EPA Analysis of the American Power Act
in the 111th Congress

6/14/10

Major Findings

- The American Power Act (APA) of 2010:
  - Establishes a multi-sector cap-and-trade program with delayed phase-in for the industrial sector, and with an alternative compliance program for the transportation fuels and refined petroleum products sectors.
  - Creates other incentives and standards for increasing energy efficiency and low-carbon energy development and consumption.

- This analysis models the multi-sector cap-and-trade program, the alternative compliance program for the transportation fuels and refined petroleum products sectors, the competitiveness provisions, and many of the energy efficiency provisions of the APA.
  - Sensitivity analysis conducted to examine the impacts of:
    - Technology development
    - Pace of international action
    - Availability of international and domestic offsets
  - Several provisions outside of the multi-sector cap-and-trade program are not modeled in this analysis (e.g. lighting standards, new regulation for offshore oil and gas extraction, powering vehicles with natural gas provisions, and GHG tailpipe standards are not modeled in this analysis; and, the special incentives for nuclear power are not modeled in the economy-wide modeling, but are analyzed in the detailed electricity sector modeling).
  - See Appendix 1 for a detailed description of the bill and of the provisions modeled in this analysis.

- While there are important differences between the American Power Act (APA) and H.R. 2454 (discussed in the following section), the modeled impacts of the APA are very similar to those of H.R. 2454.
  - Estimated allowance prices under the two bills differ on the order of 0-1%.
  - The percentage reductions represented by the emissions caps are identical beginning in 2013.
  - Both bills allow for 2 billion tons of offsets in each year.
  - Both bills contain provisions to prevent emissions leakage and to address competitiveness concerns.
  - The Cost Containment Reserve provisions of the APA provide a greater level of price certainty than do provisions in H.R. 2454's Strategic Reserve Allowance Program by, among other things, allocating a greater share of allowances to the reserve. This higher level of price certainty comes at a slightly higher cost to the APA over H.R. 2454.
  - The APA's approach to cover GHGs from the transportation fuels and refined products sectors does not impact modeled allowance prices.

Major Findings

- Under reference assumptions the probability of observed temperature changes in 2100, relative to pre-industrial levels, remaining below 2° C (or 3.6° F) is roughly 1%, and the probability of observed temperature change exceeding 4° C (or 7.2° F) is approximately 32%.

- Under the combined APA and the G8 international agreement assumptions, the probability of observed temperature changes in 2100 remaining below 2° C (or 3.6° F) increases to 75%, and the probability of observed temperature changes exceeding 4° C is negligible given climate sensitivity assumptions.
  - Under a climate sensitivity of 3° C, the observed temperature increase in 2100 relative to pre-industrial levels is projected to be 1.6º C (2.9º F) under the APA and the G8 agreement, compared to the no-policy, no-agreement result of a 3.5º C (6.3º F) rise in observed average global mean temperature.
  - CO_2e concentrations are projected to rise to 931 ppm by 2100 without policy; however, with the APA and the recent G8 agreement, CO_2e concentrations are projected to be 457 ppm in 2100.
  - Even if developing countries delay taking action until 2050, and then simply hold emissions constant at 2050 levels, then the probability of observed temperature changes in 2100 remaining below 2° C (or 3.6° F) increases to approximately 11%, and the probability of observed temperature changes exceeding 4° C (or 7.2° F) falls to roughly 15%.

- Allowance prices under both the APA and under H.R. 2454 are projected to be $16 to $17 per metric ton CO_2 equivalent (tCO_2e) in 2013 and $23 to $24/ t$CO_2$e in 2020 in the core APA scenario (scenario 2).*
  - Across all scenarios modeled without constraints on international offsets, the expected allowance price ranges from $12 to $22/t$CO_2$e in 2013 and from $17 to $32/t$CO_2$e in 2020.
  - While the APA allows for up to one billion tons of international offsets each year, we have included scenarios that limit the availability of international offsets in order to demonstrate the impact these provisions of the bill have on costs. Across all scenarios modeled including those that prohibit the use of international offsets, the expected allowance price ranges from $12 to $41/t$CO_2$e in 2013 and from $13 to $59/ t$CO_2$e in 2020. Additional sensitivities show that if the availability of international offsets to the U.S. is simply delayed 10 years, then allowance prices increase by only one percent.

* All prices in this analysis are presented in 2005 dollars. The range of allowance prices represents the estimates of the two models (ADAGE and IGEM) used in this analysis.

Major Findings

- The APA still has a relatively modest impact on U.S. consumers, assuming the bulk of revenues from the program are returned to households lump-sum.
  - Average household consumption is reduced, relative to the no-policy case, by 0.0 – 0.1% in 2015, by between 0.0 – 0.2% in 2020, by 0.2 – 0.5% in 2030, and by 0.9 – 1.1% in 2050.
  - Despite the expected decrease in consumption over the no-policy case, average household consumption is still expected to rise over the period of analysis: the average consumption growth rate from 2010-2030 under the core scenario is expected to be between 2.5% and 2.8%.
  - The net present value of the annual household consumption loss averages $79 to $146 for each year.*
  - These costs include the effects of higher energy prices, price changes for other goods and services, impacts on wages and returns to capital. Cost estimates also reflect the value of some of the emissions allowances returned to households, which offsets much of the APA's effect on household consumption.
  - If auction revenues that are modeled as being returned to households lump sum were instead directed to particular funds, the expected reduction in household annual consumption and GDP would likely be greater. However, such revenues could be used to lower existing distortionary taxes and thus reduce policy costs.
- The APA cost estimates <u>do not</u> account for the benefits of avoiding the effects of climate change (or, stated from a different perspective, the no-policy scenario does not include estimates of the costs of climate change induced damages).

* Annual net present value cost per household (discounted at 5%) averaged over 2010-2050.

Major Findings

- Offsets have a strong impact on cost containment.
  - The annual limit on domestic offsets is never reached in the core scenario. Domestic offset usage averages approximately 0.6 billion tCO_2e in each year. This represents approximately 19 percent of cumulative GHG abatement form all sources under the bill.
  - The limits on the usage of international offsets (accounting for the extra international offsets allowed when the domestic limit is not met) are not reached. International offset usage averages between 0.6 and almost 1 billion tCO_2e each year in the core scenario. This represents from 18 to 29 percent of cumulative GHG abatement from all sources under the bill.
  - While the APA allows for up to one billion tons of international offsets each year, we have included scenarios that limit the availability of international offsets in order to demonstrate the impact these provisions of the bill have on costs. If international offsets were not allowed, the allowance price would increase 34 to 118 percent relative to the core policy scenario, and household consumption losses would increase 31 to 114 percent, the large range due to the differing international offset core scenario usage projections of EPA's two models.
  - The cost containment reserve price is met in ADAGE scenarios that limit the usage of international offsets, and 4 billion tCO_2e of allowances are released from the reserve, which somewhat limits the increase in allowance prices seen in these scenarios. However, because international offsets are not allowed in these scenarios, it is not possible to refill the cost containment reserve, and the allowance price is able to exceed the reserve price.

- While the competitiveness provisions of the APA are modeled in this analysis, scenarios isolating the impacts of those provisions are not included in this report; however, competitiveness and emissions leakage are topics explicitly addressed in the December 2, 2009 interagency report on H.R. 2454, "The Effects of H.R. 2454 on International Competitiveness and Emission Leakage in Energy-Intensive Trade-Exposed Industries."
  - The interagency report is available at www.epa.gov/climatechange/economics/economicanalyses.html.
  - Consistent with prior EPA modeling of this issue in its June 23, 2009 analysis of H.R. 2454, the economic modeling in the interagency report shows that the allowance allocations in H.R. 2454 can essentially eliminate any adverse effect that a cap-and-trade program would otherwise have on energy-intensive trade-exposed industries' international competitiveness, and can thereby prevent emissions leakage that might otherwise arise if such a program were to reduce the competitiveness of U.S. industry.
  - The modeling also concludes that, even in the absence of the allowance allocations in H.R. 2454, on average, the bill's impact on the competitiveness of energy-intensive trade-exposed industries would be relatively limited. However, some industries would experience greater impacts than others.

- While this analysis contains a set of scenarios that cover some of the important uncertainties when modeling the economic impacts of a comprehensive climate policy, other uncertainties remain that could significantly affect the results.

The American Power Act
Comparison to H.R. 2454

Changes Since EPA January 29, 2010 Analysis of H.R. 2454

- Compared to EPA's January 29, 2010 supplemental analysis of H.R. 2454, this analysis of the American Power Act includes updated assumptions about the U.S. reference case and international reference emissions.

  - Updated U.S. Reference Scenario:
    - Previous EPA analyses of H.R. 2454 used a reference case based on the March release of the AEO 2009.
    - The reference scenario used for this analysis is based on the AEO 2010.

  - Updated International Reference Emissions Projections &
    Updated International Energy Related CO_2 Marginal Abatement Cost Curves:
    - International reference emissions and international energy related CO_2 MAC curves in previous EPA analyses of H.R. 2454 were based on the MiniCAM Climate Change Science Program (CCSP) Synthesis and Assessment Product (SAP) 2.1a reference case.
      - Clarke, L., J. Edmonds, H. Jacoby, H. Pitcher, J. Reilly, and R. Richels. 2007. CCSP Synthesis and Assessment Product 2.1, Part A: Scenarios of Greenhouse Gas Emissions and Atmospheric Concentrations. U.S. Government Printing Office, Washington DC.
    - The reference scenario and the international energy related CO_2 MAC curves used for this analysis are based on the GCAM (formerly MiniCAM) Energy Modeling Forum 22 reference case.
      - Calvin KV, JA Edmonds, B Bond-Lamberty, LE Clarke, SH Kim, GP Kyle, SJ Smith, AM Thomson, and MA Wise. 2009. "2.6: Limiting Climate Change to 450 ppm CO2 Equivalent in the 21st Century," Energy Economics 31(S2): S107-S120.

APA Comparison to H.R. 2454

Overview

- Because of the changes discussed in the previous slide, the results in this analysis are not directly comparable to EPA's previous analyses of H.R. 2454. In order to enable a comparison between the APA and H.R. 2454, EPA has reanalyzed H.R. 2454 in scenario 10 of this analysis with a set of assumptions consistent with those used for the core APA policy case in scenario 2. The results of *scenario 10 – H.R. 2454* are presented throughout this analysis, and in this section we highlight some of the important differences in model results across analyses of the two bills.

- While there are important differences between the two bills that are summarized and explained in this section, there are also many similarities. Overall, the estimated impacts of the APA are very similar to those of H.R. 2454. For example, estimated allowance prices under the two bills differ on the order of zero to one percent.

- There are a few differences between the APA and H.R. 2454 that will have a slight effect on allowance prices.
  - The APA allows landfill, natural gas and coal mine CH_4 as potential offset sources, whereas H.R. 2454 instead subjected them to performance standards. This will lower allowance prices slightly and result in an increase in total GHG emissions.
  - The cost containment reserve allowance provisions in the APA are changed to provide greater price certainty than the strategic reserve allowance provisions in H.R. 2454. The APA also allocates more allowances to the cost containment reserve than H.R. 2454 allocates to the strategic reserve. This change will result in slightly higher expected allowance prices, but greater near-term price certainty, in the APA compared to H.R. 2454.
  - Instead of including transportation emissions in the allowance market, the allowances needed for the transportation sector are held back from auction each quarter and sold directly to covered entities at the auction-clearing price. This will not impact modeled allowance prices or GHG emissions reductions.
  - The APA begins in 2013 instead of 2012, and phases-in coverage of industrial GHG emissions in 2016 instead of 2014. This will increase emissions slightly, but will have only a negligible impact on allowance prices.
  - The energy efficiency provisions in APA (including those specified for inclusion in this analysis from S. 1462) are less substantial than those included in H.R. 2454. This change will result in slightly higher allowance prices in the APA compared to H.R. 2454, but the effect on overall costs is less certain.
  - While the overall limits on offsets are similar in APA and H.R. 2454, the one billion ton ultimate limit on international offsets in APA is smaller than the 1.5 billion ton ultimate limit in H.R. 2454. While this does not impact scenarios that use less than one billion tons of international offsets annually, it does increase allowance prices in scenarios that limit other GHG abatement options and thus drive greater international offset usage.

- The percentage reduction in covered GHG emissions represented by the caps are identical starting in 2013.
  - Coverage is the same after 2016.
  - Both bills have output-based rebate provisions designed to reduce emissions leakage and address competitiveness concerns for energy intensive and trade exposed industries, these provisions are modeled in all scenarios of this analysis.

