U.S. Environmental Protection Agency
Office of Atmospheric Programs

EPA Analysis of the Lieberman-Warner Climate Security Act of 2008

S. 2191 in 110th Congress

*****Summary Presentation*****

at

EPRI Cost Modeling Workshop

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	ICF International (IPM)

Take away points

1. Value of economic analysis is in the assessment of the *change* to key values, e.g., GHG emissions, GDP, energy prices.
2. Among many uncertainties, three key uncertainties are the availability of technologies, the level of international action, and reference case economic growth.
3. The use of offsets – both domestic and international – potentially has a larger impact on allowance prices than does the availability of technologies. This needs to be weighted against the integrity of those reductions and the size of international credit payments.
4. The ability to bank allowances has both economic and environmental benefits.
5. When evaluating different proposal, it is important to compare the *Total* level of GHG emissions, all gases – all sectors, not just the caps on covered sectors.

"Lieberman-Warner Climate Security Act of 2008" (S. 2191) Bill Summary

- Economy-wide coverage:
  - Upstream on petroleum, natural gas, as well as manufacturers of F-gases and N_2O
  - Downstream on coal facilities (that use over 5,000 tons of coal per year)
- GHG emission targets for covered sectors (targets decline in each calendar year):

  2012: 5,775 $MtCO_2e$
  2020: 4,924 $MtCO_2e$
  2030: 3,860 $MtCO_2e$
  2050: 1,732 $MtCO_2e$ (70% below 2005 emissions levels from covered facilities)

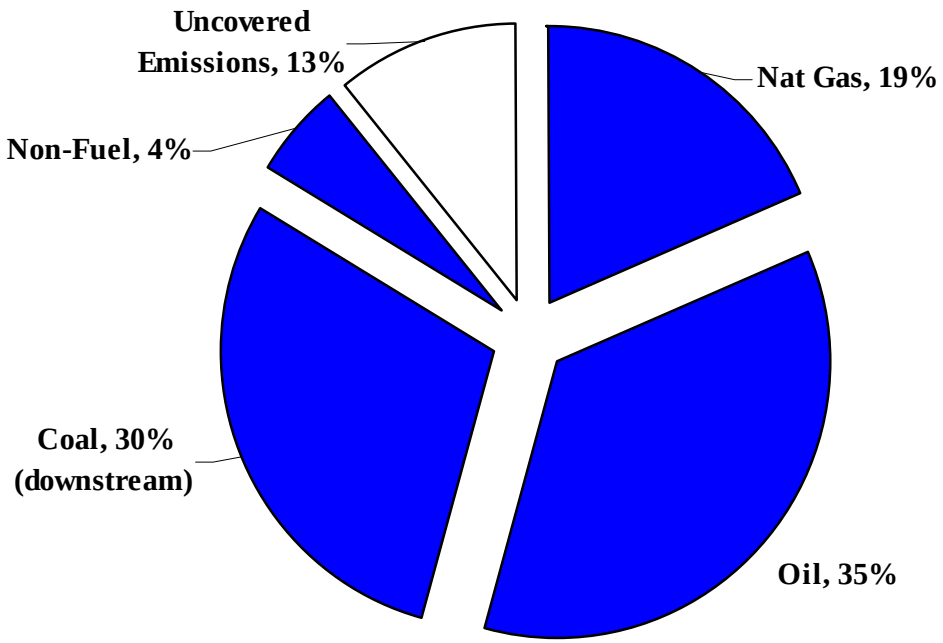
- Establishes a market-driven system of tradable emission allowances
- Establishes a separate cap and trade system for the consumption of HFCs
  - EPA's mitigation estimates for HFCs are based on production of the chemicals; the bill calls for reductions in HFC consumption. EPA is currently revising its mitigation estimates to more appropriately analyze this provision of the bill and will provide the analysis in the revised version of the full analysis in early June.
- Domestic offsets may be used to meet 15% of compliance obligation
- International credits may be used to meet 15% of compliance obligation
- Establishes a Carbon Market Efficiency Board
- Set-asides for agriculture and forestry sequestration as well as landfill and coal mine methane
- Bonus allowances for CCS*
- International reserve allowance requirement*

* The bonus allowances for CCS, and the international reserve allowance requirement provisions are similar to provisions in the Bingaman Specter bill (S. 1766). EPA's analysis of S. 1766 is available at:www.epa.gov/climatechange/economics/economicanalyses.html

Note: Additional Provisions of the bill that are not modeled are discussed in Appendix 1: Modeling Approach and Limitations

Emissions Coverage in S. 2191

87% of US Emissions (2005)



Types of covered facilities

- Oil Refineries and Importers
- Natural Gas Processors and Importers
- Facilities that use more than 5,000 tons of coal/year, e.g.
  - Power Plants
  - Iron and Steel Plants
  - Cement Manufacturers
- Industrial Gas Producers and Importers, e.g.
  - HFCs, PFCs, SF_6
  - N_2O

EPA Models and Corresponding GHG Mitigation

Sectors		Economy-wide Computable General Equilibrium (CGE) Models		Models Used to Provide Inputs to CGEs				Partial Equilibrium Model (Uses CGE Outputs)
		ADAGE	IGEM	NCGM	FASOM	GTM	MiniCAM	IPM
Domestic	Electricity Generation	All GHGs	All GHGs					CO_2, NOx, SO_2
	Transportation	All GHGs	All GHGs					
	Industry	All GHGs	All GHGs	CH_4, N_20, F-gases				
	Commercial	All GHGs	All GHGs					
	Agriculture (& Forestry)	All GHGs	All GHGs		CO_2, CH_4, N_20			
	Residential	All GHGs	All GHGs	CH_4, N_20,				
International Credits*				CH_4, N_20, F-gases		CO_2	CO_2, CH_4, N_20, F-gases	

* International allowance and domestic offset markets were analyzed using EPA's spreadsheet tool which combines results from the NCGM, FASOM, GTM and MiniCAM models.

ADAGE Applied Dynamic Analysis of the Global Economy (Ross, 2007)
IGEM Intertemporal General Equilibrium Model (Jorgenson, 2007)
IPM Integrated Planning Model (EPA, 2007)
NCGM EPA's non-CO_2 GHG spreadsheet tools for estimating projections and mitigation of CH_4, N_2O, and F-gases (EPA, 2005)
FASOMGHG Forest and Agriculture Sector Optimization Model, GHG version (EPA, 2005)
GTM Global Timber Model (Sohngen, 2006)
MiniCAM Mini-Climate Assessment Model (Edmonds, 2005)

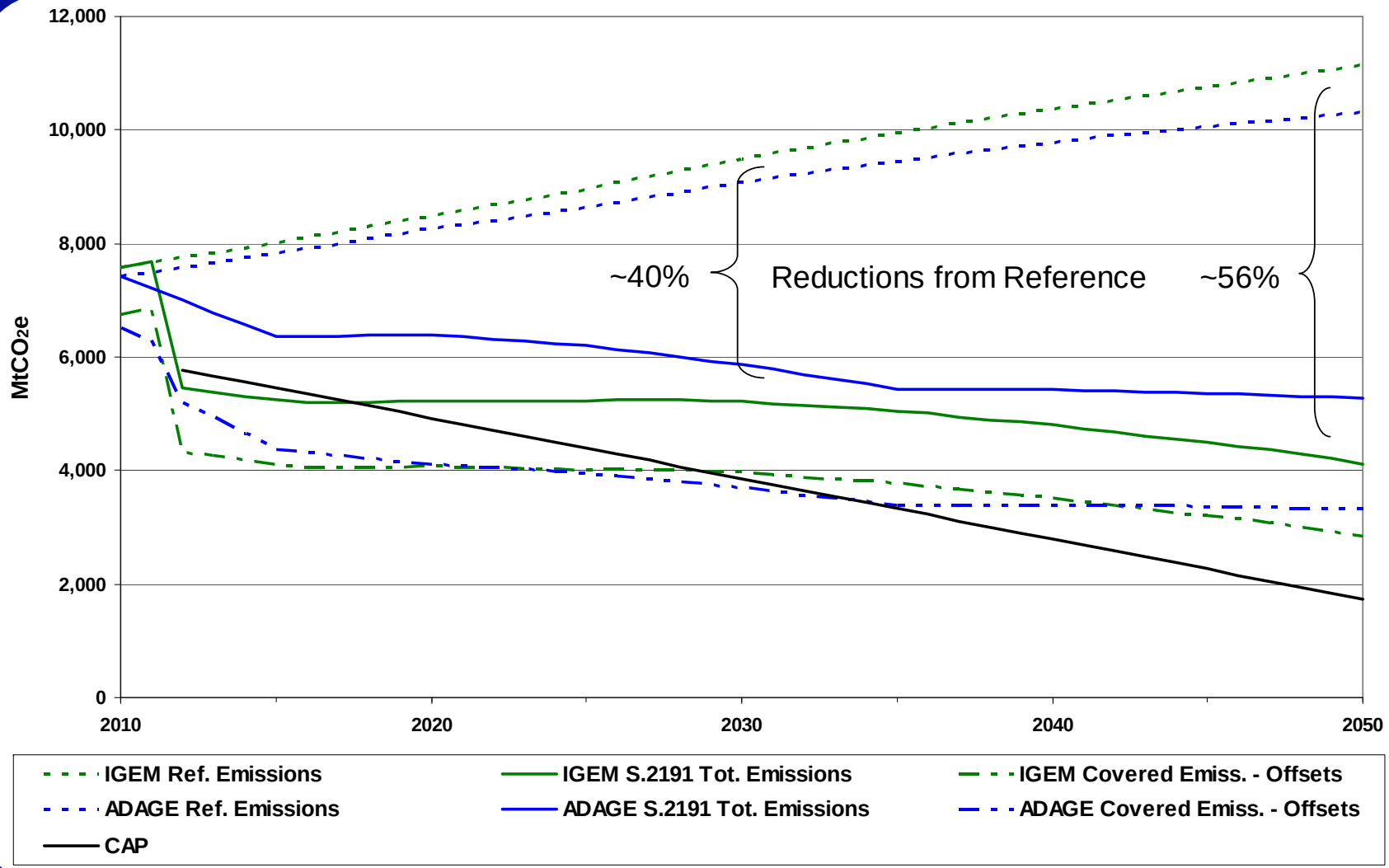
Analytical Scenarios

EPA analyzed ten different scenarios to evaluate a range of assumptions and key parameters. This analysis does not necessarily reflect EPA's views on what is most likely to occur.

