Climate Policy and Energy-Intensive Manufacturing: Impacts & Options

Senate Briefing

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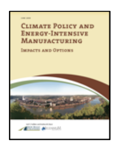
Climate Policy and EI Manufacturing Study

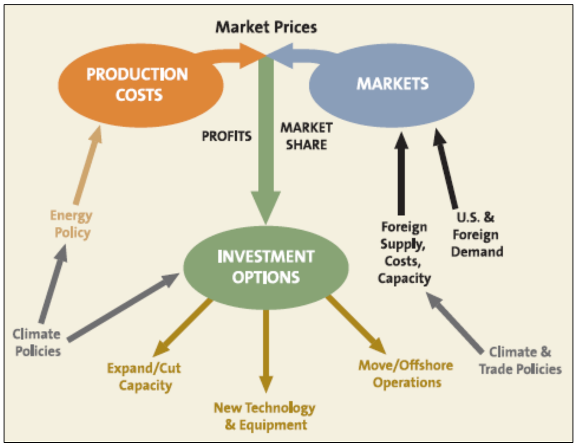


- What are climate policy impacts on energy-intensive manufacturing industries
  - Iron & steel, primary & secondary aluminum, paper & paperboard, petrochemicals, chorine-alkalies manufacturing
- What are the best policies to maintain manufacturing competitiveness and retain jobs, while cutting emissions?
  - To mitigate cost impacts and level the playing field in international trade
  - Enable and encourage industry investments in new technology

Summary of Findings

- Modest to high impacts on production costs, operating surplus (profits), market shares from higher energy prices:
  - Contingent on energy mix, cost-pass along assumptions, market conditions
- Pressure on industries to take actions to reduce costs and prevent profits from decreasing to undesired levels
- Technology options available, but timing critical
- Allowance allocation policy would buy time for industry adjustment
- Other policies may be needed to encourage long-term investment in advanced energy-saving technologies

Study Framework



Climate Policy Cases

- **Business As Usual (BAU) Case**
  - No GHG-emissions pricing policies
  - Based on AEO 2008 Reference Case
- **Mid-CO2 Price Case**
  - Based on Lieberman-Warner Climate Security Act (S. 2191)
  - Emissions allowance price: 2020-2030, \$30-\$61/mt CO_2-equivalent
    - 30% emissions below 2005 by 2030; 70% below by 2050
- **EIA NEMS Fossil-Energy Price Scenarios**
  - Electricity, natural gas, metallurgical coal, coal coke, liquid petroleum gas, residual fuel oil, distillate fuel oil

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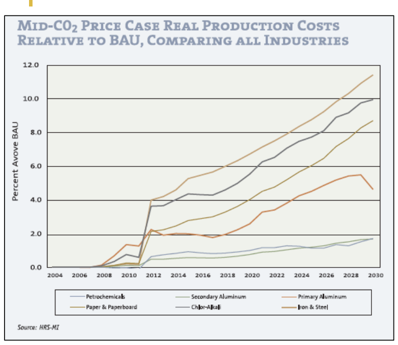
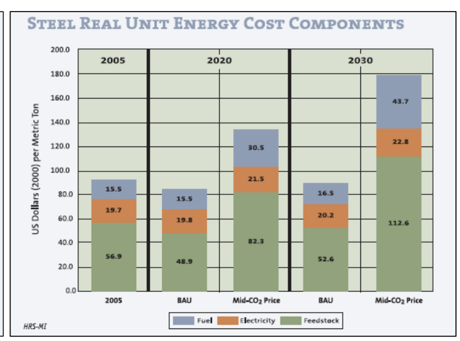
Production Cost Impacts





- Iron & steel—6.7% above BAU, 2020; 11.4%, 2030
- Chlor-Alkali—5.5%, 2020; 9.0%, 2030
- Paper and paperboard—4.0%, 2020; 8.7%, 2030
- Primary aluminum—2.8% (4.6% inc. anode/alumina); 2020; 4.6% (8.7%), 2030