APA Comparison to H.R. 2454

Cost Containment Reserve

- Both H.R. 2454 and the American Power Act set aside a portion of allowances to establish a reserve pool of allowances that are made available at auction each compliance period, and would be purchased if allowance prices rise high enough. Auction revenues from selling these reserve allowances can then be used to purchase offsets that are used to refill the reserve. These provisions are designed to contain price volatility, contain costs, or both, depending on the specifics of the provisions.
- One difference between the strategic reserve in H.R. 2454 and the cost containment reserve in the APA is how the reserve price is set. H.R. 2454 sets the reserve price (price ceiling) at $28 (in constant 2009 dollars) in 2012, and the price rises at a real rate of 5 percent through 2014. Starting in 2015, the reserve price is set at 60 percent above the 36-month rolling average of that year's emissions allowance vintage. This way of setting the reserve price allows the reserve to be triggered when price volatility leads to suddenly high prices; however, sustained non-volatile high allowance prices would not trigger the reserve. The strategic reserve in H.R. 2454 appears primarily designed to address price volatility and not cost containment in general.
- In contrast, the APA sets the reserve price (price ceiling) at $25 (in constant 2009 dollars) in 2013 rising at a real rate of 5 percent. This change results in a predetermined reserve price for every year, which can be met either by high allowance prices caused by price volatility, or by sustained high allowance prices. The cost containment reserve in the APA is designed to address both price volatility and cost containment in general. The revenues from auctioning the reserve allowances are used to purchase either international REDD offsets or domestic offsets to refill the reserve. If offsets are not available for purchase, then the reserve cannot be refilled, and it is possible for the reserve to completely empty, and for allowance prices to exceed the reserve price.
- Both bills contain an auction price floor, which in the APA is $12 (in constant 2009 dollars) in 2013 rising at 3% annually.
- Another key difference between the strategic reserve in H.R. 2454 and the cost containment reserve in the APA is that a greater number of allowances are taken out of the cap and placed in the reserve under the APA.

Share of Total Allowances

HR. 2454 Strategic Reserve		*APA Cost Containment Reserve*	
2012 – 2019	1%	2013 – 2021	1.5%
2020 – 2029	2%	2022 – 2029	2.5%
2030 – 2050	3%	2030 – 2050	5.0%

- Cumulatively over 2012 – 2050, H.R. 2454 places 2.8 billion allowances in the strategic reserve, representing 2.1% of all allowances, while from 2013 – 2050 the APA places 4.0 billion allowances in the cost containment reserve representing 3.1% of all allowances.
- If allowance prices remain low and the minimum prices for releasing allowances from the reserves are not met, then the existence of the reserve has the effect of tightening the cap and raising allowance prices.
  - In the APA, removing the reserve would decrease allowance prices by 0.7% in all years, and also decrease the usage of international offsets by 18% (compared to IGEM scenario 2 – APA in this analysis).
  - In the H.R. 2454, removing the reserve would decrease allowance prices by 0.5% in all years, and also decrease the usage of international offsets by 11% (compared to IGEM scenario 10 – H.R. 2454).

APA Comparison to H.R. 2454

Coal Mine, Landfill & Natural Gas CH_4

- An additional difference between the two bills is that H.R. 2454 requires the establishment of performance standards for uncapped stationary sources including: any individual sources with uncapped emissions greater than 10,000 tons CO_2e; and any source category responsible for at least 20% of uncapped stationary GHG emissions. The bill requires that source categories to be identified by EPA include those responsible for at least 10% of uncapped methane emissions. Performance standards for new sources would then be set under the provisions of section 111 of the Clean Air Act. In general, performance standards are emissions limits set based on an analysis of best demonstrated technologies but do not require that particular technologies be used. Under section 111(d), states are then directed to set performance standards for existing sources based on the new source performance standards and may take into account other criteria such as a facility's remaining useful life. Sources that would potentially be covered by this provision likely includes, at a minimum: landfills; coal mines; and natural gas systems. While it is possible that reductions occurring prior to adoption of standards and reductions beyond those nominally required by standards would be eligible for offsets, modeling of these sources assumes reductions stemming from performance standards maximize the potential reductions from these sources and eliminates their eligibility to provide offset credits.

- In the American Power Act, these performance standard provisions are no longer mandated for landfills, coal mines, and natural gas systems. Reductions from these sources are instead eligible to provide offset credits.
  - The bill does give the EPA Administrator discretion to set performance standards for uncapped sources after 2020, which could affect the availability of offsets from these sectors; however, previous EPA modeling of climate legislation has generally assumed that such discretionary options are not exercised.

- An extension of EPA's June 23, 2009 analysis of H.R. 2454 has shown that allowing these sources as offset projects under H.R. 2454 instead of covering them under performance standards would increase 2012 – 2050 cumulative U.S. GHG emissions by 6 $GtCO_2e$; increase 2012 – 2050 cumulative domestic offsets usage by 46% (6 $GtCO_2e$); decrease 2012 – 2050 cumulative international offset usage by 12% (5 $GtCO_2e$); and decrease allowance prices by 2% in all years from the allowance price in the core scenario of EPA's H.R. 2454 analysis (\$13/tCO_2e 2015; \$16/tCO_2e in 2020) (Fawcett, 2009). The overall impact on the modeled cost of the policy would likely be small.
  - However, there are other general equilibrium consequences from the way that these emission sources are controlled that are not included in the reduced form modeling used to generate these results. Including these sources in an offsets program allows the market to determine the appropriate level of abatement from these sources so that the marginal cost of abatement is equal to the offset price. A performance standard dictates what level of abatement particular sources must achieve. If costs end up being lower than expected, then there will be less abatement activity than under an offsets program, although sources may be able to over-comply and generate additional offsets; if costs end up being higher than expected, there will be more abatement activity than under an offsets program, and the marginal cost of abatement for these sources will be higher than for sources covered by the cap.

APA Comparison to H.R. 2454

Transportation Fuels and Refined Petroleum Products

- Under H.R. 2454, covered entities with compliance obligations for GHG emissions from transportation fuels and refined petroleum products must obtain allowances to meet their compliance obligations either at auction or in secondary markets.

- Under APA, instead of purchasing allowances at auction or in the secondary market, covered entities that supply transportation fuels and refined petroleum products must purchase allowances directly from EPA.
  - Ahead of each quarter's auction, EPA must set aside from the allowances to be auctioned the number of allowances expected to be needed to cover emissions from combustion of refined products for that quarter.
    - If the number of allowances to be auctioned is less than the number of allowances that must be set aside to cover emissions from the combustion of refined products, then EPA may borrow allowances from the next year, or may require consignment of allowances allocated for other purposes. This consignment of allowances must be large enough to fulfill the set aside, and to provide a sufficient number of allowances for auction to ensure adequate market liquidity, price discovery, and allowance availability. Revenues from the sale of consigned allowances are returned to the original allowance holder. In this analysis, EPA has not estimated the number of freely allocated allowances that must be consigned, and the models assume that any necessary consignment occurs.
  - Refined product providers purchase set-aside allowances 30 days after the end of each quarter at the current year vintage auction-clearing price from the previous quarter.
  - The number of allowances refined product providers must purchase is based on the amount of fuel sold multiplied by EPA-determined emissions factors for the type of fuel sold.
  - The system will be officially reassessed no later than January 1, 2033 and may subsequently be revised if a modification is appropriate.
    - This analysis assumes that the system phases out in 2033. If the system is not phased out or modified, it is possible that the number of allowances required to be set aside from the auction will eventually exceed the total number of allowances in the cap.

- Allowing the direct purchase of allowances from the EPA for GHG emissions from transportation fuels and refined petroleum products under the APA may result in less price volatility for covered entities in these sectors compared to H.R. 2454.
  - Because the models used in this analysis do not represent price volatility, this difference does not impact model outcomes including allowance price or the sources of GHG abatement.
  - For other covered entities that must obtain allowances at auction or in the secondary market, the reduction in the size of the market for allowances may result in greater price volatility. Additionally, the alternative compliance mechanism will result in these other entities purchasing a greater amount of offsets than in H.R. 2454, as entities that are under the alternative compliance mechanism are not allowed to obtain offsets to meet their compliance obligations.

Contents

Bill Summary & Analytical Scenarios

The American Power Act

Bill Summary

- Title I of the APA outlines a direction for energy policy that includes the expansion of nuclear power generation, new regulation for offshore oil and gas extraction, development and deployment of carbon capture and sequestration (CCS) technology, promotion of renewable energy and energy efficiency, development of a clean transportation network, and further support for clean energy research.

- Title II of the APA outlines the GHG reduction mechanism and emissions targets.
  - Cap target is identical to H.R. 2454 (17% reduction from 2005 levels by 2020, 83% by 2050) but begins a year later in 2013.
  - The set of GHGs is defined to include $C0_2$, methane, nitrous oxide, sulfur hexafluoride, hydrofluorocarbons emitted as a byproduct, perfluorocarbons, and nitrogen trifluoride.
  - Cap and trade program regulates entities to hold allowances equal to their annual emissions.
  - Covered entity may bank allowances without limit, borrow from the following year's allowance vintage interest-free, and may borrow allowances from vintages up to five years in the future with interest to comply with a maximum of 15% of its compliance obligation.
  - Establishment of a cost containment reserve of 4 billion allowances to be open for sale when the allowance market price reaches $25 (constant 2009 dollars, adjusted annually for inflation plus 5%). Reserve is refilled with allowances from developing country offsets from the Reducing Emissions from Deforestation and Degradation (REDD) category when available.
  - Establishment of a compliance program for the transportation fuels and petroleum products sectors in which covered entities are obligated to buy allowances at the most recent allowance auction clearing price to cover their emissions.
  - Establishment of an offset credit program, defining crediting rules for both domestic and international projects.
  - Details the yearly allocation of emissions allowances to covered entities, categorized in seven categories: consumer protection, job protection and growth, clean energy development and deployment, adaptation, GHG reduction early action, transportation infrastructure and efficiency, and deficit reduction (see appendix 1 for further details).
  - Sets the allowance auction reserve price of $12 (2009 constant dollars, adjusted yearly for inflation +3%).
  - Establishes a separate reduction program for hydrofluorocarbons with a target of 15% of the 2005 emissions level by 2032.
  - Supports further research on and continuation of programs confronting black carbon and international methane.
  - In general, precludes the Environmental Protection Agency from using the existing Clean Air Act to issue GHG standards for entities covered under this bill.
  - Establishes strict rules governing the carbon market, giving the Commodity Futures Trading Commission regulatory authority.

The American Power Act
Bill Summary

- Title III of the APA focuses on consumer protection.
  - Allowances are distributed to electricity and natural gas local distribution companies (LDCs) to offset increases in consumer costs, while allowances are distributed to states to offset increased costs to consumers of home heating oil and propane.
  - Low income households will benefit from the Working Families Refundable Relief Program and the Energy Refund Program. The Universal Refund is established as a rebate to all U.S. citizens that will begin in 2026.

- Title IV of the APA focuses on job protection and U.S. economic growth.
  - Covered entities identified as energy-intensive trade-exposed (EITE) will initially receive allowance credits to allow them to adjust to emissions requirements.
  - Beginning in 2020, an international reserve allowance program may be established for covered EITE sectors, less than 70% of whose global production originates in countries that have signed onto an international emissions reduction agreement to which the U.S. is a party. Importers of EITE products will be obligated to purchase allowances to cover GHG emissions arising from production.
  - Education and grant support for clean energy curriculum and career development.
  - Substantial support for the development of plug-in drive and natural gas (heavy-duty) vehicles.
  - Requires the Environmental Protection Agency to set and enforce mobile source GHG standards.

- Title V of the APA outlines proposed international climate change activities.
  - Establishes program to build capacity in developing countries to reduce emissions from deforestation.
  - Requires annual interagency report on the climate change and energy policies of the top five largest GHG emitting non-OECD countries.

- Title VI of the APA provides a plan for domestic adaptation to global warming.

- Title VII requires the APA to be deficit-neutral.

*See Appendix 1 for further details of the American Power Act

Analytical Scenarios

Reference and Core Policy Scenarios

EPA analyzed 10 different scenarios in this report. A full description of all scenarios is available in Appendix 1. The assumptions about other domestic and international policies that affect the results of this analysis do not necessarily reflect EPA's views on likely future actions.

Scenario 1 - EPA 2010 Reference

- This reference scenario is benchmarked to the AEO 2010 forecast and includes both the Energy Independence and Securtity Act (EISA) and the American Recover and Reinvestemtn Act (ARRA).
  - Does not include any additional domestic or international climate policies or measures to reduce international GHG emissions
  - For international projections, uses the EMF-22 GCAM reference.

