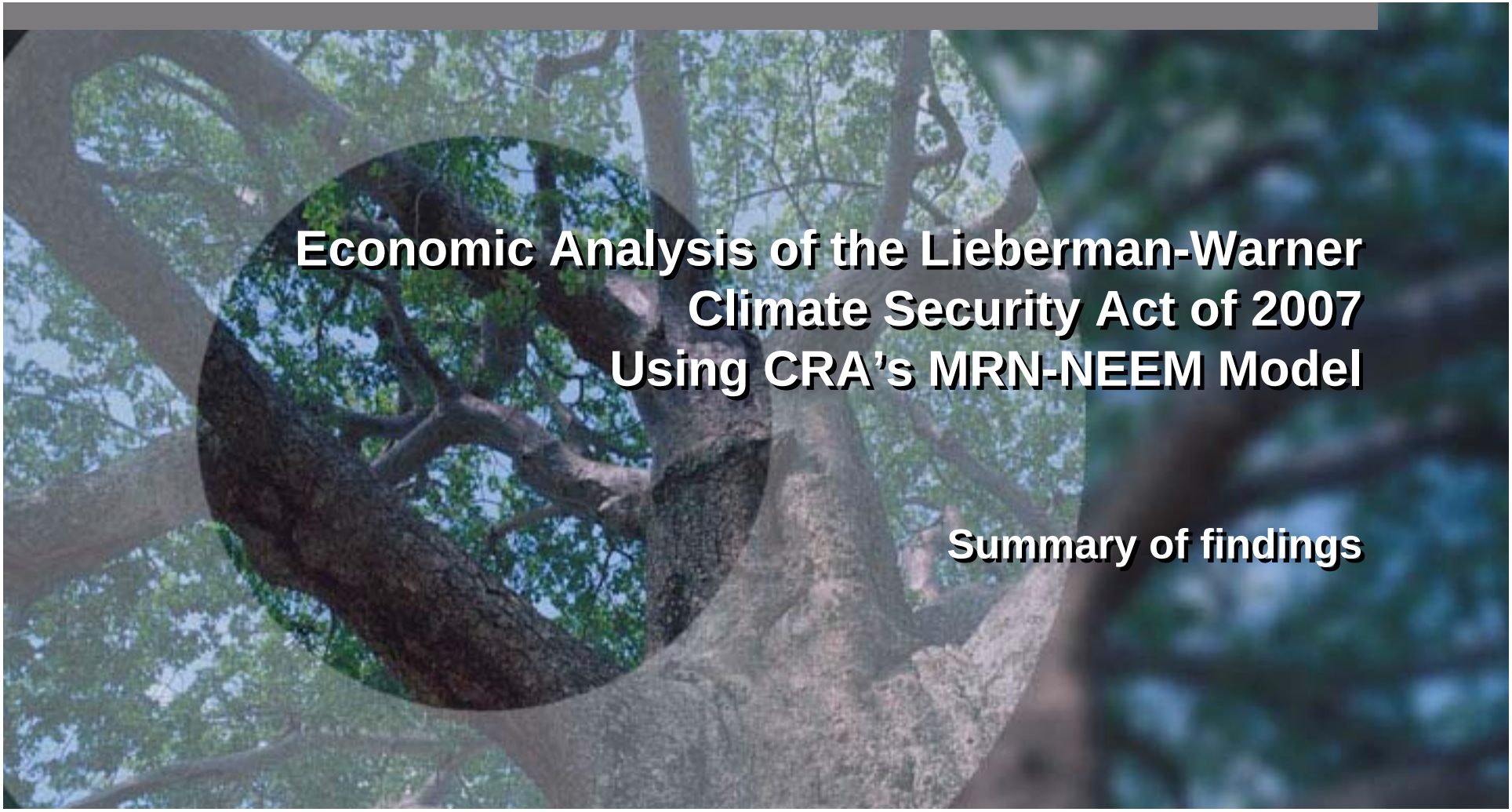

Economic Analysis of the Lieberman-Warner Climate Security Act of 2007 Using CRA's MRN-NEEM Model

Summary of findings

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For Additional Information Contact:
W. David Montgomery
Anne E. Smith

April 8, 2008

Introduction

In the 110th Congress, Senators Lieberman and Warner introduced a bill, the *Lieberman-Warner Climate Security Act of 2007* (S.2191), to reduce GHG emissions. CRA International, Inc. (CRA) has analyzed the economic and industry impacts of S.2191 *as passed by the Senate Environment and Public Works committee*.

The following pages describe CRA's approach to modeling S.2191 and summarize the results of the analysis. This summary of findings was prepared for the National Mining Association.

All impacts are stated relative to a baseline that includes H.R.6, unless otherwise noted.

CRA's Climate Team members who contributed to this study:

Robert Baron	Barclay Gibbs	Anne Smith
Paul Bernstein	David Montgomery	Sugandha Tuladhar
Scott Bloomberg	Jeff Plewes	Mei Yuan

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CRA's Analysis Is the First to Include All the Provisions of S.2191, H.R.6 and AEO2008

- **Earlier analyses released by others did not include one or more of the following:**
  - Final CO_2 cap and coverage
  - Low Carbon Fuel Standard
  - H.R.6 provisions
  - EIA's AEO2008

This analysis supersedes earlier MRN-NEEM results released in 2007, which were for an earlier version of S.2191 and which pre-dated the enactment of H.R.6 and the early release of AEO2008

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Contents

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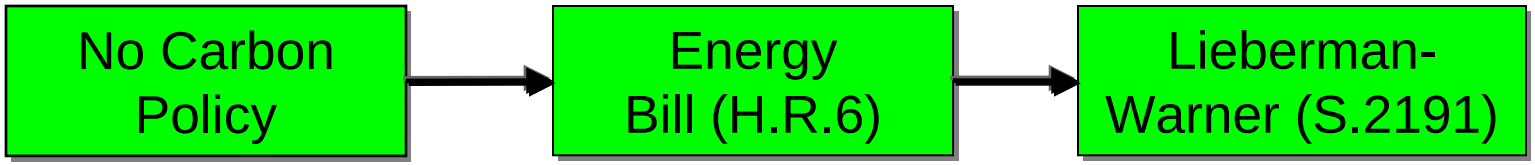
I. Key Elements of S.2191

Key Elements of S.2191

- **Emission cap of 5,775 million metric tons CO_2 for covered sectors and gases in 2012, declining to 1,732 million metric tons by 2050**
  - All emissions from natural gas combustion are covered under an upstream cap
- **Low Carbon Fuel Standard (LCFS)**
  - Average lifecycle GHG emissions per unit of energy in transportation fuel have to be reduced to 5% and 10% below the 2008 average in 2015 and 2020, respectively
- **Domestic offsets are limited to 15% of allowance submission requirements**
  - This is approximately equivalent to 17.65% of the cap
  - Allowances issued by other countries having “mandatory” caps of “comparable stringency” to the US could provide an additional 15%
- **Unlimited banking and limited borrowing are allowed**
- **Carbon Market Efficiency Board (CMEB)**
  - Can authorize additional borrowing or use of offsets
- **Bonus allowances to CCS and specified land use changes**
- **Specific allotment of auction revenues for technology subsidies**

II. Overview of CRA's Modeling Approach for S.2191

Scenarios Considered in CRA's Modeling of S.2191



This includes:

- AEO2008 (early release) natural gas prices
- AEO2008 (early release) electricity demand growth
- AEO2008 (early release) non-electric CO_2 emissions
- AEO2008 (early release) vehicle miles traveled (VMT)

CRA used EIA's early release of AEO2008, which does not include H.R.6 provisions

This adds:

- CAFE
- Renewable Fuel Standard (RFS)
- Electricity end-use efficiency standards

This further adds:

- GHG cap (as reported out of committee)
- Low Carbon Fuel Standard (LCFS)
- 15% domestic offsets
- CCS bonus allowances
- Sector/region-specific allowance allocations

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MRN-NEEM Has Been Significantly Enhanced to Be Able to Address Specific Elements of H.R.6 and S.2191

- **Explicit representation of consumer choices of fuel economy and driving**
- **Variety of low/zero carbon transportation fuels that can be substituted for gasoline**
- **Additional zero carbon substitutes for natural gas uses in households and commercial buildings**
  - Assumes the availability of unknown future technologies with widespread applicability and low enough cost to limit the long-term negative economic outcomes
- **Feedback effects to incorporate the benefits of lower world crude oil prices due to H.R.6 and S.2191**
- **Calibration to AEO2008 (early release)**

This analysis supersedes earlier MRN-NEEM results released in 2007, which were for an earlier version of S.2191 and which pre-dated passage of H.R.6 and AEO2008 (early release)

Key Technology Assumptions

- **Generating technologies**
  - Cost assumptions for new technologies are in line with other recent estimates and decline over time (*see table at back of appendix*)
  - Recent inflation in construction costs has driven actual new plant costs above even these recent estimates
- **CAFE standards**
  - Costs of improving new car fuel economy are based on the low end of the cost range in NAS's study, "Effectiveness and Impact of CAFE Standards" (2002)
- **Low carbon fuels lifecycle emissions *relative to gasoline***
  - Corn-based ethanol – 25% reduction
  - Low carbon biofuel – 80% reduction
  - Zero carbon fuel – 100% reduction

A more detailed description of the assumptions and methodology will be provided in a forthcoming report

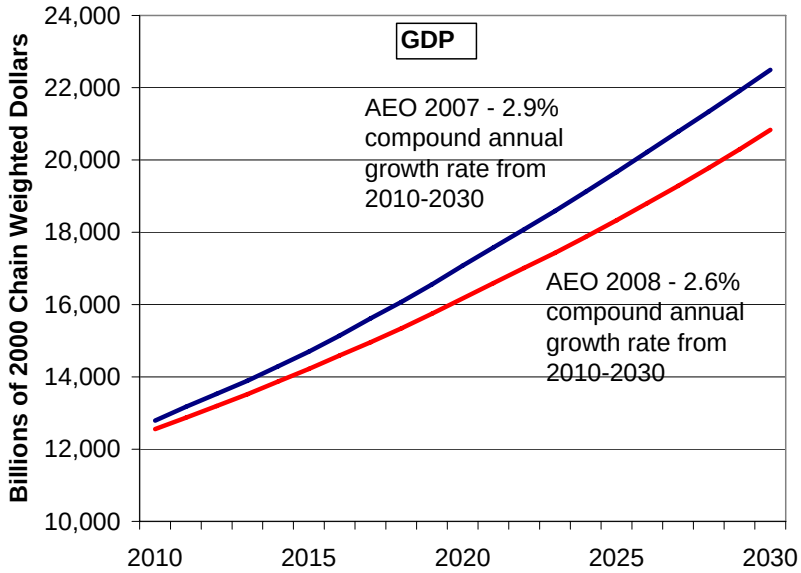
CRA's Analysis Fully Represents S.2191 Provisions that Are Intended to Lower Costs