1) **EPA Reference Scenario**
   - For domestic projections, benchmarked to AEO 2006 (which does not include the Energy Independence and Security Act).
   - For international projections, uses CCSP Synthesis and Assessment Report 2.1 A MiniCAM Reference
2) **S. 2191 Scenario**
   - Substantial growth in nuclear power (nuclear power generation increases by ≈150% from 782 bill. kWh in 2005 to 1,982 bill. kWh in 2050) reflecting possible future policies to promote this technology in S. 2191 and elsewhere
   - Widespread international actions by developed and developing countries over the modeled time period. International policy assumptions are based on those used in the recent MIT report, "Assessment of U.S. Cap-and-Trade Proposals"
     - Group 1 countries (Kyoto group less Russia) follow an allowance path that is falling gradually from the simulated Kyoto emissions levels in 2012 to 50% below 1990 in 2050
     - Group 2 countries (rest of world) adopt a policy beginning in 2025 that returns and holds them at year 2015 emissions levels through 2034, and then returns and maintains them at 2000 emissions levels from 2035 to 2050
3) **S. 2191 Scenario with Low International Actions**
4) **S. 2191 Scenario Allowing Unlimited Offsets**
5) **S. 2191 Scenario with No Offsets**
6) **S. 2191 Constrained Nuclear & Biomass**
7) **S. 2191 Constrained Nuclear, Biomass, and CCS**
8) **S. 2191 Constrained Nuclear, Biomass, and CCS + Beyond Kyoto + Natural Gas Cartel**
9) **Alternative Reference Scenario**
10) **S. 2191 Alternative Reference Scenario**

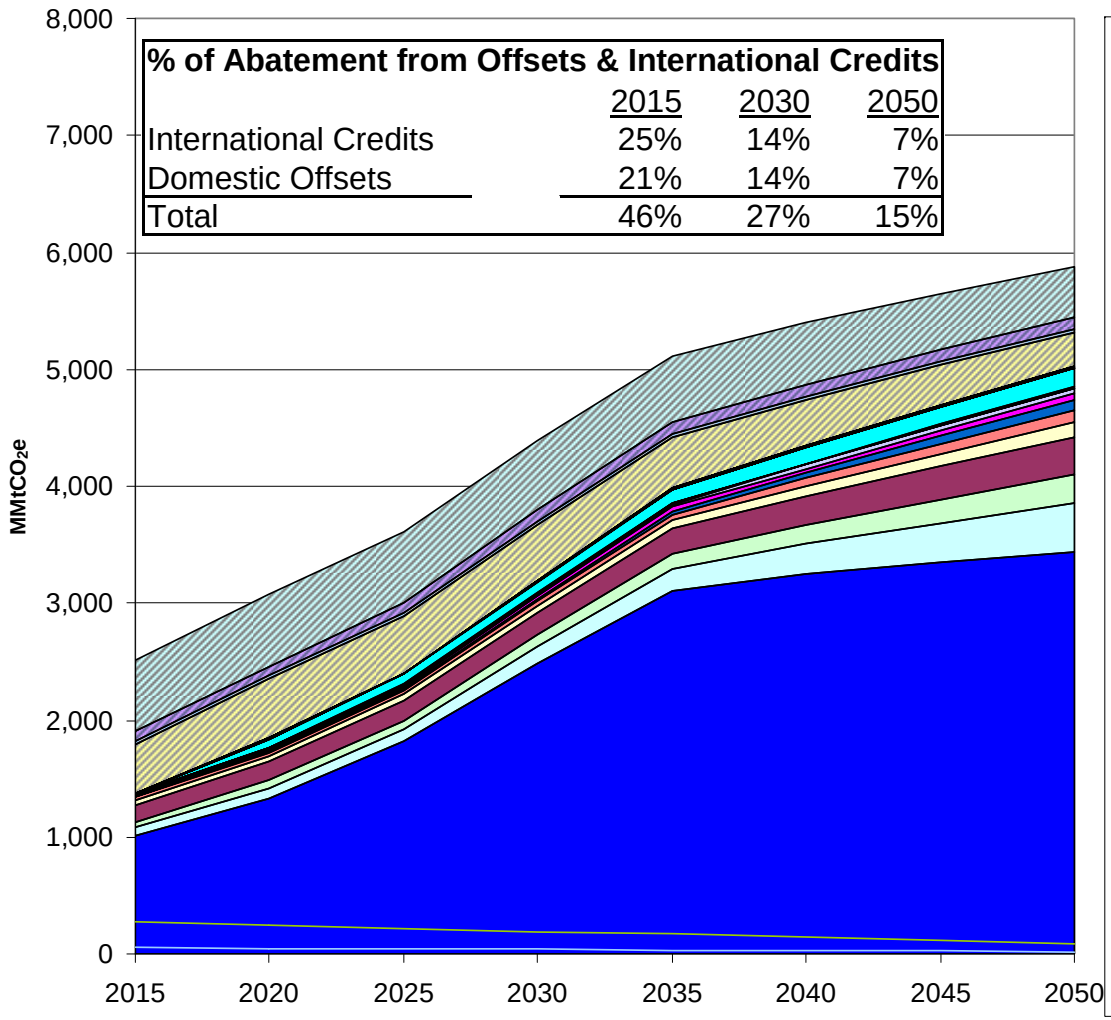
Results: Scenario 2 - S. 2191

U.S. GHG Emissions



Results: Scenario 2 - S. 2191

Sources of GHG Abatement (ADAGE)



% of Abatement from Offsets & International Credits

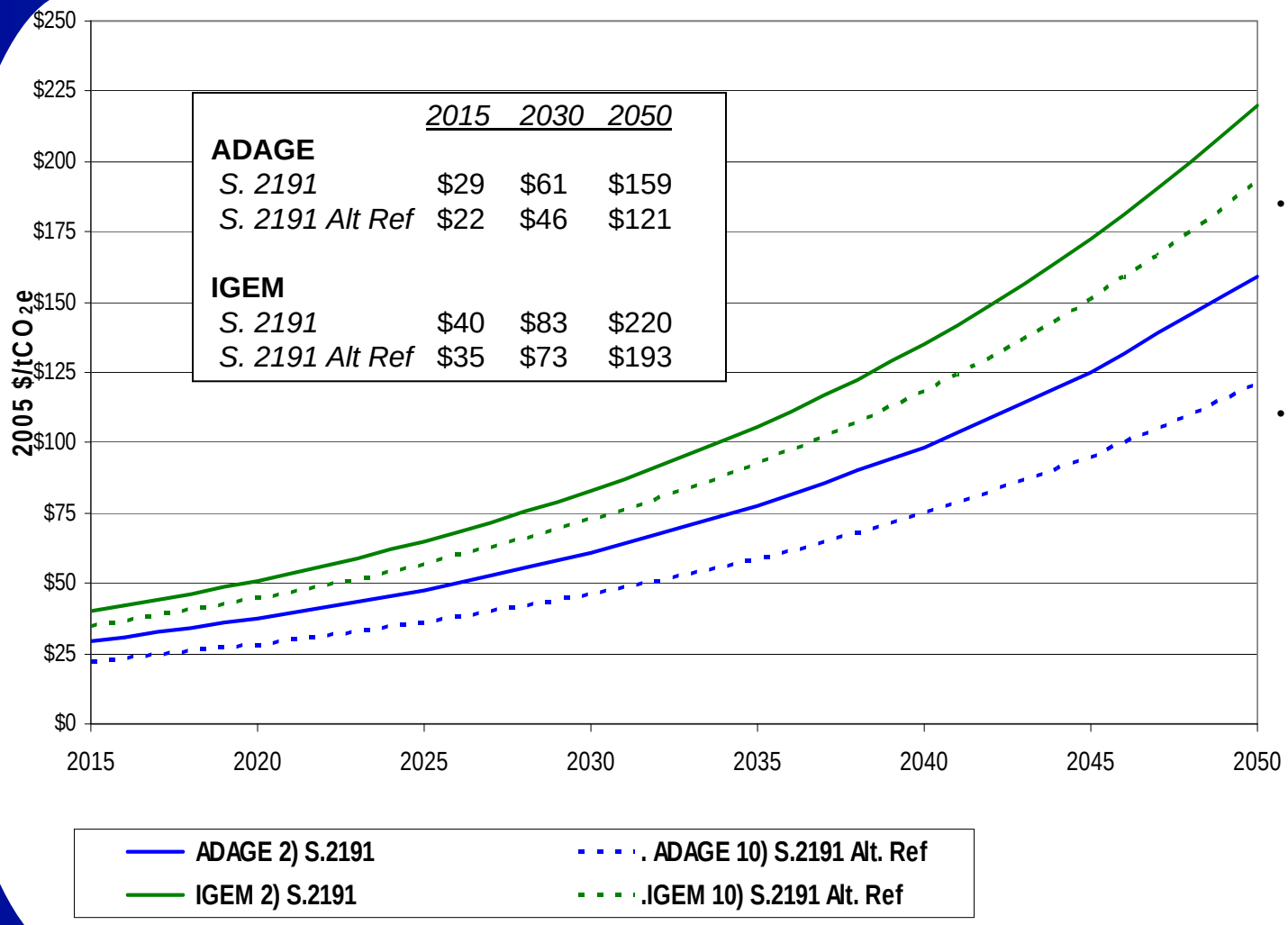
	2015	2030	2050
International Credits	25%	14%	7%
Domestic Offsets	21%	14%	7%
Total	46%	27%	15%

- International Credits
- Offsets - Landfill/Coal Mine CH4
- Offsets - Nat Gas/Oil Sector CH4
- Offsets - Ag/Forestry
- SF6 - Energy-Int Man
- SF6 - Electricity
- PFC - Energy-Int Man
- PFC - Other Manuf
- CH4 - Nat. Gas
- CO2 - Agriculture
- CO2 - Coal
- CO2 - Natural Gas
- CO2 - Services
- CO2 - Crude Oil
- CO2 - Petroleum
- CO2 - Other Manuf
- CO2 - Energy-Int Man
- CO2 - Transport
- CO2 - Residential - Autos
- CO2 - Electricity
- Allowance Set-Asides - Ag/Forestry
- Allowance Set-Asides - Landfill/Coal Mine

- S. 2191 allows offsets and international credits to each make up 15% of the total allowance submissions requirement.
- The quantity of offsets and international credits allowed decreases as allowance submissions decrease.
- Since the quantity of offsets allowed is decreasing over time and the quantity of abatement is increasing over time, offsets make up a large fraction of abatement in the early years of the policy, and there contribution to total abatement decreases over time.

Results: Scenario 2 – S. 2191, Scenario 10 – S. 2191 Alt. Ref.

GHG Allowance Prices

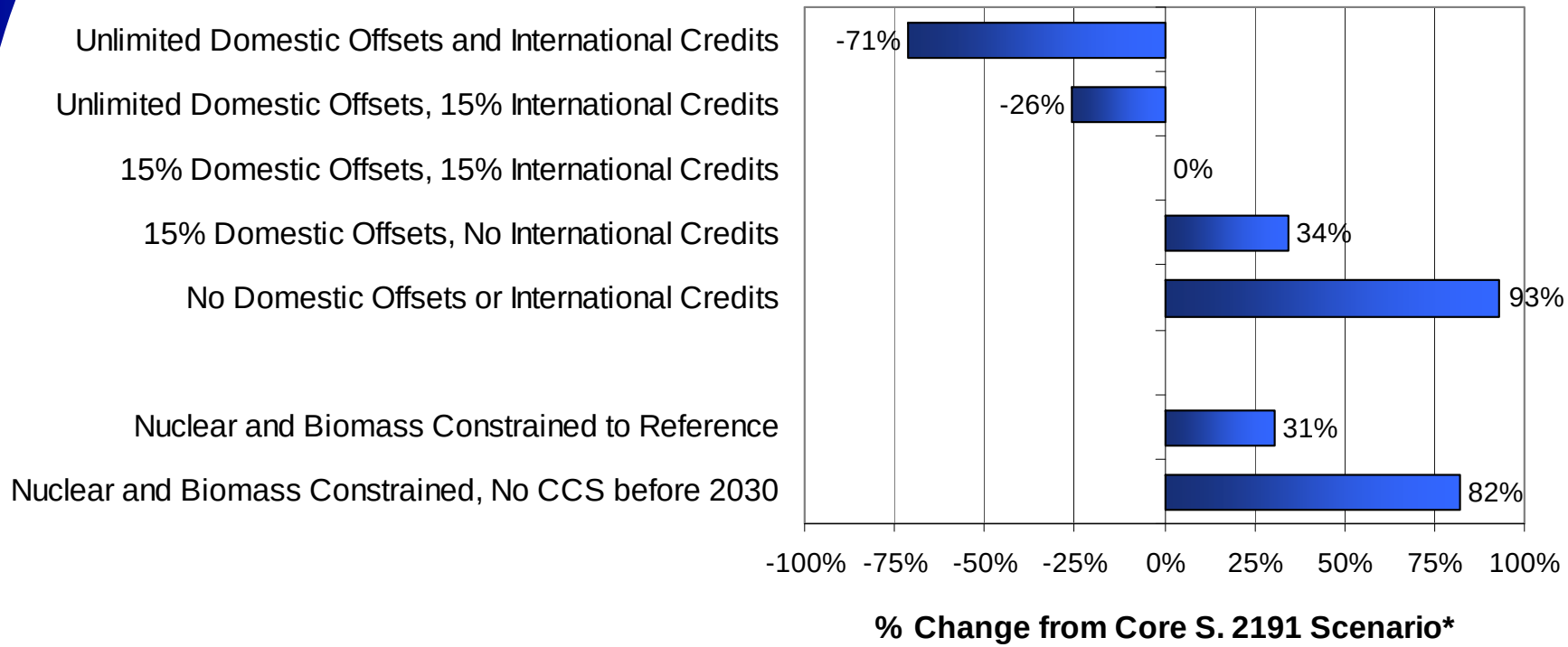


	2015	2030	2050
ADAGE			
S. 2191	$29	$61	$159
S. 2191 Alt Ref	$22	$46	$121
IGEM			
S. 2191	$40	$83	$220
S. 2191 Alt Ref	$35	$73	$193

- The $61 - $83 range of 2030 allowance prices only reflects differences in the models and does not reflect other scenarios or additional uncertainties discussed elsewhere.
- Note that although the offset price differs from the allowance price, these prices do reflect the use of offsets and international credits.