Scenario 2 – American Power Act (core policy scenario)

- This core policy scenario models the cap-and-trade program established in Title II of the American Power Act.
- Provisions explicitly modeled in this scenario:
  - CCS bonus allowances
  - EE provisions (allowance allocations and building energy efficiency codes*)
  - Output-based rebates
  - The cost containment reserve
  - Allocations to electricity local distribution companies (LDCs) (used to lower electricity prices)
- Widespread international actions by developed and developing countries over the modeled time period. International policy assumptions are consistent with the agreement among G8 leaders at the July 9, 2009 Major Economies Forum "to reduce their emissions 80% or more by 2050 as its share of a global goal to lower emissions 50% by 2050."
  - Group 1 countries (Kyoto group less Russia) follow an allowance path that is falling linearly from the simulated Kyoto emissions levels in 2012 to 83% below 2005 in 2050.
  - Group 2 countries (rest of world) adopt a policy beginning in 2025 that caps emissions at 2015 levels, and linearly reduces emissions to 26% below 2005 levels by 2050.
  - The combination of U.S., Group 1, and Group 2 actions caps 2050 emissions at 50% below 2005 levels.

* Building codes provision from S. 1462, Sec. 241, included per Senate specifications to EPA

Analytical Scenarios

Sensitivity Scenarios

A full description of all scenarios is available in Appendix 1.

International action sensitivities

- **Scenario 3 – Early developing country action**
- **Scenario 4 – No developing country action**

Technology and offset sensitivities requested by Senator Voinovich

- **Scenario 5 – V – No Int'l Offsets***
- **Scenario 6 – V – Reference Nuclear & Biomass / Delayed CCS***
- **Scenario 7 – V – Reference Nuclear & Biomass / Delayed CCS – No Int'l Offsets***
- **Scenario 8 – V – IPM electricity sector reductions imposed on ADAGE***
- **Scenario 9 – No CCS Bonus Allowances**

H.R. 2454 Comparison Scenario

- **Scenario 10 – H.R. 2454**

*** "V" signifies scenarios requested by Senator Voinovich. See Appendix 6 for a discussion of the current state of nuclear, bioelectricity, and CCS deployment.**

Key Uncertainties

- There are many uncertainties that affect the economic impacts of the APA.
- This analysis contains a set of scenarios that cover some of the important uncertainties.*
  - The degree to which CCS and new nuclear power are technically and politically feasible.
  - The availability of international offset projects.
  - The extent and stringency of international actions to reduce GHG emissions by developed and developing countries.
- Some additional uncertainties covered in this analysis outside of the main scenarios include:
  - The impact of the Cost Containment Reserve on overall costs.
  - The distributional consequences of the APA.
  - The availability of domestic offsets.
  - The impact of post-2050 emissions caps.
  - The availability of REDD offsets.
  - International reference case GHG emissions.
- Additional uncertainties include but are not limited to:
  - Long-run cost of achieving substantial GHG abatement.
    - Note that because of banking, uncertainty in long run abatement costs can have a significant impact on near term prices.
  - The pace of domestic economic and emissions growth in the absence of climate policy.
  - The impact of output based rebates to energy intensive and trade exposed industries, on GHG emissions leakage, trade patterns, and allowance prices.
  - Possible interactions among modeled and non-modeled policies.
  - The impact of subsidizing electricity prices versus lump sum transfers to consumers from local electric distribution companies.
  - The responsiveness of household labor supply to changes in wages and prices (labor supply elasticity).
  - The impacts of technology learning and spillover effects.
  - Other parameter uncertainty, particularly substitution elasticities (e.g., the abilities of firms to substitute capital, labor, and materials for energy inputs).

* Note that because of time limitations this analysis does not contain an extensive set of scenarios that would cover some of the additional uncertainties described above.

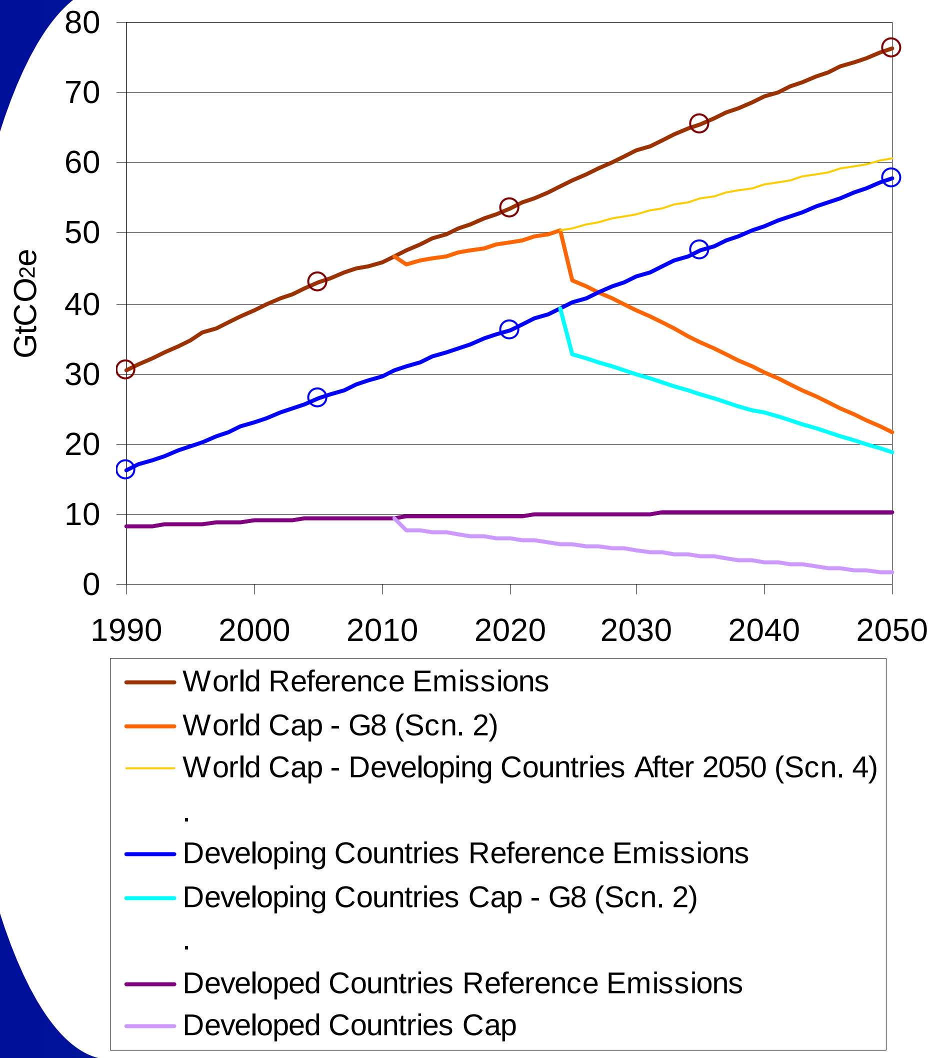
Global Results:

CO_2e Concentrations and Temperature Changes

Overview of Benefits

- Scientists project that the world could face a significant increase in global average surface temperature in the absence of effective policies to reduce GHG concentrations.
  - CO_2 concentrations may double from pre-industrial levels as early as 2050
- This doubling of concentrations is associated with a *likely* global equilibrium temperature increase of 2 to 4.5°C (3.6 to 8.1°F), with a best estimate of 3°C (5.4°F) (IPCC 2007).
- Climate change associated with these temperatures will lead to a range of potentially negative impacts, including
  - increased heat-related mortality rates,
  - reduced agricultural yields in many parts of the world,
  - rising sea levels that could inundate low-lying coastal areas,
  - increased power of the strongest hurricanes and typhoons,
  - increased risk of catastrophic climactic tipping points, such as melting permafrost and collapse of the Greenland and West Antarctic ice sheets, and
  - increased frequency and intensity of other extreme weather events such as heat waves, heavy precipitation, floods, and droughts.
- Economic effects of these impacts are likely to be significant and largely negative, and to vary substantially by region; however, the economic benefits of GHG mitigation are not estimated for this analysis.

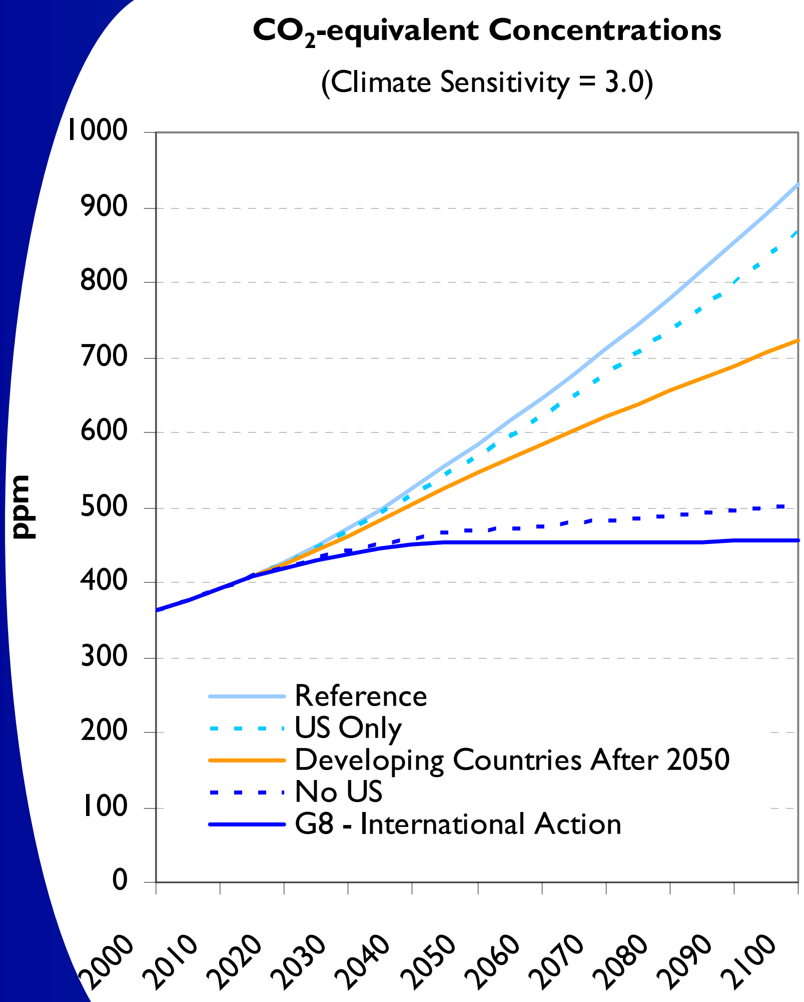
International Action Assumptions



- At the July 9, 2009 Major Economies Forum, "the G8 leaders agreed to reduce their emissions 80% or more by 2050 as its share of a global goal to lower emissions 50% by 2050." The assumptions about international action used in this analysis are consistent with the G8 agreement:
  - Developed countries (Kyoto group less Russia) follow an allowance path that is falling linearly from the simulated Kyoto emissions levels in 2012 to 83% below 2005 in 2050.
  - Developing countries (rest of world) adopt a policy beginning in 2025 that caps emissions at 2015 levels, and linearly reduces emissions to 26% below 2005 levels by 2050.
  - The combination of U.S., developed, and developing country actions cap 2050 emissions at 50% below 2005 levels.
  - After 2050, caps for all regions are assumed to be constant at 2050 levels.
- For the scenario with no developing country action before 2050, developing countries adopt no policies before 2050, and after 2050 GHG emissions are held constant at 2050 levels. The U.S. and other developed countries adopt the same caps in this scenario as in the G8 international action scenario.
- In the global GHG concentration and temperature analysis, we have also analyzed two scenarios that examine the incremental impact of U.S. policy.
  - In the U.S. only scenario, the U.S. adopts the GHG emissions targets in the APA, while all other countries follow a reference GHG emissions path.
  - In the no U.S. scenario, the U.S. follows a reference GHG emissions path, and all other regions follow the G8 – international action GHG emissions path.