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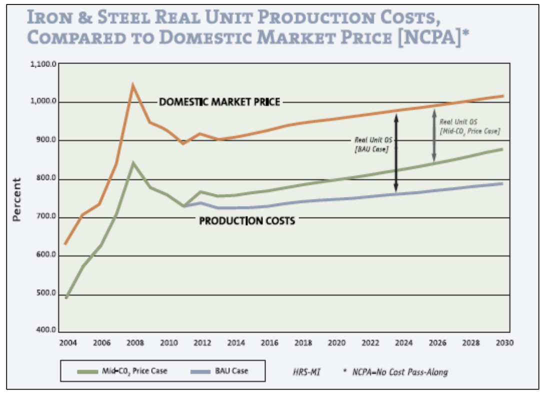
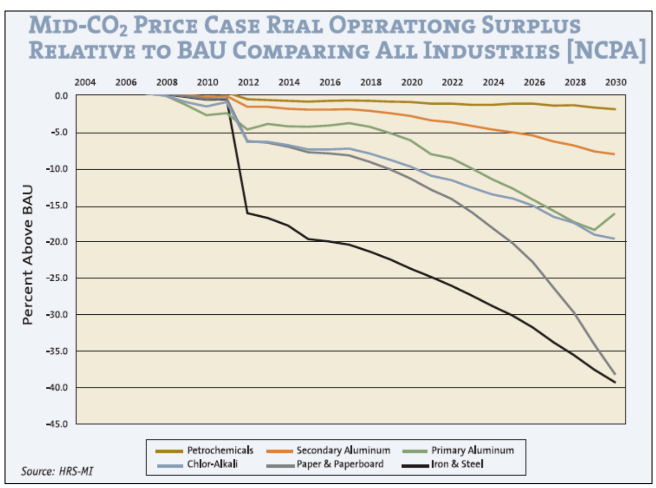
Operating Surplus Defined

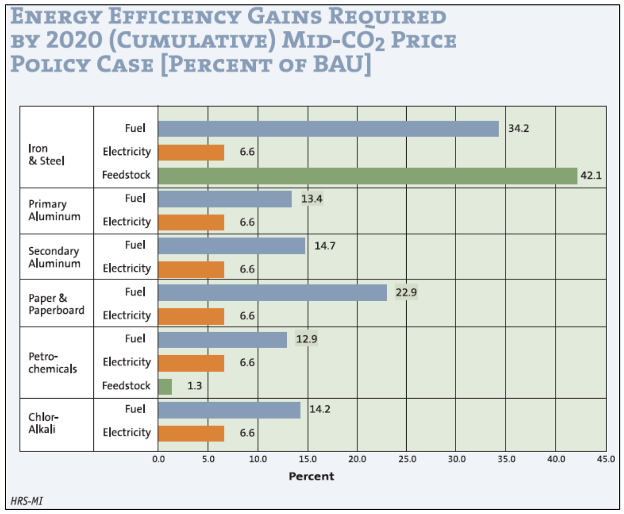
- **Operating Surplus:** Domestic Market Price Minus Unit Production Cost
  - Sales, General and Administrative costs
  - Depreciation, interest on capital
  - Other fixed costs
  - Profits, taxes
  - Reduced OS means lower profits
- **Operating Margin:** Ratio of total OS and total revenues



Operating Surplus Impacts



Energy Efficiency Gains Needed



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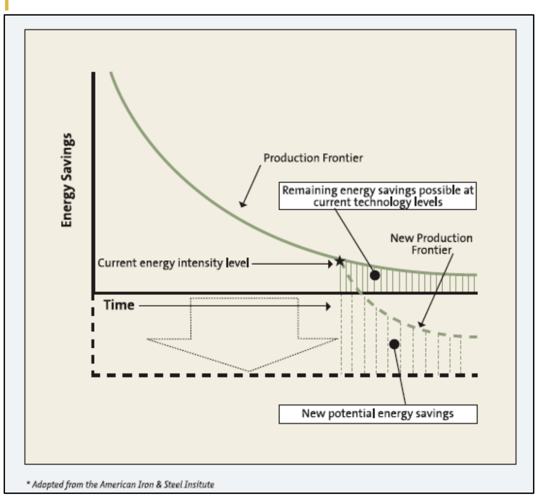
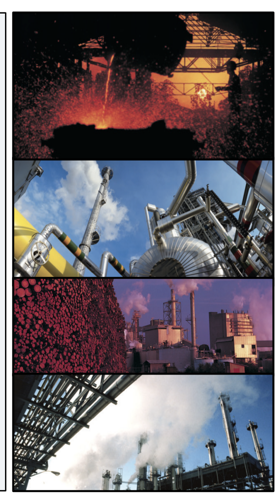
Energy Savings Potential