Offset Provisions of S. 2191 and Availability of Technology Significantly Influence Costs

Marginal Cost of GHG Abatement in 2030 - Sensitivity Cases

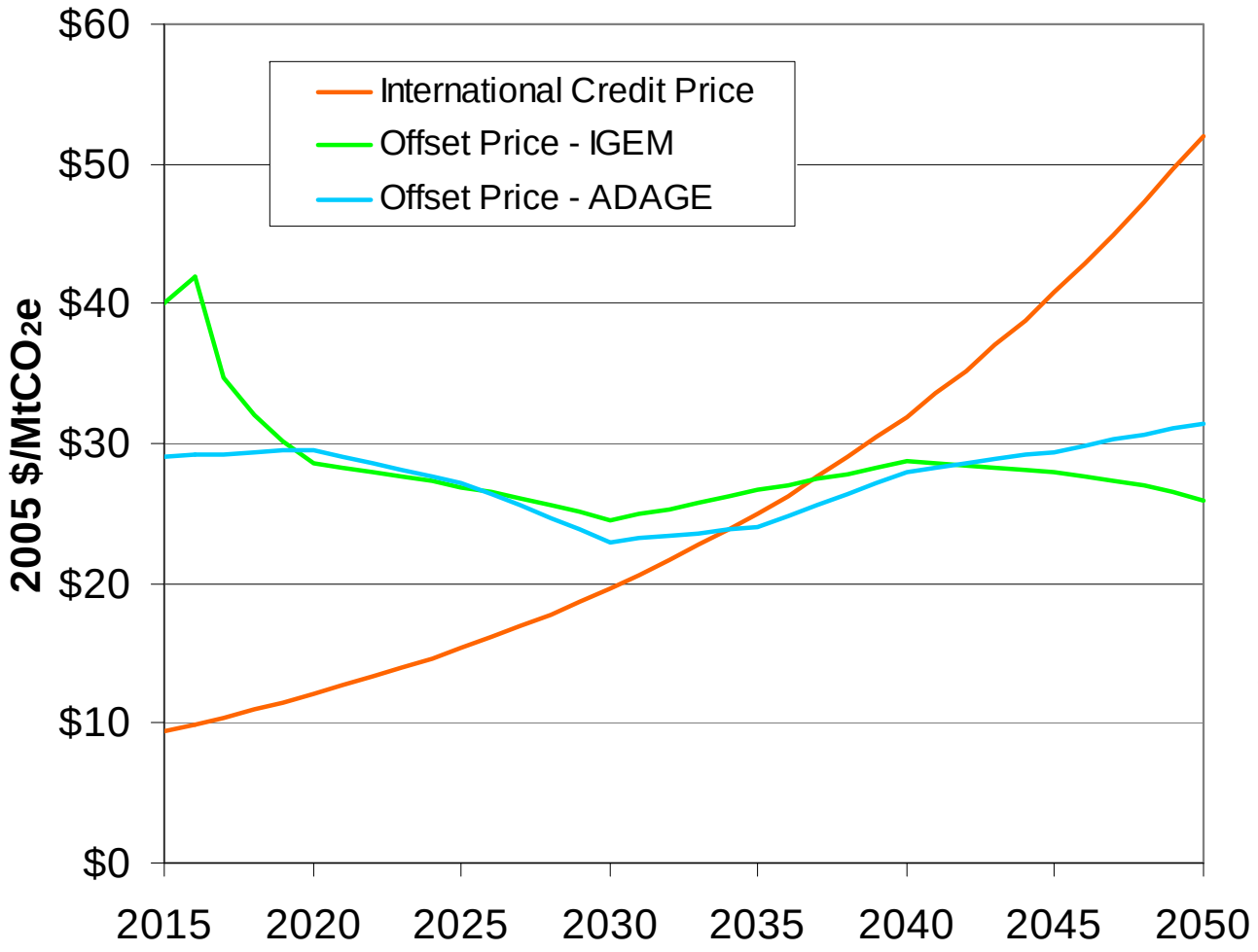


- 2030 Allowance price in core S. 2191 Scenario: $61 - $83
- Range of 2030 Allowance prices in all scenarios: $24 - $160

* Scenario 2 from EPA's analysis of S. 2191: S. 2191 as written (15% of compliance obligation from domestic offsets, 15% from international credits), assumes 150% increase in nuclear power between now and 2050, assumes CCS available after 2015.

Results: Scenario 2 - S. 2191

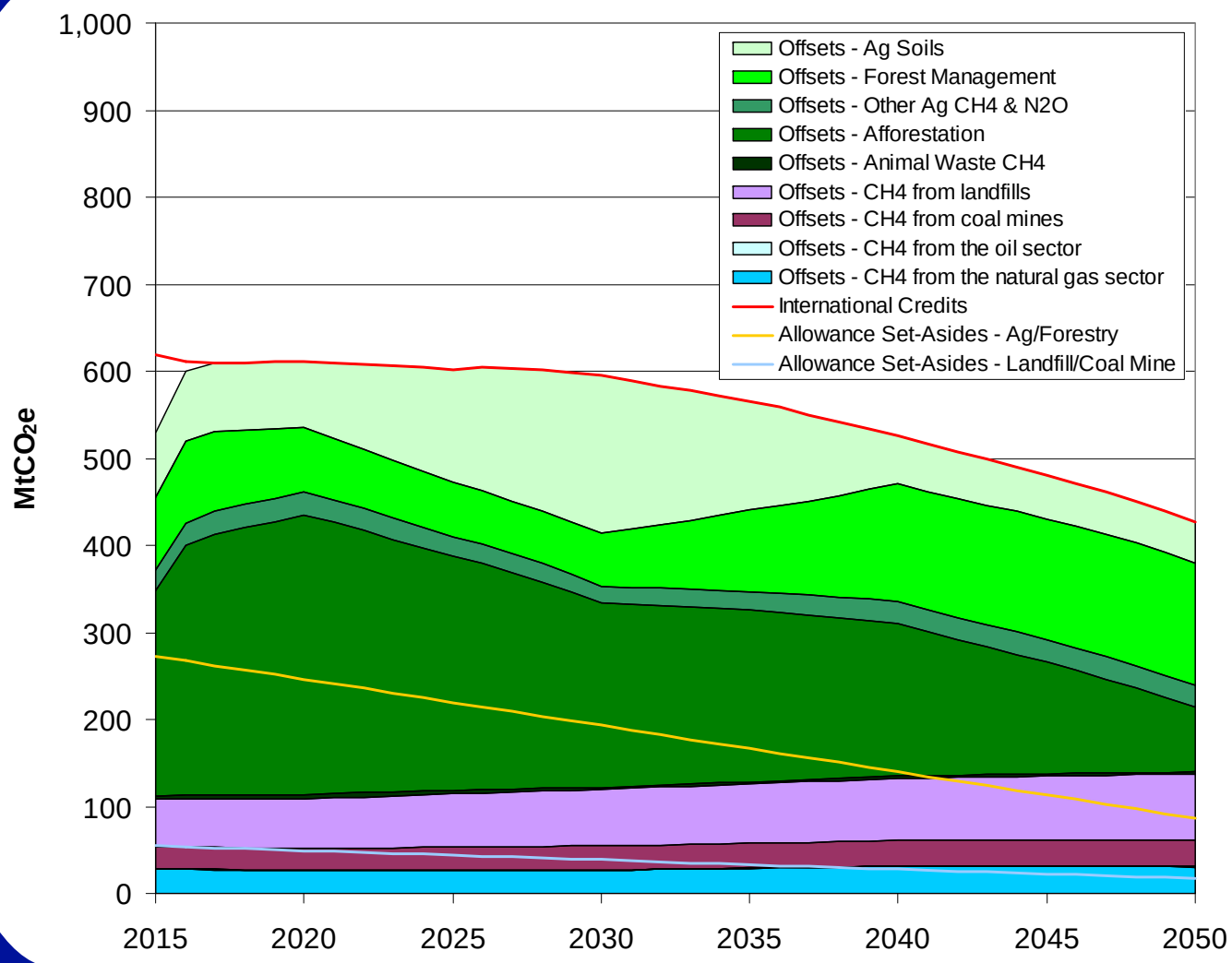
Offset and International Credit Prices



- S. 2191 limits the use of offsets and international credits to 15% of allowance submissions.
- The 15% limit on the use of domestic offsets is binding in IGEM starting in 2017, and in ADAGE starting in 2015.
- In IGEM, the offset price is equal to the GHG allowance price before 2017 when the 15% limit is not binding.
- Starting in 2017 in IGEM, and 2015 in ADAGE, when the 15% limit is binding, the offset price is lower than the GHG allowance price.
- The international credit price is driven by the international demand and supply of GHG abatement.
- This scenario assumes that offsets are not discounted, if offsets were discounted, the offset price would be expected to rise.

