CLIMATE POLICY AND ENERGY-INTENSIVE MANUFACTURING: THE COMPETITIVENESS IMPACTS OF THE AMERICAN ENERGY AND SECURITY ACT OF 2009

Report to the

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OVERVIEW

This report summarizes the results of a study on the economic impacts of H.R. 2454, the *American Clean Energy and Security Act of 2009* (*ACES*), as passed by the U.S. House of Representatives on June 26, 2009, on energy-intensive and trade-exposed (EITE) industries, performed by High Road Strategies, LLC (HRS) and the Millennium Institute (MI), in Arlington VA, under contract from the Environmental Defense Fund.[1] It examines the impacts on selected EITE manufacturing industries at the 5 to 6-digit NAICS levels[2]—iron and steel and ferroalloy products (33111), primary aluminum (331312) and secondary smelting of aluminum (331314),[3] paper and paperboard mills (32212,3), alkalies and chlorine (or chlor-alkalies, 325181), and petrochemicals (325110).

The analysis primarily focused on evaluating the effectiveness of the output-based allowance rebate measure in the *ACES* to mitigate greenhouse gas (GHG) emissions allowances costs directly and indirectly incurred by EITE industries, for the period 2012 (when *ACES* would go into effect) through 2025. Because it does not evaluate other cost mitigation measures in ACES—the international reserve allowance program (border adjustment tax) starting in 2020, and delayed phase out of the rebate program starting in 2026, both subject to Presidential discretion—it does not include potential cost impacts on the EITE industries after 2025.

The analysis may over-estimate the effect on companies' operating surplus between 2020 and 2025 *if* the international reserve allowance kicks in, in that period. The analysis' results also do not reflect the possibility that the industries might make energy-saving investments before 2025 or adopt breakthrough technologies that generate electricity onsite, which could minimize or preclude the need for additional cost offsetting measures. [The HRS-MI team, however, is conducting a follow-up study on the effectiveness of the border adjustment mechanism, in combination with the allowance rebates, to mitigate costs impacts through 2030.]

This work updates an earlier study that constructed and employed the Integrated Industry-Climate Change Model (II-CPM) to analyze the impacts of the *Lieberman-Warner Climate Security Act of 2007* (S. 2191) on these same industries, sponsored by the National Commission on Energy Policy (NCEP)/Bipartisan Policy Center, in Washington, DC. Results of the study, presented in *Climate Policy and Energy-Intensive Manufacturing: Impacts and Options* (June 2009), by Joel S. Yudken (HRS) and Andrea M. Bassi (MI) are compared to the findings of this analysis of H.R. 2454.

METHODOLOGY

Updating the industry models from the earlier HRS-MI study involved the following:

- **Update of financial, energy, industry and other data used in the II-CMP models.** Recalibrated the II-CPM with the most recent data: financial data (value of shipments, materials, capital, labor, energy purchases) from the Census

Bureau's Annual Survey of Manufactures (ASM); production, supply and other data from industrial statistical tables;[4] industrial energy consumption from the Energy Information Administration's (EIA) Manufacturing Energy Consumption Survey (MECS) 2006;[5] industry trade data from the US International Trade Commission (USITC);[6] and, market price projections from IHS-Global Insight.[7]

- **Characterization of the Reference (business-as-usual or BAU) and ACES cases.** Energy price projections through 2025 from the EIA *Annual Energy Outlook for 2009 (AEO2009)* were used to characterize the BAU case. Price projections for certain energy fuels (natural gas, coal) from the EIA analysis of the *ACES Basic Case*[8] were incorporated to partially account for the supply-demand dynamics of fossil fuels that would result from enactment of this policy (see appendix A). Table A summarizes key provisions of the *ACES*, including the *ACES Basic Case*, simulated by the II-CPM, and the Lieberman-Warner climate bill examined in the earlier study.

  Analyzing the *ACES Basic Case* entailed estimating the costs incurred on the selected EITE industries from the purchase of greenhouse gas (GHG) emission permits, and the cost mitigation impacts of the output-based allowance rebates, closely following the method to calculate allowances and rebates stipulated in *ACES*. These included the following steps:

  - *Calculate industry GHG (CO_2-equivalent) emissions for each industry*. The HRS-MI team considered using either an endogenous or an exogenous approach. The latter drew upon EPA, EIA documents and EPA and industry experts, to estimate baseline emissions outputs for each industry and extrapolate into future years.[9] The endogenous method directly converts energy consumed by the industries (from MECS) into GHG emissions—from fossil fuels (coal, coke, natural gas, residual and distillate fuel oils) directly combusted or used as feedstock in industrial processes, and the indirect emissions associated with electricity purchased by industrial enterprises.[10] Although subsequent modeling used both approaches, the endogenous method was used, largely to remain internally consistent with the II-CPM.[11]
  - *Calculate production-based allowance costs for each industry*. These are the costs incurred by each industry from the purchase of GHG allowance permits to cover their GHG emissions for each year, as required by the ACES policy. This entailed multiplying the industries' emissions levels by the emissions allowance prices generated by EIA analysis of the *ACES Basic Case*, using the National Energy Modeling System (NEMS).[12]

- **Calculate output-based rebate allocations for each industry.** *ACES* was designed to cover 100 percent of the production-based emissions allowance costs for each EITE industry in early years and then steadily fall off, covering a declining share of these costs over time, starting in 2014. It would provide a limited amount of free allowances each year to the EITE industries—up to 15% of all allowance permits in the economy. This number would begin to decline in

2021—falling sharply after 2025 to zero by 2035, unless the Presidential discretionary cost mitigation measures are put into effect. The II-CPM dynamically simulated the output-based rebates to each industry by calculating the yearly shares each would receive of this overall allocation, based on their shares of total emissions (direct and indirect) generated by EITE industries.[13]

- **Industry simulations of ACES impacts.** The updated II-CPM simulated the impacts of the *ACES Basic Case* on key economic variables (production costs, operating surplus) for the six industries. Only no cost pass-along (NCPA) scenarios were simulated. These reflect a worse—but also a more likely—case that these industries would experience with passage of the climate policy.[14]
- **Estimates of energy-efficiency requirements to offset cost impacts.** Based on the simulation results, estimates were made of the energy-efficiency gains required to offset the added costs from *ACES* relative to BAU, for each industry, on top of an assumed baseline 0.5% yearly energy efficiency improvement.[15]

SUMMARY OF FINDINGS

Allowance Rebates and Cost Mitigation.

The simulations of the *ACES Basic Case* impacts on EITE industries show that:

- ➢ Over the short-to-mid term, allowance rebates would substantially mitigate the costs of emissions permits on the production costs and operating surpluses of the industries;
- ➢ Cost mitigation would diminish as the allowance rebates start phasing out after 2020—paralleled by rising economic costs, though the extent and nature of these impacts would vary by industry.
- ➢ The cost impacts are modest through 2025, since the rebates diminish relative to emissions costs only slowly. However, it is possible to project that these impacts could accelerate after 2025, as the rebates rapidly fall off—unless the Presidential discretionary cost mitigation measures are put into effect, and/or the industries have made sufficient energy-saving investments.[16]

- **Production Cost Impacts.** Figure 1 (and table B) illustrates the impacts of emissions allowance costs and rebates on the production costs structures of industries (for steel, in this case) through 2025. The additions at the top of the columns from 2012-2025, represent, (i) the impacts of an allocation rebate program in place (*gray*), and (ii) the full impacts of emissions permit costs without an allocation rebate, on the production costs (*black + gray*).

  Figure 2 compares costs for an allocation and no allocation scenario, and the BAU case, (for paper and paperboard). This illustrates that the allocation rebate would almost fully offset allowance costs—as intended—at least through 2020. Costs would then rise steadily above BAU from 2020 on.[17]

Figure 3 compares production cost impacts relative to BAU for all the industries, from H.R. 2454 with the allocation (see also table B). The II-CPM projects 7 years of almost no impacts—the rebates completely cover emission costs—and then a steady rise in costs beginning in 2021, as production-based emissions allowance costs outpace the rebates.[18] Primary aluminum would suffer the largest increases, followed by chlor-alkalies, and paper and paperboard. Iron and steel and petrochemicals would experience more modest impacts relative to BAU, according to the II-CPM projections.

- **Operating Surplus Impacts.** Figure 4 shows the potential impacts of the *ACES* on the operating surplus of the steel industry, which is illustrative of the impacts on the other industries. As defined in Yudken and Bassi (2009), an industry's operating surplus is the difference between its total revenues and its production costs (materials and capital, labor, energy)—or, for NCPA, between market price and unit production costs, on a per unit basis. It encompasses some of the industry's fixed production costs, non-production variable costs, and profits (before taxes). As such, it is a reasonable indicator of how rising production costs from a climate policy might affect an industry's "bottom-line."[19]

  As with the production costs, in the II-CPM simulations show that the industries would suffer few cost impacts for the first eight years (see table B). The industries' operating surpluses then would shrink from 2020 on assuming business as usual and no significant increases in energy efficiency. Without an allocation measure the operating surplus declines would be far greater for all the industries, even before 2020, but especially after the rebates phase out, again assuming business as usual and no significant increases in energy efficiency..[20]

Energy Consumption, Emissions Outputs and Industry Impacts

As summarized in table B, the varied impacts of *ACES* on the industries (summarized in table B), reflect different market factors that influence market prices, input costs, and market demand and different patterns of energy consumption (fuels, electricity, and feedstock energy) and associated emissions. Figures 5a through 5e illustrate the relationship between an industry's market price, which is a reflection of its overall market conditions, and production costs and resulting operating surplus trends, comparing the allocation and no-allocation policy scenarios to BAU.

As the figures illustrate, for industries whose market prices are projected to trend high or show only small declines relative to BAU production costs—possibly implying expectations of strong demand and markets—the operating surpluses will be larger and less easily weakened by rising policy-driven costs. Conversely, a declining market price relative to BAU costs—indicating weakening demand and perhaps supply overcapacity—would result in shrinking operating surpluses, which could be exacerbated by increased costs due to a climate policy. These results assume only standard energy efficiency gains of 0.5% per year.