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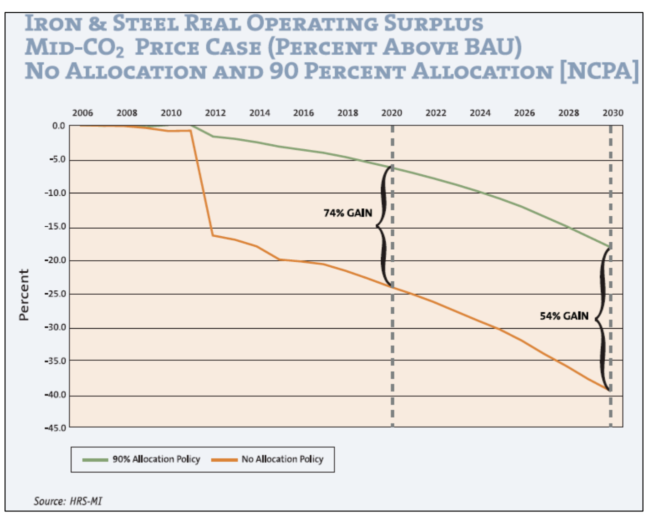
Technology Investment Options

- "Low-hanging fruit"
  - Heat recovery, CHP, sensors and process controls, more efficient pumping, motor, compressed air systems, etc.
- Improved recycling (steel, aluminum, paper)

- Advanced and alternative process technologies:
  - Low-carbon iron-making technology (iron & steel)
  - Wetted drained cathode/inert anodes (aluminum)
  - Black-liquor gasification; efficient drying technology; biorefineries (paper)
  - Shift to membrane technology (chlor-alkali)
  - Advanced furnaces, CHP, biomass-based systems (petrochemicals)
- Barriers to Adoption:
  - Costs; timing (technical feasibility, vintage); lack of capital

90 Percent Allocation Policy



Key Conclusion

- Energy-intensive manufacturing industries may need additional measures:
  - To mitigate adverse cost impacts in the short-to-medium term
  - To encourage and facilitate the *transition* of energy-reliant companies (and their employees) to a low-carbon future, while maintaining their global competitiveness

Policy Implications

- Cost Containment and Mitigation*
  - "Safety valve," offsets, banking
  - Allowance allocations
    - E.g., output-based rebates
- Technology Investment and Adoption*
  - R&D funding, tax incentives, loan funds, etc.
    - E.g., Sen. Brown's IMPACT bill; accelerated capital stock recovery
- Border Adjustment & International Provisions
- Workforce and Community Transition

ADDITIONAL SLIDES

Climate-Manufacturing Challenge

- Crisis in U.S. manufacturing
  - Loss of capacity, jobs
  - Foreign competition, offshoring
- Energy-intensive industries especially affected
  - Consolidation, restructuring, import penetration

Columbia Falls Aluminum Plant

- EI manufacturing and climate policy
  - Sensitive to fossil-fuel energy prices
  - Carbon leakage if U.S. EI manufacturers move offshore
  - EI industries cornerstone of manufacturing—beginning of supply chains for all other manufacturing

Energy-Intensive Industries, 2006

[Industries in bold are examined in the study]

NAICS Code	Industry Sector	Energy Intensity* [Percent]
31-33	Manufacturing	2.9
322	Paper Manufacturing	7.3
32212,3	**Paper and Paperboard Mills**	**14.5**
32212	**Paper Mills**	***13.0***
32213	**Paperboard Mills**	***18.0***
325	Chemicals Manufacturing	5.6
3251	Basic Chemicals	10.2
32511	**Petrochemicals**	**8.0**
325181	**Alkalies and Chlorine**	**38.9**
331	Primary Metals	6.4
3311	**Iron & Steel & Ferroalloy Products**	**8.8**
3313	Alumina and Aluminum Production and Processing	7.5
331312,4	Primary and Secondary Aluminum Production	14.8
331312	**Primary Aluminum Production**	***26.5***
331314	**Secondary Aluminum Production**	***6.2***

*Energy intensity is calculated as the share of total energy expenditures (fuel and electricity) as a share of total operating expenditures (roughly equal to sum of materials costs, labor compensation and new capital expenditures in the Census Bureau's *Annual Survey of Manufactures*, for 2006)

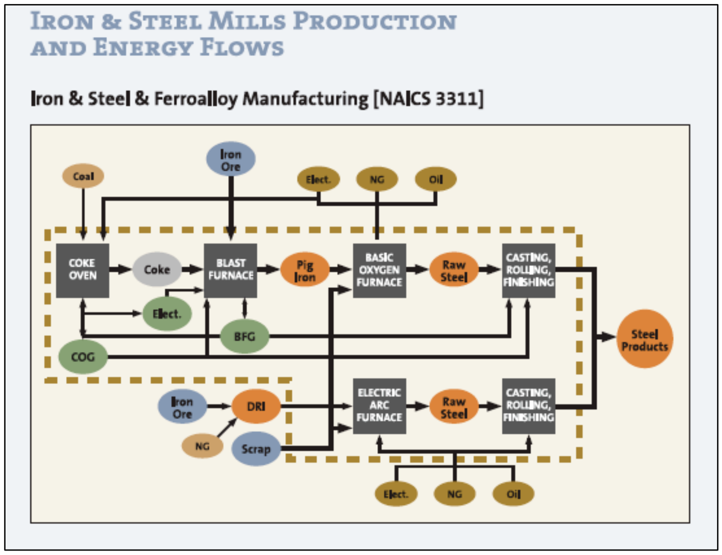
†Does not include expenditures on energy fuels used as manufacturing feedstock (e.g., natural gas used in petrochemical production; coke used in steel production).