Results: Scenario 2 - S. 2191

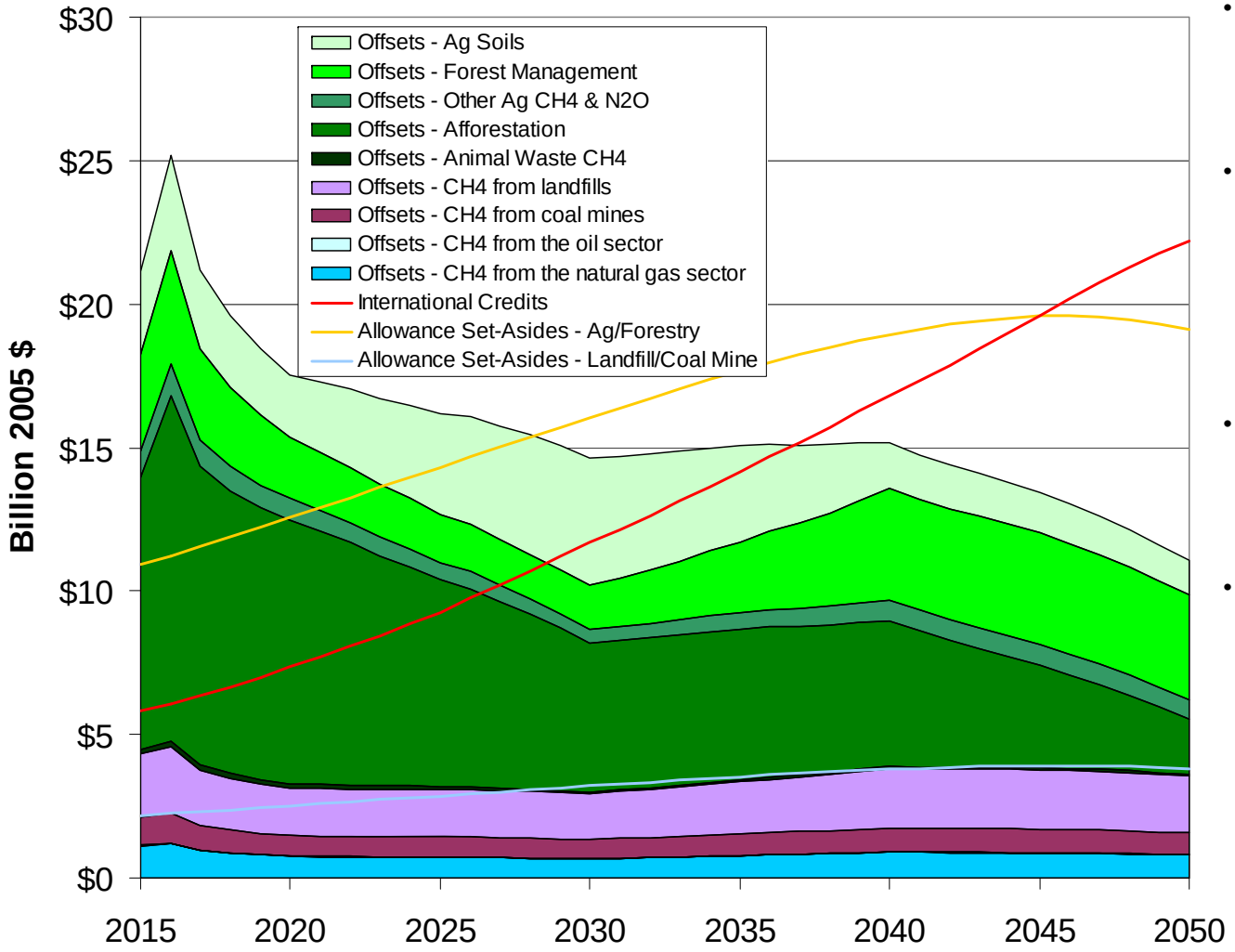
Allowance Set-Aside, Offset, and International Credit Abatement (IGEM)



- The total quantity of abatement from domestic offsets is limited to 15% of allowance submissions in each year.
- The quantity of abatement from international credits is similarly limited to 15% of allowance submissions in each year.
- The quantity of abatement from allowance set-asides is proscribed by the bill, 4% of allowances in each year are set aside for Ag/Forestry abatement projects, and 1% are set aside for landfill and coal mine CH_4 abatement projects.
- Because the offset price is lower than the GHG allowance price, projects that are eligible for both allowance set-asides and offsets would prefer to be in the allowance set-aside program.

Results: Scenario 2 - S. 2191

Allowance Set-Aside, Offset, and International Credit Payments (IGEM)



- Payments for offsets are simply determined by multiplying the offset price by the quantity of offsets supplied from each source.
- Before 2017, offset payments are considerably higher than in later years. This is driven by the high offset prices in these early years when the 15% limit on the use of offsets is not binding, and the offset price is thus equal to the price of GHG allowances.
- Payments for international credits are simply the product of the international credit price and the quantity of international credits purchased.
- Similarly, the value of the allowance set-asides is the product of the GHG allowance price and the quantity of abatement associated with the allowance set-aside programs.

Detailed Electricity Sector Modeling with IPM

Motivation for Using the Integrated Planning Model (IPM):

- The CGE models used for this analysis do not have detailed technology representations; they are better suited for capturing long-run equilibrium responses than near-term responses.
- Since the electricity sector plays a key role in GHG mitigation, and the near-term response in the electricity sector is of particular interest, we have employed the Integrated Planning Model (IPM) model to shed further light on the near-term impact of S. 2191 on the electricity sector as a complement to the broader picture presented by the CGE models.

Power Sector Modeling (EPA Base Case v3.01 using IPM):

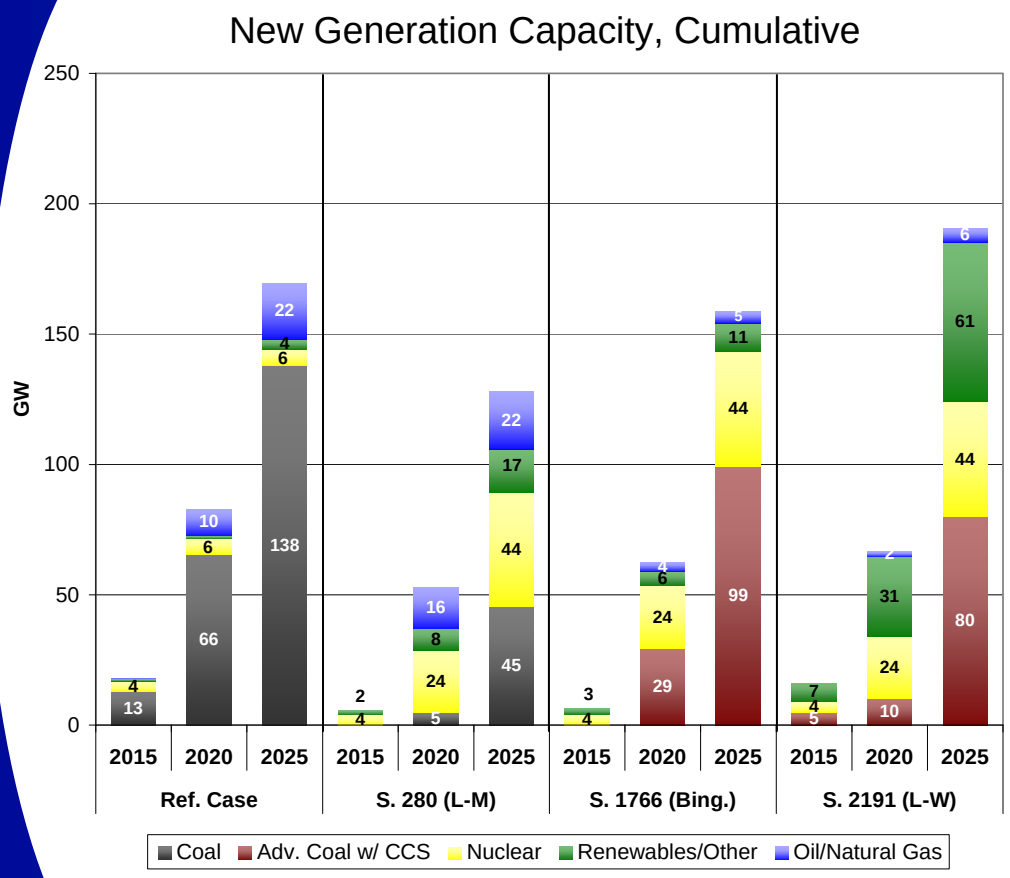
- This version of IPM builds off recently released EPA Base Case v3.0, with the following updates for purposes of modeling carbon policies:
  - Carbon capture and storage (for new plants)
  - Biomass co-firing option
  - Constraints on new nuclear, renewable, and advanced coal (with CCS) capacity

Modeling Approach:

For this analysis, EPA's Base Case v3.01 using IPM was used and incorporated two sets of data from the ADAGE model:

- CO_2 allowance price projections
- Percent change in electricity demand

New Generation Capacity (IPM)

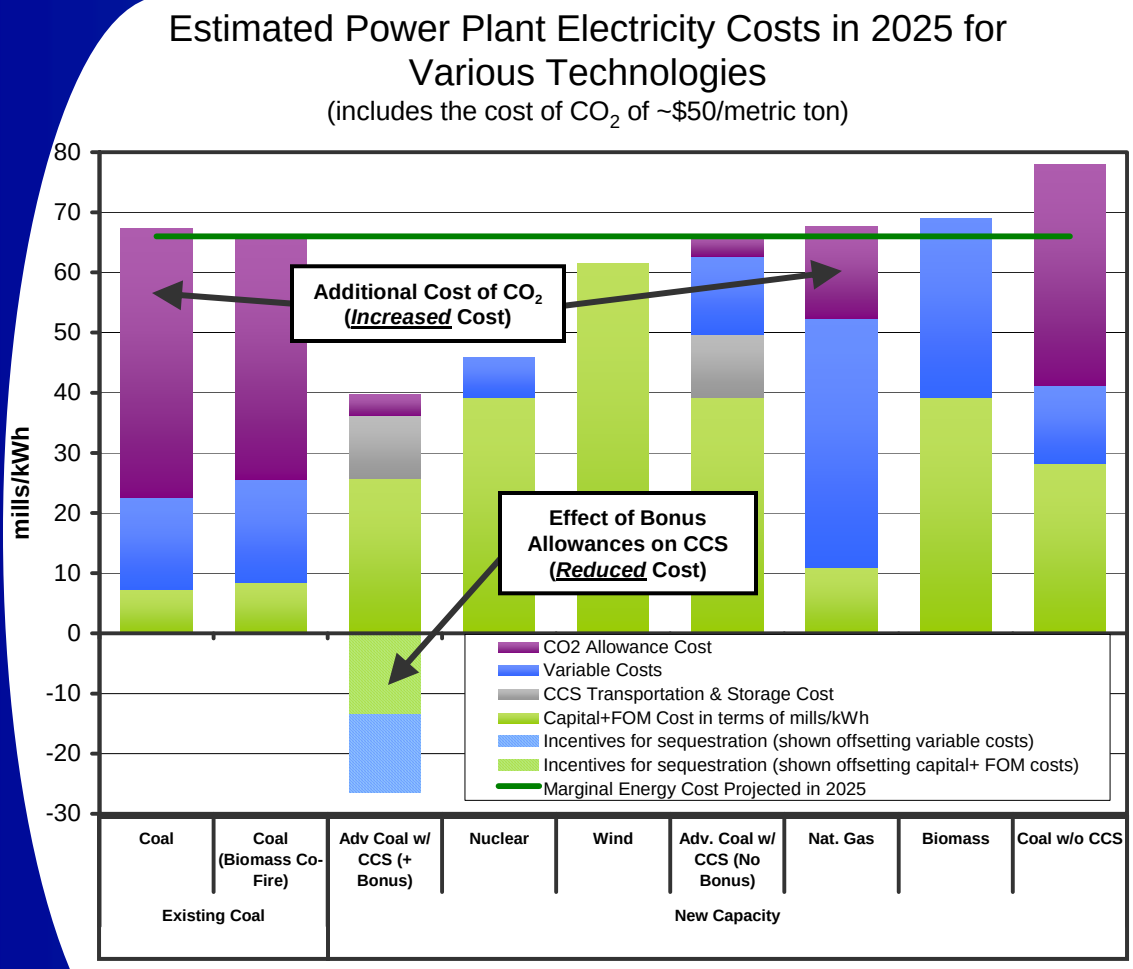


Note: New capacity additions less that 1 GW of capacity are not indicated.

- S. 2191 contains an allowance bonus provision, which is capped, for CO_2 emissions that are captured and sequestered, resulting in significant penetration of new coal capacity with CCS technology (S. 1766 has a similar provision).
  - Bonus allowances go unused in 2015 only, when there is a 5 GW constraint on new adv. coal with CCS (the bonus is used entirely in all years post-2015).
- In 2025, adv. coal with CCS is economic even without the bonus.
- S. 2191 also results in significant penetration of new nuclear and renewable capacity.
- More capacity is built under S. 2191 because a significant amount of the existing fossil fleet is not economic to operate and must be replaced.