CO_2e Concentrations

Impacts of International Action Assumptions (GCAM & MAGICC)

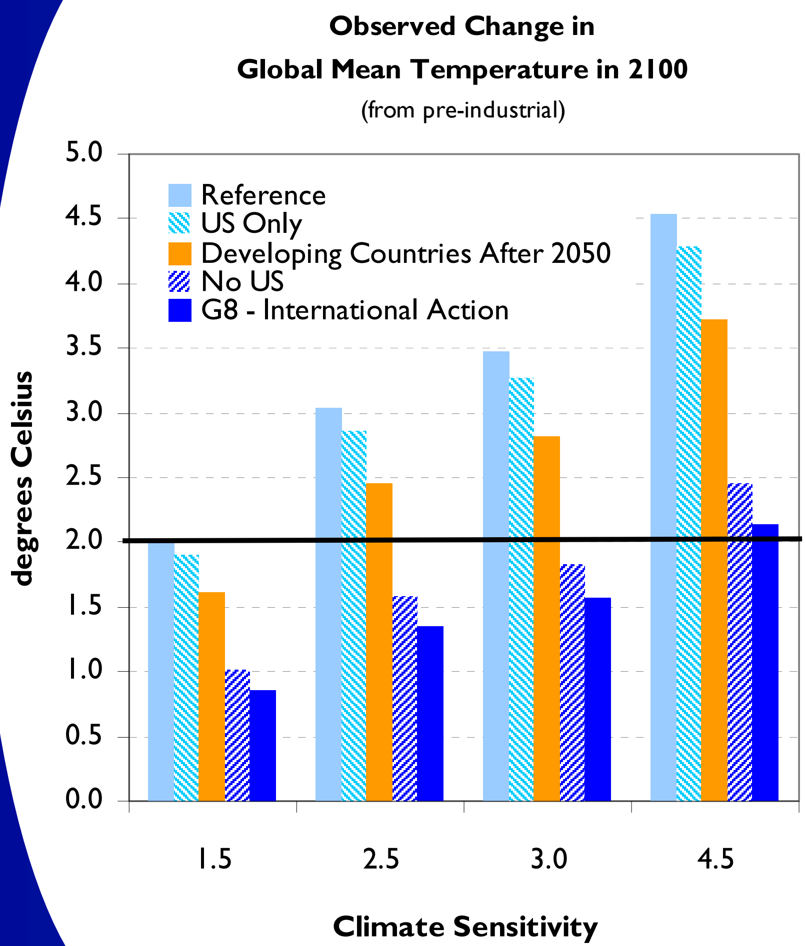


- CO_2e concentrations through 2100 are presented here. Feedbacks between the warming climate and the carbon cycle are calculated assuming a climate sensitivity (CS) of 3.0°C. (CS is the equilibrium temperature response to a doubling of CO_2. 3.0 is deemed "most likely" by the IPCC).
- The five scenarios shown here are:
  - **Reference**: no climate polices or measures adopted by any countries.
  - **US Only**: US adopts the APA, all other countries follow BAU emissions.
  - **Developing Countries After 2050**: US and developed (group 1) countries same as G8 scenario. Developing (group 2) countries adopt policy in 2050 holding emissions constant at 2050 levels.
  - **No US**: US follows BAU emissions, all other counties same as G8 scenario.
  - **G8 - International Action Assumptions**: Consistent with G8 agreement to reduce global emissions to 50% below 2005 levels by 2050. US adopts the APA, developed countries (group 1) reduce emissions to 83% below 2005 levels by 2050, and developing (group 2) countries cap emissions beginning in 2025, and return emissions to 26% below 2005 levels by 2050. All countries hold emissions targets constant after 2050.*
- CO_2e concentrations are approximately 457 ppm in 2100 under G8 – international action assumptions.
  - Note that CO_2e concentrations are not stabilized in these scenarios. To prevent concentrations from continuing to rise after 2100, post-2100 GHG emissions would need to be further reduced. (For example, stabilization of CO_2 concentrations at 457 ppm would require net CO_2 emissions to go to zero in the very long run).
- No participation from developing countries before 2050 would increase CO_2e concentrations to 723 ppm in 2100, while reference assumptions produce CO_2e concentrations of 931 ppm in 2100.
- Removing US action from the G8 scenario raises CO_2e concentrations by 46 ppm in 2100 to 503 ppm. Adding US action to the reference scenario lowers CO_2e concentrations by 64 ppm in 2100 to 868 ppm

•Note that the ADAGE and IGEM models do not model post 2050 caps, doing so would likely raise allowance prices by only 2%. See the banking discussion in appendix 5 for more details.

Global Mean Temperature Change in 2100

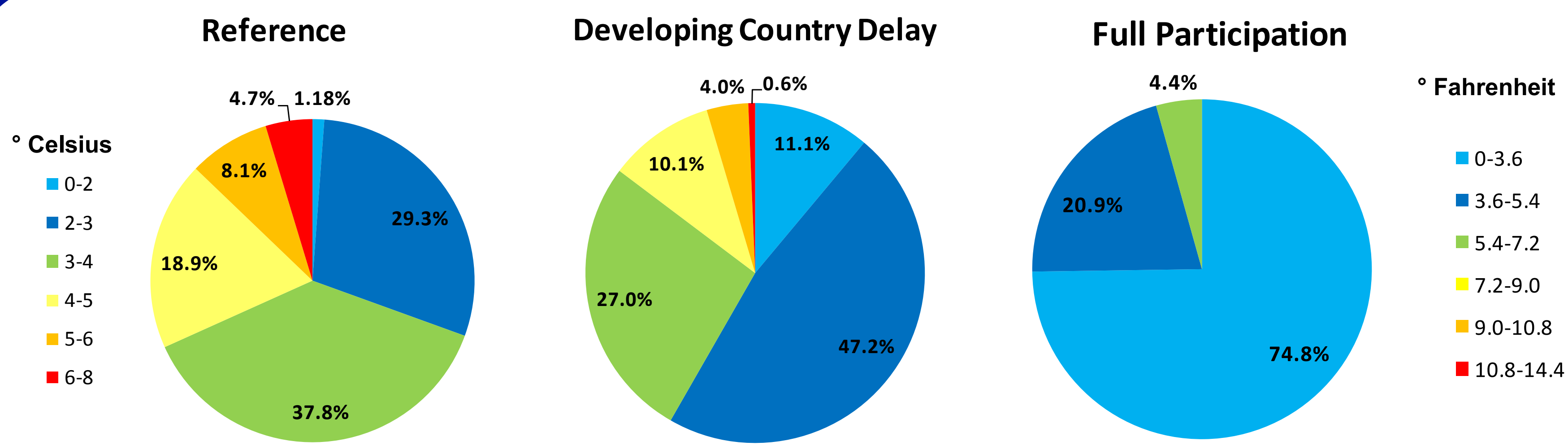
Impacts of International Action Assumptions (MAGICC)



- This chart demonstrates projections of observed temperature changes (from pre-industrial time) in 2100 under various assumptions about the climate sensitivity. A climate sensitivity (CS) of 3.0° C is deemed "most likely" by the IPCC.
- For any given climate sensitivity, lower emissions result in less temperature change.
- Under the G8 – international goals (reducing global emissions to 50% below 2005 by 2050), a 2 degree target in 2100 is attainable for climate sensitivities of 3° C or lower.
- The temperature and GHG concentrations in these scenarios will keep rising after 2100 – continued GHG reductions will be necessary to stabilize temperatures and concentrations.
- At a CS of 3.0° C, in order to achieve an equilibrium temperature change of 2 degrees CO_2e concentrations must be stabilized below 457 ppm.
  - This would require continued abatement beyond the level needed to stabilize concentrations at 2100 levels.
  - It would be possible to reduce CO_2e concentrations after 2100 below 457 ppm by even further reducing GHG emissions in the next century. An 'overshoot' scenario such as this would further reduce the equilibrium temperature change, making it possible to achieve the 2 degrees C target even with a climate sensitivity of 3.0° C.
  - See Appendix 5 for equilibrium temperature impacts.

Probability of Observed Temperature Changes in 2100

Reference, Delayed Participation, and Full Participation Scenarios

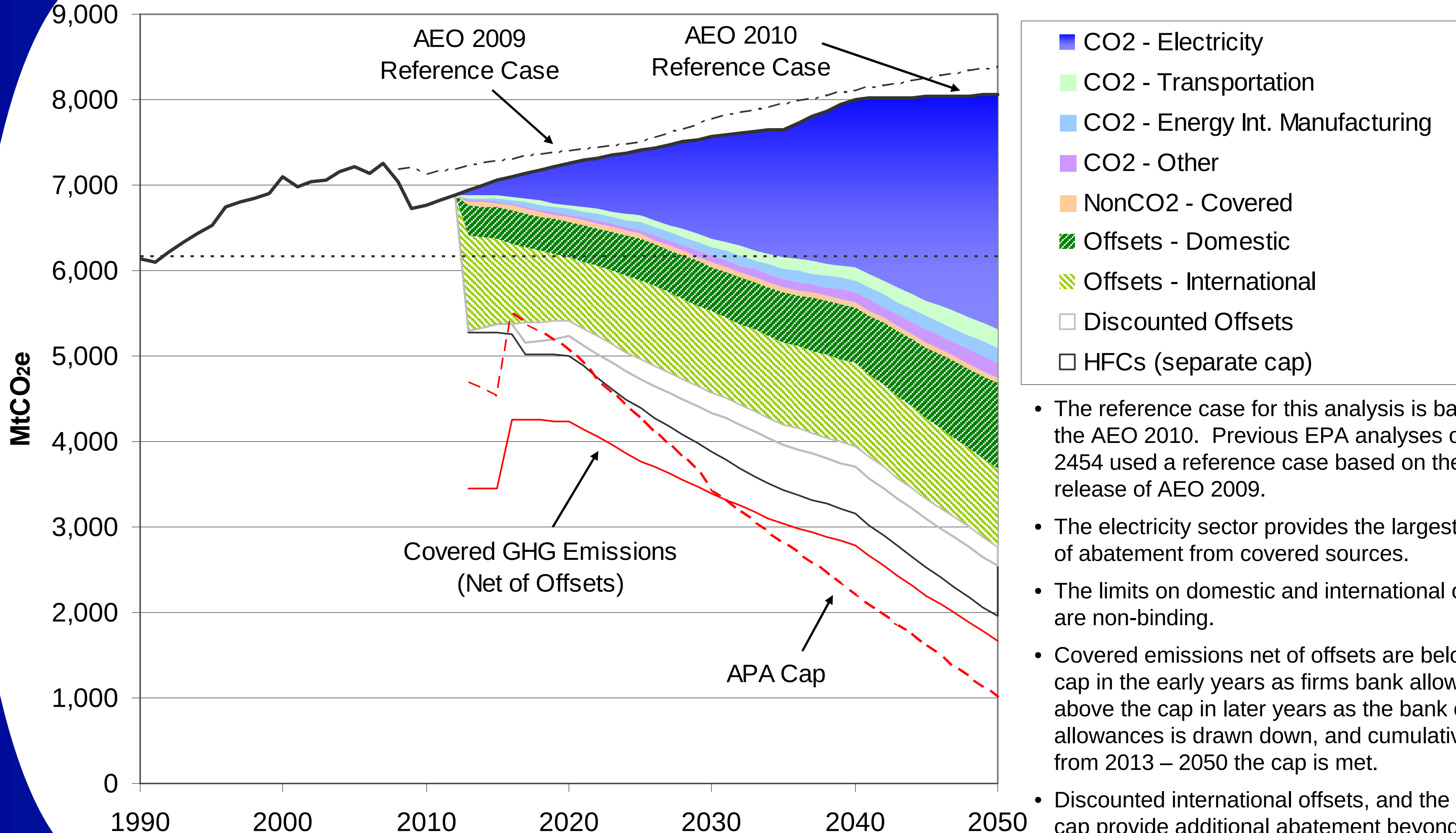


- The pie charts show the approximate probability of **observed** global mean temperature changes in 2100, relative to pre-industrial, falling within specific temperature ranges under reference, developing country action delayed until 2050, and G8 international action scenarios.
  - The figures were developed using MAGICC 5.3 and the truncated (at 10° C) Roe and Baker (2007) distribution over climate sensitivity.
  - Observed temperature change is that resulting from the concentration levels in a specific year.
  - See appendix 5 for equilibrium temperature results.
- Observed temperature change does not equal the change in equilibrium temperature because
  - **CO_2e concentrations rise after 2100**: Equilibrium temperature change is not achieved until after CO_2e concentrations are stabilized. In this analysis, CO_2e concentrations will continue to rise after 2100. Therefore, changes in equilibrium temperature will differ from the observed temperature changes.
  - **Ocean temperature inertia**: This inertia causes the equilibrium global mean surface temperature change to lag behind the observed global mean surface temperature change by as much as 500 years. Even if CO_2e concentrations in 2100 were stabilized, observed temperatures would continue to rise for centuries before the equilibrium was reached.
- Under the Reference scenario (1st chart), the probability of the observed temperature change in 2100 being below 2 degrees C is approximately 1%, while there is a nearly 75% probability associated with this under the Full Participation scenario (3rd chart).
- The probability of being above 4 degrees C is about 32% in the Reference case, while it is just under 15% in the Delayed Participation scenario (2nd chart) and zero under Full Participation (3rd chart).