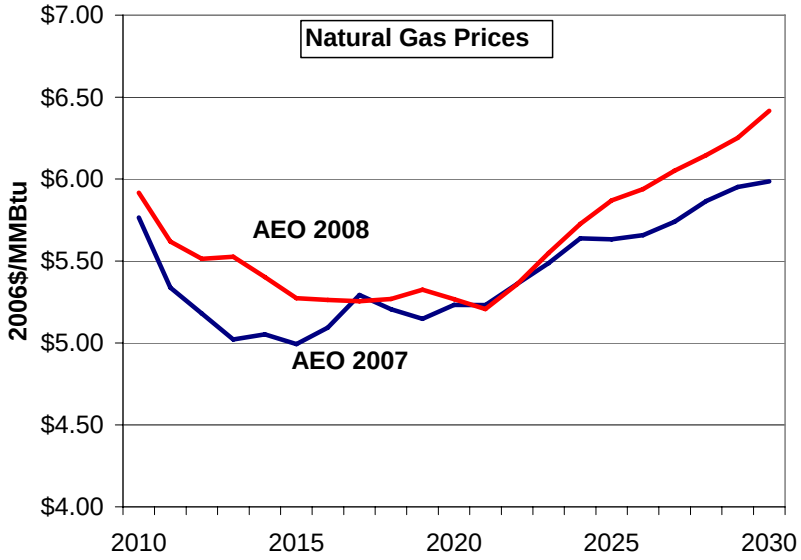
- **Bonus allocations and technology deployment subsidies**
  - CCS bonus allocations are assumed to be fully subscribed and lead to 34 GW of CCS between 2015 and 2030
  - New technologies for zero carbon transportation fuels and replacement of natural gas in buildings are assumed to appear and be cost competitive
  - These technologies do not exist today and will require large investments in R&D
  - Deployment subsidies under Title IV of S.2191 would be fully utilized by CRA's projected technology investments
- **Low Carbon Fuel Standard reduces emissions starting in 2015**
- **Allocations of allowances are based on the explicit language of the bill, including allocations for low income energy assistance**
  - Household impacts include the benefits of these allowance allocations

Some Bill Provisions Are Projected to Have No Effect

- **Carbon Market Efficiency Board (CMEB)**
  - Analysis shows that all the incentives are for banking, thus CMEB's powers to alter borrowing limits and terms does not affect estimates of long-term expected prices
  - Since the limit on domestic offsets is projected not to be reached until after 2025, allowing greater use of domestic offsets does not reduce near term costs
- **International allowances may only be obtained from countries having "mandatory" caps of "comparable stringency," which CRA interprets to imply that CO_2 prices would be similar to those under US policy**
  - These words in S.2191 mean that international offsets (e.g., CDM) from developing countries without mandatory caps cannot be used to meet the S.2191 cap
  - Access to international offsets, in particular from legitimate forestry or other projects not allowed under CDM rules, could reduce costs if the language were to be changed to allow them

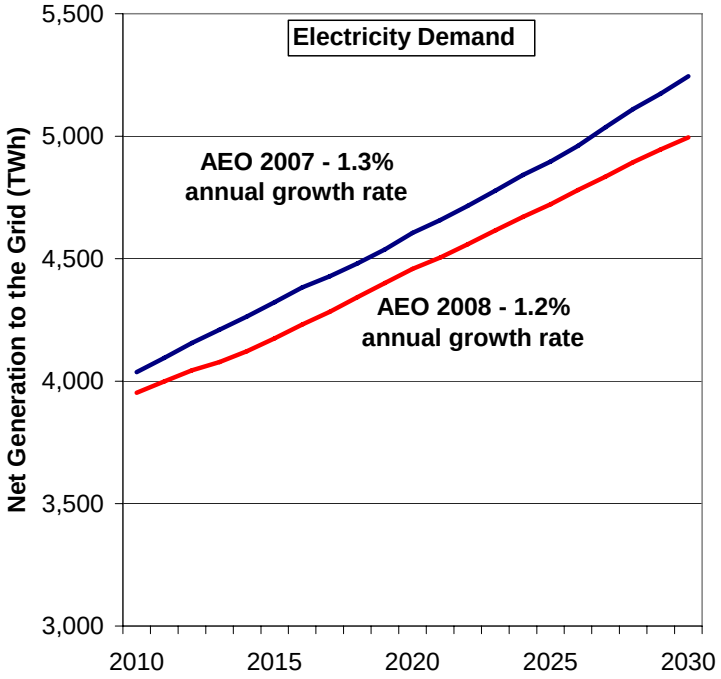
AEO2008[1] Projects Lower Output and CO_2 Emissions





Compared to AEO2007 Forecast

- Lower GDP growth, coupled with lower electricity demand growth lead to lower baseline CO_2 emissions
- Higher natural gas prices make natural gas a less favorable alternative to coal in the electricity generation baseline



[1] Early release of AEO2008 – excludes H.R.6 provisions

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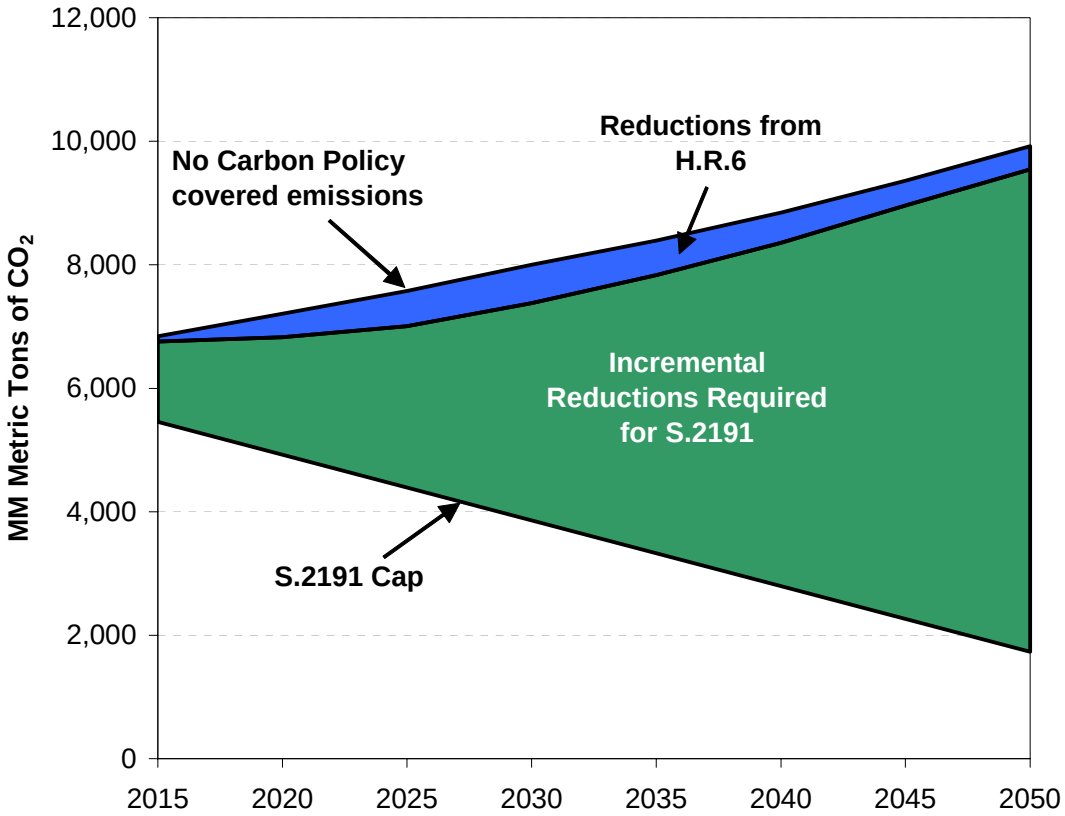
H.R.6 Mandates Lead to Lower CO_2 Emissions … at a Cost

The costs of these mandates are included in the H.R.6 scenario to which the S.2191 scenario is compared

The H.R.6 mandates modeled in this analysis are:

- **CAFE - average new vehicle fuel economy standard increased to 35 miles per gallon (MPG) by the year 2020**
  - Phase-in begins in 2011 and increases at the "maximum feasible rate" thereafter
- **Renewable Fuel Standard (RFS) - requires renewable fuel use to increase from 9 billion gallons in 2008 to at least 36 billion gallons by the year 2022**
  - In 2022, at least 21 billion gallons of the 36 billion gallons must be advanced biofuels
- **Energy efficiency standards prescribed for external power supplies, some home appliances, certain air-conditioning products, incandescent lamps and other lighting products**

Respective Emission Reductions Estimated for H.R.6 and S.2191



- H.R.6 provides emission reductions from its mandated fuel economy, energy efficiency and renewable fuel standards
- S.2191 requires a large incremental emission reduction beyond those likely to be achieved as a result of H.R.6
- Even the No Carbon Policy scenario has substantial built-in improvements in carbon-intensity, as can be seen on slide 35 of the Appendix

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III. Summary Results for S.2191

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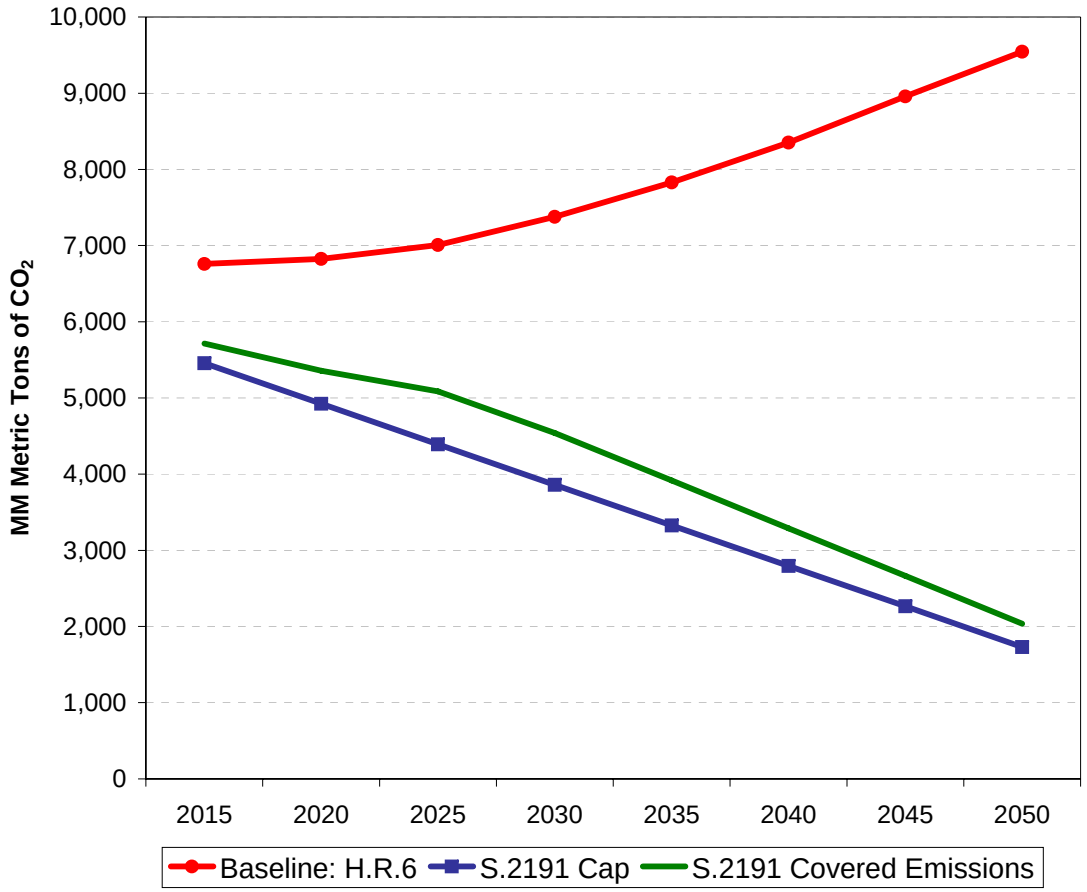
CO_2 Cap and Emissions



- Difference between S.2191 Cap and S.2191 Covered Emissions is the purchase of offsets
- The limit on domestic offsets is projected to be reached only after 2025
- This means that the CMEB's power to increase the domestic offset limit would not be able to reduce economic impacts of S.2191 in years before 2025

