirement. However, the incremental cost of these allowances is not explicitly reflected in delivered petroleum prices, as the Petroleum Market Module of NEMS is not structured to represent such costs explicitly.
- To reflect the bill's allowance allocations to electricity and natural gas LDCs for rebates to end users, average delivered prices are adjusted to reflect the rebates. Consumers receiving such rebates are assumed to treat their net average energy cost as the price basis for fuel-related decisions.

Additional details on modeling treatment of specific elements of the cap-and-trade provisions and other bill provisions are presented below for each modeling area.

Buildings Sector

The ACESA legislation contains several provisions designed to reduce energy use in buildings and to provide credit for buildings-related renewable electricity generation. The programs include codes and standards as well as direct funding from the sale of allowance aimed at increasing the energy efficiency in buildings. The buildings sector energy efficiency provisions directly modeled in NEMS include the following:

Building Codes (Section 201)

Section 201 establishes Federal building codes for both residential and commercial buildings, with provisions to improve the code every several years. This provision is funded with 0.5 percent of the total emissions allowances and is implemented in both the NEMS residential and commercial demand modules.

All of the improvements in commercial building codes are relative to the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) code 90.1-2004 and are assumed to be feasible. The building code efficiency improves by 30 percent upon enactment of the bill and by 50 percent in 2015, with 5-percent incremental improvements to the 2015 code every 3 years thereafter. It is assumed that the codes are phased in over 5 years following State adoption, reflecting the time it takes States to fully comply with each revision of the building code.

The improvements in residential building codes are relative to the International Energy Conservation Code (IECC) 2006. Similar to the commercial sector implementation, a 30-percent improvement in the code occurs with the enactment of the bill, with subsequent increments identical to those for commercial buildings over the projection period. Each code improvement, following State adoption, is assumed to require 5 years for all the States to fully comply; however, each of the nine Census divisions complies consistent with the historical level of building code compliance in each State.¹⁸

Existing Building Retrofit Program (Section 202)

Section 202 establishes the Retrofit for Energy and Environmental Performance (REEP) program which is funded by allowance allocation revenues as specified in section 782(g). Because individual States determine the amount of money to spend on various sectors of the economy (buildings, transportation, industry, etc) and the fact that allowance revenue streams and allocations for this provision change over the projection period, the energy savings impacts of this provision are subject to great uncertainty. For this analysis, it is assumed that \$2 billion per year is available to retrofit residential buildings and that the investment and energy savings per house are comparable to EIA's previous analysis of the impact of weatherization funding included in ARRA.¹⁹ For commercial buildings, it is assumed that funding is available to improve the shell efficiency of existing buildings by an additional 1 percent relative to the Reference Case by 2030.

Standards (Sections 211 and 212)

- Outdoor lighting standards effective 2011 to 2015
- Hot and cold water dispensers effective 2012
- Hot food holding cabinets effective 2012

The impact of the above standards is relatively modest. In the residential sector, the preponderance of lighting fixtures are located inside the house and many outdoor fixtures use traditional incandescent bulbs, which are already covered by aggressive efficiency standards under the Energy Independence and Security Act of 2007. The commercial sector accounts for outdoor stationary lighting such as roadway lighting, parking lots, billboards, airport runways, etc., which account for only about 8 percent of all lighting use in the United States.²⁰

Rebates for Natural Gas and Oil Customers (Sections 782b and 782c)

Sections 782b and 782c allocate a relatively small portion of the overall emission allowances to oil and natural gas customers specifically for energy efficiency programs. In the buildings sector, these provisions are assumed to take the form of rebate programs for the purchase of energy-efficient furnaces and boilers.

¹⁸ Each State was given a "score" from 1 to 5 and weighted by housing permits to calculate a Census division average. The relative score for each State was derived from American Council for an Energy-Efficient Economy (ACEEE), *The State Energy Efficiency Scorecard for 2006*, June 2007.

¹⁹ For more detail on the assumptions, see <http://www.eia.doe.gov/oiaf/servicerpt/stimulus/index.html>.

²⁰ Navigant Consulting Incorporated, *U.S. Lighting Market Characterization, Volume I: National Lighting Inventory and Energy Consumption Estimate*, September 2002.

Buildings sector participation in the Renewable Electricity Credit program that is part of the ACESA Clean Energy Title is directly modeled as discussed below.