- **Primary aluminum** is the second most energy-intensive of the study's industries—energy accounts for 30-40 percent of production costs. It would suffer the largest impacts on its production costs and operating surplus after 2020, when rebates decline. With rebates after 2020, production costs would rise by about 4 percent and the operating surplus could fall by nearly 10 percent, relative to BAU, by 2025. Without a rebate, these cost impacts would much greater—15 percent and 39 percent, respectively. Production cost increases from emissions permits would cut into the industry's operating surplus—already shrinking due to market factors (see figure 5a)—deeper than production costs with rebates. Although electricity use is a significant source of the industry's cost increases,[21] the oxidation of carbon anodes during the alumina reduction process is an important source of CO_2 and other GHG emissions.[22]
- **Iron and steel**, in part because of its more favorable projected market conditions (see figure 5b), would experience a more modest impact. Coal, coke, natural gas and electricity are the largest sources of the industry's emissions, and emissions costs would equal 40 percent of its energy costs by 2025, with no rebate. Because energy costs are only 10-15 percent of total production costs (due to its high materials costs), the emissions allowance costs would drive up production costs by only a little more than 1 percent by 2025 with rebates—compared to 5 percent without rebates— and drive down its operating surplus by 4 percent—compared to 15 percent without rebates.[23]
- **Paper and paperboard** would experience moderate impacts. Its production costs are projected to rise by close to 2 percent, and operating surplus fall by about 5 percent, by 2025, *with a rebate*—compared to 7 percent and 22 percent, respectively, *with no rebate*. Energy fuels for combustion (coal, natural gas, residual fuel oil) would account for nearly 60 percent of the industry's emissions costs in 2012, rising to over two-thirds by 2025. Market factors also would be important, as the industry's real market prices and operating surplus are projected to fall steadily in the BAU case, which amplifies the production cost impacts arising from emissions permits (see figure 5c).
- **Alkalies and Chlorine** would suffer impacts comparable to paper and paperboard, though still somewhat less than primary aluminum. It is the most energy-intensive industry (46 percent of production costs, 2008), 60 percent of its energy costs and 57 percent of its emissions (rising to over 65 percent by 2025) coming from combusting fuels (natural gas, coal, LPG) and 40 percent of its costs and 43 percent of its emissions from purchased electricity in 2012. Its production costs would rise by over 2 percent, and its operating surplus would shrink by 5 percent (figure 5d), *with the rebate*, in 2025—compared 12 percent and 24 percent, respectively *with no rebate*.
- **Petrochemical Manufacturing** would experience the smallest impacts among the energy-intensive industries (i.e., not including secondary aluminum). Its production costs, *with a rebate*, would rise only 1 percent and its operating surplus would fall 2 percent relative to BAU by 2025 (figure 5e)—compared to 5

percent and 6 percent, respectively, *with no rebate*. Energy accounts about a fifth of its production costs: over 80 percent of which—and three-quarters of overall emissions—derive from feedstock energy (LPG, natural gas). These fuels have the lowest emissions intensity of all the energy sources, which may in part explains the relatively modest cost and operating surplus results.[24]

- **Secondary aluminum** is the least energy-intensive industry—energy costs account for under 5 percent of total costs (2008), about half from fuels (natural gas) and half from electricity, with comparable emissions shares. The industry would not be eligible for an allowance rebate (and EPA's analysis of EITE emissions),[25] under the criteria in the legislation, though it may still be required to purchase allowance permits to cover its carbon-based emissions. If required to cover all its emissions, its production costs would steadily rise, but only very modestly, to 2 percent by 2025, but its operating surplus would fall by 7 percent—greater than for petrochemicals.

Energy-Efficiency Gains Required

Figures 6a and 6b show estimates of energy-efficiency gains that would be required, for a given year, to offset the added costs of *ACES* from 2012-2025 for each industry. Figure 6a compares the gains if no rebates given to the industries and the gains if they received rebates, with a breakdown of the gains required for the three main energy types—fuels (for heat and power), feedstock energy, and electricity (purchased, and source of indirect emissions). The method of calculation used estimates the energy-efficiency gains (percent of Btus reduced relative to BAU) required for a given year, for the energy types, assuming only minor yearly efficiency gains of 0.5 percent are made in prior years.[26]

Figure 6b shows the energy efficiency gains required aggregating across all energy fuels consumed by an industry, comparing the no-allocation rebates and allocation cases. However, it must be noted that efficiency gains can only be achieved by making gains in the consumption of individual energy types, requiring different technologies and practices to achieve these gains. For example, investments in heat recovery technologies and internal electricity generation, and other incremental improvements, would reduce fuel combustion and purchased electricity. But, major production process changes may be needed to achieve desired efficiency gains and emissions reductions in the consumption of fossil-fuel feedstock in these industries.

Figure 7 provides a closer look, showing the efficiency gains required to offset the cost impacts from *ACES*, for the allocation and no allocation scenarios for iron and steel. The no allocation requirements not surprisingly are somewhat larger than the allocation scenario requirements. Nearly zero efficiency gains would be needed through 2020 for the allocation case, and modest to large gains would be required for the no allocation scenario, depending on the industry.[27] However, 2025 and later, because of the decline of rebate coverage and growth of emissions costs, the requirements for both the allocation and no allocation cases would continue to grow if no additional cost offsetting measures were implemented.[28]

The size of the requirement must be weighed against the baseline energy costs of an industry, however. For example, it appears that secondary aluminum would require large efficiency gains to offset the costs it would incur if it had to purchase emissions permits. However, its energy costs are under 5 percent of its production costs, and perhaps not until after 2025 would the added costs begin to grow large enough to warrant the industry making investments in energy savings.

COMPARISON WITH LIEBERMAN-WARNER

Although the basic cap-and-trade provisions and other elements are similar, there are important differences between the *ACES* and the Lieberman-Warner climate bill (*S. 2191*), and in the assumptions the EIA employed analyzing the two bills (see table A).[29] A major difference are the free allowance allocations *ACES* would provide to compensate energy consumers and energy-intensive businesses for higher energy costs, which would influence the macroeconomic and energy market responses to the bill. The EIA's analysis projects that output and employment impacts would be less than under *S. 2191*, as energy-intensive industries would be compensated for higher energy costs due to allowance prices.

Differences in the EIA analyses of the two bills also must be considered. The EIA's analyses of *S. 2191,* based on *AEO2008*, and of *ACES*, based on the latest *AEO2009,* included different energy price paths and macroeconomic growth assumptions. On the one hand, the long-run economic growth projected in *AEO2009* was only slightly lower at 2.4 percent, compared to *AEO2008* that projected a growth rate of 2.5 percent between 2008-2030. On the other hand, short-term growth was assumed to be lower in *AEO2009* relative to *AEO2008* as a result of the current recession.

In addition, the HRS-MI team employed very different methodologies to characterize and calculate the policy impacts on the industries in modeling the two bills. The analysis of S. 2191 relied on EIA's analysis of the bill, using its energy price projections to characterize the cost increases that would be incurred from the purchase of GHG emissions allowances. It proved to be very difficult to employ the same approach to analyzing H.R. 2454, largely because of problems accounting for the allowance rebates provided to industry, generators and other entities. Instead, the HRS-MI team decided to construct a "bottom-up" model, that directly calculates emissions allowance costs and the subsequent output-based rebates for each industry, using the *II-CPM*, as described above.

Hence, caution must be taken in comparing the results of the two studies. See, for example, comparisons of the production and operating surplus impacts for the two climate bills in table C and of energy-efficiency requirements for ACES, S.2191 and

S.2191 with an assumed 90 percent allocation (modeling in the earlier study) shown in table D.

The results for a few of the industries are somewhat different across the two studies. Primary aluminum exhibits significantly greater cost impacts in the Waxman-Markey analysis than in the Leiberman-Warner study. This in part might be attributed to calculating and incorporating the large feedstock (carbon anode, alumina) emissions costs in the current approach, which were only approximated in the earlier work. At the same time, the iron and steel industry seems to make out better under H.R. 2454, especially with the rebate, than under S. 2191. On the other hand, petrochemicals would experience somewhat smaller impacts under S. 2191 compared to H.R. 2454,[30] though these impacts would be very modest in both cases.

Despite their differences, some broad conclusions can be drawn that hold for both analyses. Both suggest that, assuming no cost mitigation measures (allowance rebates, border adjustments) are enacted or the industries do not invest in new energy saving production and process technologies, *EITE industries would eventually experience growing and potentially troubling cost impacts from a cap-and-trade policy that could threaten their competitiveness in the face of global competition*. Both studies also show that, lacking cost mitigation, *the industries, over time*, *would require increasing, and eventually, at least in some instances, substantial energy efficiency gains to offset the growing impacts of a carbon policy*. On the other hand, if they invest in becoming more energy-efficient and low-carbon, they could cut costs and increase their competitiveness.

At the same time, both studies clearly show the benefits of implementing some kind of allowance allocation rebate to offset the costs incurred by the industries. The H.R. 2454 rebates, in fact, are more generous than the assumed 90 percent allocation policy under S.2191 evaluated in the earlier study, at least over the first decade of the policy time period.[31]

Methodology Note

Both approaches have strengths and weaknesses. The price-based approach used in the early study assumed that the energy prices generated by the EIA NEMS analysis of *S. 2191* were price equivalents reflecting costs associated with the purchase and trading of emissions allowances. The emissions costs and rebate calculation approach capture more directly and perhaps more accurately the costs impacts for the industries at a more disaggregated level. In any event, it was not possible to back out the allowance rebates for the study's industries and adequately separate them from the larger EITE and industrial categories evaluated by NEMS.

Some attempt was made in the emissions-based approach to take into account some of the energy supply and demand dynamics that would result in changing prices relative to BAU (see appendix A), that were directly taken into account in the price-based approach (i.e., by NEMS), though some second order effects still might have been missed. On the other hand, the highly aggregated, macroeconomic model used by the EIA, that generated the prices used in the original study, also might have dampened down impacts that become more visible only when a less aggregated approach, such as used in the current study, is employed.

ENDNOTES

1 The National Commission on Energy Policy and the AFL-CIO Working for America Institute also contributed funding support, as part of a larger project, towards completion of this update.

2 NAICS is the North American Industrial Classification System. Low-digit (2, 3) NAICS are assigned to industry sectors at the highest levels of aggregation (e.g., 31-33 includes all manufacturing industries, 322 includes all paper manufacturing industries, 325 is chemicals manufacturing, and 331, primary metal manufacturing). Most analyses of climate policy impacts on industry look at industrial sectors only at the highly aggregated 2-3 digit NAICS levels. However, the most energy and emissions-intensive industries in the economy are sub-sectors within low-digit NAICS sectors, with 4-6 digit NAICS codes. At the same time, many non-energy-intensive industries also fall within the aggregated low-digit NAICS industrial categories. Hence, the current and earlier HRS-MI studies focused on a selected group of highly energy-intensive industries at the 5-6 digit NAICS levels, to obtain a better understand of how climate policies would affect the EITE manufacturing sector.