Impacts are stated relative to a baseline that includes H.R.6

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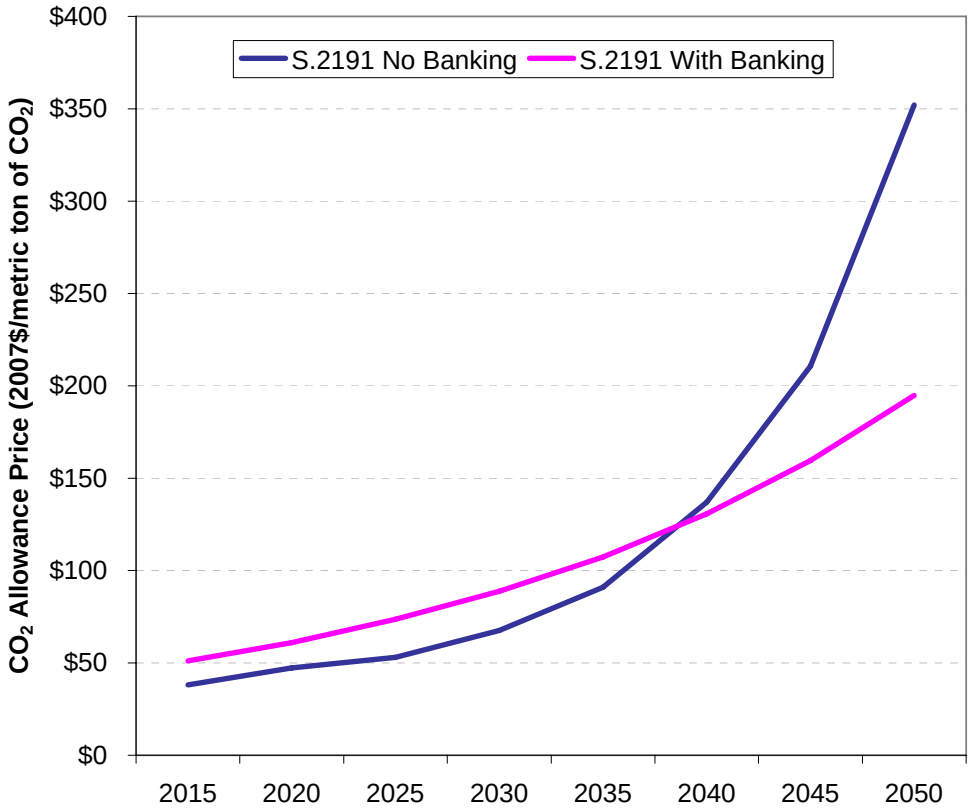
Cost of Reducing Emissions - CO_2 Allowance Prices

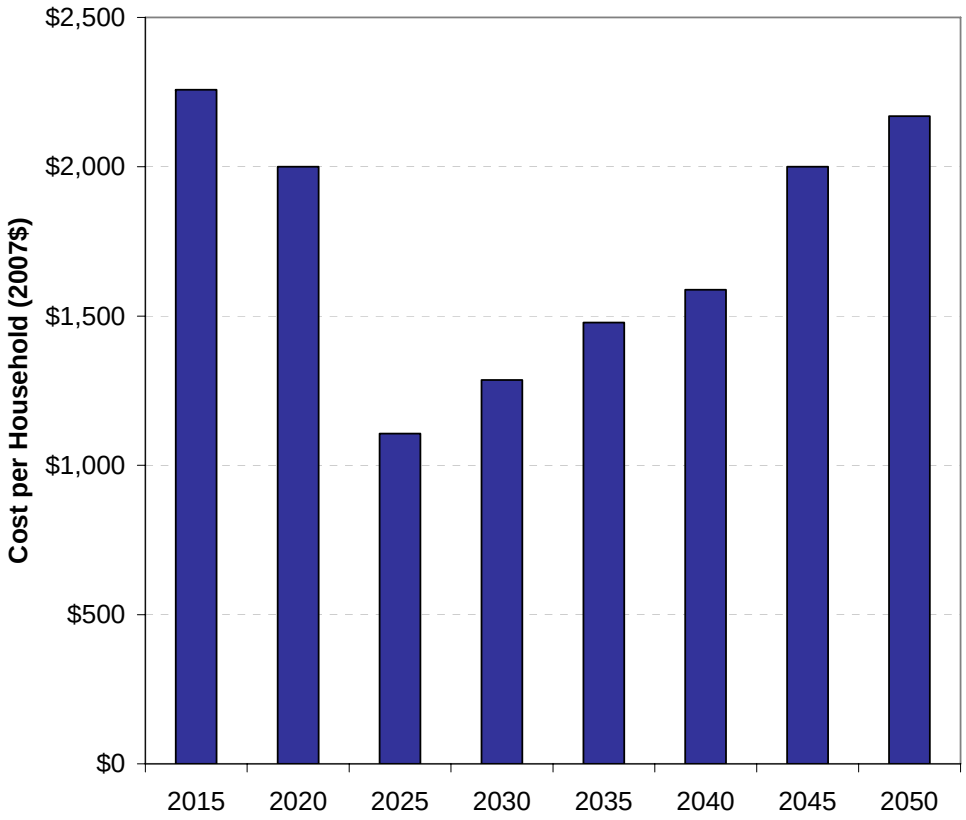


- Allowance prices would have been higher in the early years if the command and control regulations (CAFE, RFS, LCFS and efficiency standards) that loosen the effective cap on the remaining sources had not been modeled
- In scenarios in which banking takes place, carbon prices are higher before 2040 and lower after 2040

The inclusion of banking reduces total costs of S.2191 from $4.8 trillion to $4.7 trillion (present value, 2007$)

Impacts are stated relative to a baseline that includes H.R.6. The cost of H.R.6 is an additional $2.0 trillion.

Cost per Household

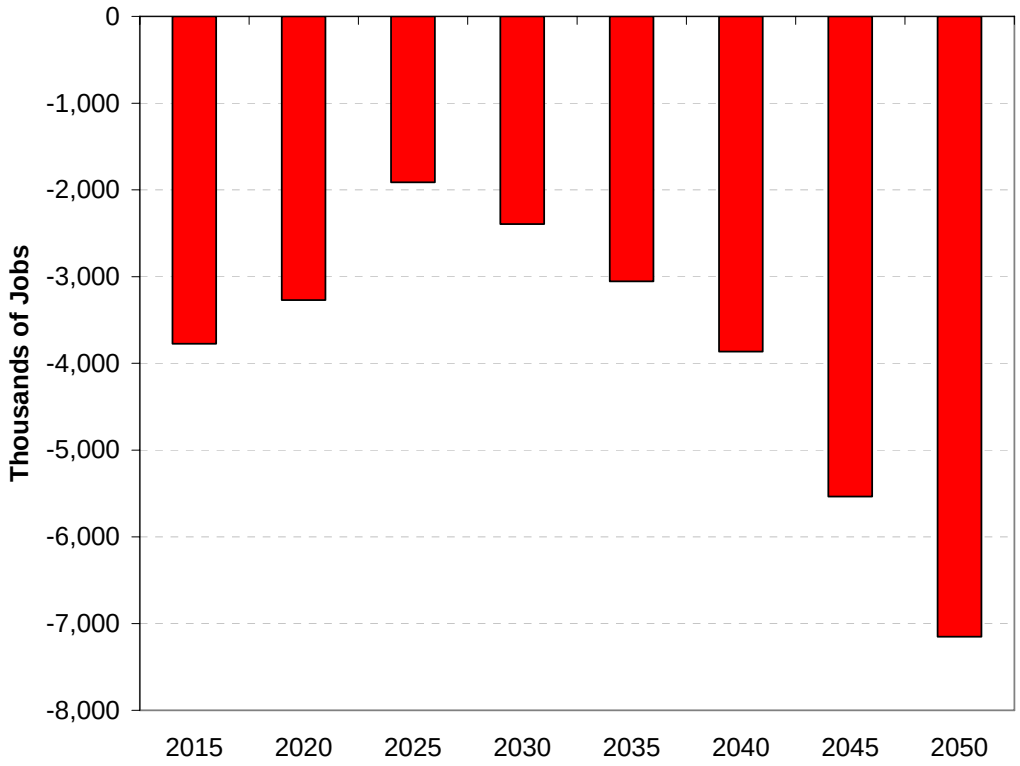


- Cost per household sums up all the effects of legislation, including energy and other prices, wages, hours worked, investment income and taxes
- The dollar impacts shown at the left are calculated as the percentage reduction in the future year applied to today's income, to give a number that is meaningful in relation to readers' income experiences
- Average household of 2.6 persons has median income today of about $50,000

The reason that costs are higher in 2015 and 2020 than in later years is the tightness of S.2191's LCFS in those years. Costs fall in 2025 because the CAFE standard in the H.R.6 scenario becomes the requirement that is harder to attain, hence, those costs are moved to the H.R.6 scenario and are no longer attributed to the incremental impact of S.2191 (see slide 36 of the Appendix for information on costs of H.R.6 alone).

Impacts are stated relative to a baseline that includes H.R.6

Net Change in Employment



- With S.2191, there is lower labor productivity due to the diversion of investment and resources to mitigation leading to fewer job opportunities and lower total employment
- Green job gains are fully accounted for, but more than offset by job losses in declining sectors and the overall economy

Impacts are stated relative to a baseline that includes H.R.6

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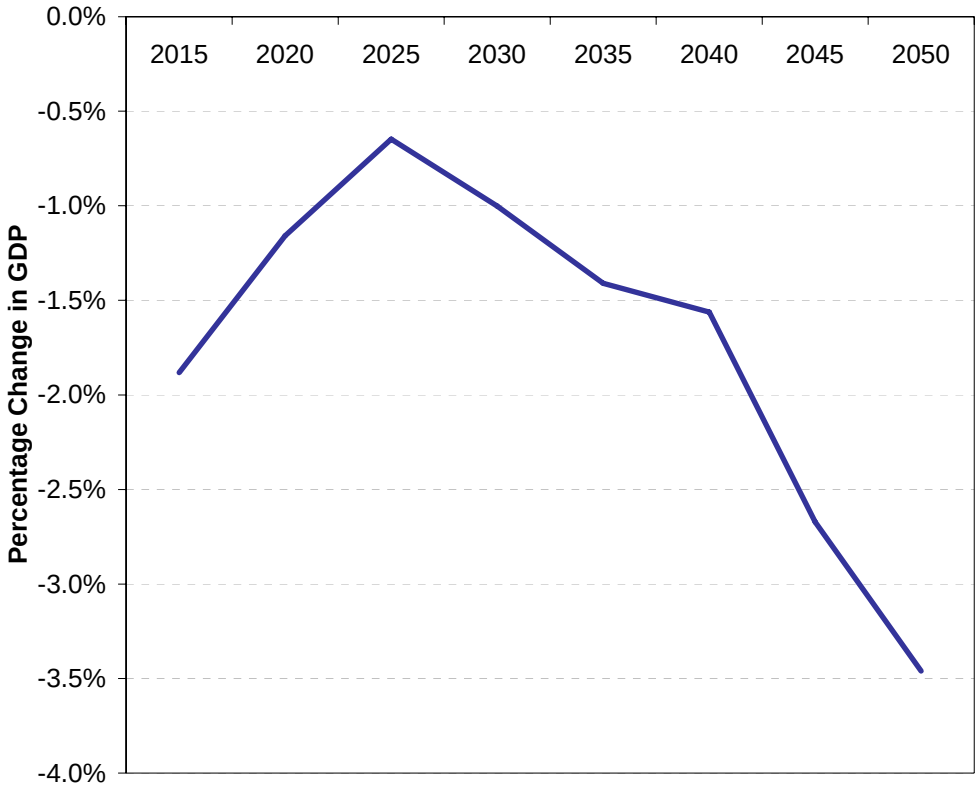
Impacts of S.2191 on GDP



- The relatively large GDP losses in 2015 and 2020 are attributable to the high cost of complying with the LCFS
- 2025 through 2035 impacts are moderated because CAFE is already incorporated in the H.R.6 "baseline" in the chart (see slide 36 of the Appendix for information on H.R.6 impacts)
- Late year impacts are attributable to the limited applicability of zero carbon technologies throughout the economy when caps require near zero emissions

The 1.9% decline in GDP in 2015 translates to a $330 billion GDP reduction in that year (2007$). Annual GDP losses accumulate to $5.3 trillion by 2050 (present value, 2007$).