Industrial Sector

Title I, Subtitle B, Section 115 promotes the commercial deployment of carbon capture and storage (CCS) technologies. After review of the state of the current technology, it was determined that the industrial CCS provision in the proposal would not be readily adopted by industry. This technology as it applies under the stipulations of the provision would require very large investments to retrofit existing facilities (or add new ones) and substantial land areas at an industrial site to capture the CO₂. Space is always limited at industrial facilities and the addition of new land would ultimately add a high “real-estate premium” to adoption of these systems. Many industries already producing pure CO₂ streams that could be supplied for CCS but these streams are already sold as a valued-added secondary product in the food industries and for enhanced oil recovery, among others. Consequently, it is assumed that industrial non-refining CCS would not penetrate that market through the projection period.

Title I, Subtitle C, Sections 123 and 125 provide financial assistance to automobile manufacturers to facilitate the manufacture of plug-in and other advanced technology vehicles. In the manufacture of vehicles, the platforms used and designed to manufacture standard vehicles are the same as those to manufacture plug-in and other advance technology vehicles. As such, the energy efficiency trends for the transportation equipment industry (NAICS 336) are assumed to be unchanged relative to the *AEO2009* Reference Case.

Title I, Subtitle H, Section 173, establishes several Centers for Energy and Environmental Knowledge and Outreach. Each center is to provide technical assistance, including energy savings assessments for industrial establishments. The proposed increased funding for energy savings assessments programs is expected to accelerate the penetration of energy efficiency measures and options in industries. To model this, the industrial demand module (IDM) of NEMS used the industrial sector high technology assumptions of *AEO2009*.

Title II, Subtitle D establishes various energy efficiency standards and programs for industries. The design and implementation of these standards and programs are yet to be decided. Due to this lack of information, no model changes were made to accommodate this part of the bill. Title II, Subtitle D, Sections 244 and 245 establishes a rebate and incentive programs designed to increase industrial motor efficiency. These were not adequately defined in the proposal and therefore no changes pertaining to the rebate and programs were made in the IDM. Nevertheless, the motor model remains an economic and technology choice system, and as such, any changes in industrial production and energy prices will impact the projected energy use in motors in industry.

The allocation of carbon allowances in the IDM has been applied as prescribed by the bill. These allowances are allocated to energy-intensive industries only, as indirect emissions allowances in 2012 and 2013 and full emissions allowances (direct and indirect) for the remaining timeframe. This allocation is, however, phased out beginning in 2025 as mandated in

the proposal. To accurately reflect the lack of CO₂ emissions coverage for small industrial emitters in the early years of the cap-and-trade regime, a bifurcation of natural gas consumption was applied to the IDM for calendar years 2014 and 2015.

Transportation Sector

ACESA includes several provisions that are related to transportation, specifically, Sections 121-130 and Sections 221-224. However, none of these provisions have been incorporated into NEMS because they call for (a) analysis and not action, (b) the creation of programs without any specific measures that can be modeled in NEMS, or (c) are of such limited nature that they are not deemed large enough to impact transportation trends significantly.

- Section 121 mandates utilities to complete studies assessing the future electrification of the U.S. transportation fleet.
- Section 122 calls for the establishment of a program by which the Secretary of Energy can provide financial assistance to State or local governments for the demonstration of plug-in hybrid electric vehicles.
- Section 123 establishes a program by which the Secretary of Energy can provide financial assistance to automobile manufacturers to facilitate the manufacture of plug-in electric drive vehicles.
- Section 124 grants various emissions credits to the manufacture of alternatively-fueled vehicles.
- Section 125 provides loans to manufacturers of advanced vehicle technology.
- Section 126 amends the term "renewable biomass."
- Section 127 calls for the promotion of an open fuel standard and allows regulations to require each light-duty automobile manufacturer to produce a minimum percentage of fuel-choice-enabling automobiles.
- Section 128 amends diesel emissions regulations.
- Section 129 provides loan guarantees for the construction of renewable fuel pipelines.
- Section 221 calls for studies to propose changes to the emissions standards for heavy-duty vehicles, non-road vehicles, and aircraft engines.
- Section 222 calls for States to produce plans and create goals for the reduction of GHG emissions from transportation.
- Section 223 establishes within EPA a SmartWay Transport program to quantify, demonstrate, and promote transportation efficiency programs.

- Section 224 allows the Secretary of Energy to change State vehicle fleet requirements.