3 Secondary aluminum industry is only marginally an energy-intensive industry (only 5% energy footprint of primary aluminum). It uses different processing technologies—based solely on producing aluminum ingot from recovered/recycled aluminum—in different plants and locations, and it is not considered a trade-vulnerable industry. However, its products are chemically and mechanically indistinguishable from aluminum produced by primary aluminum smelters. Its goods are sold in common aluminum markets, also subject to the prices set in the London Metal Exchange (LME) which handles most of the sales and sets prices for aluminum for global markets. It's inclusion in the study allowed a comparison and counterpoint to its sibling industry and the other energy-intensive industries examined in the study.

4 This includes annual statistical reviews provided by the American Iron & Steel Institute, the Aluminum Association, American Forest and Paper Association, and American Chemistry Council.

5 The EIA only recently released its MECS 2006 survey, which it conducts and releases every four years. These data may account for some of the differences between the ACES analysis and Lieberman-Warner analysis, though with the exception of the petrochemicals industry, the energy consumption mixes and consumptions levels are reasonably consistent with prior year consumption patterns. The petrochemicals data showed substantially different feedstock energy consumption quantities from the MECS 2002 data, and earlier. There also was an added level of uncertainty because of withheld data in the MECS database, because of concerns about protecting proprietary information, in the petrochemicals—and to a lesser extent, aluminum.

6 This includes general imports (custom values and quantities), FAS exports (values and quantities), and import charges.

7 The earlier NCEP-supported study used data provided from IHS-Global Insight to project commodity market prices for each industry and adjusting materials cost projections accordingly. These data were the most recent data available as of late 2008 and early 2009, and therefore at least reflected the early impacts of the recession that drove down demand and market prices for these industries. This data also was used in the current analysis, as more up-to-date data (for 2008) was not available at this time.

8 Energy Information Administration, *Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009,* SR/OIAF/2009-05 (Washington, DC, August

2009); —, *An Updated Annual Energy Outlook of 2009 Reflecting Provisions of the American Recovery and Reinvestment Act and Recent Changes in the Economic Outlook,* SR/OIAF/2009-03 (Washington, DC, April 2009). The EIA analysis of ACES also examines several other cases based on varying assumptions about international offsets, generation technology costs, banking of allowances, etc.

9 See U.S. Environmental Protection Agency, "Comparison of FTI and EPA analyses of H.R. 2454 Title IV," Memorandum to the House Energy & Commerce Committee Staff, June 10, 2009; Mark Schipper, "Energy-Related Carbon Dioxide Emissions in U.S. Manufacturing," Report #: DOE/EIA-0573(2005), Energy Information Administration, November 2006.

10 That is, historical energy consumption values were taken from MECS and future projections were derived by the II-CPM. Emissions are calculated by multiplying energy consumption (by source, in Million BTU, with the exception of electricity), by the carbon equivalent emission factor of each energy source (as reported by the Intergovernmental Panel on Climate Change (IPCC), *IPCC Guidelines for National Greenhouse Gas Inventories,* Volume 1, Table 1.4, 2006). For electricity, emissions calculations entailed multiplying carbon intensity per kWh (calculated by NEMS) by electricity consumption. Since under the climate policy there would a steady shift to lower carbon electricity generation, electricity carbon intensity would fall accordingly. Adjusted carbon intensity data for electricity was provided by Lessly A. Goudarzi, CEO and Managing Director of OnLocation, Inc., Vienna, VA, November, 2009.

11 The two methods yield similar results in the modeling runs. However, using the exogenous method in the II-CPM modeling runs showed allowance rebates falling below production-based allowance costs earlier (2018) than predicted than using the endogenous method (2021). The latter, therefore, represents a more optimistic scenario than using the EPA-based emissions numbers as the baseline for calculating emissions allowances and output-based rebates.

12 The emissions values for a given year used to calculate production-based allowance costs were the averages of the prior-year emissions, as stipulated in legislation (as they are calculated by multiplying production output and production unit energy consumption levels for each fuel used as fuel or feedstock, or purchased electricity). It was assumed that the costs for combustion fuel and feedstock emissions generated by each industry, and the indirect emissions associated with purchased electricity, would not to be incurred until 2014, as stipulated in the legislation.

13 The share for each industry for a given year was based on its share of total production-based emissions generated averaged over the two-prior years. The industries in the current study accounted for nearly half of all EITE-eligible industries, averaged over 2004-2006, based on EPA and EIA analyses. See EPA (2009) and Schipper (2006). Because of a lack of data regarding all other EITE industries, it was assumed that this share would remain fixed throughout the time frame examined in the study—that is production levels (and therefore emissions) would grow at a rate comparable to the study's industries. However, the dynamic calculations incorporated into the II-CPM did enable estimates of the shifting shares for each industry relative to the other industries in the study group.

14 As discussed in Yudken and Bassi (2009), since these industries are trade-sensitive and market prices tend to be set in global markets, they typically would have difficulty passing along higher energy costs arising from a geographically limited policy, as many foreign competitors would not be subject to these cost impacts.

15 That is, the gains required to offset the added costs of higher prices for fuel, electricity, and feedstock energy for a given year, assuming no substantial gains were made in prior years.

16 The acceleration of cost impacts after 2025, when allowance rebates begin to sharply decline unless Presidential discretion is used to delay phase-outs of allowances, are illustrated in the HRS-MI's modeling of border adjustment and alternative policy options in a study still underway, which projects cost impacts (production costs, operating surplus) through 2030, comparing the allocation and no allocation cases, and with and without border adjustment fees introduced.

[17] The study currently underway by the HRS-MI team, modeling border adjustment fees and alternative policy options through 2030, shows that the industries, with allocation rebates—but with no other cost mitigation measures in effect—would start to see costs rising after 2025 unless Presidential discretion is used to delay phase-outs of allocations, to levels that would be incurred with no allocations by 2030, as production-based allowance costs grow (tied to GDP growth) relative to shrinking rebates.

[18] The modest fluctuations in these costs for each industry relative to their BAU levels are wholly a result of comparable fluctuations in the prices for natural gas, coal, and coke used in the model, based on the projected wholesale prices for these fuels in the EIA analysis of the *ACES Basic Case.* As described in appendix A, these prices were used to better take into account in the model some of the supply dynamics for these fuels that would result from enactment of the bill, i.e., eventually demand for these fuels would diminish, resulting in lowered prices relative to BAU. For the same reason, a diminishing emissions intensity associated with electricity generation was assumed, as fossil-fuel generated electricity is projected to decline in the policy case (see n. 9, above).

[19] See Yudken and Bassi (2009) for further explanation of operating surplus, its definition and measurement. As explained in Yudken and Bassi (2009), operating surplus impacts are somewhat contingent on projected market price projections, as estimated by IHS-Global Insight. When market prices are high or growing, the higher energy costs from a climate policy might not have as significant an impact as when market prices are relatively low shrinking.

[20] As noted above, the HRS-MI study, currently underway, which models the impact of border adjustment and alternative policies on EITE industries through 2030, shows large rises in production costs and sharp drop-offs in operating surpluses after 2025, even with the allocation rebates, <u>if</u> no other mitigation measures are in place, and no cost-saving, energy efficiency investments have been made by the industries. For some industries (primary aluminum, and to a lesser extent paper and paperboard, chlor-alkali), the operating surplus decline could be dramatic, portending potentially serious threats to their competitiveness if actions are not taken to mitigate or avoid these costs.

[21] Electricity costs account for about 70 percent (2008) of the industry's energy costs, reflecting costs passed along from electricity generators' emissions permit costs. Emissions allowance costs, however, would not be as proportionally large, as it is estimated that at least half of all electricity purchased by primary aluminum smelters in the United States comes from hydro-electric power plants, which do not have any associated greenhouse emissions. To reflect this, the II-CPM model assumes that the industry would incur only half the emissions allowance costs it would incur if the national average emissions associated with the total quantity of electricity it is projected to purchase. In addition, as noted above (n. 9), the calculated indirect emissions costs associated with electricity generated using fossil-fuels were deflated, using a declining carbon intensity coefficient (i.e., MT CO_2-equivalent per kWh), based on an assumption that electricity generators would shift over time to lower-carbon fuels.

[22] See Office of Air and Radiation, U.S. Environmental Protection Agency (EPA), *Technical Support Document for Process Emissions From Primary Production of Aluminum: Proposed Rule for Mandatory Reporting of Greenhouse Gases,* February 4, 2009. Alumina and carbon anode emissions account for about 30 percent of the primary aluminum industry's GHG emissions (see table B), including its indirect emissions from electricity consumption. According to the EPA, "CO2 is emitted during the aluminum smelting process when alumina (aluminum oxide, Al_2O_3) is reduced to aluminum using the Hall-Heroult reduction process. . . . The reduction cells contain a carbon lining that serves as the cathode. Carbon is also contained in the anode, which can be a carbon mass of paste, coke briquettes, or prebaked carbon blocks from petroleum coke. During reduction, most of the carbon in the anode is oxidized and released to the atmosphere CO_2." The industry is also a source of PFC emissions. (p.3).

[23] The iron and steel industry is an aggregate of two major steel making segments with different production processes and energy consumption mixes: the integrated steel mills (basic oxygen

furnace, BOF) highly reliant on coal and coke for feedstock and fuel, and the electric arc furnace (EAF) mills which are mostly reliant on electricity. BOF mills have a substantially larger energy footprint than EAF mills. An analysis that examines the impacts of emissions permit costs and rebates for each segment would reflect their different energy mix and associated emissions. The integrated mills would experience sharply higher emissions costs due to coal, coke and natural gas consumption. The EAF segment's costs would show greater effects from electricity-related emissions, though as noted above, declining carbon intensities in the electric power sector would dampen these impacts. Due to of lack of data—not to mention and time and resources—the HRS-MI team did not attempt to tease apart the relative contributions of these two important steel sectors in its models. However, a preliminary treatment can be found in the iron and steel chapter (chapter five) in Yudken and Bassi (2009).