Impacts are stated relative to a baseline that includes H.R.6. The GDP loss due to H.R.6 is an additional $1.7 trillion (present value, 2007$).

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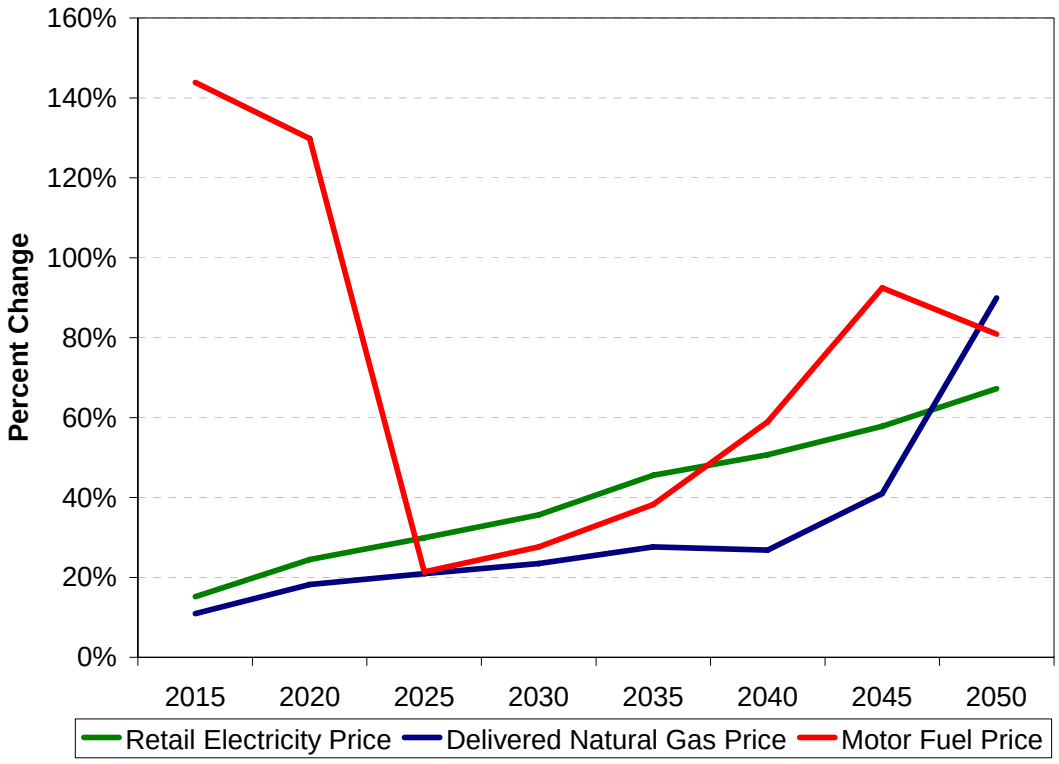
Household Cost of Energy

Electricity, Natural Gas and Motor Fuel at the Pump



- Motor fuel prices increase to extraordinary levels in 2015 and 2020 due to the high price associated with low carbon fuel credits in response to the infeasibility of meeting near term LCFS requirements without large reductions in total fuel demand
- Retail electricity prices increase to cover higher fuel costs, increased capital expenditures for new generation technologies and CO_2 allowance prices
- Delivered natural gas prices increase in the near term because of the increased demand for natural gas and long term because of the CO_2 emissions from natural gas combustion
- Retail electricity prices increase less than natural gas in 2050 because electricity is effectively decarbonized

Impacts are stated relative to a baseline that includes H.R.6

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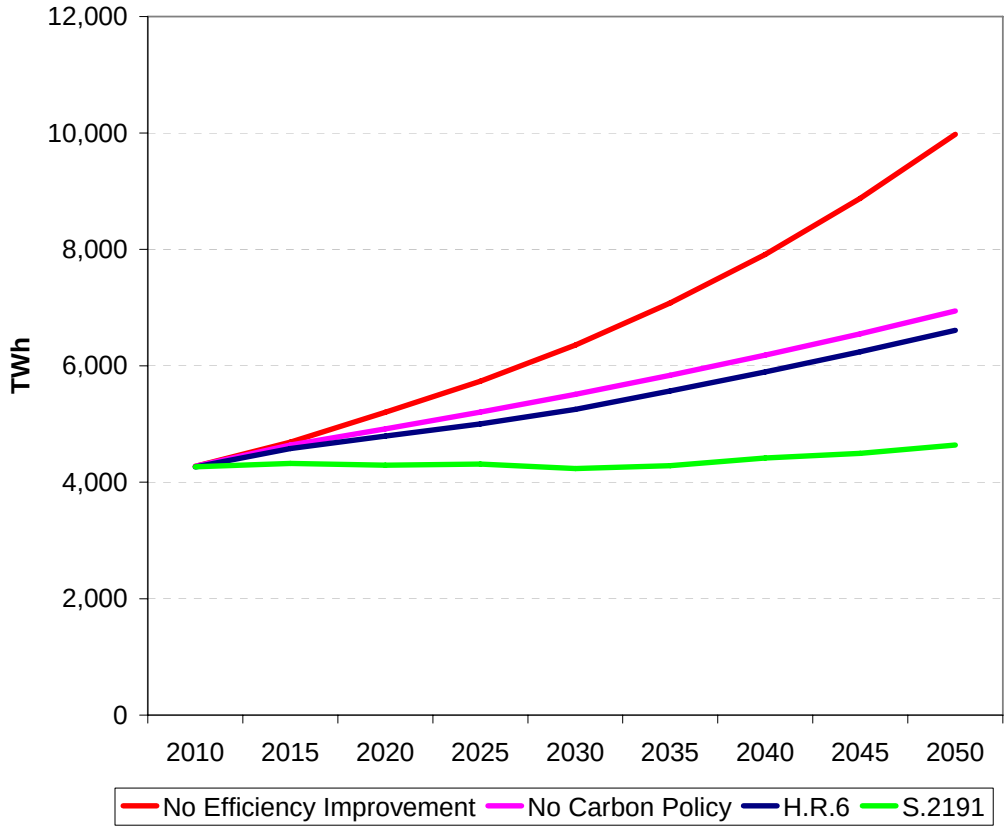
Electricity Demand



- Achieving S.2191 emission targets requires an additional efficiency improvement that exceeds the efficiency improvement built into the No Carbon Policy scenario
- The No Efficiency Improvement scenario assumes a constant emissions to GDP ratio given GDP projection (*e.g.*, no technology improvement in the future)
- The No Carbon Policy scenario incorporates efficiency improvements in AEO2008 (early release)
- The H.R.6 scenario includes efficiency improvements resulting from new standards
- The S.2191 scenario incorporates additional efficiency improvements and demand destruction driven by high CO_2 prices

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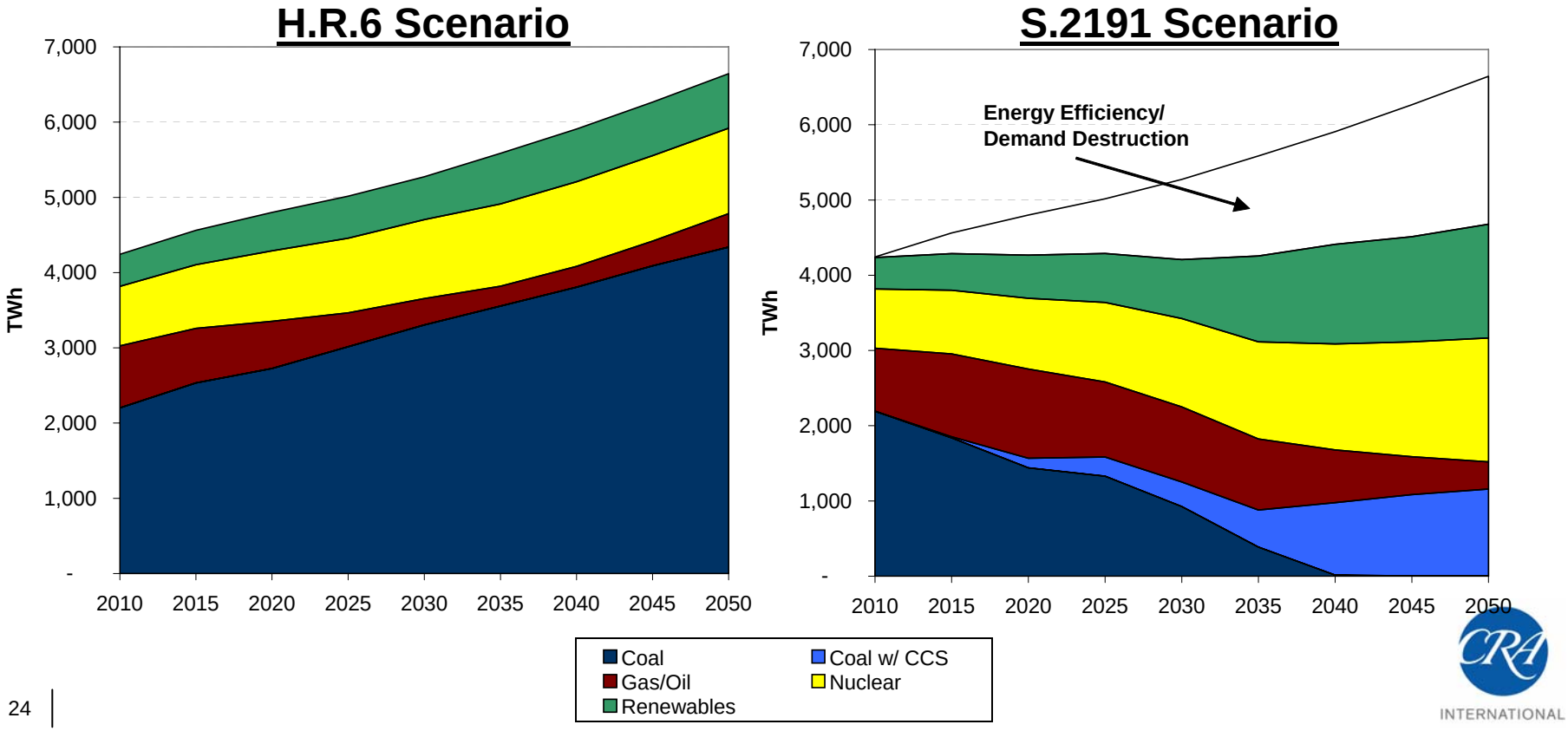
S.2191 Shifts Generation to Lower Carbon Technologies

- Meeting the S.2191 emissions targets requires the addition of significant quantities of nuclear and renewables generating capacity … and a large increase in energy efficiency
- S.2191's bonus allowances lead to 34 GW of CCS up to 2030
- CCS is necessary to meet demand after 2030, but has the highest cost of the lower carbon options
- Natural gas generation must increase significantly before 2030 as one of the ways of replacing coal, but then declines because its emissions are too high to meet long-term targets