New Capacity Limitations in IPM (Incremental/Cumulative)				
GW	**2010**	**2015**	**2020**	**2025**
Nuclear	N/A	4	20 / 24	20 / 44
Adv. Coal w/ CCS	N/A	5	70 / 75	70 / 145
Renewables *(Cumulative Only)*	4	24	44	64

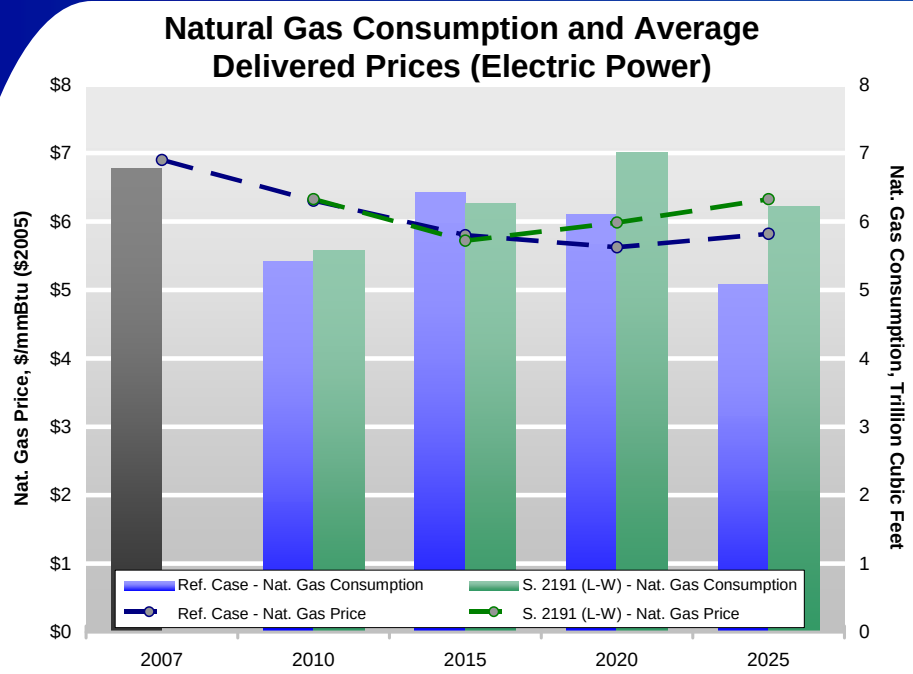
Near-Term Power Plant Economics with CO_2 Allowance Costs

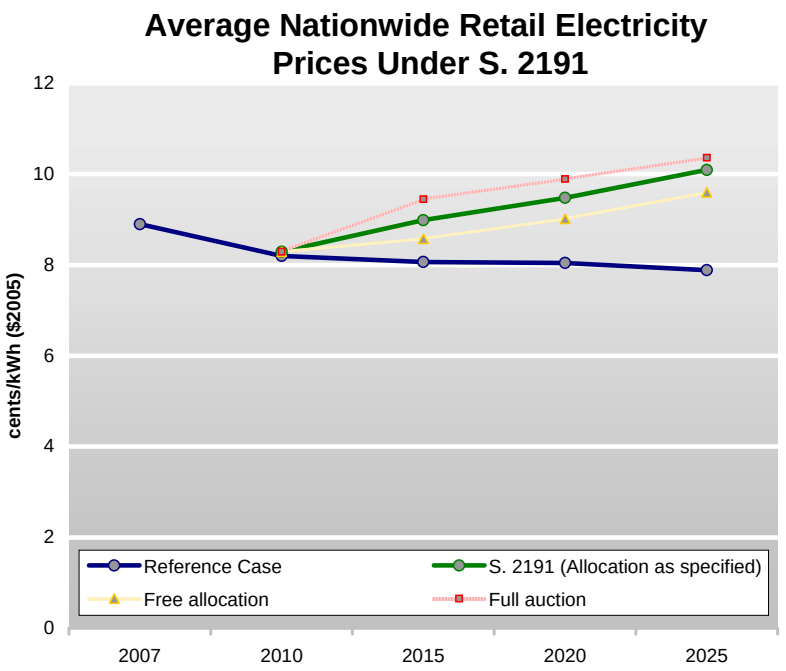


- To illustrate the economics of operating existing and new power technologies, the chart shows the cost of various technologies when the projected CO_2 allowance prices are included.
- Projected CO_2 allowance prices of roughly $50/ton in 2025 increase variable costs of existing plants powered by fossil fuels to the point where many are likely to shut down.
- However, S. 2191 provides significant incentives for CCS technology for coal plants in the form of bonus allowances, resulting in earlier penetration of advanced coal with CCS.

Notes: For the case with bonus allowances, the variable, capital, and fixed O&M costs are actually an aggregate of the solid part and the hashed part but the net cost is only the solid part. For this illustrative calculation, EPA used a conservative efficiency metric for existing coal plants (10,500 Btu/kWh), which most plants currently meet or exceed. The marginal energy cost is defined as the cost of production of the most expensive unit operating in that hour. It includes the cost of fuel, variable O&M cost and the cost of environmental allowances. The capital costs used here are from IPM v3.01, which relies upon EIA capital cost data from AEO 2005. More recently, capital costs have increased with increasing international demand for raw materials. It is not clear how the market will respond to these price increases and whether these increased costs will be sustained over the period of the analysis.

Power Sector Natural Gas Consumption, Prices, and Retail Electricity Prices (IPM)





		Natural Gas Consumption and Prices				
		2007	2010	2015	2020	2025
Nat. Gas Consumption (TCF)	Ref. Case	*6.8*	5.4	6.4	6.1	5.1
	S. 2191		5.6	6.3	7.0	6.2
Nat. Gas Price ($/mmBtu)	Ref. Case	*6.90*	6.30	5.80	5.60	5.80
	S. 2191		6.30	5.70	6.00	6.30

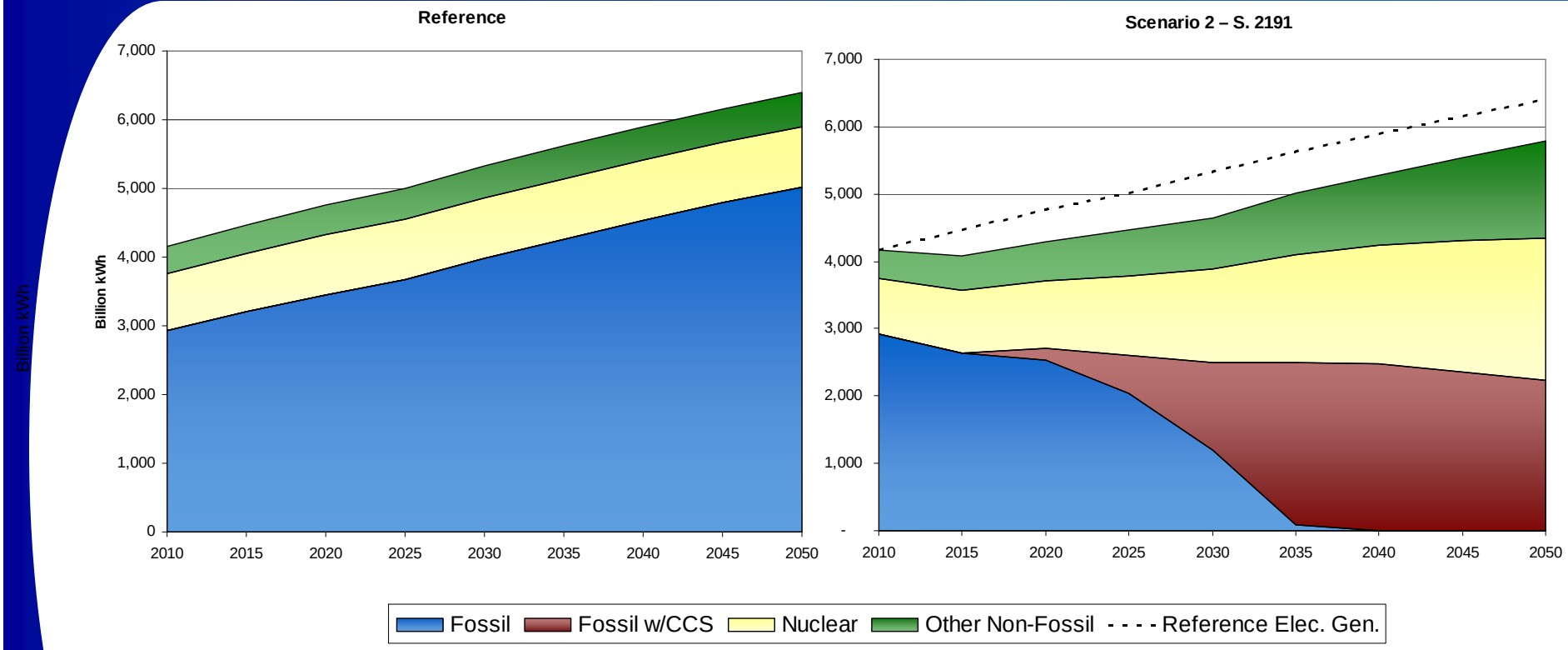
	Retail Electricity Prices (¢/kWh)				
	2007	2010	2015	2020	2025
Ref. Case	*8.9*	8.2	8.1	8.0	7.9
S. 2191 (allocation as specified)		8.3	9.0	9.5	10.1
S. 2191 (free allocation)		8.3	8.6	9.0	9.6
S. 2191 (full auction)		8.3	9.4	9.9	10.4

Source: 2007 data is from EIA, projections are from EPA's IPM Outlook 2006 and analysis of S. 2191 using IPM.

Note: Natural gas prices and consumption presented here are determined endogenously in IPM and do not reflect changes in supply/demand (and thus prices) outside the power sector as a result of S. 2191 (the ADAGE model is the economy-wide model that EPA uses to reflect this dynamic). To the extent that natural gas demand increases outside the power sector, the price impacts reflected here may be a bit lower than if the total demand for natural gas were reflected in IPM. However, demand for natural gas in ADAGE outside the power sector is not projected to increase significantly, so the price projections presented here would not be greatly impacted by demand from other sectors.

Results: Scenario 1 – Reference; Scenario 2 – S. 2191

U.S. Electricity Generation, mid-term results (ADAGE)