Economy-Wide Impacts:
GHG Emissions & Economic Costs

Total US GHG Emissions & Sources of Abatement

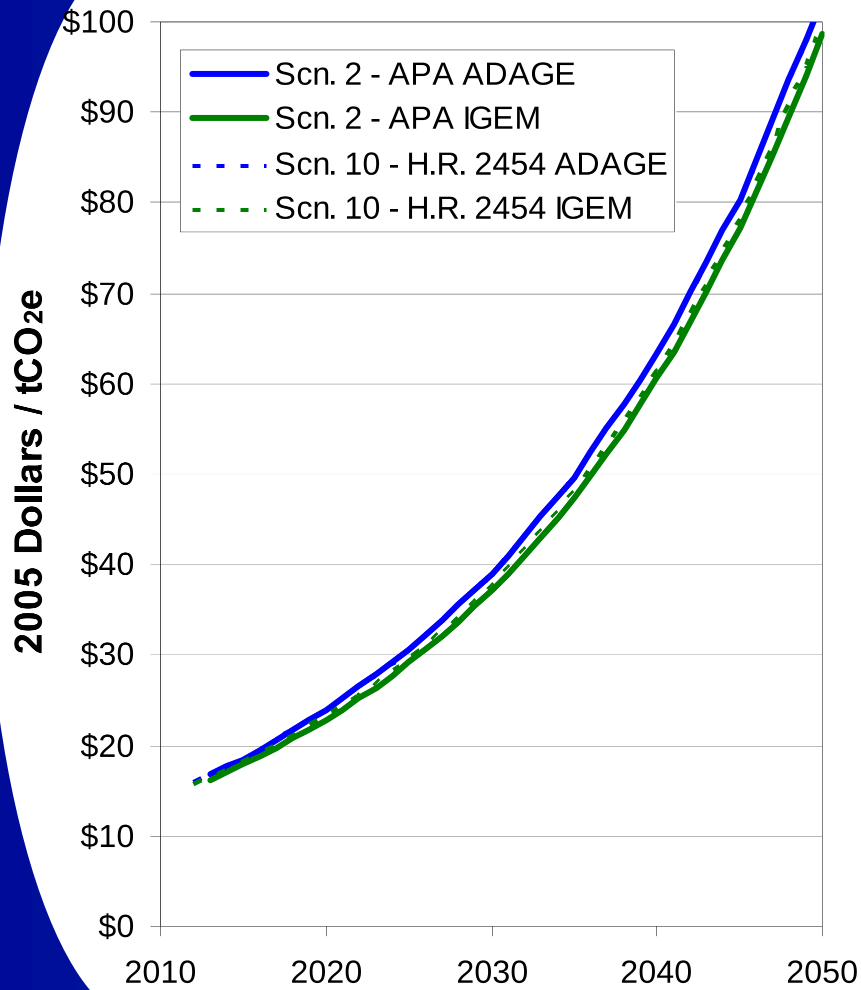
Scenario 1 - Reference & Scenario 2 – APA (ADAGE)



- The reference case for this analysis is based on the AEO 2010. Previous EPA analyses of H.R. 2454 used a reference case based on the March release of AEO 2009.
- The electricity sector provides the largest share of abatement from covered sources.
- The limits on domestic and international offsets are non-binding.
- Covered emissions net of offsets are below the cap in the early years as firms bank allowances, above the cap in later years as the bank of allowances is drawn down, and cumulatively from 2013 – 2050 the cap is met.
- Discounted international offsets, and the HFC cap provide additional abatement beyond what is required by the main cap.

GHG Allowance Prices

Scenario 2 – APA & Scenario 10 - H.R. 2454



Scn. 2 - APA

	2013	2020	2030	2050
ADAGE	$17	$24	$39	$102
IGEM	$16	$23	$37	$99

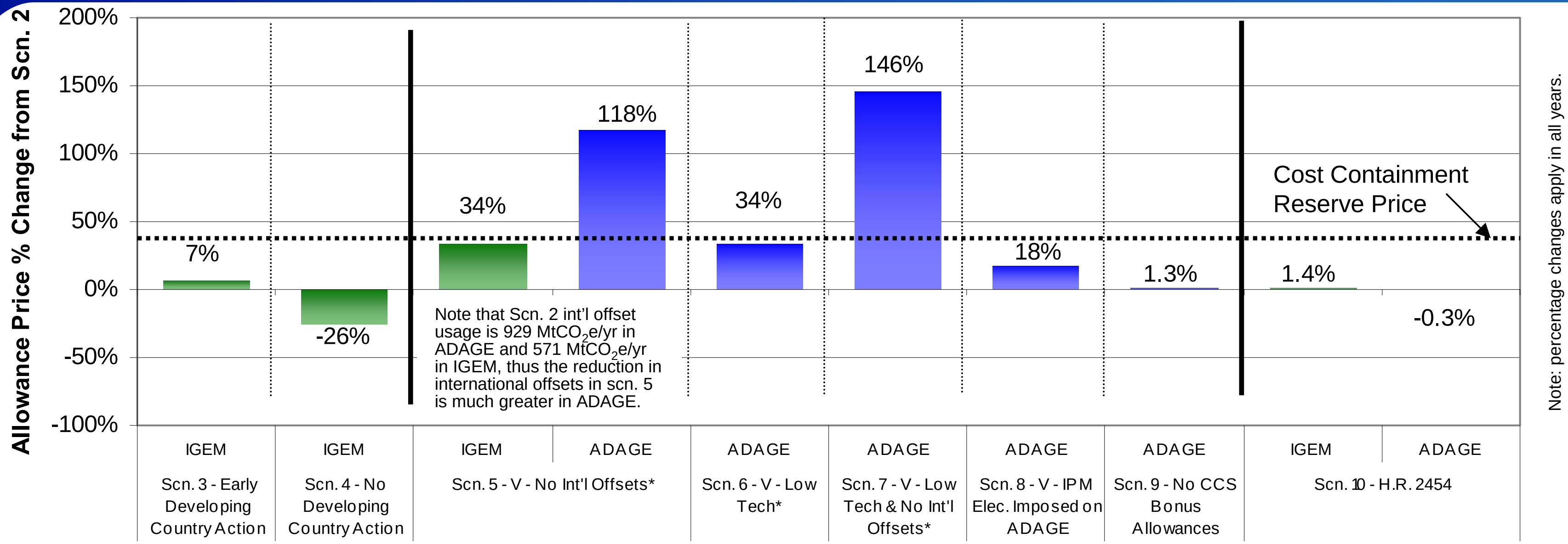
Scn. 10 - H.R. 2454

	2013	2020	2030	2050
ADAGE	$17	$24	$39	$102
IGEM	$16	$23	$38	$100

- The marginal cost of GHG abatement is equal to the allowance price.
- Range of 2030 allowance price in *"scenario 2 – APA"* across models is $37 - $39. This range only reflects differences in the models and does not reflect other scenarios or additional uncertainties discussed elsewhere.
- The limit on international offsets usage is non-binding in both models, and thus the domestic allowance price is equal to the international offset price (after discounting) and the international offset price acts as a floor on the allowance price.
- When the international offsets limit is non-binding, the differences in allowance prices between the models arises from differing demands for international offsets.
  - The differences between the models in terms of cost and availability of domestic abatement show up in the differing amount of international offsets used instead of differing allowance prices.
  - In scenario 2, ADAGE projects an average of 929 $MtCO_2e$ of international offsets will be used annually, and IGEM projects average annual international offsets usage to be 522 $MtCO_2e$.
  - See the 'Offsets Usage & Limits' section for further discussion of international offsets.
- Allowance prices under the American Power Act in scenario 2 are almost identical to allowance prices estimated for H.R. 2454 in scenario 10.

GHG Allowance Prices & Sensitivities

APA Scenario Comparison – Percentage Change from Scenario 2



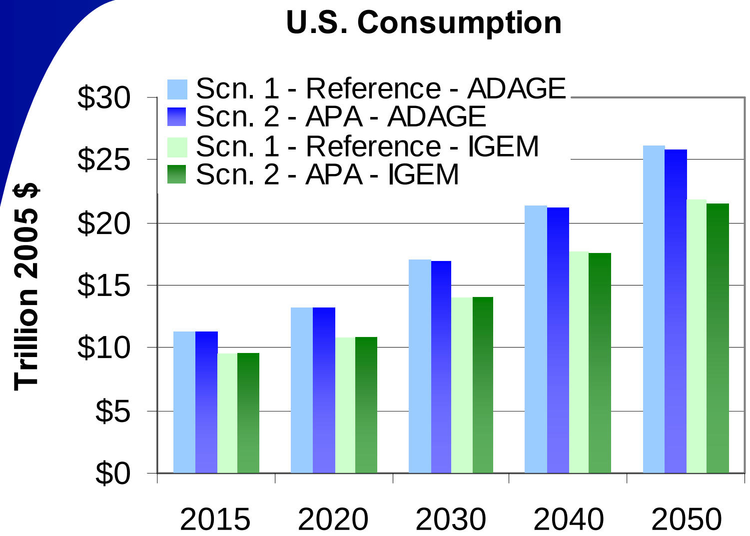
- In scenario 2 the limit on international offsets usage is non-binding, and thus the domestic allowance price is equal to the international offset price (after discounting) and the international offset price acts an allowance price floor. Because of this, the impact of these sensitivities on allowance prices is muted by the change in the usage of international offsets and the amount of abatement occurring in the U.S. (e.g. a change that would ordinarily lead to lower allowance prices instead would lead to fewer international offsets.)
- ADAGE shows greater usage of international offsets than IGEM in scenario 2, so removing international offsets in scenario 5 has a much larger impact on allowance prices in ADAGE than in IGEM. It should be noted that allowing no international offsets is an extreme case. If instead international offsets were simply not available for the first ten years, then allowance prices in IGEM would only increase by 1% (see slide 53).

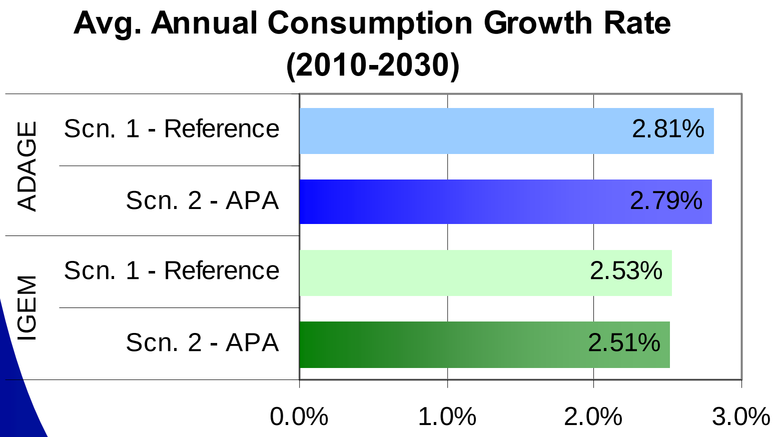
* Scenarios 5 – 7, requested by Senator Voinovich, place limits on technology and international offsets.

  - In ADAGE scenarios 5 and 7, the reserve price is reached, and all 4 billion tons of reserve allowances are sold. This reduces the impact on allowance prices in these scenarios. Since international offsets are not allowed, it is not possible to use the revenues from auctioning reserve allowances to purchase REDD offsets to refill the reserve. Thus the allowance price is able to exceed the reserve (ceiling) price.
  - The cost containment reserve price is 36% higher than the scenario 2 price in ADAGE, and 40% higher than the scenario 2 price in IGEM. The price floor grows at 3% per year instead of the 5% growth rat of the price ceiling and allowance price in this analysis and is not expected to be triggered under any scenario analyzed. For example, the price floor is 33% lower than the scenario 2 price in 2013, and 67% lower in 2050.
  - While not allowing CCS technology before 2030 in the "low tech" scenarios provides pessimistic scenarios, even without the APA there are already more than 3 GW of CCS projects in the early phases of planning, design, and/or construction that could potentially capitalize on the funding opportunities available under H.R. 2454; and the U.S. Nuclear Regulator Commission currently has 30-40 GW of new nuclear capacity under review, before taking into account additional nuclear power that would be able to take advantage of the special incentives for nuclear power in APA Title I, Subtitle A, Part II, Sec. 1121-1122. See Appendix 6 for more detail.