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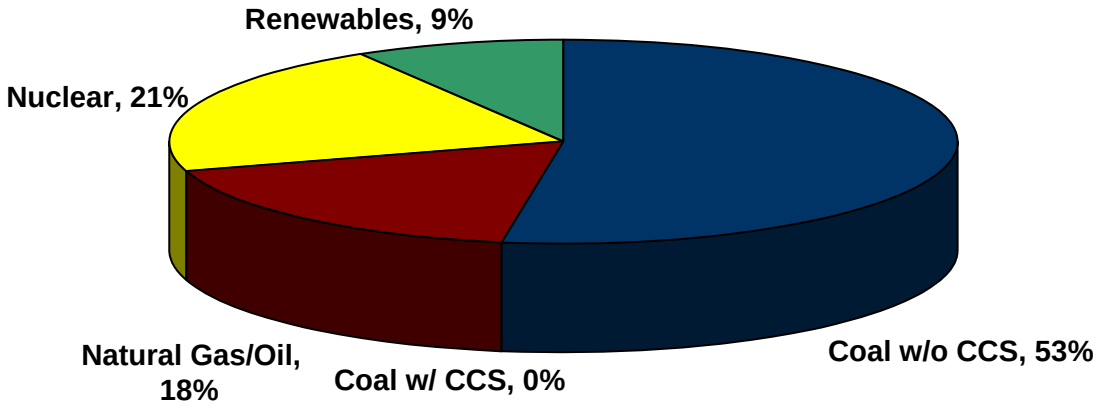
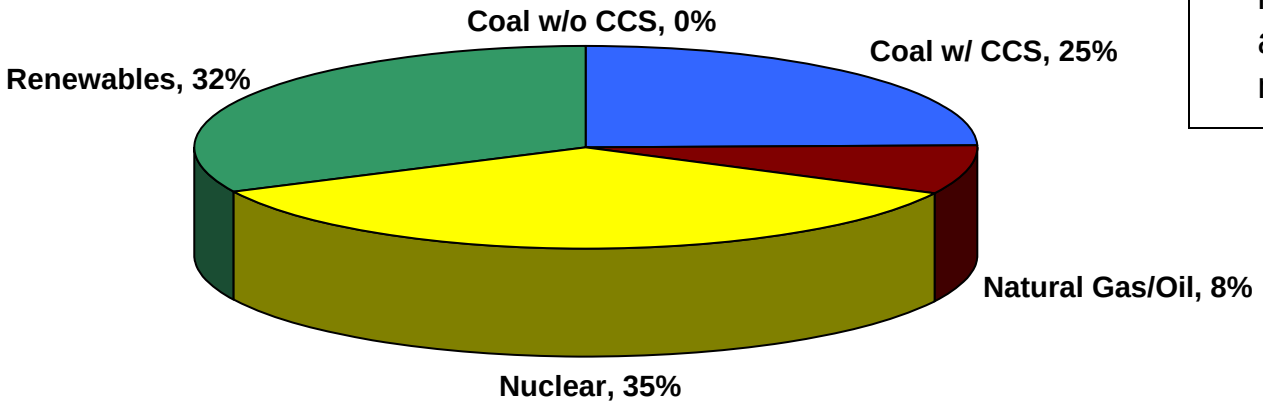
Generation Mix Comparison

2005 Generation Mix[1]



2050 Generation Mix under S.2191 Scenario[2]



- In 2005, coal without CCS provided more than 50% of US generation
- To meet the 2050 S.2191 emission target would require eliminating all coal without CCS; reducing natural gas/oil generation by half; adding coal with CCS to meet 25% of generation needs; increasing nuclear to 35%; and increasing renewables to more than 30%

[1] Historical data from AEO2008 (early release)

[2] CRA projection

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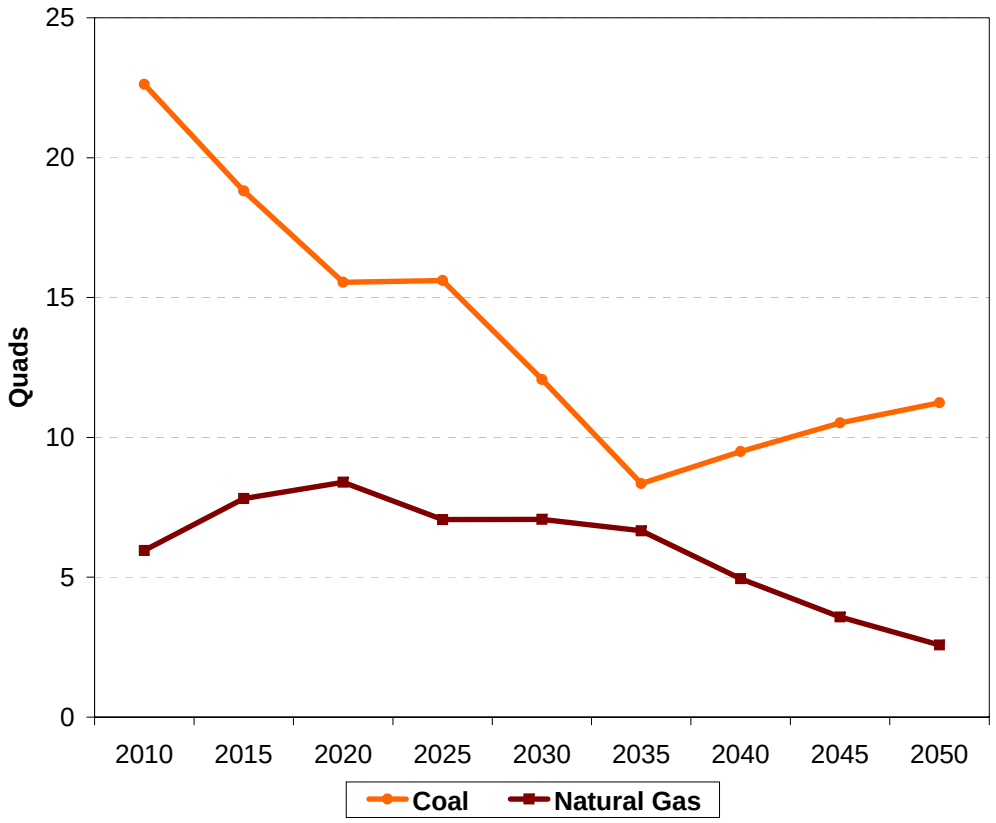
Fuel Use in the Electric Sector



- Required reductions pre-2020 can only be achieved via replacement of coal-fired generation with natural gas-fired generation
- Coal use will decline by more than 60% before CCS technology is projected to become widely available and allow coal to return
- Nuclear builds are likely to be limited by regulatory requirements
- CCS, which would capture CO_2 emissions from coal-fired generation, is not likely to be available on a large scale before 2025
- S.2191 has a mismatch between the timing of the CO_2 cuts required and the availability of the advanced technologies needed for large CO_2 reductions
- Reduction requirements for 2015 through 2025 are far ahead of the technologies required to achieve them cost-effectively

Impacts are stated relative to a baseline that includes H.R.6

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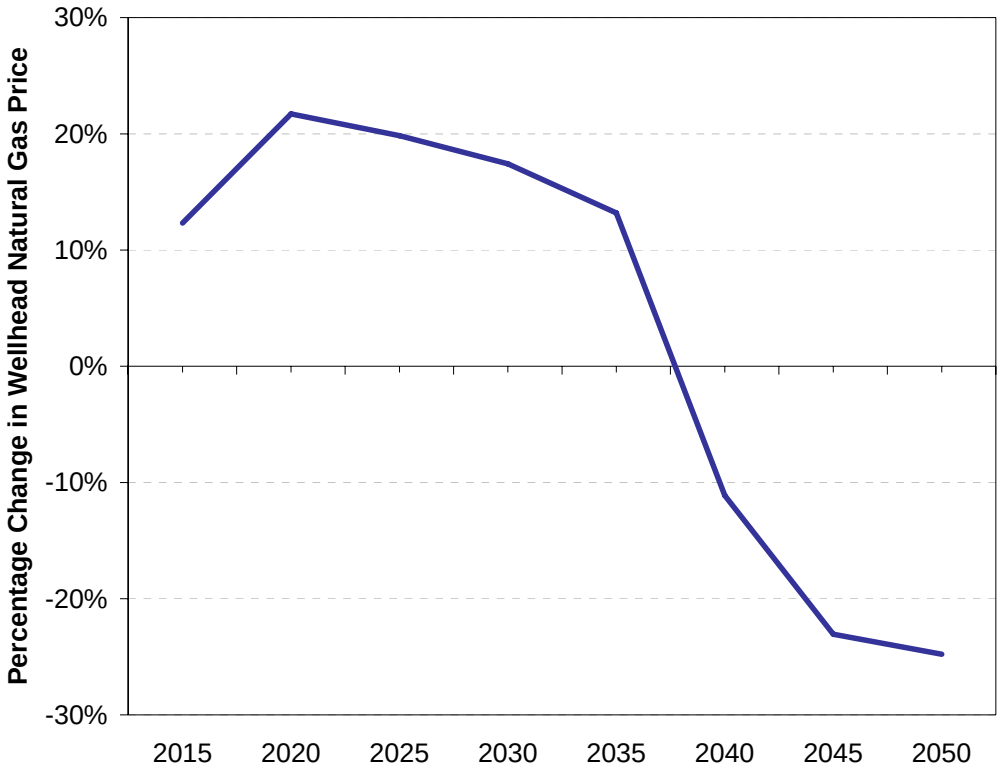
Average Wellhead Natural Gas Prices



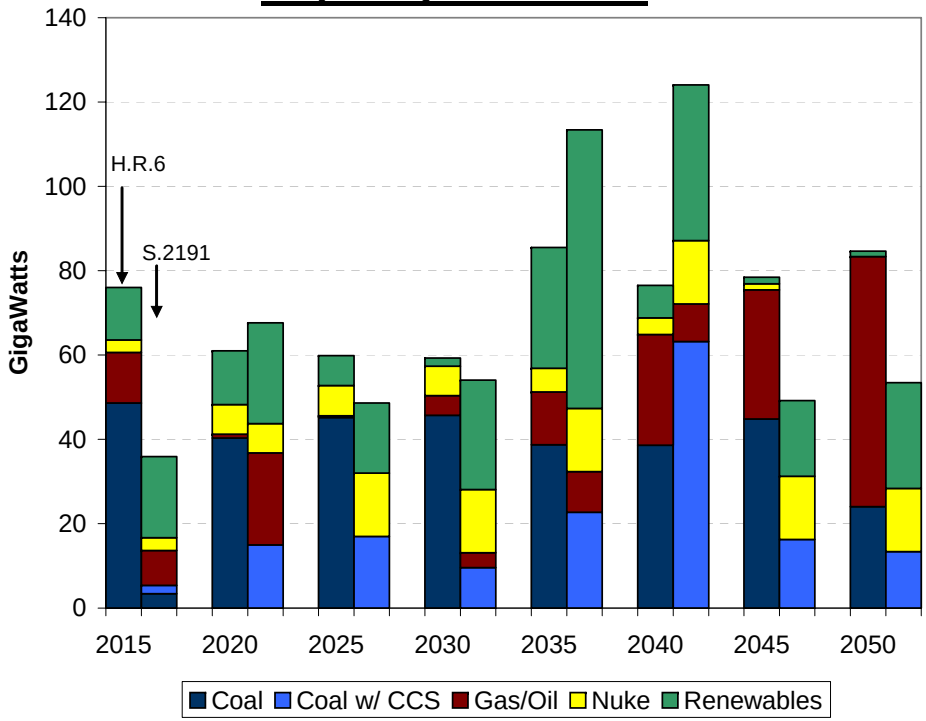
- The requirements for natural gas in the electric sector will be supplied by (1) displacing natural gas use in other sectors and (2) increased domestic production and imports
- The pressure on gas supply is shown by the rapid increase in prices received by natural gas producers
- This rapid, but temporary, increase in natural gas deliveries may be difficult to achieve due to the required increases in drilling and infrastructure
- In the longer term, natural gas use emits too much CO_2 to remain viable as the caps continue to tighten, hence natural gas demand and prices fall below the H.R.6 scenario levels