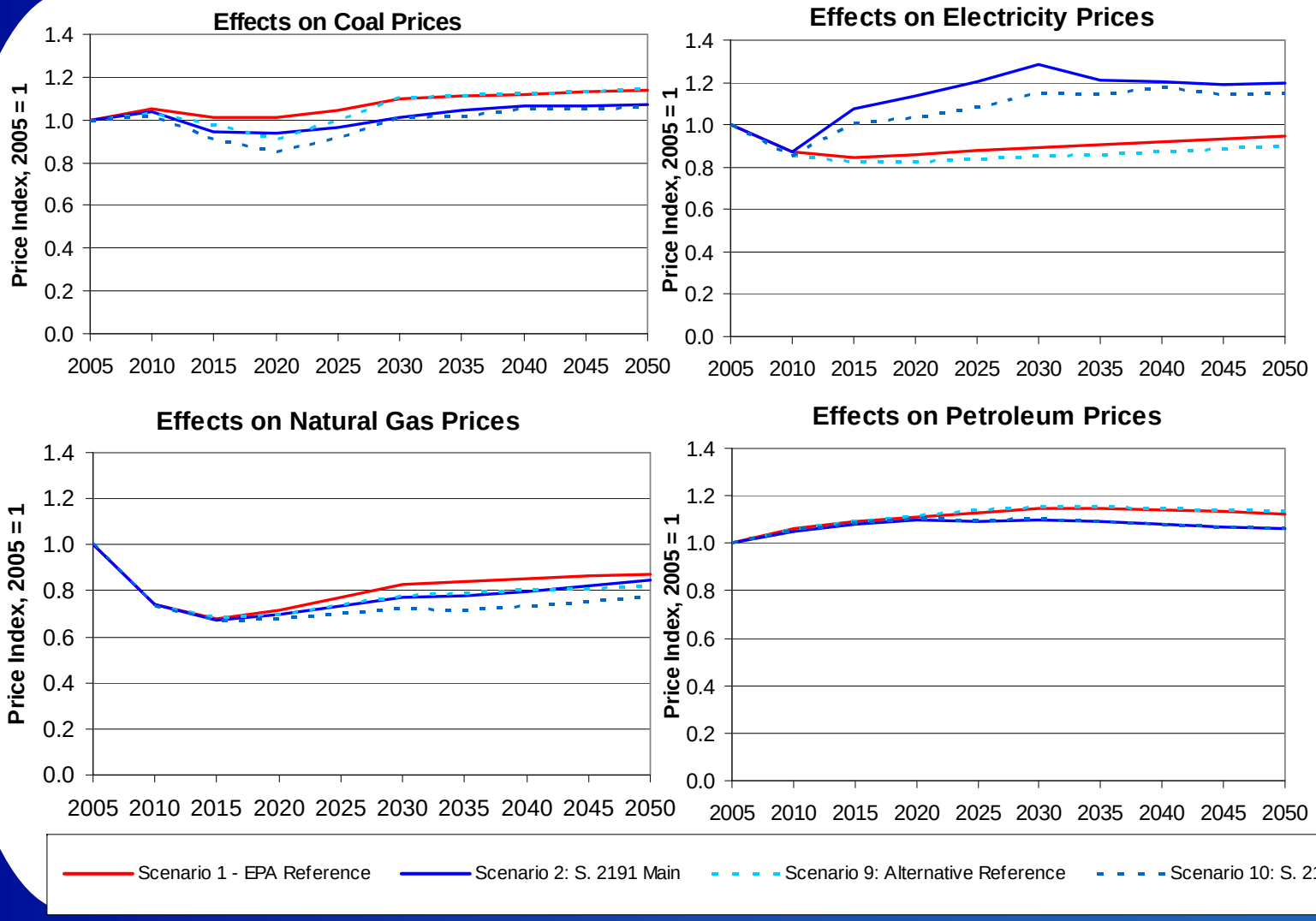
- Under S. 2191, both nuclear and renewable electricity generation expands above the reference levels.
- In addition, CCS deployment on fossil-fuel generation begins after 2015. By 2030, 175 GW of new CCS capacity is projected to be built, which is the equivalent of 318 CCS units of 550 MW each. By 2050, 299 GW of new CCS capacity is projected to be built, which is the equivalent of 543 CCS units 550 MW each.
- By 2035, almost all fossil electricity generation is capturing and storing CO_2 emissions. (Note that because ADAGE does not represent peak versus base load generation requirements, the use of CCS technology on almost all fossil fuel generation by 2035 may be overly optimistic).

Note: Other non-fossil includes hydro, geothermal, wind, solar, biomass and municipal solid waste.

Electricity Generation with CCS (ADAGE)

- As noted previously, large-scale availability of CCS technology is a key uncertainty in the analysis.
- ADAGE uses EIA data on CCS technology costs and effectiveness (*Assumptions to the Annual Energy Outlook*). Costs are also influenced by fuel prices and any bonus allowances received.
- Maximum penetration rates for CCS in each time period are based on a "learning-by-doing" structure, in which construction in previous years influences future capacity:
  - economic considerations control when CCS initially becomes cost effective in the model.
  - feasible capacity is initially generally based on construction rates for related technologies from AEO forecasts.
  - construction in future years is then controlled by the influence of past decisions on the existing technology base.

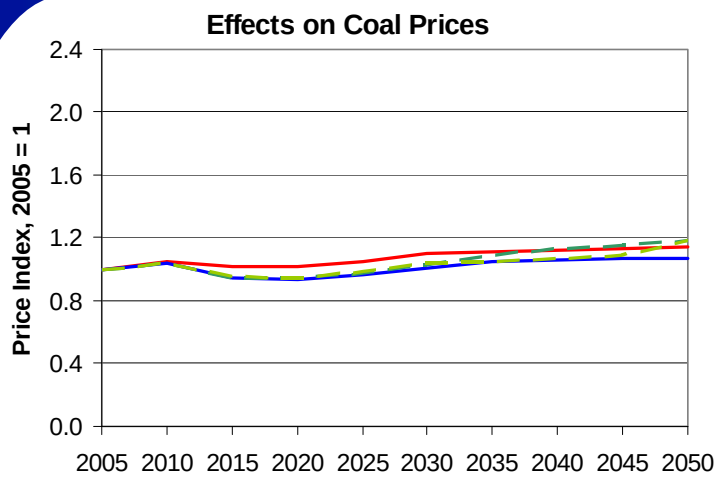
Results: Scenario 1 – Reference; Scenario 2 – S. 2191; Scenario 9 – Alternative Reference; Scenario 10 – S. 2191 Alt. Ref.
Fuel Prices (ADAGE)

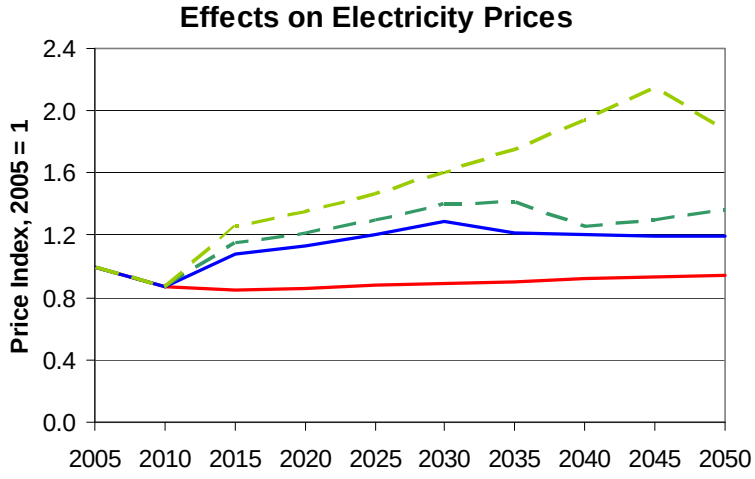


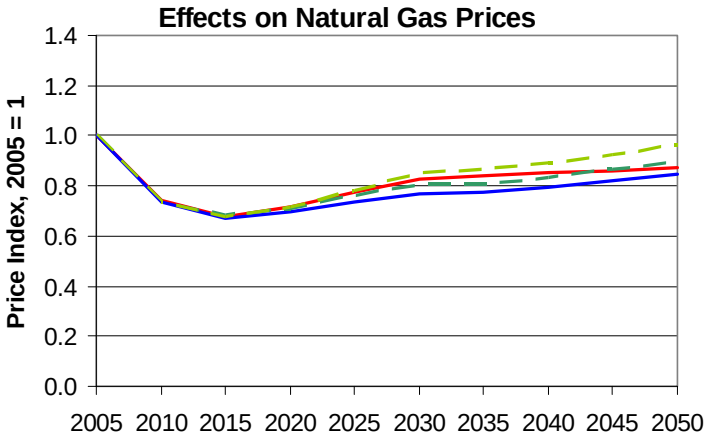
- Coal, natural gas, and oil prices are producer prices, and thus do not reflect the cost of allowances
- Electricity prices do reflect the cost of allowances

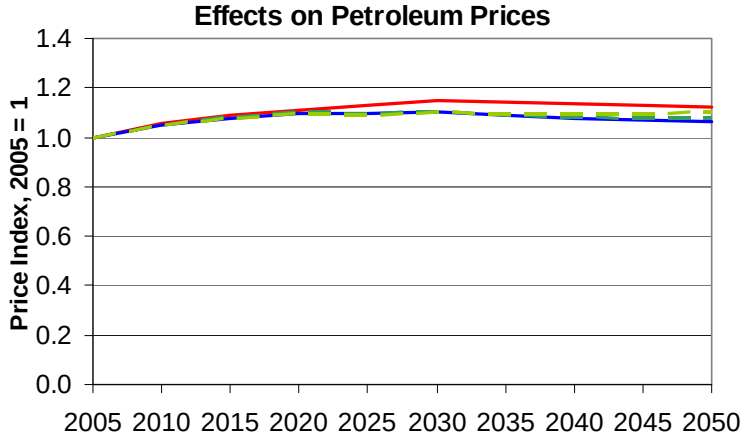
Results: Scenario 1 – Reference; Scenario 2 – S. 2191; Scenario 6 – S. 2191 Constrained Nuclear & Biomass; Scenario 7 – S. 2191 Constrained Nuclear & Biomass, and CCS

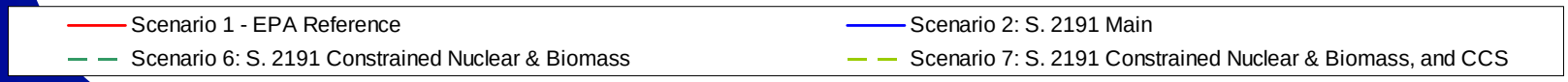
Fuel Prices (ADAGE)







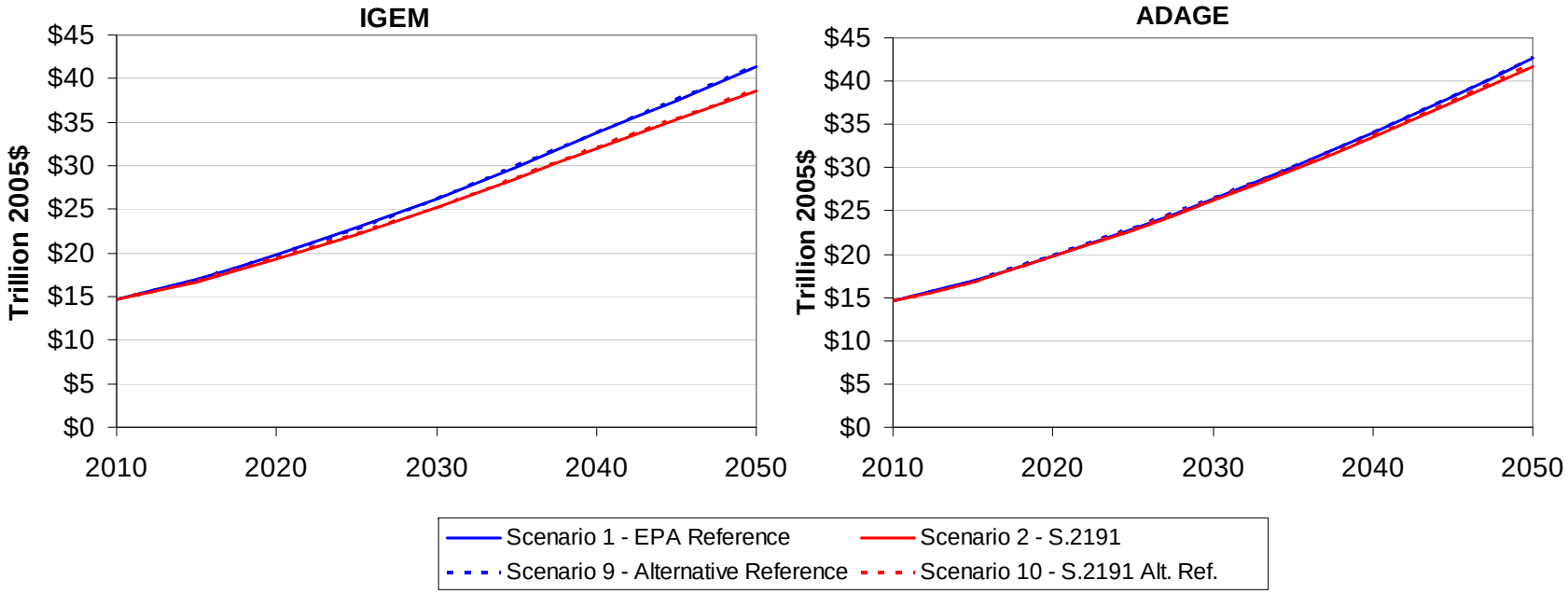




- Coal, natural gas, and oil prices are producer prices, and thus do not reflect the cost of allowances
- Electricity prices do reflect the cost of allowances