Consumption

Scenario 1 – Reference & Scenario 2 - APA





ADAGE	2015	2020	2030	2040	2050
% Change	-0.14%	-0.17%	-0.46%	-0.68%	-0.86%
Annual Change / HH	-$122	-$169	-$529	-$901	-$1,316
NPV of Change / HH	-$91	-$99	-$190	-$199	-$178

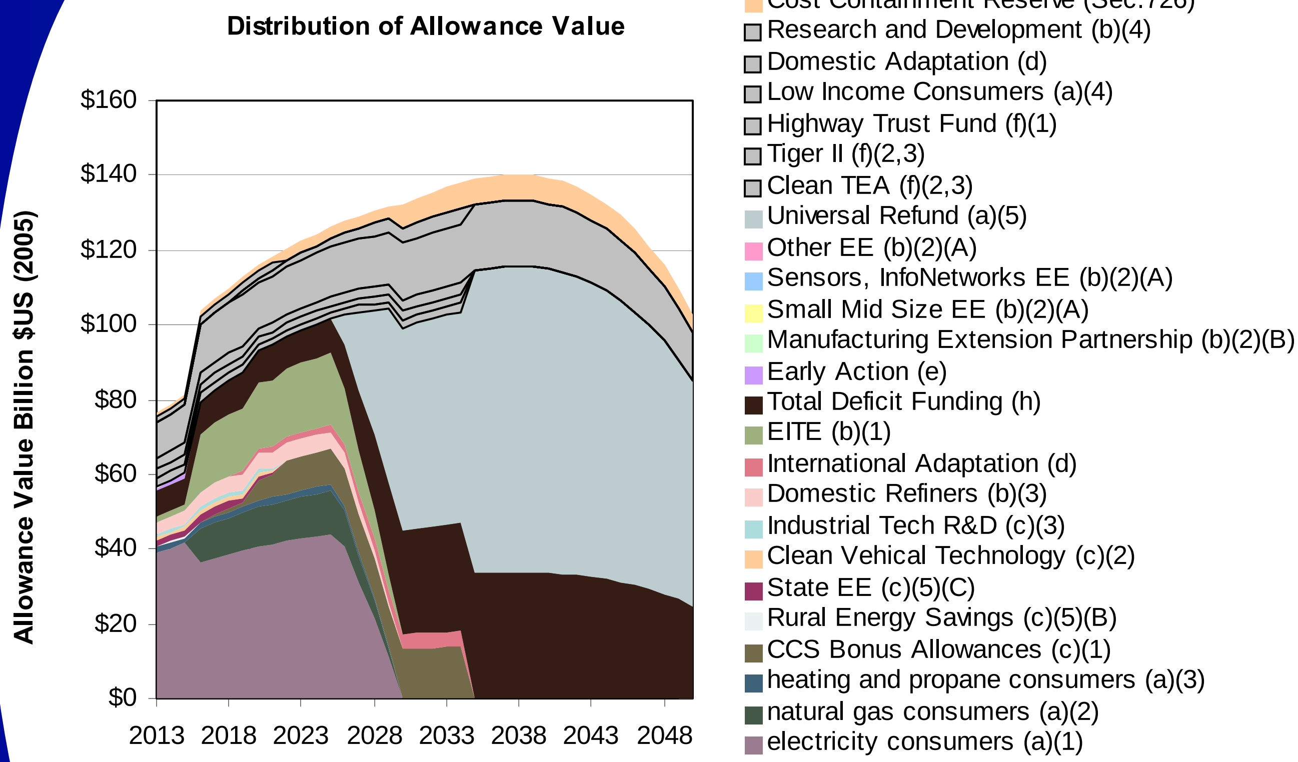
Average Annual Cost per Household (NPV)	**-$146**
Total Cost per Household (2010-2050) (NPV)	-$5,985

IGEM	2015	2020	2030	2040	2050
% Change	0.00%	0.01%	-0.16%	-0.72%	-1.10%
Annual Change / HH	-$3	$12	-$153	-$786	-$1,360
PV of Change / HH	-$2	$7	-$55	-$173	-$184

Average Annual Cost per Household (NPV)	**-$79**
Total Cost per Household (2010-2050) (NPV)	-$3,225

- The average annual cost of the APA per household is the 2010 through 2050 average of the net present value of the per household consumption loss in "*scenario 2 – APA*."
  - The net present value of the per household consumption loss is the cost in a particular year discounted back to today.
- The costs above include the effects of higher energy prices, price changes for other goods and services, impacts on wages and returns to capital, and importantly, the the value of emissions allowances returned lump sum to households, which offsets much of the APA's effect on household consumption. The cost does not include the impacts on leisure.
- This analysis is a cost-effectiveness analysis, not a cost-benefit analysis. As such, the benefits of reducing GHG emissions were not determined in this analysis.
- The $79 - $146 average annual cost per household is the annual cost of achieving the emissions reductions and resulting climate benefits associated with this bill.
- Across all scenarios, the highest average annual NPV cost per household is $350 in ADAGE scenario 7, requested by Senator Voinovich, without international offsets and restricted nuclear, bioelectricity and CCS.
- See Appendix 1 for a discussion of consumption accounting differences between ADAGE and IGEM and of composition of GDP.
- See Appendix 5 for a more detailed discussion of the average annual NPV cost per household calculation, and additional consumption cost metrics.

Value of Allocated & Auctioned Allowances
(IGEM/ADAGE)



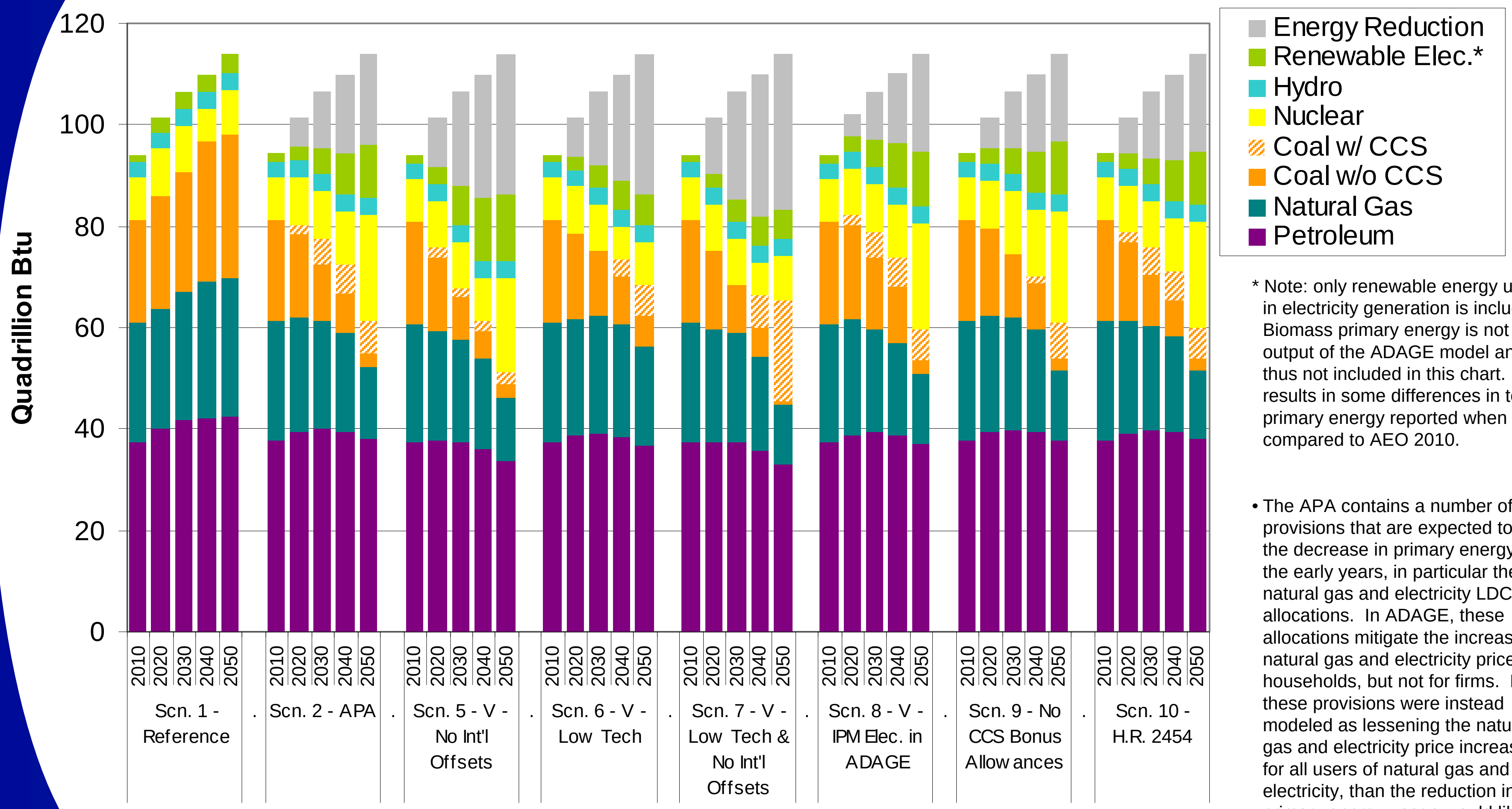
- The American Power Act Sec. 2101 amends the Clean Air Act by inserting "Sec. 781. Allocation of Emissions Allowances." Parts (a) through (h) of this section allocate allowances whose estimated value is shown in the figure.
- The allowance prices used in this figure are from the IGEM "*scenario 2 APA*". The sets of components explicitly modeled by ADAGE and IGEM are slightly different from each other – details can be found in appendix 1.
- Except for items color-coded in gray, allowances are modeled in IGEM and/or ADAGE such that they accrue directly to the corresponding sector.
- Those items color-coded in gray indicate allowances that are modeled such that they, along with the Universal Refund, accrue in lump-sum fashion to households.
- Both of the computable general equilibrium models used in this analysis have a single representative agent household. Any auction revenue returned to households clearly accrue to households. Additionally, any private sector revenues from allocated allowances also accrue to the employee-shareholder households.

- While being able to provide outcomes on aggregate household impacts, the limitation of a single representative household model is its inability to show household <u>distributional</u> results of the various policy scenarios. Distributional results of a separately conducted analysis are discussed at the end of this report.
- If auction revenues that are modeled as being returned to households lump sum were instead directed to particular funds, the expected reduction in household annual consumption and GDP would likely be greater. However, such revenues could be used to lower existing distortionary taxes and thus reduce policy costs. See "Scenario 16 – Revenue Recycling – Labor Tax" of EPA's January 29, 2010 supplemental analysis of H.R. 2454 for analysis of this issue.

Energy Sector Modeling Results from Economy-Wide Modeling

Primary Energy

APA Scenario Comparison (ADAGE)



* Note: only renewable energy used in electricity generation is included. Biomass primary energy is not an output of the ADAGE model and is thus not included in this chart. This results in some differences in total primary energy reported when compared to AEO 2010.

- The APA contains a number of provisions that are expected to limit the decrease in primary energy in the early years, in particular the natural gas and electricity LDC allocations. In ADAGE, these allocations mitigate the increase in natural gas and electricity prices for households, but not for firms. If these provisions were instead modeled as lessening the natural gas and electricity price increases for all users of natural gas and electricity, than the reduction in primary energy usage would likely be smaller than what is shown here.

Primary Energy

APA Scenario Comparison (ADAGE)

- A joint constraint on nuclear power and CCS in ADAGE is based on the constraint used in IPM (see Appendix 5 and Appendix 6 for more detail).
- In the reference scenario, primary energy use is 94 quadrillion Btu in 2010, grows 13% by 2030 and 21% by 2050.
- The American Power Act, on average, would maintain 2010 primary energy use levels within 2%.
- Not allowing international offsets to enter the American Power Act emissions reduction framework or not supporting the advancement of nuclear and biomass primary energy production would serve to further reduce total primary energy use in comparison to the proposed bill in current form.
- H.R. 2454 is estimated to reduce primary energy use (from the reference case) to a slightly larger extent than would the American Power Act.