24 There is some uncertainty whether the primary fuel used in petrochemicals production, as feedstock is LPG or natural gas liquids (NGL), which are lumped together in the MECS databases. Both the earlier study and the current models have used LPG as the source, though industry experts have noted that NGL may also been more widely used than indicated. Yudken and Bassi's (2009) chapter on the chemicals industry (chapter eight) examines the potential impacts if NGL was the primary feedstock rather than LPG. The preliminary results of that work suggest however that the differences would not be as great if LPG is used. On a different note, although LPG/NGL feedstock consumed in the production of petrochemicals does result in some release of CO_2 and GHG's into the atmosphere, these feedstock fuels may also be chemically locked into petrochemical products, and "nonemissive" in the definition used in the Waxman-Markey bill. The legislation allows for some "compensatory allowances" for the "nonemissive use, in 2012 or later, of petroleum-based or coal-based liquid, natural gas as a feedstock, if allowances or offset credits were retired for the greenhouse gases that would have been emitted from their combustion," See H. R. 2454, Sec.721(f)(1)(B), p. 729.

25 See EPA (2009). Secondary aluminum is not listed as an EITE-eligible industry in this document. This was confirmed by subsequent conversations with EPA staff.

26 That is, the energy-efficiency gains would be on top of an assumed annual O.5 percent energy-efficiency gain in all the simulations.

27 The small rises in energy efficiency requirements before 2020 which then go into negative territory by 2020 (which in the real world, means no efficiency gains are required), reflect the supply-demand dynamics, and subsequent price variations, of natural gas, coal and coke under the policy case. Natural gas prices in particular rise above the reference initially, before falling substantially below BAU from 2019 on. See appendix A for further discussion.

28 The results from HRS-MI new study (nearing completion) show that without other cost mitigating policies, and assuming no cost-saving investments are made by the industries, the allocation requirements would rapidly grow, approaching the no allocation levels by 2030.

29 Energy Information Administration*, Energy Market and Economic Impacts of S. 2191, the Lieberman-Warner Climate Security Act of 2007,* SR/OIAF/2008-01 (Washington, DC, April 2008); —, *Annual Energy Outlook of 2008,* DOE/EIA-0383(2008) (Washington, DC, April 2008).

30 The difference impacts on petrochemicals may also be due to different price projections for LPG, a major fuel consumed by the industry, in the two EIA analyses.

31 However, the results from HRS-MI new study (nearing completion) show that, assuming no other cost mitigating policies and no cost-saving investments are made by the industries, from 2025 on, the assumed 90 percent allocation (which would only decrease by 2 percent annually) might actually result in better gains for the industries, which would experience continued sharp increase in emissions costs, under H.R. 2454, as their rebates rapidly phase out after 2025 (continuing down to zero by 2035). For example, Under the S. 2191 90% assumed allocation scenario, cost impacts would be only about half of the no allocation case by 2030. However, for the ACES Basic Case, with a rebate, the costs impacts would be around three-quarters of the no-allocation case.

Table A: Comparison of ACES and S. 2191 Provisions and EIA Analyses

<table>
<tr><th>American Clean Energy and Security Act of 2009
(ACES; H.R. 2454)[*]</th><th>Lieberman-Warner Climate Security Act of 2007
(S. 2191)[**]</th></tr>
<tr><td>Reference Case (AEO 2009)[†]:
• Reflects impact of American Recovery and Reinvestment Act, Energy Improvement and Extension Act of 2008, Energy Independence and Security Act of 2007, Energy Policy Act of 2005
• Long-term economic growth 2.4 % 2008-2030
• Short-term growth substantially lower than AEO2008 due to current recession</td><td>Reference Case (AEO 2008)[††]:
• Includes provisions of Energy Independence & Security Act of 2007,
• Assumes continuance of other current laws and regulation
• Long-term economic growth 2.5% 2008-2030</td></tr>
<tr><td>ACES—all EIA analysis cases:
• GHG cap-and-trade program for gases other than HFCs
— ~84% of total US GHG emissions covered <u>by</u> 2016
— 17% reduction by 2020, 58% in 2030, 83% by 2050, relative to 2005
• Provisions for allocation of allowances to electricity and natural gas distribution utilities, low-income consumers, State efficiency programs, rebate programs, energy-intensive industries, other purposes
• CCS demonstration and early deployment program
• Federal building code updates
• Federal lighting and appliances efficiency standards
• Technology improvements driven by Centers for Energy and Environmental Knowledge and Outreach
• Smart grid peak savings program</td><td rowspan="2">S. 2191 Core Case:
• GHG cap-and-trade program capping GHG emissions, including HFCs from <u>production</u> of HCFCs
— ~87% of total US GHG emissions in 2006
— 39% reduction by 2030, 72% by 2050, relative to 2006
• Allowances tradable and bankable
• Allowance price ($2006/mt CO_2-equivalent): $30 in 2020, $61 in 2030
• Increasing share of auctioned allowances, proceeds used for low-carbon energy technology programs
• Remainder distributed for transition assistance to covered entities, energy consumers, manufacturers; incentives for CO_2 sequestration; States; forest protection and research;
• Key low-emission technologies—nuclear, coal with CCS, developed and deployed n timeframe consistent with emissions reduction requirements without major obstacles
• Bonus credit incentives for CCS
• Domestic and international offsets, each capped at 15% of total allowance obligations each year
• Incentives for CCS, biogenic carbon sequestration
• Stringent appliance efficiency and building codes</td></tr>
<tr><td>ACES Basic Case:
• Also assumes use of domestic and international offsets, not severely constrained by cost, regulation, pace of negotiations with key countries covering key sectors
• Assumes covered entities will bank total of approx. 13 BMT by 2030 through offset usage, emissions reduction that exceeds level required under emissions cap
• Allowance price ($2007/mt CO_2-equivalent): $31.7 in 2020, $64.8 in 2030</td></tr>
<tr><td>Provisions of ACES not addressed:
• Clean Energy Deployment Administration
• Strategic allowance reserves
• Separate cap-and-trade program for HFCs
• GHG performance standards for activities not covered by cap-and-trade
• Distribution of allowances to coal merchant plants
• Effects of increased investment in energy R&D</td><td>Not addressed:
• International policies to encourage emissions reductions
• Separate cap for <u>consumption</u> of HFCs beginning in 2010
• Allocation of allowances to new fossil generators as a function of their generation</td></tr>
</table>

[*] Energy Information Administration*, Energy Market and Economic Impacts of H.R. 2454, the American Clean Energy and Security Act of 2009,* SR/OIAF/2009-05 (Washington, DC, August 2009).

[**] Energy Information Administration*, Energy Market and Economic Impacts of S. 2191, the Lieberman-Warner Climate Security Act of 2007,* SR/OIAF/2008-01 (Washington, DC, April 2008).

[†] Energy Information Administration, *An Updated Annual Energy Outlook of 2009 Reflecting Provisions of the American Recovery and Reinvestment Act and Recent Changes in the Economic Outlook,* SR/OIAF/2009-03 (Washington, DC, April 2009).

[††] Energy Information Administration, *Annual Energy Outlook of 2008,* DOE/EIA-0383(2008)(Washington, DC, April 2008).