Results: Scenario 2 – S. 2191; and Scenario 10 – S. 2191 Alternative Reference

GDP



Scenario 2 - S. 2191

IGEM

	2010	2020	2030	2040	2050
Absolute Change	-$138	-$506	-$983	-$1,752	-$2,856
% Change	-0.94%	-2.55%	-3.76%	-5.20%	-6.90%

ADAGE

	2010	2020	2030	2040	2050
Absolute Change	-$27	-$137	-$238	-$488	-$1,012
% Change	-0.18%	-0.69%	-0.90%	-1.44%	-2.37%

Scenario 10 - S. 2191 High Technology

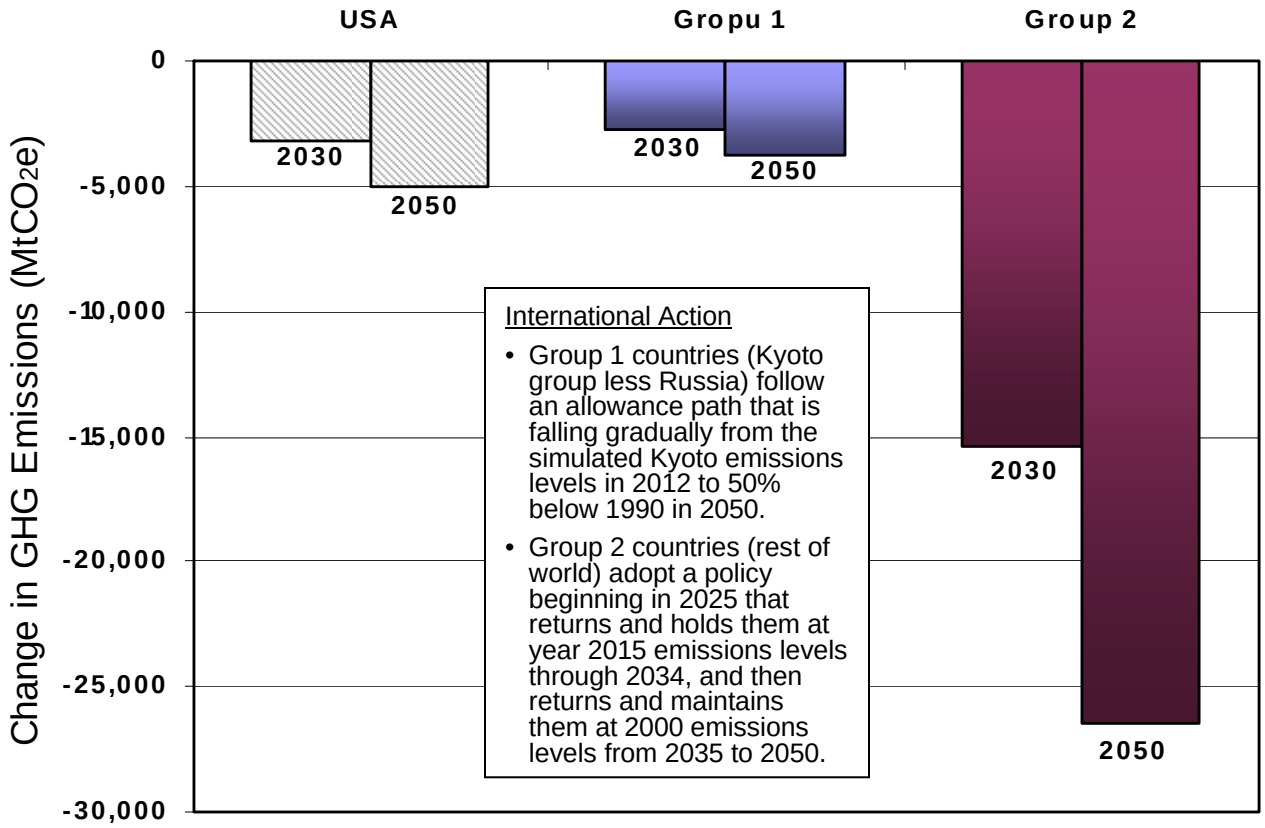
	2010	2020	2030	2040	2050
Absolute Change	-$95	-$417	-$947	-$1,700	-$2,747
% Change	-0.65%	-2.10%	-3.61%	-5.03%	-6.62%

	2010	2020	2030	2040	2050
Absolute Change	-$20	-$99	-$158	-$353	-$754
% Change	-0.13%	-0.50%	-0.60%	-1.04%	-1.76%

Global Results: Emissions Leakage, Alternative International Action Sensitivities, and Global CO_2 Concentrations

Results: Scenario 2 – S. 2191

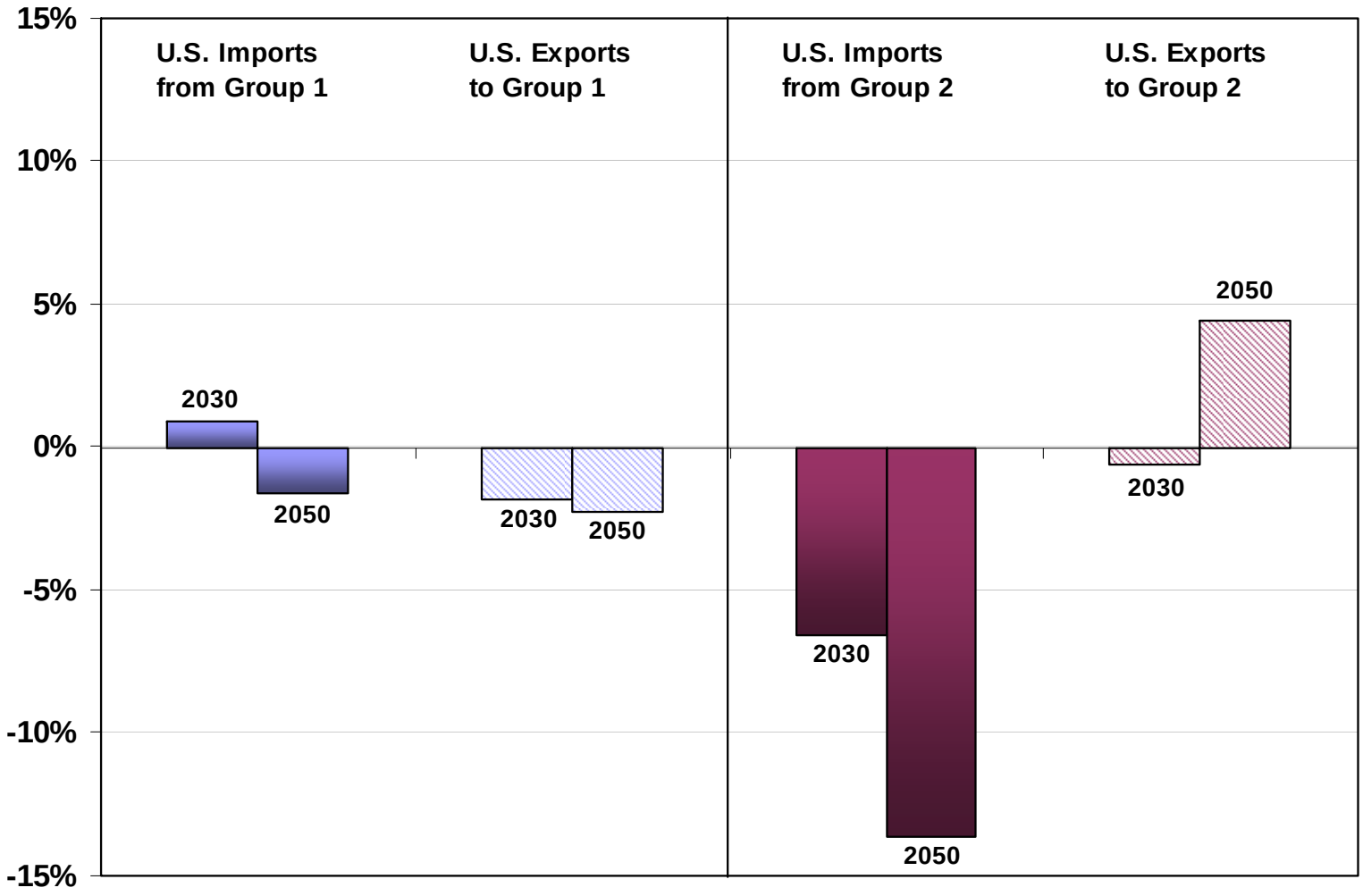
International GHG Emissions Reductions (ADAGE)



- Emissions leakage occurs when a domestic GHG policy causes a relative price differential between domestically produced goods and imported goods, which causes production of goods that domestically would have GHG allowance prices embodied in their cost to shift abroad, and thus causes an increase in GHG emissions in other countries.
- Under the Scenario 2 - S. 2191 international assumptions, no international emissions leakage occurs.
- Emissions in Group 2 fall by over 26,000 $MtCO_2e$ as they adopt emission targets beginning in 2025.
- Emission reductions are greater in 2050 than in 2030 for all regions as they face more stringent targets.

Results: Scenario 2 – S. 2191

International Trade Leakage for Energy-Intensive Manufacturing (ADAGE)

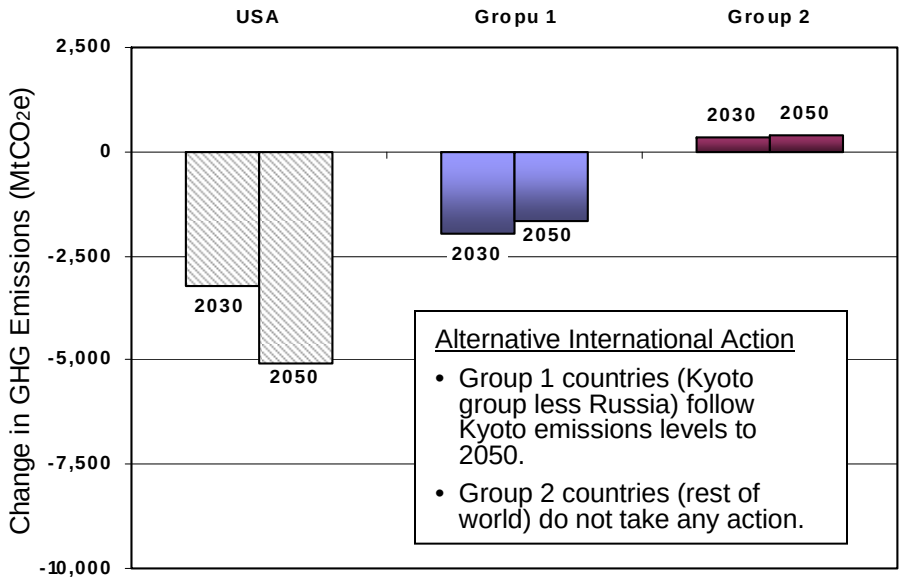


- Under Scenario 2 – S. 2191, imports of energy-intensive manufacturing goods from Group 2 to the U.S. fall as Group 2 takes on emission targets.
- The U.S. exports more energy-intensive manufacturing goods to Group 2, particularly in 2050 as Group 2 is meeting a stable emission target from 2035 to 2050.
- Trade of energy-intensive manufactured goods with Group 1 countries falls somewhat as both groups face emissions targets.