Carbon-Based Fuels and Electricity Price Scenarios

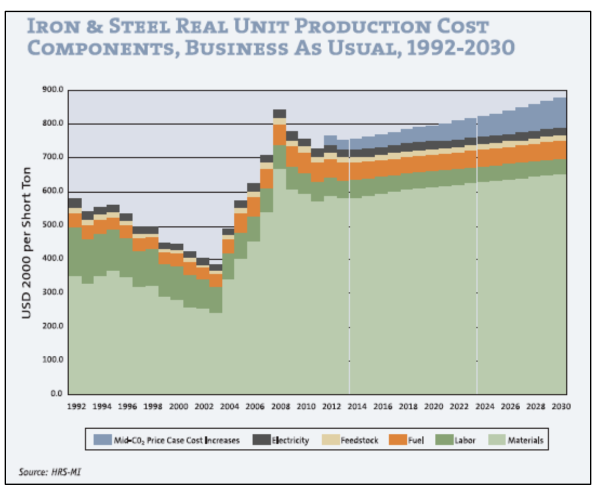
($2000/MBtu and % above BAU)

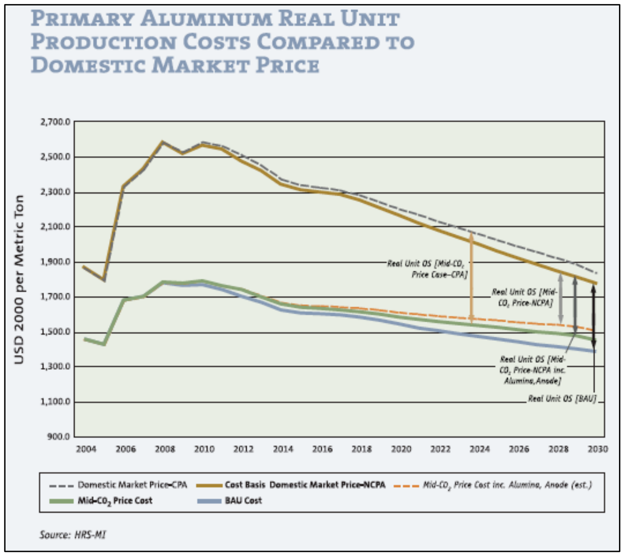
Energy Source	Real Energy Prices ($2000)		
	BAU 2006	Mid-CO_2 Price 2020	Mid-CO_2 Price 2030
Electricity	15.42	16.09	17.11
Percent above BAU	—	*8.6*	*13.1*
Natural Gas	6.57	6.51	8.69
Percent above BAU	—	*22.2*	*39.0*
Metallurgical Coal	3.04	6.01	8.65
Percent above BAU	—	*104.7*	*180.0*
Liquefied Petroleum Gas	16.91	14.48	15.25
Percent above BAU	—	*0.5*	*-0.1*
Coal Coke	9.11	18.02	25.94
Percent above BAU	—	*104.7*	*180.0*
Residual Fuel	7.77	9.01	11.81
Percent above BAU	—	*26.7*	*43.1*
Distillate Fuel	13.15	*14.31*	17.30
Percent above BAU	—	*14.1*	*24.0*

Source: EIA, HRS-MI



Production Cost Structure





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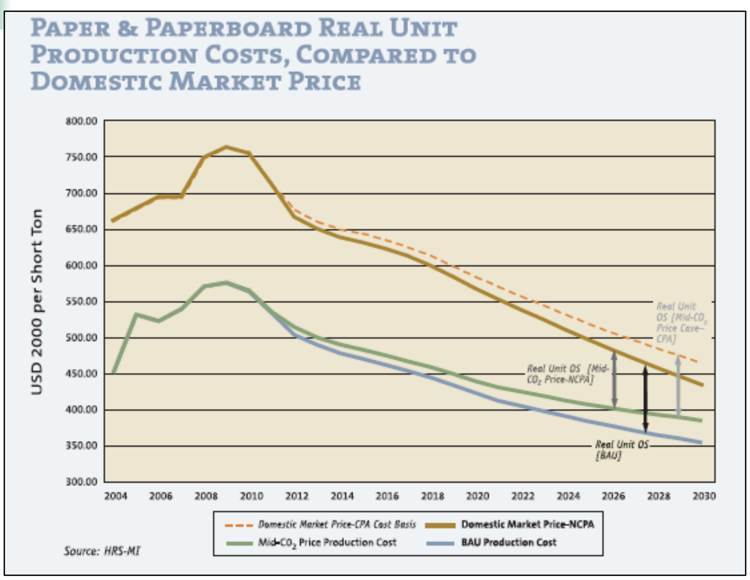