New Fuel Economy and Tailpipe Emissions Standards for Light-Duty Vehicles

President Obama unveiled a plan for tougher vehicle fuel economy standards that would require passenger cars to reach a fleet average of 39 miles per gallon and light trucks to reach a fleet average of 30 miles per gallon in model year 2016. The President has called for EPA and the National Highway Traffic Safety Administration to jointly produce these new standards as both a footprint based Corporate Average Fuel Economy and a tailpipe emissions standard. Since the policy change was only recently announced by the President and has not been formally implemented, the new fuel economy standards are only included in a sensitivity case for ACESA.

In the sensitivity case, the new fuel efficiency standards have been incorporated into NEMS that meet and slightly exceed the President's targets for model year 2016. The revised standards do not start in NEMS until 2012, as fuel economy standards for model year 2011 have already been promulgated by the National Highway Traffic Safety Administration. Standards are assumed to remain the same after model year 2016.

Macroeconomic

In all cases, MAM assumes exchange rates remain at the Reference Case levels. EIA assumes, as has been customary in several historical responses by the Federal Reserve, that the Federal Reserve will use a modified Taylor rule which will decrease interest rates in the face of rising unemployment. MAM takes all appropriate energy price and quantity variables from NEMS and converts them into IHS Global Insight aggregate energy measures.

Specific to the ACESA analysis, MAM implemented two major modeling changes: one pertaining to energy-intensive industries and the other to redistributing carbon allowance revenues back to the economy. As part of the H.R. 2454 bill, section 782 (e) allocates shares of allowances to trade- and energy-vulnerable industries. In MAM, these industries are impacted by various industrial fuel prices as well as overall changes in final demands. In the ACESA analysis, the energy-intensive industries react to pre-tax industry fuel prices, rather than post-tax prices under the assumption that when the industries receive the allocated allowances, the revenue will enable them to restructure their production processes to ameliorate the impact of rapidly rising energy prices.

MAM redistributes a certain portion of total allowance revenue. The following list includes the revenues being collected and redistributed by the model: Section 726 Strategic Reserve, Section 781, Supplemental Reserves, Section 782 (d) Low Income Allocation; Section 782 (g) Investment in Energy Efficiency and Renewable Energy; Section 782 (g) 1 f Investment in Energy Efficiency and Renewable Energy; Section 782 (g) Investment in Energy Efficiency and Renewable Energy (2) building codes; Section 782(h) Clean Energy Innovation Centers; Section

782(i) Clean Vehicle Technology; Section 782(k) Investment in workers; Section 782 (l) Domestic Adaptation; Section 782 (m) Wildlife and Natural Resource; Section 782 (m) Wildlife and Natural Resource; Section 782 (n) International Adaptation; Section 782 (o) International Clean Technology; and Section 782 (r) Consumer Climate Change Refund. MAM treated Section 782 (d) low income allocations as transfer payments, Section 782 (n) and (o) (international transfer of allocations) as other Federal government transfers to the rest of the world. Sections 782 (g) (h) (i) (k) (l) (m), Section 726 and Section 781 were treated as Federal government non-defense spending. Section 782 (r) which distributed funds post-2025 were treated as lump-sum personal tax rebates. All of the other allowances specified in H.R. 2454 went to energy-producing or -distributing entities or were given to energy-intensive industries and were not collected or redistributed by MAM. Changing the level of non-defense government expenditures insured that the Federal deficit at full employment was unchanged from the Reference Case across all ACESA cases. The uses of the carbon allowance revenues as stipulated by H.R. 2454 were modeled; however to the extent that the resulting change in government expenditures were lower than the actual amounts specified by the bill, other non-defense government expenditures would have to be reduced to insure unchanged Federal deficits over time.

Electric Power and Coal

Renewable Electricity Credits

Section 101 establishes a program requiring retail electric suppliers to submit renewable energy credits and electricity savings equal to a percentage of their annual electricity sales beginning in 2012. Distributed renewable generation facilities are issued 3 Federal renewable electricity credits for each megawatthour of renewable electricity generated with the granting of triple credits to be reviewed for adjustment in 2014 and every 4 years thereafter. It is assumed that the adjustment reviews result in an adjustment to 1 Federal renewable electricity credit per megawatt hour issued to distributed generation facilities starting in 2014. However, distributed renewable generators placed in service during a year when triple credit is granted continue to receive triple credit for 10 years. This provision is directly modeled in the buildings sector but is expected to have minimal impact on buildings sector renewable generation because the requirements of the cap-and-trade program in ACESA lead to sufficient renewable generation capacity in the power sector to meet the renewable electricity standard targets.