Figure 1–
Iron & Steel Industry Cost Structure, 2008-2025

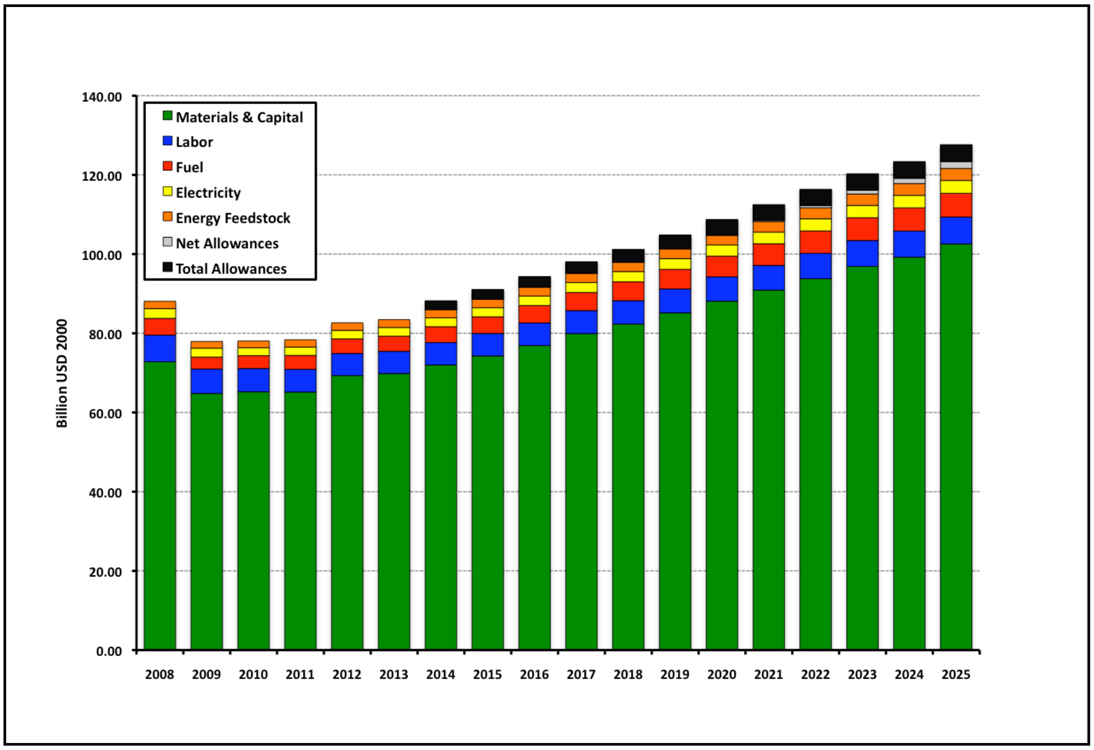


Figure 2–
Paper & Paperboard Real Production Costs, 2006-2025

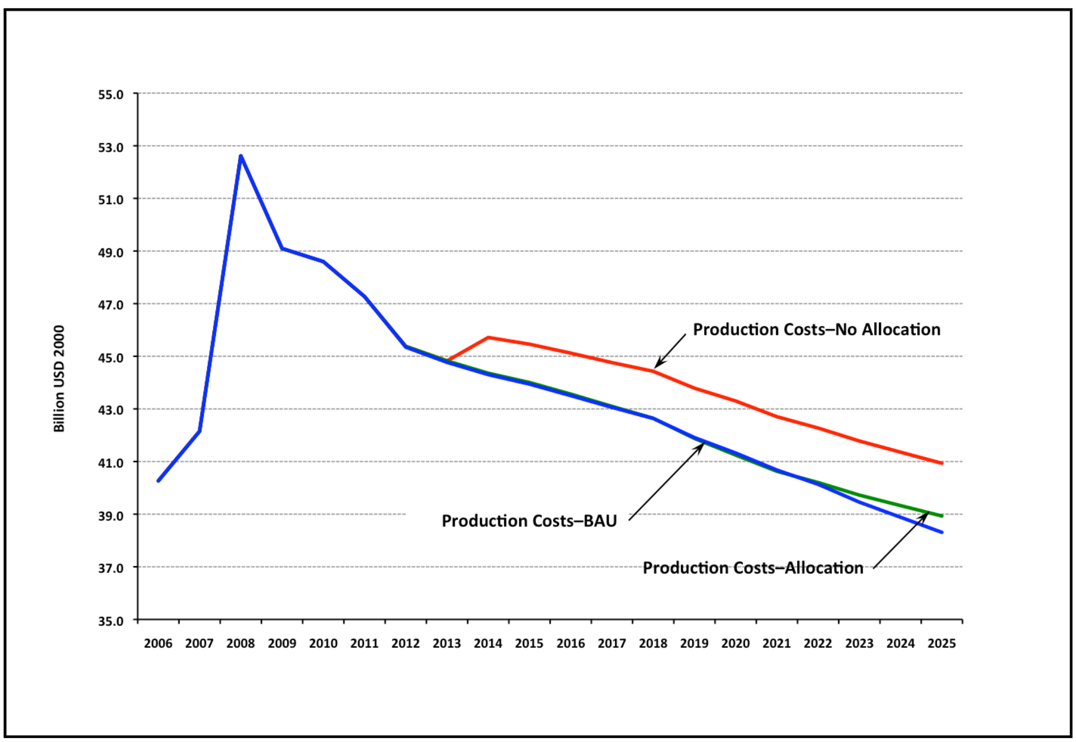


Table B: Summary of Results

Industry [NAICS]	Energy Cost Share* (2008)	Primary Energy Sources	Emissions Characteristics		Production Costs (% Above BAU)				Operating Surplus (% Above BAU)			
					No Allocation		Allocation		No Allocation		Allocation	
			Energy Type	% of Industry Emissions (2012)	2020	2025	2020	2025	2020	2025	2020	2025
Primary Aluminum [331312]	36.0%	NG, Petro Coke, RFO, Elect	Fuel	4.3	10.8	14.9	-0.2	3.7	-23.8	-38.7	0.5	-9.7
			Feedstock	44.3								
			Electricity	51.4								
Secondary Aluminum [331314]	4.4%	NG, Elect	Fuel	38.2	1.3	1.7	—	—	-5.0	-7.2	—	—
			Electricity	61.8								
Iron & Steel [33111]	10.0%	Coal, Coke, NG, RFO, Elec	Fuel	35.8	3.6	4.7	-0.1	1.2	-11.6	-14.9	0.3	-3.9
			Feedstock	35.4								
			Electricity	28.7								
Paper & Paperboard [32212,3]	13.1%	Coal, NG, RFO, Elect	Fuel	58.3	4.8	6.9	-0.2	1.6	-13.4	-22.1	0.5	-5.2
			Electricity	41.7								
Petro-chemicals [325110]	19.0%	NG, LPG, RFO	Fuel	15.5	3.5	4.9	-0.1	1.3	-4.2	-6.0	0.1	-1.6
			Feedstock	76.7								
			Electricity	7.9								
Chlor-Alkalies [325181]	45.9%	NG, Coal, LPG, Elect	Fuel	57.3	9.2	11.6	-0.6	2.3	-18.9	-24.4	1.3	-4.8
			Electricity	42.7								

NG= Natural Gas; RFO = Residual Fuel Oil; LPG = Liquefied Petroleum Gas; Elect = Electricity; Petrocoke = Petroleum Coke
** Energy share of production costs*

Figure 3–
Production Costs Above BAU—All Industries
Allocation Scenario, 2008-2025