Impacts are stated relative to a baseline that includes H.R.6

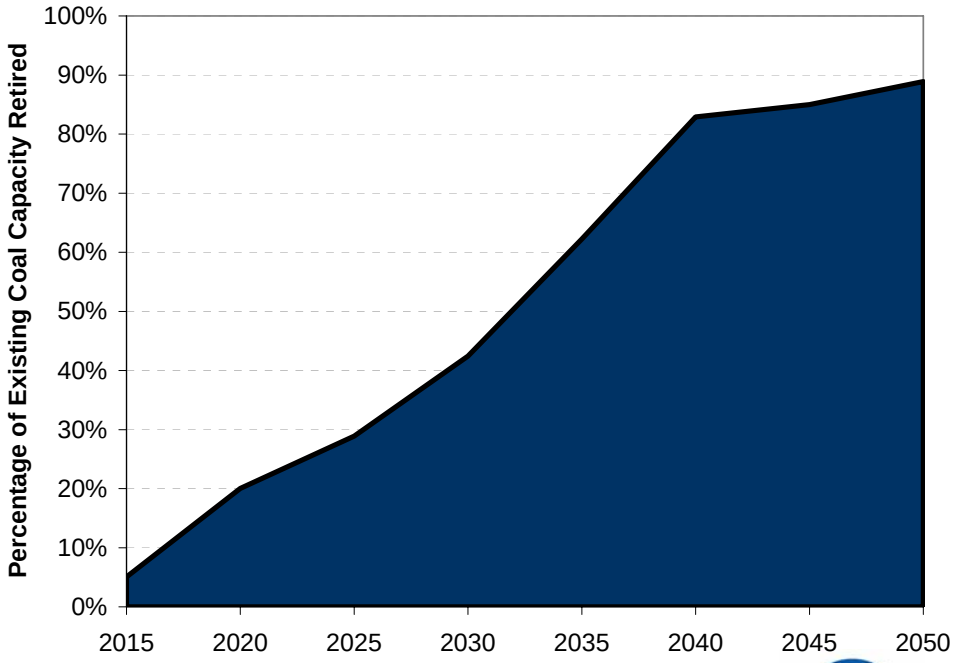
Electric Generating Capacity Additions and Retirements of Existing Pulverized Coal Plant Capacity

- More than 80% of existing pulverized coal plant capacity will be retired by 2040
- In 2035 and 2040 capacity additions exceed the No Carbon Policy scenario levels in order to replace the retiring coal units with new low/zero carbon generation technologies

Annual Electric Generating Capacity Additions



Retirements of Existing Pulverized Coal Plant Capacity



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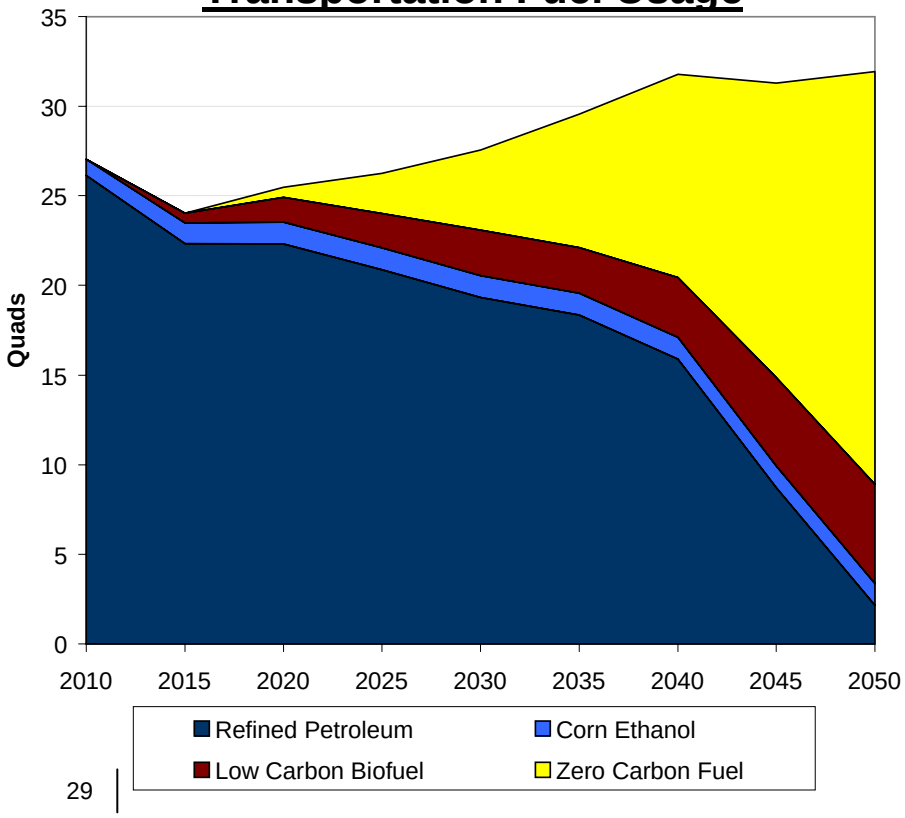
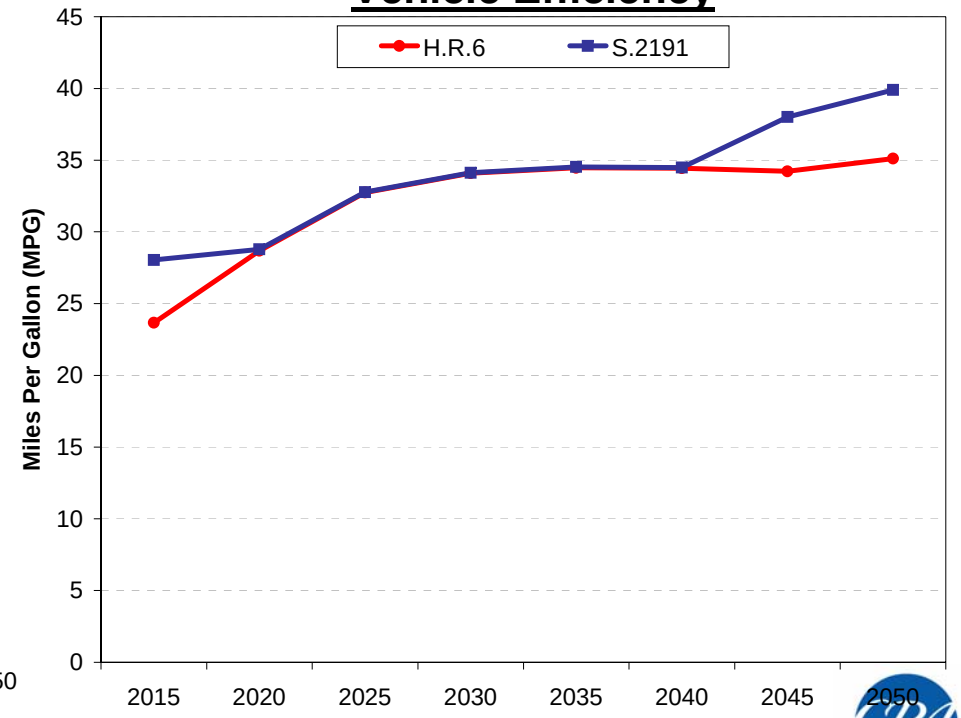
Transportation Fuel Usage and Vehicle Efficiency

- Zero carbon fuels take over transportation because of the relatively high lifecycle emissions from corn-based ethanol and cost effectiveness relative to low carbon biofuel production
- The reduction in total fuel use in 2015 is caused by the LCFS, which can only be met by a decrease in gasoline consumption to allow the limited supplies of low carbon biofuel to meet the averaging requirements of the standard
- Average fuel economy is projected to be higher than the CAFE standard in 2015 because of the impact of the LCFS on total motor fuel demand. In 2020-2040, the CAFE standard becomes the limiting factor

Transportation Fuel Usage



Vehicle Efficiency



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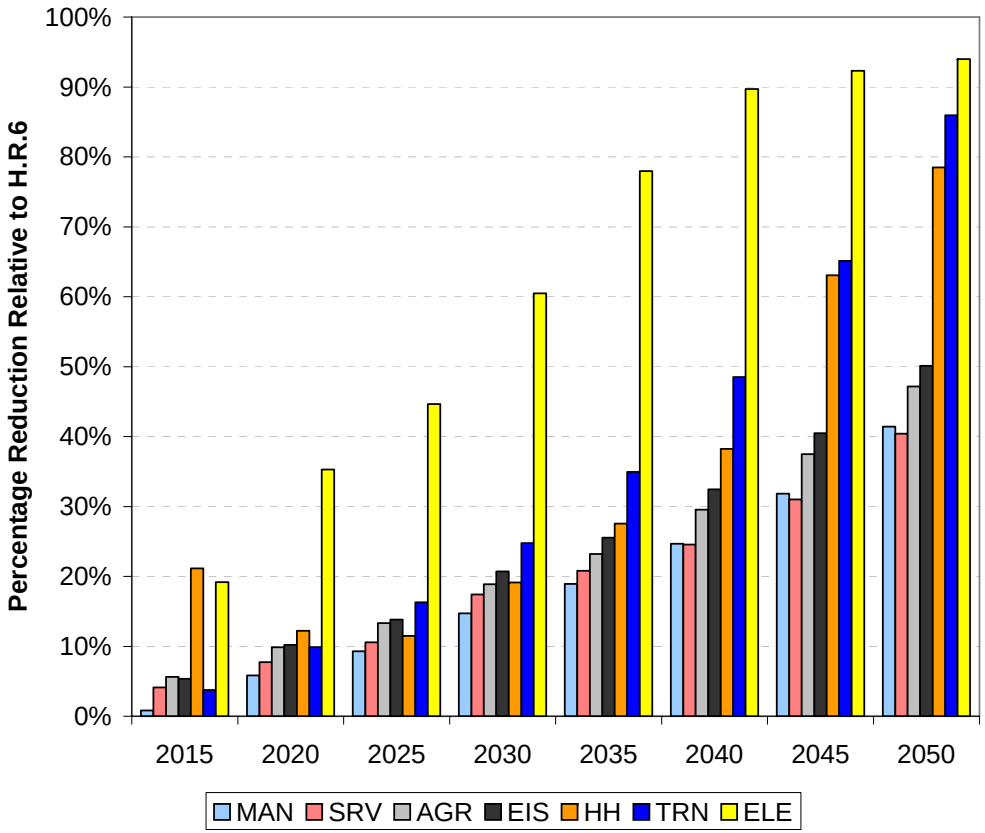
Compliance with LCFS Mandate Explains 2015 Results

- The LCFS can be met by increasing the quantity of low carbon biofuel or decreasing the quantity of gasoline in the blend
- Corn-based ethanol is likely the only alternative fuel available in large quantities by 2015
- Corn-based ethanol's lifecycle emissions are only 25% below gasoline so that ethanol would have to reach an infeasible share of total fuel consumption to satisfy LCFS
- Since the LCFS requirements go beyond what can be accomplished with available low carbon biofuels, gasoline consumption must fall to make the share of low carbon biofuels sufficient to satisfy the LCFS
- Therefore, delivered pump prices (including the price of LCFS credits, if a trading system is created) must rise sufficiently to choke off gasoline demand causing:
  - **Reductions in driving (VMT)**
  - **Demand for increased fuel economy in new cars**
- This leads to:
  - Large economic impacts in 2015, which moderate as low/zero carbon fuels with better performance than corn-based ethanol become feasible to produce in adequate quantities
  - Projected fuel economy that is higher than the CAFE standard in 2015

Emission Reductions by Sector

(Relative to the H.R.6 Scenario)