Carbon Capture and Sequestration

Section 114 outlines a CCS demonstration program that is to be run by the private sector, under the lead of the Electric Power Research Institute and funded by small fees on the distribution of fossil-fired electricity. The fees range from 0.22 mills per kilowatthour for natural-gas-fired electricity to 0.43 mills per kilowatthour for coal-fired electricity. The goal of this 10-year, \$10-billion program is to support 5 commercial-scale CCS or conversion technology projects. The small fees on fossil-fired electricity distribution specified in this section are accounted for in the cases analyzed for this report and are assessed for the years 2010 through 2019.

Section 115 adds Section 786 “Commercial Deployment of Carbon Capture and Sequestration Technologies” to Section H of Title VII of the Clean Air Act. This section establishes a program to distribute bonus GHG emission allowances to new projects in the electricity and industrial sectors to help defray the costs associated with equipment and infrastructure needed to capture and sequester CO₂ emissions produced from the combustion of fossil fuels at these facilities. To be eligible for the bonus allowances allocated for this program, the project must derive at least 50 percent of its energy input from coal and/or petroleum coke. The first 6 gigawatts of approved capacity under this program are eligible to receive a \$90 bonus allowance for each metric ton of CO₂ captured and sequestered. Beyond the initial 6 gigawatts of capacity with CCS, an additional 66 gigawatts are eligible for bonus allowances on the basis of a reverse auction administered by EPA or, at EPA’s discretion, an alternative program for distributing the program’s remaining bonus allowances. Only 1 gigawatt of retrofitted CCS capacity at existing plants is eligible for bonus allowances allocated under this section. Qualified CCS projects are eligible for 1.75 percent of allowances established according to section 721(a) for the years 2014 through 2017, 4.75 percent of allowances for the years 2018 and 2019, and 5.0 percent of allowances for the years 2020 through 2050.

This program is represented within the analysis for this report by reducing the estimated costs of new coal-fired generating capacity by the value of the bonus allowances that the plant would be eligible to receive. The amount of new coal-fired generating capacity projected within a given forecast scenario is determined by a number of factors such as the costs and availability of electricity from other generating technologies, the availability of international and domestic offsets, and the projected levels of electricity demand.

Section 116 adds a new Section 812 “Performance Standards For New Coal-Fired Power Plants” to Title VIII of the Clean Air Act, which specifies that new power plants authorized under State or Federal law to derive at least 30 percent of their energy input from coal and/or petroleum coke will initially be required to capture and sequester a minimum of 50 percent of their potential CO₂ emissions. The CCS requirement rises to 65 percent for plants built in 2020 or later. Additionally, based on reviews of the standards to be completed by the EPA Administrator at 5-year intervals, and beginning no later than 2025, CCS requirements would be increased to levels higher than 65 percent if higher capture and storage rates are determined to be reasonably achievable. In the analysis completed for this report, new coal-fired power plants with CCS are assumed to capture and sequester 90 percent of their potential CO₂ emissions.

Peak Demand Reductions (Section 143)

This section requires States to determine and publish peak demand reduction goals for load-serving entities with a baseline above 250 megawatts. The Secretary, with the Federal Energy Regulatory Commission (FERC) and the North American Electricity Reliability Council, will develop a methodology for measurement and verification of demand response. The FERC report 2009 National Demand Response Potential Assessment should be used to help determine peak reduction goals. The load-serving entities must reduce peak load by 2012 and further by 2015, by amounts determined by each State.

This program is represented in the analysis by assuming that peak demand will be reduced by 3 percent by 2020, instead of the 1 percent assumed in the Reference Case due to ARRA.

Allocation of Emission Allowances (Sec. 782)

Section 782 (a)(1) allocates allowances for the benefit of electricity consumers, starting at 44 percent of total allowances in 2012 and falling over time through 2029, after which no further allowances are given out. Section 782 (a)(2) allocates a separate 0.5 percent specifically to small load distribution centers. For modeling purposes, these allowances are added together and treated as one allocation. Section 783 describes the method of distributing the allowances, with the majority going to LDCs to be used exclusively for the benefit of retail ratepayers. Up to 10 percent of the allowances under this section can be given to merchant coal generators, based on their qualifying emissions through a base historical period.

These allocations are accounted for in the electricity pricing calculations. The allowances given to merchant coal generators are calculated based on historic emissions, and the value of the allowances in each year would offset the rising fuel costs in the affected regions. The remaining allowances are shared to the regions based on a combination of historic emissions and overall electricity sales, as described in Section 783(b)(2) and Section 783(b)(3). The revenue from this allowance allocation is assumed to go to reduced distribution costs, lowering the distribution component of electricity price to all consumers.