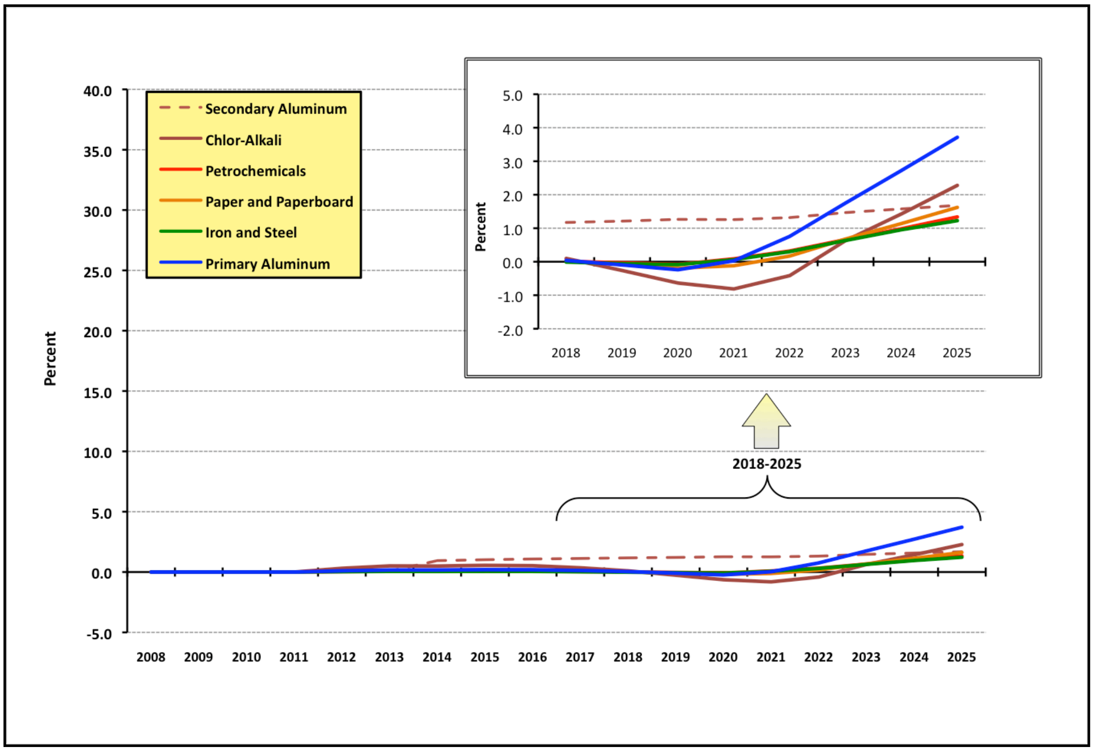


Figure 4–
Iron & Steel Industry Real Operating Surplus, 2008-2025

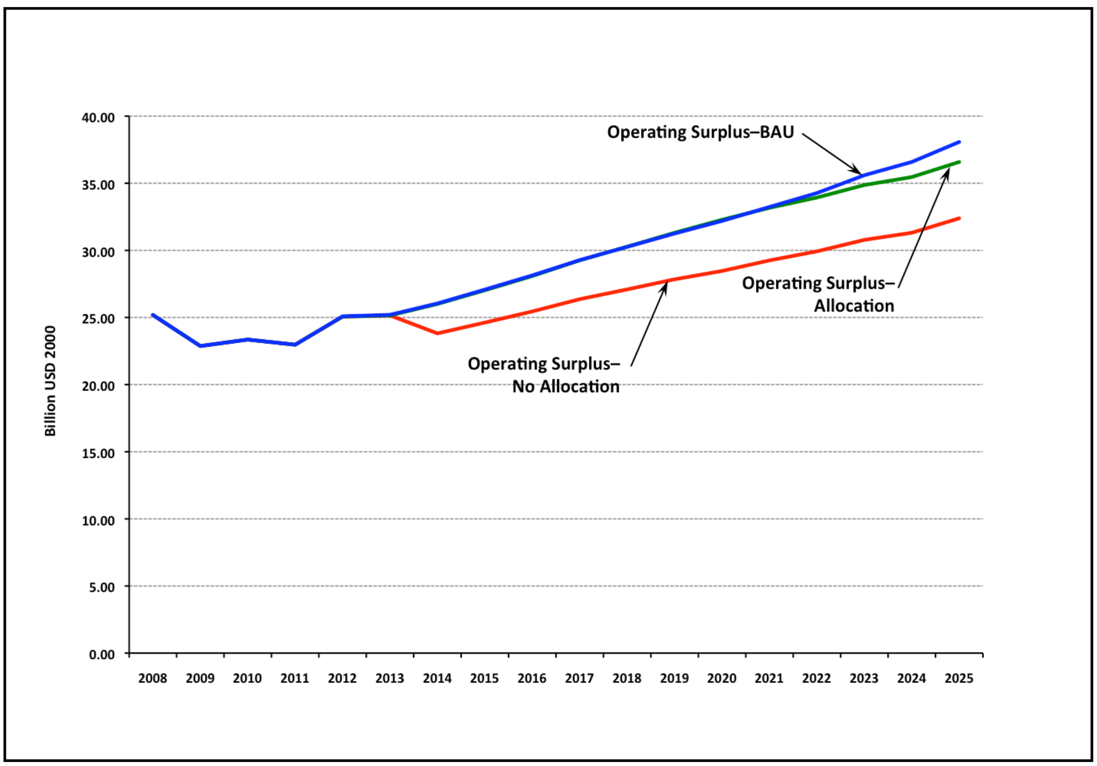


Figure 5a–
Primary Aluminum Production Costs and Operating Surplus, 2006-2025

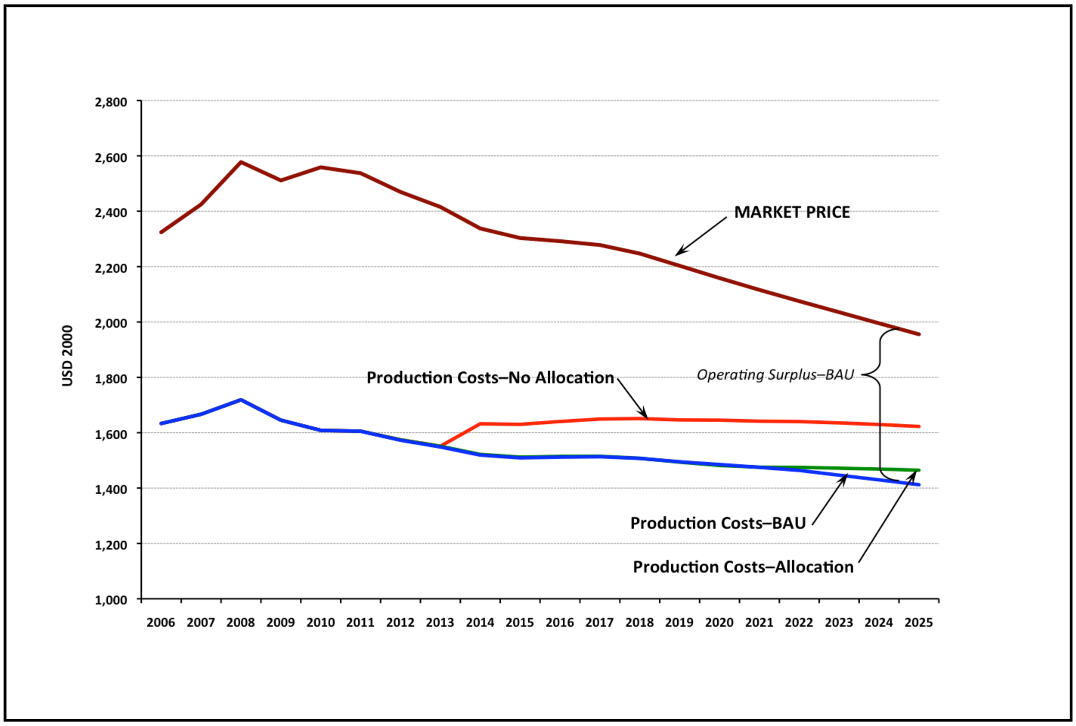


Figure 5b–
Iron & Steel Production Costs and Operating Surplus, 2006-2025

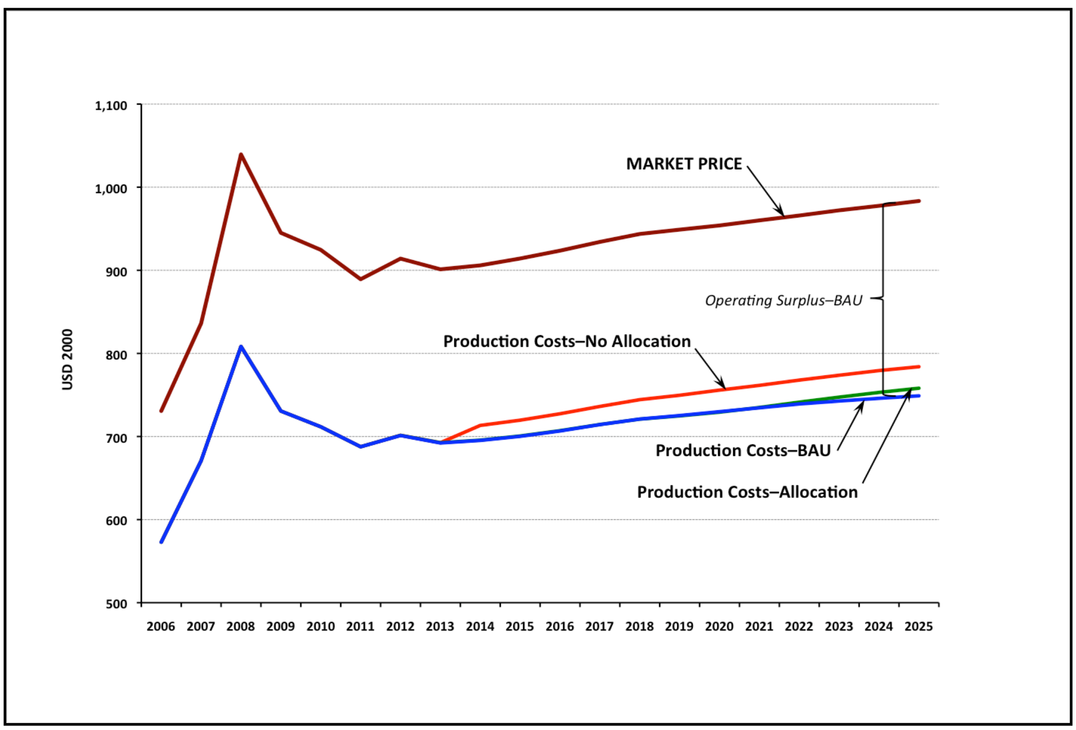


Figure 5c–
Paper & Paperboard Production Costs and Operating Surplus, 2006-2025

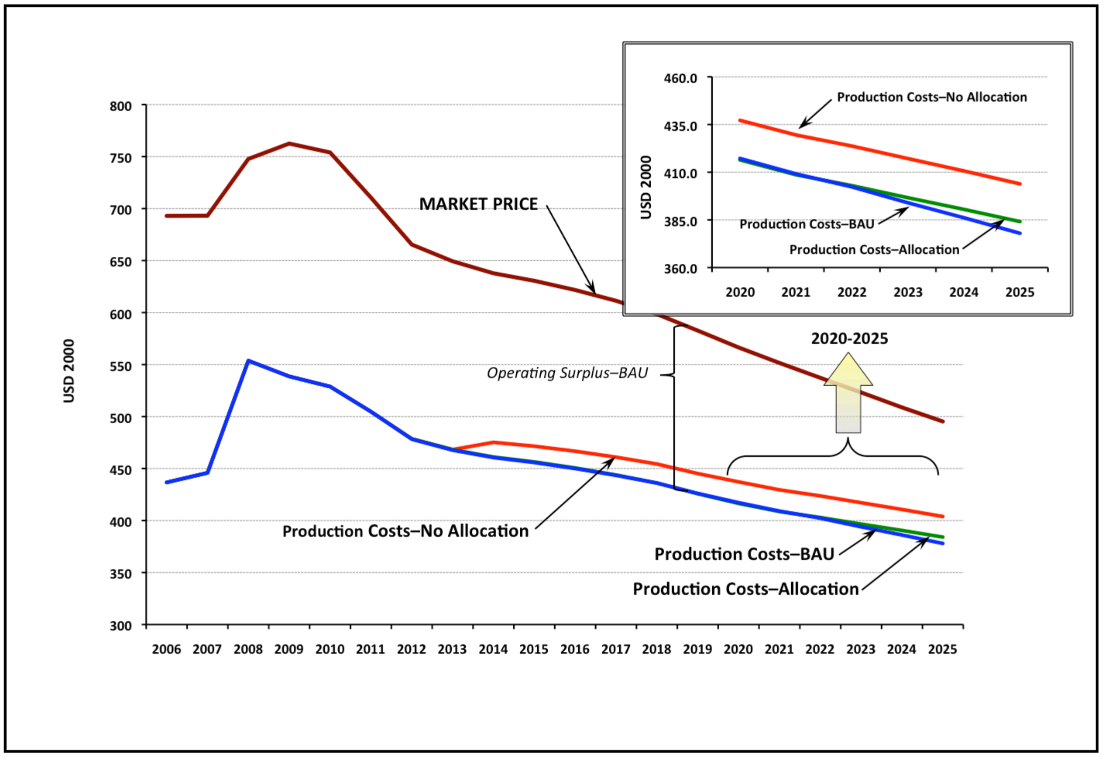


Figure 5d–
Petrochemicals Production Costs and Operating Surplus, 2006-2025

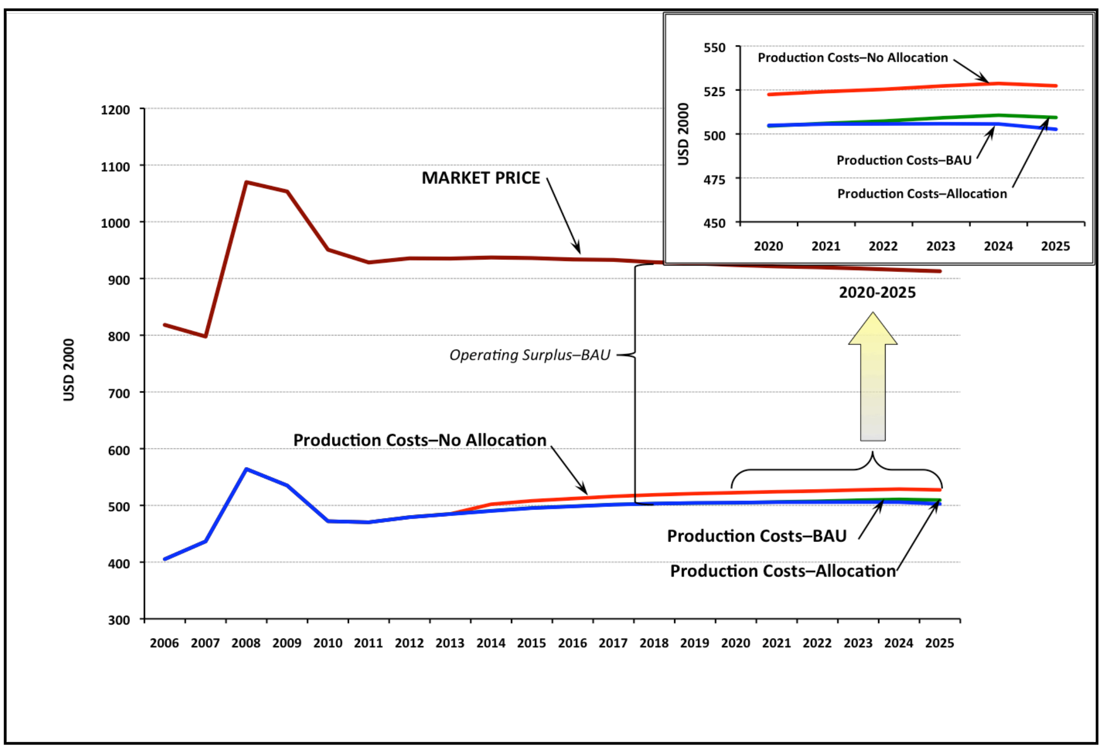


Figure 5d–
Chlor-Alkalies Production Costs and Operating Surplus

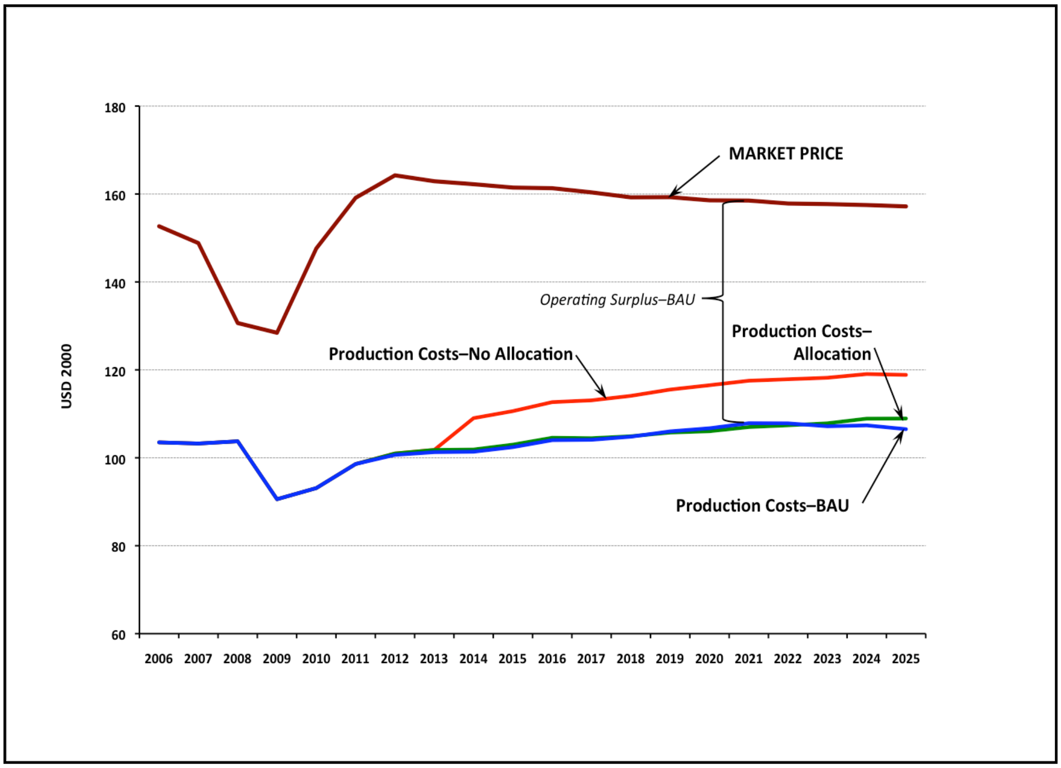


Figure 6a–
Energy Efficiency Gains Required (Percent)—2025

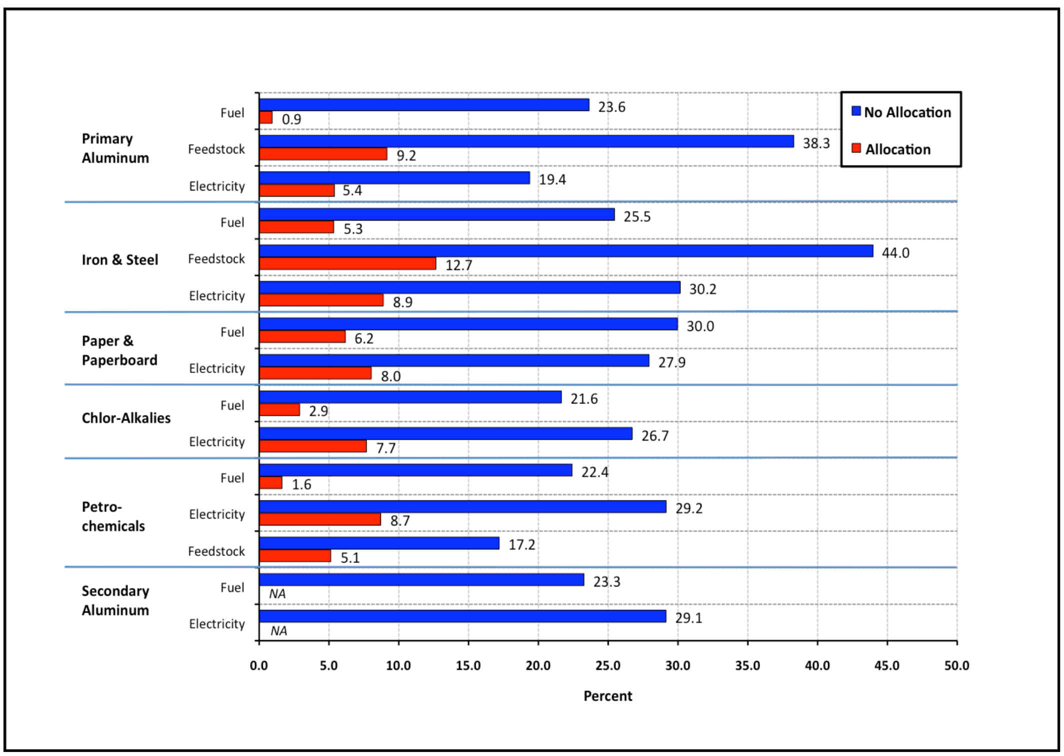


Figure 6b–
Total Energy Efficiency Gains Required (Percent)—2025