Scenario	Description	Quadrillion BTU Total Primary Energy Use					% Change from 2010			
		2010	2020	2030	2040	2050	2020	2030	2040	2050
1	Reference	94	102	107	110	114	8%	13%	17%	21%
2	American Power Act	94	96	95	94	96	1%	1%	0%	2%
5	No International Offsets	94	92	88	86	86	-2%	-6%	-9%	-8%
6	Nuclear/Biomass Reference and Delayed CCS	94	94	92	89	86	0%	-2%	-5%	-8%
7	Scenario 6 and no International Offsets	94	90	85	82	83	-4%	-9%	-13%	-11%
8	IPM Electricity Imposed in ADAGE	94	98	97	96	95	4%	3%	2%	1%
9	No CCS Bonus Allowances	94	95	95	95	97	2%	2%	1%	3%
10	H.R. 2454	94	94	94	93	95	0%	0%	-1%	1%

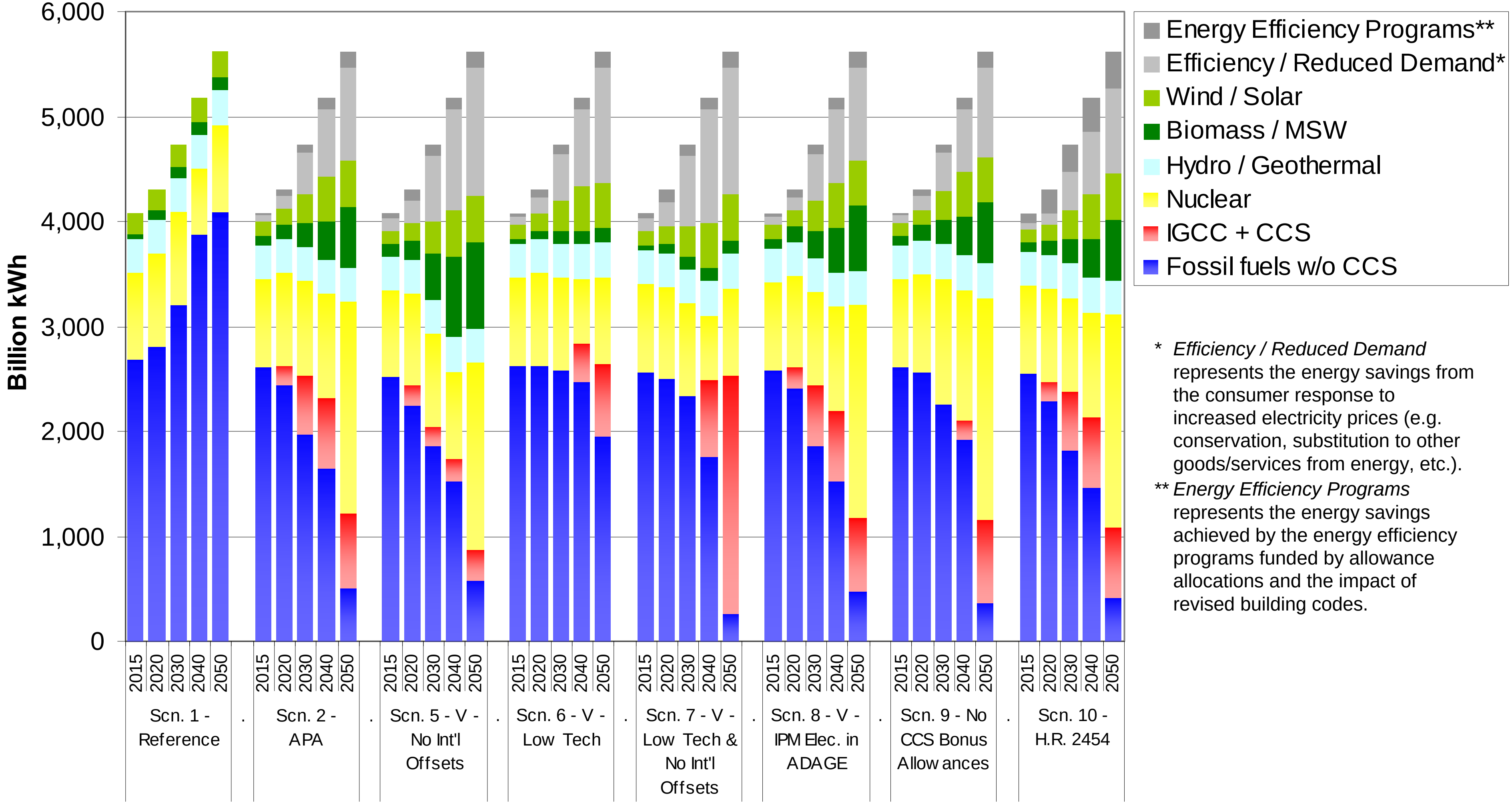
- In the reference case, low- or zero-carbon energy (including nuclear, renewables, and CCS) is expected to rise to a steady 15% of total primary energy through 2030 before it drops to between 12-14% after 2030.
- The American Power Act is estimated to more than triple the share of low- or zero- carbon energy in total primary energy use between 2010 and 2050.
- Preventing international offsets from entering the trading system would substantially increase allowance prices and thus further encourage the use of low- and zero- carbon energy sources.

Scenario	Description	Low/Zero Carbon Energy Use as Share of Total					% Change from 2010			
		2010	2020	2030	2040	2050	2020	2030	2040	2050
1	Reference	13%	15%	15%	12%	14%	13%	11%	-10%	3%
2	American Power Act	14%	18%	24%	29%	43%	31%	74%	111%	208%
5	No International Offsets	14%	20%	25%	31%	43%	39%	77%	118%	209%
6	Nuclear/Biomass Reference and Delayed CCS	14%	16%	18%	21%	28%	17%	33%	53%	102%
7	Scenario 6 and no International Offsets	14%	17%	20%	27%	45%	22%	44%	96%	231%
8	IPM Electricity Imposed in ADAGE	14%	18%	24%	29%	44%	31%	77%	116%	220%
9	No CCS Bonus Allowances	14%	17%	22%	28%	44%	20%	58%	97%	217%
10	H.R. 2454	14%	18%	25%	30%	43%	32%	76%	113%	208%

- Although not modeled in this analysis, the APA requires EPA to set new GHG standards for light-duty, heavy-duty, and non-road vehicles and engines, which would be expected to further reduce U.S. petroleum demand.

U.S. Electricity Generation

APA Scenario Comparison (ADAGE)



* *Efficiency / Reduced Demand* represents the energy savings from the consumer response to increased electricity prices (e.g. conservation, substitution to other goods/services from energy, etc.).

** *Energy Efficiency Programs* represents the energy savings achieved by the energy efficiency programs funded by allowance allocations and the impact of revised building codes.

U.S. Electricity Generation

APA Scenario Comparison (ADAGE)

- The APA is estimated to lead to a significant decline in electricity generation from non-CCS fossil fuels -- a 23% decrease from 2010 levels by 2030 and an 81% decrease by 2050. This is in stark contrast to the expected steady increase in non-CCS fossil fuel electricity generation without the APA policy – a 22% increase by 2030 and a 56% increase by 2050.
- The APA is also expected to encourage electricity generation from cleaner technologies (CCS/IGCC Coal, Wind, Solar, biomass, hydro, geothermal, and nuclear), an increase over the 2010 level of 80% by 2030 and more than tripling the 2010 level by 2050.
- The APA allows covered entities to meet compliance obligations in a number of ways. Restrictions on such flexibilities (e.g., by not allowing international offsets as shown in scenarios 5 and 7) tend to increase electricity prices, thus lowering total electricity consumption.

		Fossil Fuels w/o CCS (Bil KWh)					% change over 2010			
Scenario	Description	2010	2020	2030	2040	2050	2020	2030	2040	2050
1	Reference	2,619	2,810	3,201	3,879	4,086	7%	22%	48%	56%
2	American Power Act	2,572	2,438	1,972	1,644	499	-5%	-23%	-36%	-81%
5	No International Offsets	2,558	2,251	1,862	1,521	575	-12%	-27%	-41%	-78%
6	Nuclear/Biomass Reference and Delayed CCS	2,595	2,623	2,581	2,480	1,959	1%	-1%	-4%	-24%
7	Scenario 6 and no International Offsets	2,593	2,498	2,335	1,750	262	-4%	-10%	-33%	-90%
8	IPM Electricity Imposed in ADAGE	2,569	2,419	1,869	1,525	478	-6%	-27%	-41%	-81%
9	No CCS Bonus Allowances	2,572	2,565	2,255	1,922	359	0%	-12%	-25%	-86%
10	H.R. 2454	2,572	2,286	1,818	1,471	411	-11%	-29%	-43%	-84%

- Prohibiting international offsets from entering the APA emissions reduction program in scenario 5 increases allowance prices and forces greater amounts of GHG abatement to occur in covered sectors, including the power sector. CCS deployment is actually lower in scenario 5 than in scenario 2. With high allowance prices in scenario 5, the small amount of GHG emissions from CCS, which is assumed to have a 90% capture efficiency, make nuclear the preferred option. Given the joint constraint on nuclear and CCS, as nuclear increases in scenario 5 relative to scenario 2, CCS must decrease.
- Approaching 2050, prohibiting international offsets as in scenario 7 results in substitution away from fossil fuels and towards cleaner technologies such that the resulting changes over 2015 are similar to those to result from the APA. In the shorter-term, however, this substitution is slow to occur.
- Eliminating CCS bonus allowances from APA (scenario 9) is estimated to result in a slower decrease in fossil-fuel based electricity generation and a slower advancement of clean electricity generation compared with the expected result of implementing the APA as proposed. While eliminating the CCS bonus allowances results in slightly higher allowance prices, it could potentially reduce the overall cost of the bill.

		Low/Zero Carbon Energy (Bil KWh)					% change over 2010			
Scenario	Description	2010	2020	2030	2040	2050	2020	2030	2040	2050
1	Reference	1,219	1,488	1,532	1,290	1,528	22%	26%	6%	25%
2	American Power Act	1,266	1,681	2,284	2,784	4,077	33%	80%	120%	222%
5	No International Offsets	1,275	1,729	2,135	2,578	3,666	36%	67%	102%	187%
6	Nuclear/Biomass Reference and Delayed CCS	1,241	1,450	1,622	1,858	2,407	17%	31%	50%	94%
7	Scenario 6 and no International Offsets	1,241	1,450	1,622	2,239	3,995	17%	31%	80%	222%
8	IPM Electricity Imposed in ADAGE	1,267	1,692	2,327	2,847	4,102	33%	84%	125%	224%
9	No CCS Bonus Allowances	1,266	1,549	2,032	2,547	4,256	22%	60%	101%	236%
10	H.R. 2454	1,266	1,681	2,284	2,784	4,041	33%	80%	120%	219%

American Power Act

Energy Efficiency Provisions

Energy efficiency provisions addressed (*see Note below)

- **Allowance allocations.** Impacts on electricity and natural gas demand were calculated for the various allowance allocations (or portions thereof) that are directed to support energy efficiency. These include allocations to the following:
  - Rural energy savings program
  - Industrial energy efficiency
  - State renewable energy and energy efficiency
  - Early action recognition
  - Natural gas consumers
  - Home heating oil and propane consumers

- **Building codes.** Impacts on electricity and natural gas demand, and associated costs, were calculated for the building codes provision (Sec. 241) within S. 1462 (per Senate specifications to EPA)

Calculated demand impacts and costs (* see Note below)

- In '*scenario 2 – APA*' the reduction in total electricity demand due to the EE provisions is projected to be 1.2% of reference case electricity demand in 2020 and increase to 2.6% of reference case electricity demand in 2050.
- In '*scenario 2 – APA*' the reduction in total natural gas demand due to the EE provisions is projected to be 1.0% of reference case natural gas demand in 2020 and increase to 2.8% of reference case natural gas demand in 2050.
- Cost impacts associated with building codes were calculated and applied to the manufacturing and services sectors within ADAGE.

H.R. 2454 Comparison

- Calculated electricity demand impacts from the energy efficiency provisions of the American Power Act (scenario 2), as a fraction of H.R. 2454 savings, are roughly ~ 1/4 in 2020, 1/3 in 2030 and less than 1/2 in 2050
- The main drivers of the lower calculated impacts of the energy efficiency provisions of the American Power Act relative to H.R. 2454 are significantly less allowance value devoted to energy efficiency programs, the lack of a Combined Efficiency and Renewable Electricity Standard, and less aggressive building code targets.