- The household (HH) sector's emissions include emissions from personal transportation and residential energy use
- After 2015, the electric sector (ELE) bears the largest emission reduction burden, followed by the household (HH) and transportation (TRN) sectors
- 80%+ emission reductions in household and transportation sectors are only possible because completely new technologies providing zero carbon fuels at reasonable cost are assumed to become available over time
- Households bear the largest burden in 2015 in the cost of driving because of the high price of transportation fuels to satisfy the LCFS

For context, the absolute levels of CO_2 Emissions (MM metric tons) projected for each sector in the No Carbon Policy case are:

MAN	SRV	AGR	EIS	HH	TRN	ELE
77	173	154	897	1,470	629	2,468

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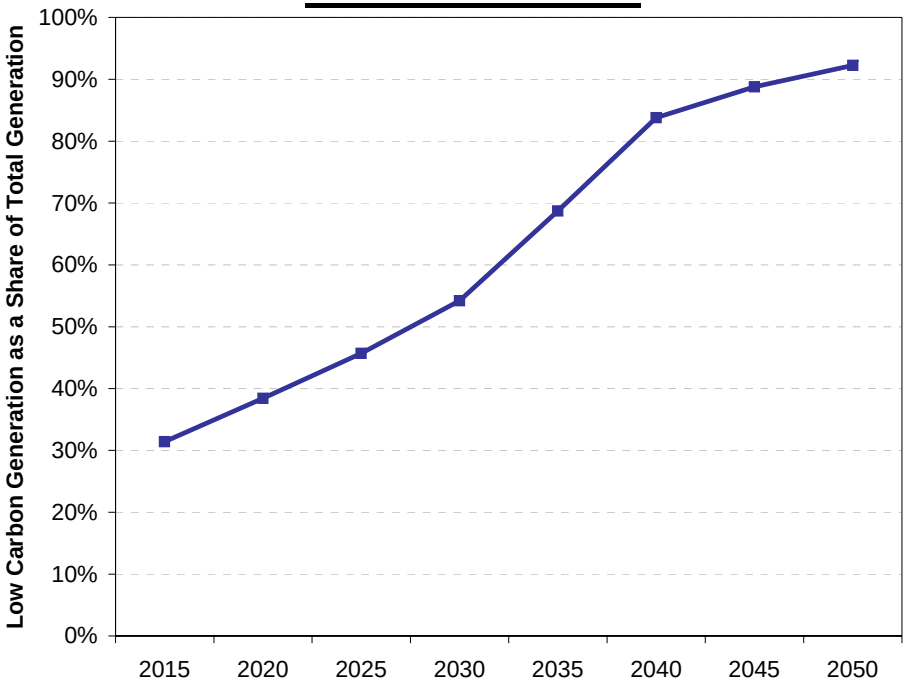
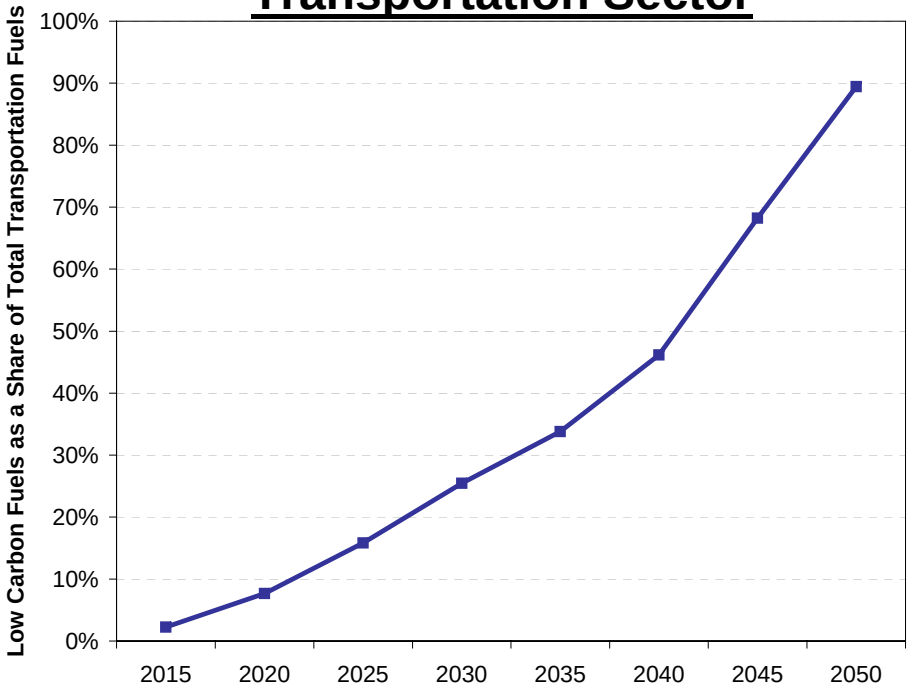
Electric Generation and Transportation Are 90% Decarbonized by 2050

Electric Sector



Transportation Sector



Corn ethanol is not included as a low carbon fuel

- The deep emission reductions required in 2050 under the S.2191 scenario necessitate nearly complete decarbonization of the electric and transportation sectors
- In sensitivity analyses with more constrained availability or higher costs of low/zero carbon transportation fuels, CO_2 prices and economic impacts in 2050 were found to be much greater

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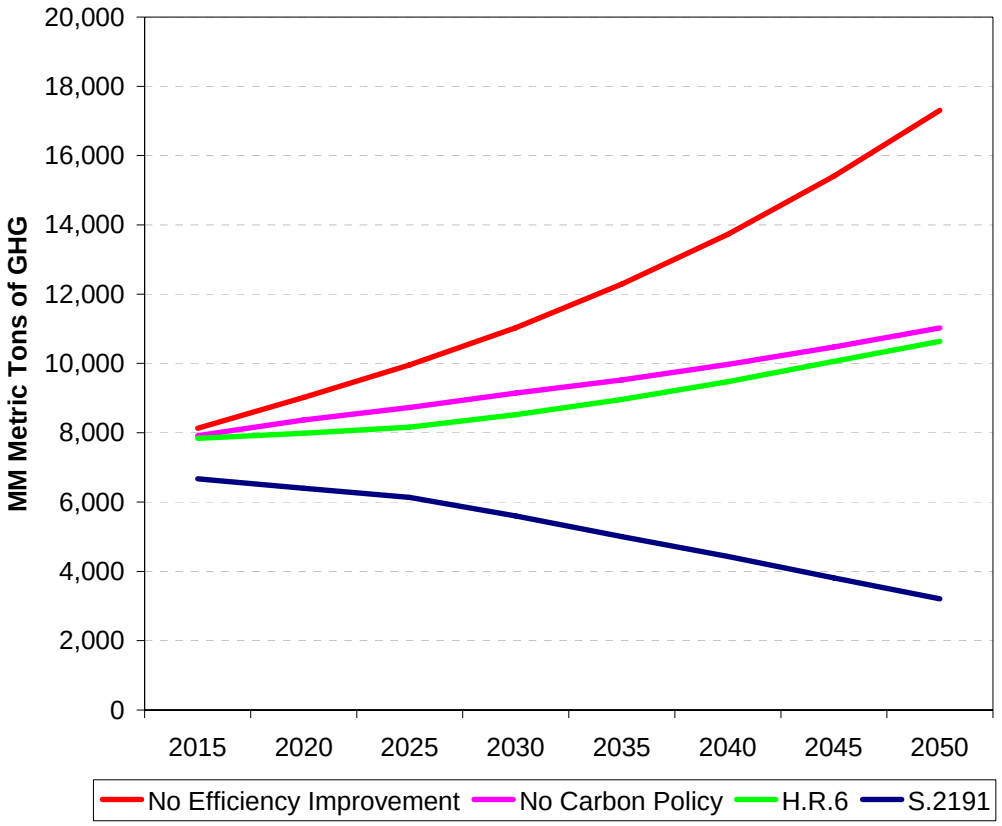
IV. Appendix and List of Acronyms

Appendix

- **The slides that follow provide more detailed results and assumptions that were referred to in earlier slides, and brief descriptions of MRN-NEEM**
- **A detailed documentation of the assumptions and the new model features will be provided in a forthcoming report**
  - **Documentation of the fundamental methodology of MRN-NEEM and of pre-existing model features can be obtained at:**
    http://www.crai.com/uploadedFiles/RELATING_MATERIALS/Publications/BC/Energy_and_Environment/files/MRN-NEEM%20Integrated%20Model%20for%20Analysis%20of%20US%20Greenhouse%20Gas%20Policies.pdf
  - **PLEASE NOTE: the version of the documentation at the above link does not include the key new features of MRN-NEEM that were developed specifically for this analysis, such as:**
    - **Use of AEO2008 (early release) as a baseline**
    - **Representation of VMT and MPG in determining total fuel demand**
    - **Representation of several types of biofuels for transportation**
    - **Methodology for simulating LCFS and CAFE policies**

Total US Greenhouse Gas Emissions



- The No Efficiency Improvement scenario assumes a constant carbon intensity at 2010 levels
- The No Carbon Policy scenario incorporates substantial improvements in carbon intensity over time due to ongoing technological improvements expected to occur even in the absence of H.R.6 and S.2191
- Provisions of H.R.6 produce a noticeable, but relatively small, reduction in emissions
- The S.2191 scenario requires an immediate drop in emissions, followed by a rapidly increasing reduction from the emission levels in the H.R.6 scenario

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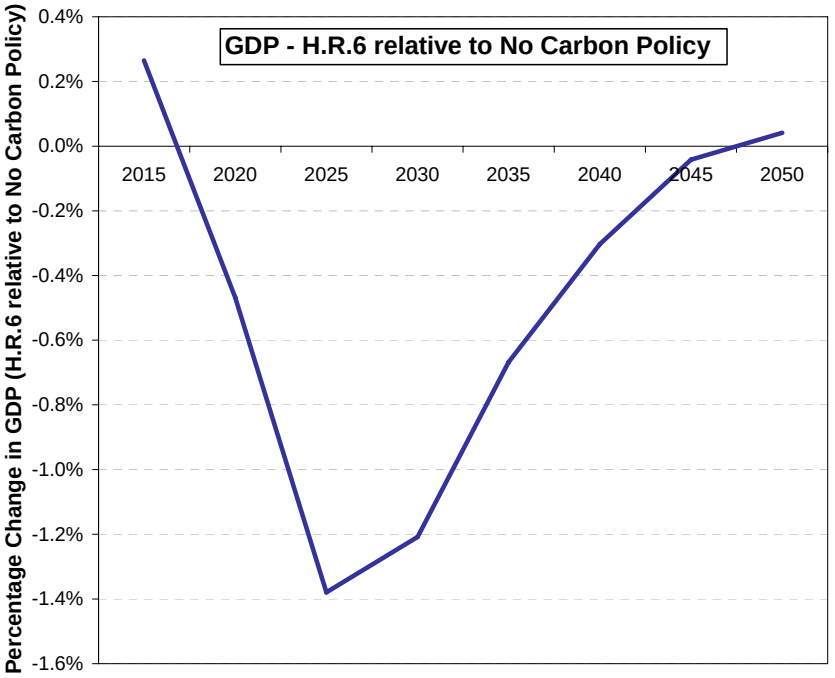
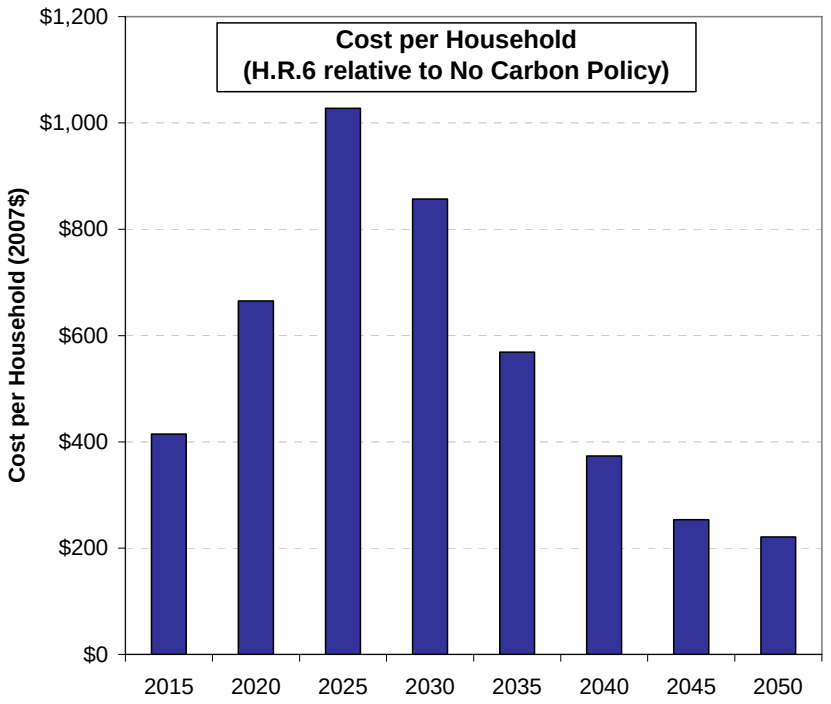
Impacts of H.R.6 Alone