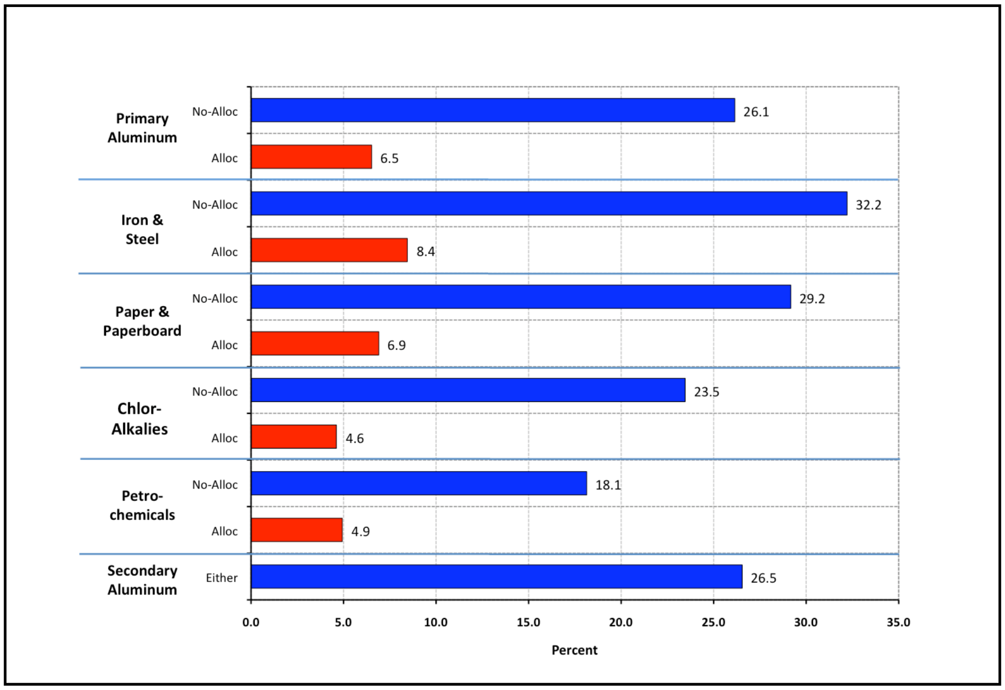


Figure 7–
Energy Efficiency Gains Required, Iron & Steel Industry Allocation and No Allocation Scenarios, 2012-2025

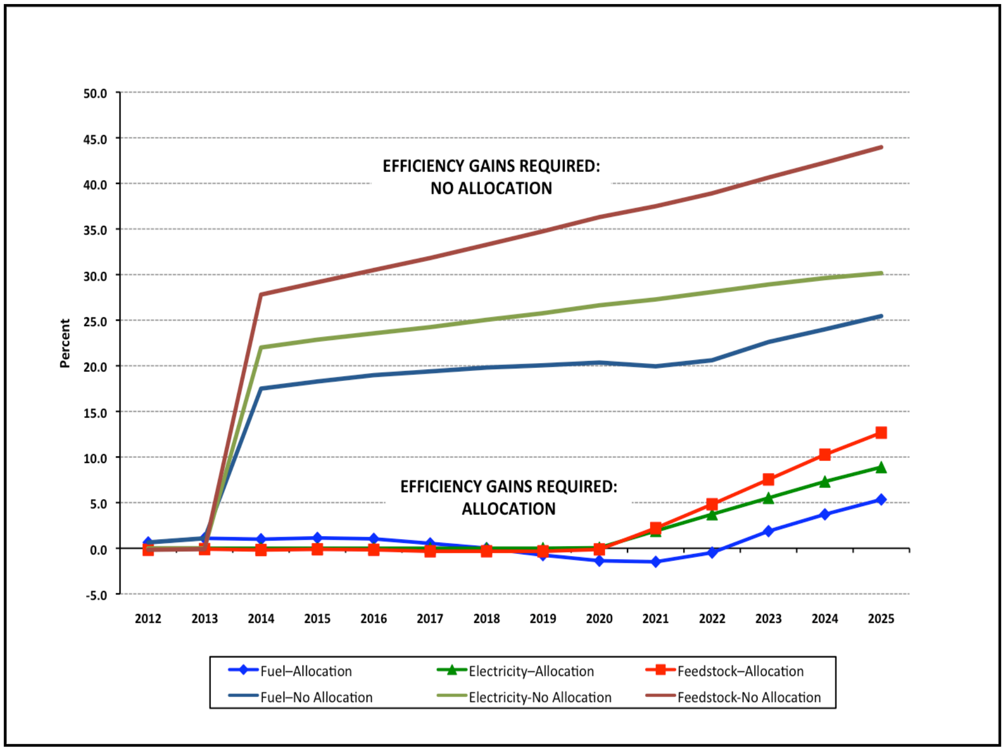


Table C: Comparison of ACES (with Allocation) and S. 2191 Production Costs and Operating Surplus Impacts

Industry	2020		2025	
	ACES	S. 2191	ACES	S. 2191
Production Costs Above BAU (Percent)				
Primary Aluminum	-0.2	2.6	3.7	4.5
Secondary Aluminum*	1.3	0.8	1.7	1.2
Iron & Steel & Ferroalloys	-0.1	6.7	1.2	8.7
Paper & Paperboard	-0.2	4.0	1.6	6.0
Petrochemicals	-0.1	1.0	1.3	1.1
Chlor-Alkalies	-0.6	5.5	2.3	7.7
Operating Surplus Above BAU (Percent)				
Primary Aluminum	0.5	-6.4	-9.7	-13.0
Secondary Aluminum*	-5.0	-3.1	-7.2	-5.3
Iron & Steel & Ferroalloys	0.3	-24.0	-3.9	-30.5
Paper & Paperboard	0.5	-11.7	-5.2	-20.5
Petrochemicals	0.1	-1.2	-1.6	-1.4
Chlor-Alkalies	1.3	-10.0	-4.8	-14.4