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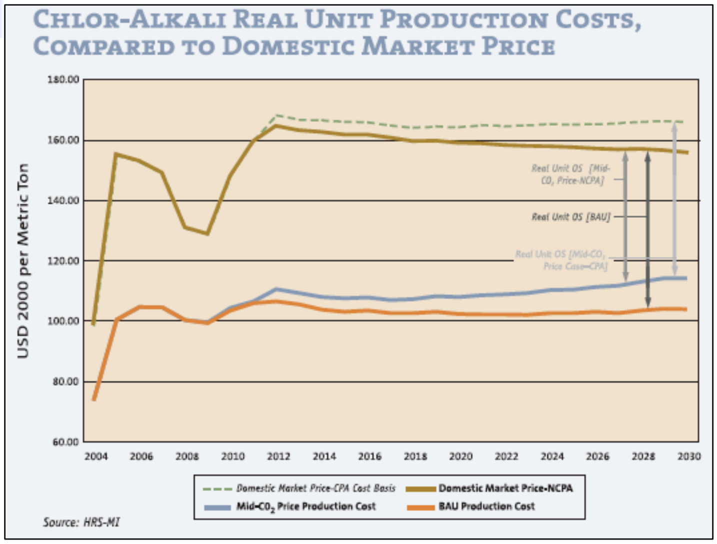

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Advanced Technology Options

Technology Option	Description	Time-frame
Iron & Steel		
Pulverized coal and plaste waste injection	Pulverized coal is already used by more than 50% of U.S. BOFs	ST-MT
New reactor designs	Uses coal and ore fines (COREX, FINEX)	MT
Paired straight hearth furnace	Substitutes coal for coke in blast furnaces, lower costs, uses 2/3 energy	MT-LT
Molten oxide electrolysis	Produces iron and oxygen, no CO_2	LT
Hydrogen flash melting	Uses hydrogen in shaft furnaces, no CO_2	MT
Geological sequestration + steelmaking		MT-LT
Paper and Paperboard		
Black liquor gasification	In demonstration, R&D; commercially available 2030; 15%-23% gain	MT-LT
Efficient drying technology	R&D now; commercial demo, 2015-2030; commercial 2030-->	MT-LT
Primary Aluminum		
Wetted, drained cathode technology		MT
Alternative cell concepts	Combines inert anode, drained cathodes	LT
Carbothermic and kaolinite reduction process on commercial scale	Alternatives to the Hall-Héroult process	LT
Petrochemicals		
High-temperature furnaces	Able to withstand more than 1,100ºC	MT-LT
Gas-turbine integration	Higher-temperature CHP for cracking furnace	MT-LT
Advanced distillation columns		MT-LT
Combined refrigeration plants		MT-LT
Biomass-based system options	Feedstock substitution	LT
Chlor-Alkali Manufacturing		
Convert mecury-process and diaphragm-process plants to membrane technology	Combined electrolytic cell with a fuel cell, using hydrogen by-product	MT-LT

ST=Short Term (Current Year-2015); MT=Medium Term (2015-2030); LT=Long Term (2030-2050)
Sources: IEA, DOE, AISI, Aluminum Assocation, Korean Energy Institute

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Success Stories

- ArcelorMittal (East Chicago, IN)
  - Partnered with Recycled Energy Development, built onsite energy plant to capture waste heat and gases
    - Cut purchases of coal-fired power by ½ at BOF mill; reduced CO_2 emissions by 1.3 million tons/yr; saved $100 million/year
    - Using waste heat recovery at 3 more steel facilities

- Flambeau River Papers (Park Mill, WI)
  - Built 1896, 300 employees in town of 3,000, paper mill shut down in 2006
    - High energy costs, foreign competition, aging equipment, outmoded processes
  - Reopened in 2 years with state and private support
    - 1st fossil fuel free, energy independent integrated pulp and paper mill in NA
    - Becoming first modern U.S.-based pulp mill biorefinery
    - Reemployed workers, 100 new jobs, reduced carbon impact