- The 2015 results demonstrate that GDP can be an inaccurate indicator of societal costs of a policy
  - Although GDP rises (left chart, 2015) the standard of living for households is down (right chart, 2015)
  - GDP increases in 2015 because of investments required to produce alternative fuels to meet the RFS
  - These investments are not wealth-creating, although they provide emission benefits
  - Consumption and the standard of living are squeezed as resources are diverted to these investments
- CAFE standards cause the deep reductions in GDP seen from 2025 to 2030
  - Alternative fuels are very capital intensive compared to making motor vehicles more efficient





The total cost of H.R.6 is projected to be $2.0 trillion (present value, 2007$)

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CRA's MRN-NEEM Model Is a Well-Documented, Peer-Reviewed State-of-the-Art System

- **State-of-the-art treatment of economy-wide and electric sector issues**
- **Used extensively in prior studies of climate legislation and in development of SO_2, NO_x and mercury regulations**
- **Documented through publications in peer-reviewed literature and open access to assumptions**
  - "Equity and the Kyoto Protocol: measuring the distributional effects of alternative emissions trading regimes." Global Environmental Change 2000
  - "The Role of Expectations in Modeling Costs of Climate Change Policies," Chapter 18 in Human-Induced Climate Change: An Interdisciplinary Assessment, Cambridge University Press, 2007
  - Documentation of Scenarios Used in Dr. Anne E. Smith's Testimony of November 8, 2007 before the Senate Environment and Public Works Committee Regarding the Economic Impacts of S.2191: Response to a request by Senator Lieberman dated November 16, 2007
- **Used in CRA/EPRI study of California climate policies and by State of California for analyzing implementation alternatives**
  - Expert panel created by EPRI reviewed model development and study

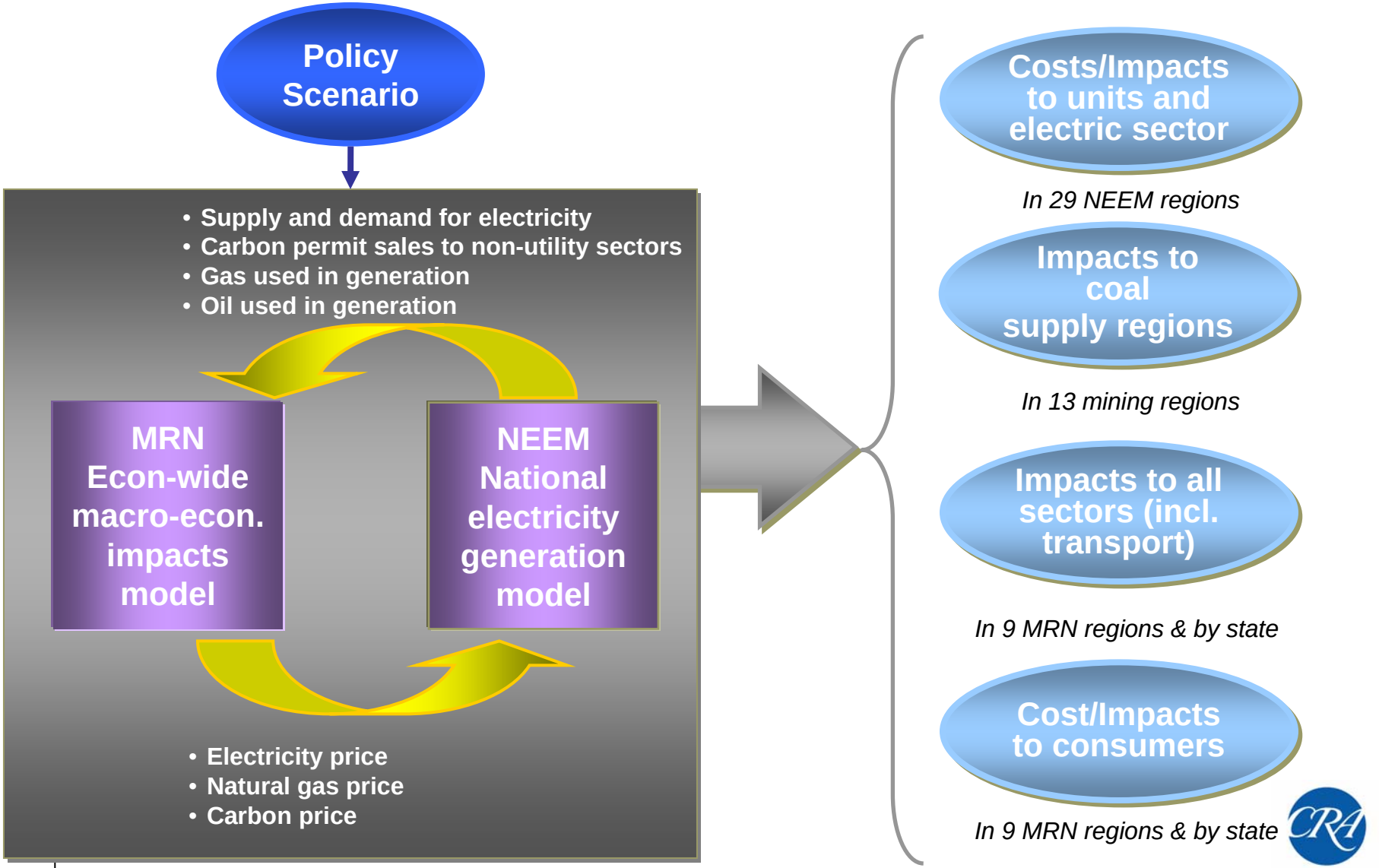
MRN Overview

- **MRN stands for "Multi-Region National Model"**
- **A macro-economic model of the entire US economy**
  - All economic sectors
  - All consumers
  - Income, consumption, investment and international trade
- **Sector detail needed for climate policy analysis**
  - 5 energy sectors
  - 6 non-energy industries
  - Household consumption and fuel use
- **Runs in 5-year time steps from 2010 through 2050**

NEEM Overview

- **NEEM is a detailed, bottom-up model of the power sector based on individual unit-level data**
- **Represents separate electricity control regions connected by transmission capacity**
- **Chooses new capacity to meet anticipated load growth at minimum cost**
- **Dispatches capacity against a load duration curve to give a realistic representation of need and use of different types of generating capacity**
- **Bases choices on future fuel prices, environmental constraints, and carbon prices**

Integration of MRN and NEEM Provides a Unique Capability for Analysis of GHG Policy Impacts



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List of Acronyms

- **AEO – Annual Energy Outlook**
- **AGR – Agricultural sector**
- **CAFE – Corporate Average Fuel Economy**
- **CCS – Carbon capture and storage**
- **CDM – Clean Development Mechanism**
- **CMEB – Carbon Market Efficiency Board**
- **CRA – CRA International, Inc.**
- **EIA – Energy Information Administration**
- **EIS – Energy-intensive sector**
- **ELE – Electric sector**
- **GDP – Gross domestic product**
- **GHG – Greenhouse gas**
- **HH – Household sector**
- **H.R.6 – Energy Independence and Security Act of 2007**
- **LCFS – Low Carbon Fuel Standard**
- **MAN – Manufacturing sector**
- **MPG – Miles per gallon**
- **MRN-NEEM – the integrated macroeconomic and electric sector model CRA used for this analysis**
- **OIL – Oil sector**
- **RFS – Renewable Fuel Standard**
- **S.2191 – Lieberman-Warner Climate Security Act of 2007**
- **SRV – Commercial/services sector**
- **TRN – Commercial transportation sector**
- **VMT – Vehicle miles traveled**

New Generation Technology Costs and Characteristics

All dollar values are in 2007$

Generation Technology	First Available	Overnight Capital Cost[1,2]	Fixed O&M[2]	Variable O&M	Heat Rate	Availability	Cumulative Capacity Limits								
							2010	2015	2020	2025	2030	2035	2040	2045	2050
	Year	*$/kW*	*$/kW-Yr*	*$/MWh*	*MMBtu/MWh*	*%*	*GW*								
Advanced Coal	2015	$1,839	$27.36	$4.56	8.844	87%	NA	60.0	No Limits						
Coal IGCC	2015	$2,356	$38.43	$2.89	8.309	85%	NA	10.0	60.0	No Limits					
Coal IGCC with CCS	2015	$4,486	$48.02	$5.53	9.713	85%	NA	2.0	17.0	47.0	107.0	197.0	287.0	377.0	467.0
	2025	$3,984	$48.02	$5.53	9.713	85%									
	2030	$3,630	$48.02	$5.53	9.713	85%									
	2035	$3,494	$48.02	$5.53	9.713	85%									
	2040	$3,379	$48.02	$5.53	9.713	85%									
	2045	$3,282	$48.02	$5.53	9.713	85%									
	2050	$3,203	$48.02	$5.53	9.713	85%									
Natural Gas Combined Cycle	2010	$705	$12.41	$2.05	7.000	86%	No Limits								
Natural Gas Combustion Turbine	2010	$536	$10.47	$3.15	10.842	93%	No Limits								
Nuclear	2015	$2,862	$67.47	$1.61	10.400	90%	NA	3.0	10.0	25.0	40.0	55.0	70.0	85.0	100.0
Wind Turbine[3]	2010	$1,946	$30.11	$1.61	NA	30%	15.0	35.0	55.0	75.0	95.0	115.0	135.0	155.0	175.0
Photovoltaic	2010	$5,437	$11.61	$1.61	NA	19% - 27%	No Limits								
Solar Thermal	2010	$3,469	$56.42	$1.61	NA	23% - 39%	No Limits								
Landfill Gas[4]	2010	$2,317	$113.53	$1.61	13.648	90%	3.0	8.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Biomass[5]	2010	$2,639	$76.40	$8.91	13.000	80%	1.2	2.5	4.5	9.5	26.5	59.5	99.6	99.6	99.6
	2020	$3,195	$52.87	$3.12	9.200	80%									
	2025	$3,083	$52.87	$3.12	8.911	80%									
Geothermal	2010	$3,451	$81.85	$0.00	NA	65%	No Limits								

[1] Excludes interest during construction

[2] Costs are for a generic region; regional costs are +/- 4% of these costs

[3] There are 3 costs classes of wind based on the terrain; capital costs for Cost Class 2 are 1.6 times higher; 2.4 times higher for Cost Class 3

[4] There are 2 costs classes of landfill gas ; capital costs for Cost Class 2 are 2.0 times higher

[5] The biomass generating technology transforms from its current burning of wood to biomass gasification in 2020

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