** Secondary Aluminum ACES values are for No Allocation scenario only.*

Table D: Comparison of Energy-Efficiency Gains Required by Industry—ACES (with Allocation), S. 2191 and S. 2191 with an Assumed 90% Allocation

Industry	Energy Source	2020			2025		
		ACES	S. 2191	S. 2190 90%	ACES	S. 2191	S. 2190 90%
Iron & Steel	Feedstock	*	40.6	15.1	12.7	55.4	30.9
	Electricity	0.1	7.9	2.2	8.9	13.1	5.1
	Fuel	*	49.1	20.0	5.3	46.7	24.0
Paper & Paperboard	Electricity	0.0	7.9	2.2	8.0	13.1	5.1
	Fuel	*	28.0	9.2	6.2	32.8	15.0
Primary Aluminum	Feedstock	*	NA	NA	9.2	NA	NA
	Electricity	0.0	7.9	2.2	5.4	13.1	5.2
	Fuel	*	16.8	5.0	0.9	20.4	8.5
Secondary Aluminum**	Electricity	27.9	7.9	2.2	29.1	13.1	5.2
	Fuel	19.9	18.2	5.5	23.3	22.1	9.3
Chlor-Alkalies	Electricity	0.0	7.9	2.2	7.7	13.1	5.2
	Fuel	*	17.6	5.3	2.9	21.2	8.9
Petrochemicals	Feedstock	0.0	1.2	0.3	5.1	0.5	0.2
	Electricity	0.0	7.9	2.2	8.7	13.1	5.2
	Fuel	*	15.9	4.7	1.6	19.4	8.0

** Small negative quantities calculated. ** Secondary Aluminum ACES values are for the No Allocation scenario.*

APPENDIX A

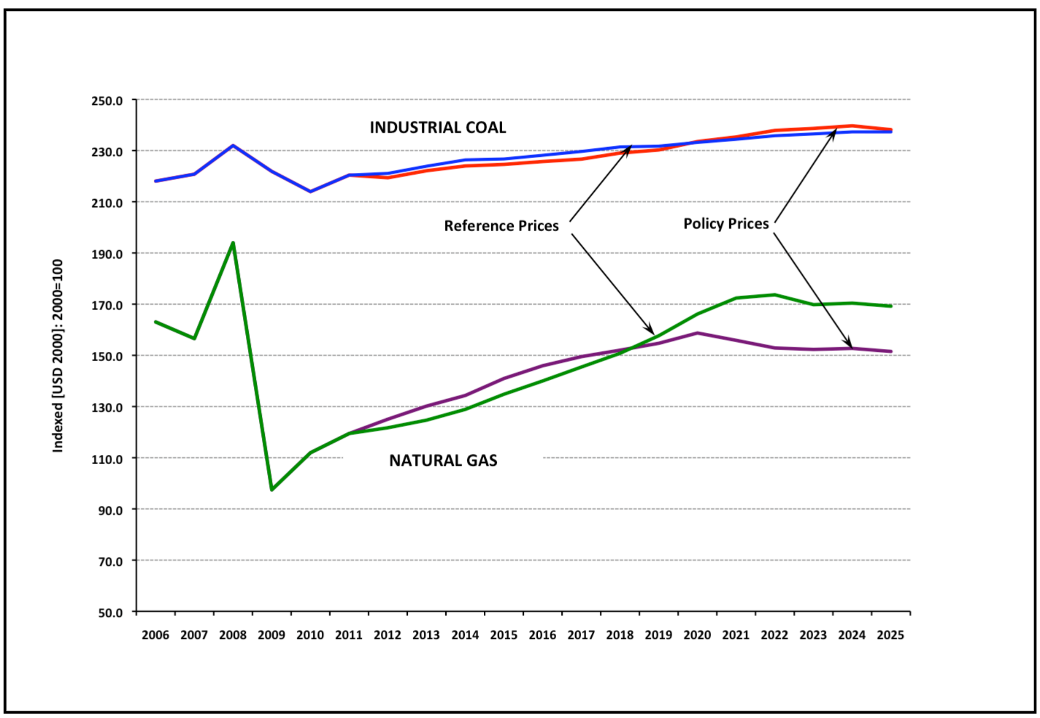
Supply-Demand Dynamics and Energy Price Variations

The HRS-MI team attempted to incorporate some of the supply-dynamics that would affect the overall consumption and their prices in the overall economy, under the *ACES Basic Case*. In particular, it uses the wholesale prices of natural gas, industrial and metallurgical coal (and by extrapolation, coal coke) as provided in the EIA analysis of *ACES*, using NEMS, in calculating the baseline energy and production costs for the industries, before adding in the emissions allowance costs and rebates.

As illustrated in Figure I, the policy prices fluctuate around the reference prices—falling before rising, and then falling again, for industrial coal (and similarly for metallurgical coal used in steelmaking) and rising and then falling below the reference prices, for natural gas. The lower prices in the later years, relative to BAU, reflect the eventual reduction in coal and natural gas consumption in the economy under the policy case, resulting from the increasing costs incurred using carbon-based fuels in energy generation and consumption (including industrial use), at least as projected by NEMS. As a result, even if all emissions allowance costs are rebated, the industries might see slightly higher or lower overall energy and production costs under the policy case, relative to BAU. These variations, however, tend to be swamped by the emissions costs, in the no allocation scenario.

Figure I

Natural Gas and Industrial Coal Prices:
Reference and ACES Policy Cases



Appendix B

Allocation Costs and Rebate Comparison

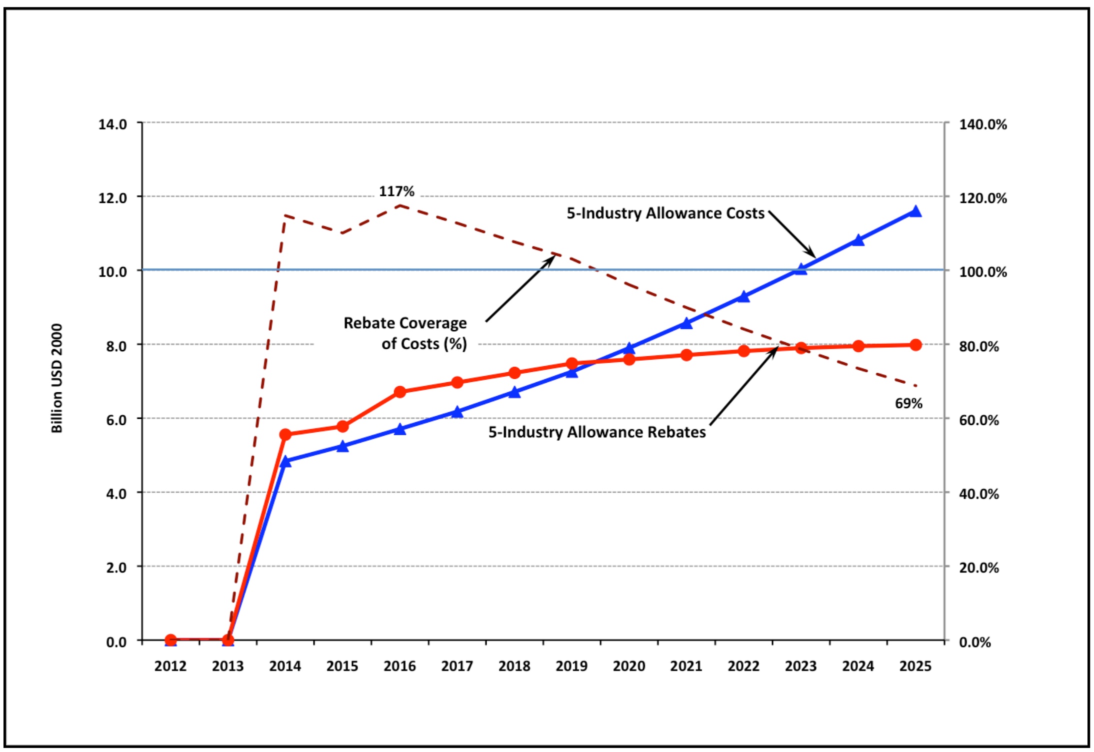
The allocation rebate for a given year was calculated based on the emissions associated with the average of the prior-two years production output for an industry. The rebates for EITE industries would rise to a high of 15 percent, and then shrink after 2020—very rapidly after 2025, falling to zero in 2035.

At the same time, the allowance costs for a given year incurred by an industry were calculated by multiplying its prior-year emissions (for electricity, fuel, feedstock) by the EIA provided-allowance price for that year. As stipulated in the legislation, the emissions costs for all fuels would be incurred by the EITE industries from 2014 on.

As Figure II shows, the total rebates provided to the five covered industries in the study—primary aluminum, iron & steel, paper and paperboard, petrochemicals, chlor-alkalies—which together were assumed to account for 45.2 percent of all EITE emissions throughout the policy period (based on EPA-derived average 2004-2006 estimates), "overshoot" these costs through 2020, after which production-based emissions allowance costs rapidly exceed the shrinking rebates available to the EITE sector (and these industries).

Figure II

Allowance Costs and Rebates Compared, 5-Industries



The current study's industries' share of total EITE emissions, and the average 2004-2006 emissions levels associated with each industry was based on a preliminary

EPA analysis conducted earlier in 2009.[1] This ratio, and the number of EITE eligible industries can affect the ultimate impacts and effectiveness of the allocation rebate cost mitigation measure. For example, a recently released EPA analysis[2] (released too late for incorporating new data into the current study) lists a total of 44 eligible EITE industries—more than the EPA's earlier analysis, with total emissions of 745.5 $MMTCO_2e$—compared to 41 industries and a total emissions of 738 $MMTCO_2e$ in the earlier list. The newer analysis also updates the emissions estimates for the industries in the study.

As a result, the industries in the current study would account for only 44 percent of the total EITE emissions, which implies that each industry would receive a smaller share of the total allowance allocations to the EITE sector in the bill (which remains the same as before). A potential implication of this change, is that "overshoot" above might be smaller (or disappear), and the production-based allowance costs could begin to exceed the rebates earlier than estimated by the II-CPM in this study.

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1 See U.S. Environmental Protection Agency, "Comparison of FTI and EPA analyses of H.R. 2454 Title IV," Memorandum to the House Energy & Commerce Committee Staff, June 10, 2009.

2 U.S. Environmental Production Agency, "The Effects of H.R. 2454 on International Competitiveness an Emission Leakage in Energy-Intensive Trade-Exposed Industries," An Interagency Report Responding to a Request from Senators Bayh, Specter, Stabenow, McCaskill, and Brown, December 2, 2009.