Results: Scenario 3 - S. 2191, Alternative International Action

International GHG Emissions Leakage (ADAGE)

- Emissions leakage occurs when a domestic GHG policy causes a relative price differential between domestically produced and imported goods. This causes domestic production, which embodies the GHG allowance price to shift abroad, and thus an increase in GHG emissions in other countries. Additionally, emissions leakage not associated with trade effects may occur when a GHG policy reduces domestic consumption of oil, lower demand for oil lowers the world oil price, which increases oil consumption in countries without a GHG policy thus increasing emissions.
- As a result of S. 2191, the prices of U.S. exports rise relative to prices in the rest of the world, and export volumes fall. Since exports are price-elastic the volumes fall proportionally more than the price rises and thus the value of exports declines. Imports are reduced in part by the overall reduction in spending associated with the lower levels of consumption. Additionally, commodities directly effected by the emissions cap (e.g. oil) are reduced proportionally more than other imports due to the allowance prices embodied in their cost. Import substitution counterbalances the above two forces. U.S. prices of commodities not directly affected by the policy are relatively higher, which leads to substitution away from domestically produced goods and towards imported goods.
- In Scenario 3 – S. 2191, Alternative International Action , the International Reserve Allowance Requirement is assumed to be triggered, due to inaction in Group 2 countries.
- Group 2 emissions rise by 350 $MtCO_2e$ in 2030, and 385 $MtCO_2e$ in 2050, since developing countries do not take any action. This is a less than 1% increase in Group 2 emissions from the reference levels, and is equivalent to U.S. emissions leakage rates of approximately 11% in 2030 and 8% in 2050.
- While Group 2 is not taking any action in this scenario, their emissions are somewhat limited by demand from the U.S. and Group 1 for offset credits from Group 2. This results in smaller amounts of leakage than may otherwise be expected.*
- The sensitivity case without the International Reserve Allowance Requirement results in a minimal effect on emissions leakage, with an increase in Group 2 emissions of 361 $MtCO_2e$ in 2030, and an increase of 412 $MtCO_2e$ in 2050 without the requirement included.
- Group 1 emissions fall by a lesser amount in 2050 than in 2030 as Group 1 follows a "Kyoto forever" constant emissions target, and greater emission reductions are needed in the earlier years to meet these targets.

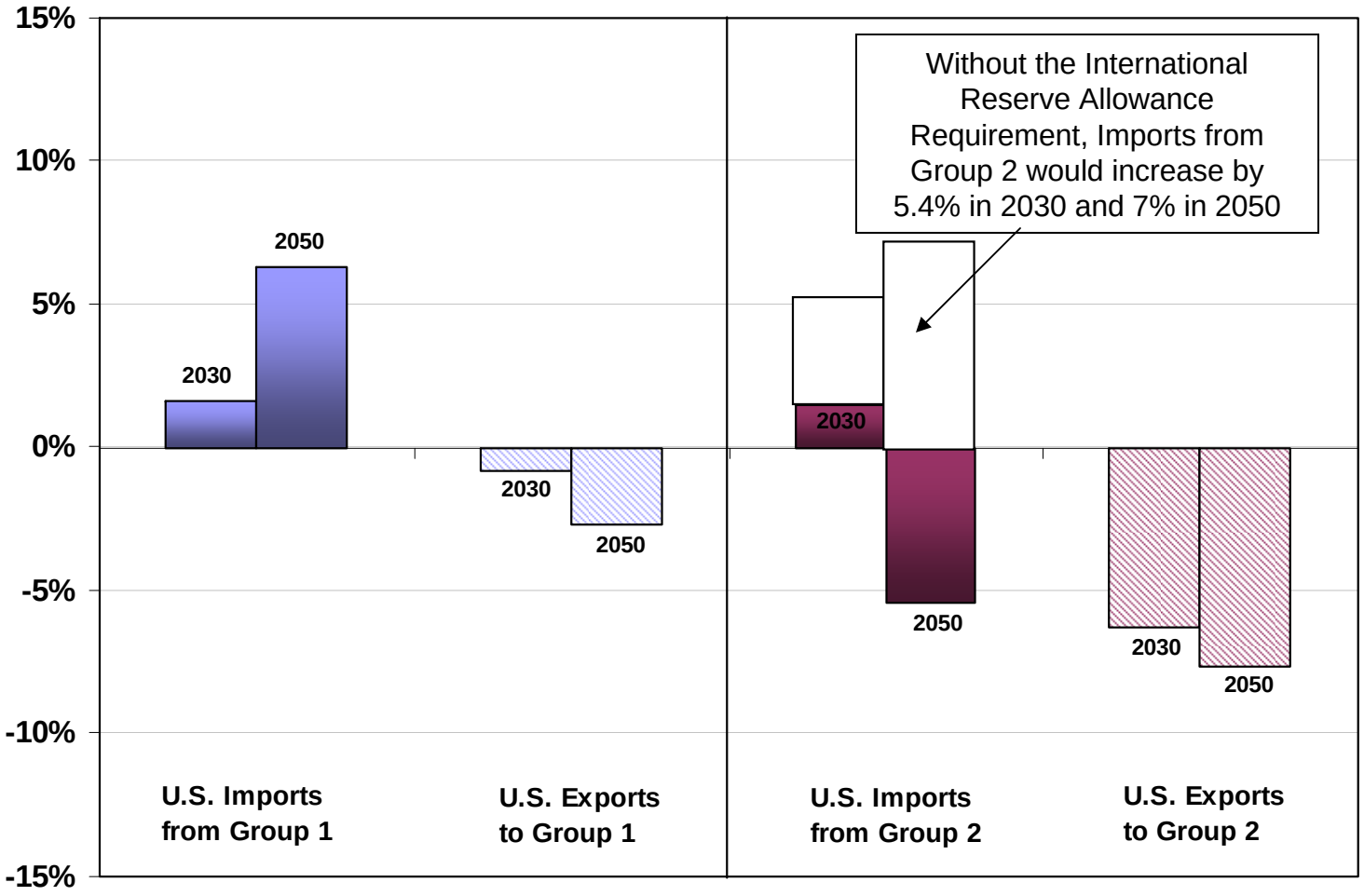


* For example Paltsev (2001) indicates that in a policy limited to industrialized countries, leakage rates can range from 5% - 34% for individual countries, although international trading may reduce that by half. One important difference between Paltsev (2001) and this analysis is that S. 2191 requires greater emissions reductions than those modeled in Paltsev (2001). This means that economic activity is reduced more under S. 2191, which results in greater reductions in overall consumption and imports. Counterbalancing this effect is the greater relative price differential, which causes a larger import substitution effect.

Paltsev, Sergey V. "The Kyoto Protocol: Regional and Sectoral Contributions to the Carbon Leakage." *The Energy Journal*, 2001, volume 22, number 4, pages 53-79.

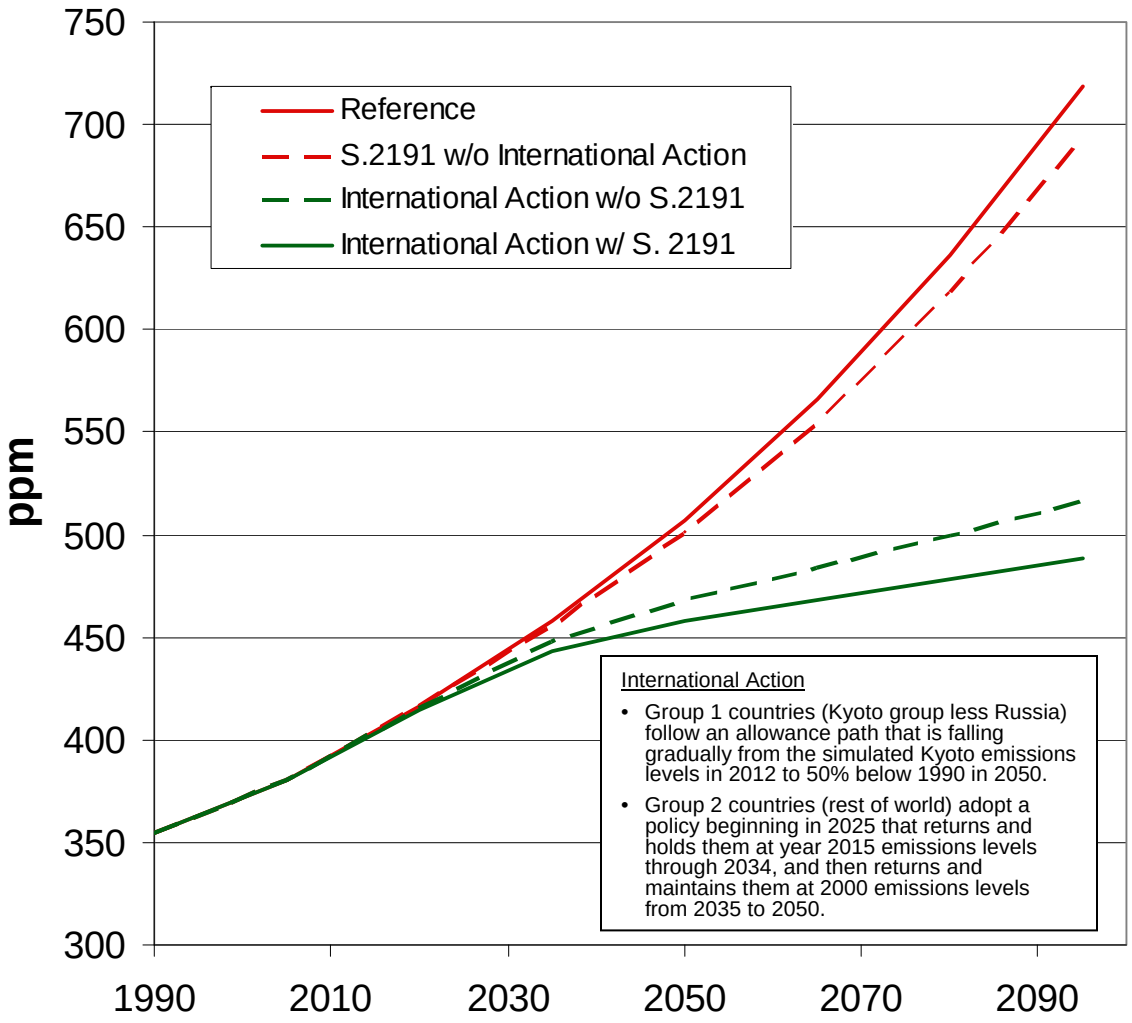
Results: Scenario 3 - S. 2191, Alternative International Action

International Trade Leakage for Energy-Intensive Manufacturing (ADAGE)



- Under Scenario 2 – S. 2191, Alternative International Action, imports of energy-intensive manufacturing goods from Group 2 countries to the U.S. rise in 2030 since Group 2 countries are not taking any emissions action.
- The International Reserve Allowance Requirement limits the imports from Group 2.
  - The International Reserve Allowance Requirement has no effect on GDP in 2030, and increases GDP impacts by $34 billion (or 0.08 percentage points) in 2050.
- The U.S. is exporting less energy-intensive manufacturing goods to Group 2, as Group 2 uses more of their domestic energy-intensive manufacturing, resulting in increased emissions in Group 2.
- Trade of energy-intensive manufactured goods with Group 1 countries is a mixed story as policies in all regions, as well as the International Reserve Allowance Requirement, interact in 2030 & 2050.

Global CO_2 Concentrations (MiniCAM) Results



In the reference scenario,* Global CO_2 concentrations rise from historical levels of 354 parts per million (ppm) in 1990 to 718 ppm in 2095.

Effect of S. 2191

Assuming the international community adopts no additional policies or measures, the global CO_2 concentrations in 2095 are estimated to be 694 ppm, which is 25 ppm lower than the reference case. Note that this incremental effect accounts for emissions leakage.

Effect of International Action plus S. 2191

Assuming the international community takes the actions described in the diagram to the left and the U.S. takes no action, the global CO_2 concentrations in 2095 are estimated to be 516 ppm; and if the U.S. adopts S. 2191 global CO_2 concentrations in 2095 would be 488 ppm, which is an additional 28 ppm lower than the case without U.S. action.

While CO_2 concentrations are significantly reduced in the scenarios with international action, they are not on a stabilization trajectory.

* Reference scenario emissions come from the Climate Change Science Program (CCSP) Synthesis and Assessment Product 2.1a MiniCAM reference case.

* This slide was added 5/5/08.

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The full analytical package and all the results data are available at:
www.epa.gov/climatechange/economics/economicanalyses.html