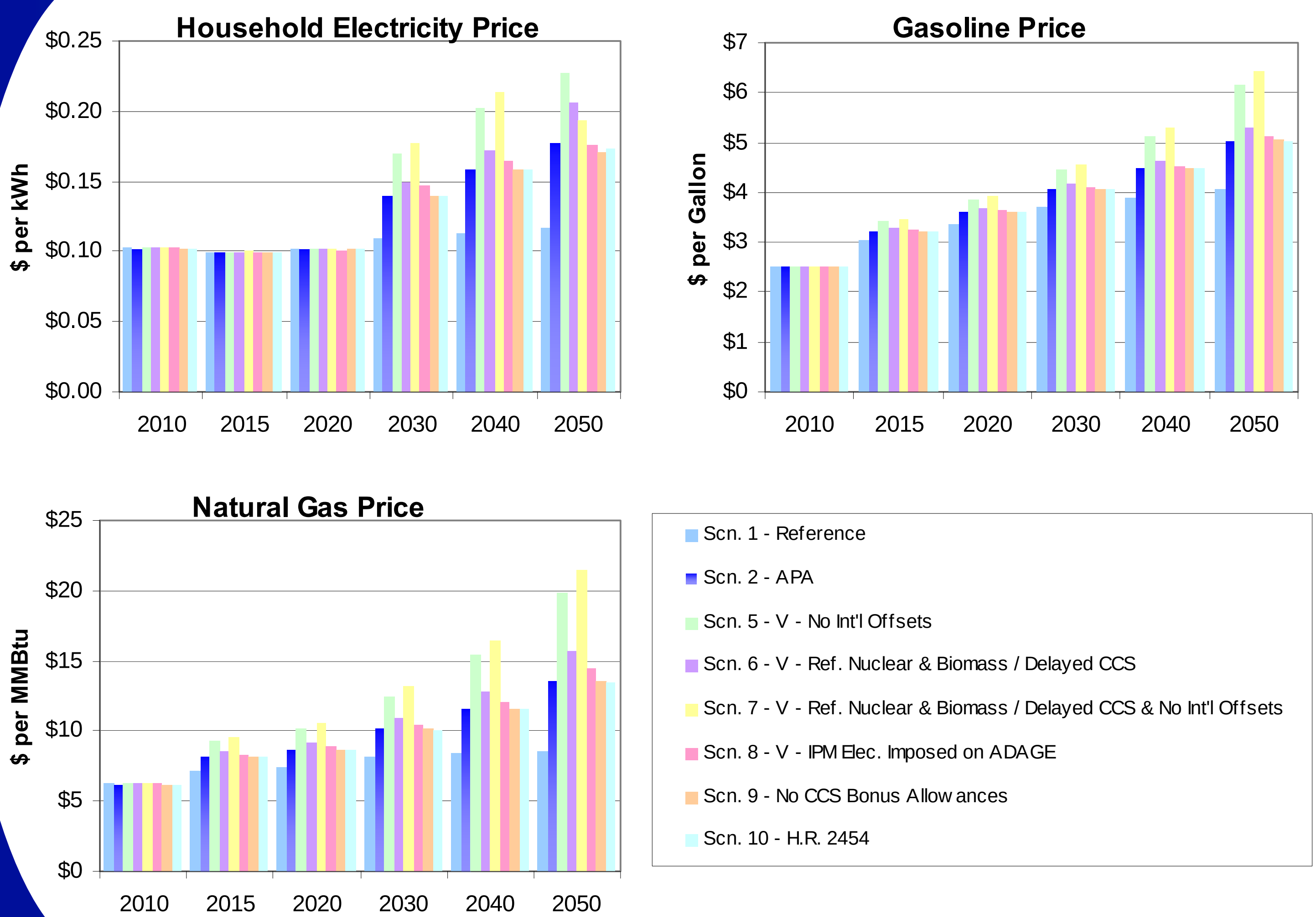
Caveats on modeling of energy efficiency provisions

- A significant energy demand price response is forecast by ADAGE. This response is driven by a number of factors including substitution away from energy consumption to other products/services, conservation behavior (e.g., turning off lights), as well as increased investments in energy efficiency.
- A portion of estimated energy demand reduction from energy efficiency provisions may be a-priori incorporated into the baseline responsiveness of demand to a price increase in ADAGE. Further analyses are needed to quantify the extent to which demand reduction may be double-counted in these scenarios.
- The costs of EE provisions are captured in the estimated economy-wide cost of APA. However, a portion of these costs are estimated outside of ADAGE and then imposed within the model, rather than endogenously determined.
- Allowance allocations for energy efficiency are used to fund energy efficiency projects assuming a cost of saved energy (CSE) at a rate of \$46/MWh (electric) and \$6.8/mmBTU (natural gas), and average measure lives of 13 and 19 years, respectively. CSE includes "program administrator" and "participant" costs. CSE escalated at 1%/year. Source ACEE (2009).

*** NOTE: See Appendix 4 for further detail on provisions addressed, as well as methodology, assumptions, caveats, and references.**

Energy Prices

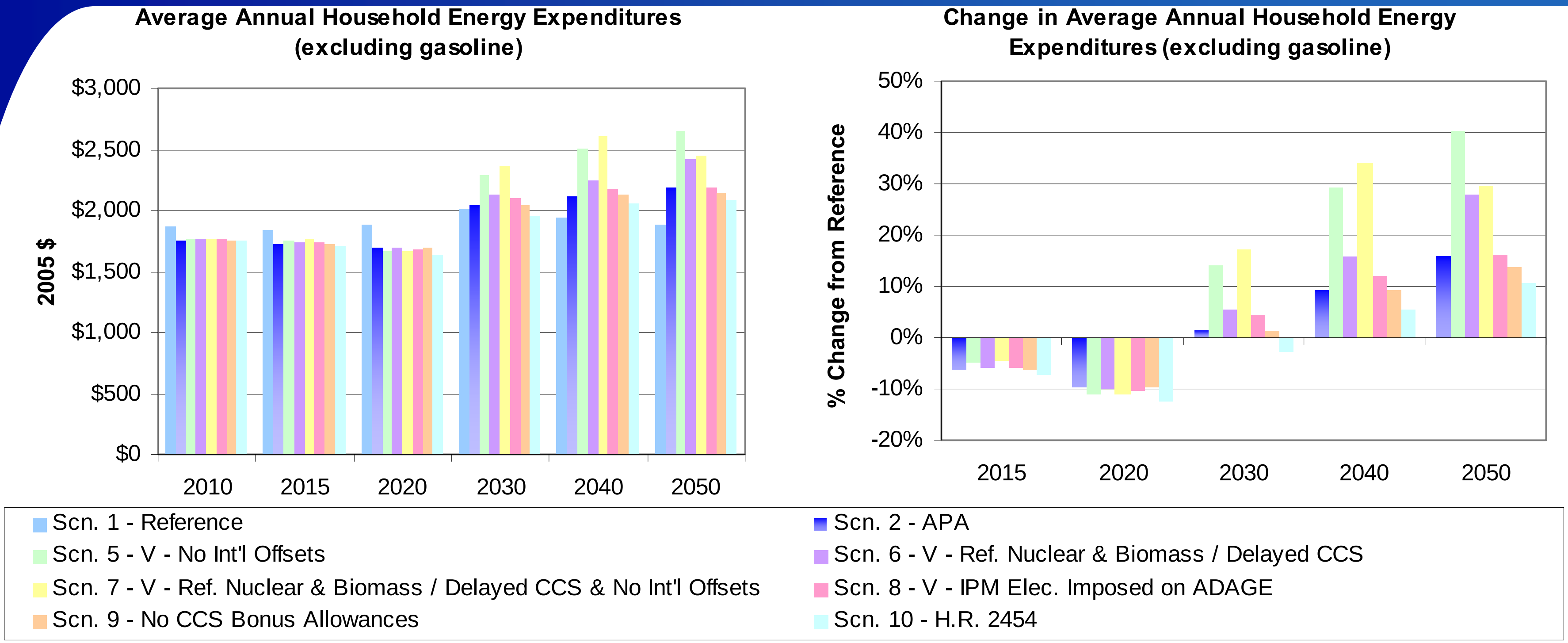
APA Scenario Comparison (ADAGE)



- Gasoline and natural gas prices are inclusive of the allowance price (i.e. they represent the price faced by consumers, not the price received by producers which would be exclusive of the allowance price).
- The gasoline price is obtained by multiplying the petroleum price index in ADAGE by the 2010 price of gasoline from the AEO 2010 projection.
- Although not modeled in this analysis, the APA requires EPA to set new GHG standards for light-duty, heavy-duty, and non-road vehicles and engines, which would be expected to lower U.S. petroleum demand.
- The allocations to electric local distribution companies (LDC's) mitigates the household electricity price increase until the allocations phase out beginning in 2025.
- As shown on the next slide, energy bills are not expected to increase as much as energy prices because of reductions in demand for energy.

Household Energy Expenditures

APA Scenario Comparison (ADAGE)



- In 2020, the average household's energy expenditures (excluding motor gasoline) falls by 10% in *scenario 2 – APA.*" In 2030, the increase is 1% over reference levels, and in 2050 the increase is 16%.
  - In 2020, electricity prices are equal to reference levels in "*scenario 2 – APA.*" In 2030 they increase by 27% over reference levels, and in 2050 the increase is 52%.
  - Actual household energy expenditures increase by a lesser amount due to reduced demand for energy.
- The differences between 'scn. 2 – APA' and 'scn. 10 – H.R. 2454' are largely driven by the differences in the energy efficiency provisions of the two bills.
- In ADAGE, energy expenditures represent approximately 2% of total consumption in 2020, falling to 1% by 2050 in all scenarios.
- The energy expenditures presented here do not include any potential increase in capital or maintenance cost associated with more energy efficient technologies incentivized by the energy efficiency programs.
- While energy expenditures begin to rise by significant amounts in 2030 to 2050, these increases are largely offset by the per-capita rebate, protection for low-income households, and other ways of returning allowance value to households. (Slide 28 shows the net impact on households accounting for both increased costs and return of allowance value, and slides 66 - 71 show the detailed incidence analysis.)

Detailed Near-Term Electricity Sector Modeling Results

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, EPA has employed the Integrated Planning Model (IPM) to project the near-term impact of this policy scenario on the electricity sector.

Power Sector Modeling (IPM 2010 Ref. Case):

- This version of the model incorporates key assumptions/ projections from the Energy Information Administration's Annual Energy Outlook 2010.
- Although it has been updated since the one used for the H.R. 2454 analysis released in June, 2009, this version is still built on the versions used previously to analyze H.R. 2454, the Waxman-Markey discussion draft, S. 280, S. 1766, and S. 2191.
- This version of the model incorporates key carbon-related options and assumptions, such as carbon capture and storage technology for new and existing coal plants, biomass co-firing options, and technology penetration constraints on new nuclear, renewable, and coal with CCS capacity.

Modeling Approach:

For this analysis, IPM 2010 Ref. Case incorporated two sets of data from the ADAGE model:

- CO_2 allowance price projections*
- Percent change in electricity demand*

Note: For more detail on the assumptions used in EPA's application of IPM, please see more detailed documentation for IPM at http://www.epa.gov/airmarkets/progsregs/epa-ipm/index.html.

* Allowance prices for the core IPM scenario are taken from the ADAGE core scenario (Scenario 2).

IPM Scenarios and Major Power Sector Provisions Modeled in IPM

The following scenarios were modeled for the power sector:

1. Core ADAGE APA Scenario (Scenario 2)
2. HIgh natural gas supply sensitivity (Same inputs as Scenario 2)
3. Low technology- No int'l offsets sensitivity (Scenario 7)
4. No CCS bonus allowances or wires charge (Scenario 9)
5. H.R. 2454 with IPM 2010 (Scenario 10)

Sensitivity modeling results for # 3 – 5 are located in the appendix.

Major Bill Provisions:

Special Funding Program for Development & Deployment of CCS and Conversion Technologies (Title I, Subtitle C, Part II, Sec. 1412-1415): Designed to "accelerate the commercial availability of carbon dioxide capture and sequestration technologies and methods."

- A CCS Program Partnership Council is created and administers funds generated through fees on electricity production by fuel type. The Council will administer and distribute roughly $2 billion in annual funding for 10 years from date of enactment.
- IPM implementation: Assumed that this funding spurs 12 additional GW of CCS capacity by 2025 (beyond the baseline amount). These projects are "hard-wired" into IPM and are not a result of the model's economic analysis. The model may independently add CCS capacity after 2015 on an economic basis, subject to an upper-bound capacity development constraint.

CCS Bonus (Title I, Subtitle C, Part III, Sec. 794): Designed to provide additional economic incentive for coal with CCS through allocation of "bonus" allowances.

- A portion of allowances are reserved for incentivizing carbon capture and storage technology (starting at 0.8% of allowances and rising to 10%). The specific incentive is designed as a fixed monetary value for every ton of CO_2 sequestered, rather than a certain number of allowances. The value is specified as $96/ton for the first 10 GW, then $85/ton for the next 10 GW (plus $10/ton for projects commencing operation by 2017), and then the amount determined through reverse auction until a maximum of 72 GW of CCS receives the bonus. A stream of specified bonus allowances are made into "current" allowances and made available to qualifying projects dependent upon allowance prices and the total quantity allocated. The bonus for the remaining capacity is administered as a reverse auction.
- IPM implementation: Similar to past IPM applications, CCS projects receive a subsidy equal to the bonus amount. The allowances are distributed on a first-come, first-serve basis and can be banked. In this analysis, $50/ton was used as the reverse auction clearing price for generation beyond the first 20 GW. This constant value does not reflect the potential for competitive deployment and learning-by-doing to lower the reverse auction clearing prices over time.

Special Incentives for Nuclear Power (Title I, Subtitle A, Part II, Sec. 1121-1122):

- Accelerated depreciation reduces the accelerated depreciation period to 5 years. Modeled in IPM as a reduction in the capital charge rate.
- Investment tax credit for nuclear power facilities provides 10% credit for certain expenditures for the construction of nuclear power facilities. Capital cost in IPM reduced by 10% for modeling.
- Increase in loan guarantee amount was not modeled in IPM.

Note: See Appendix for more detail on updates to IPM. For more detail on the all of the assumptions used in EPA's application of IPM, please see more detailed documentation for IPM at http://www.epa.gov/airmarkets/progsregs/epa-ipm/index.html.

Key Model Updates

Updates to IPM 2010 Ref. Case:

- **Electricity Demand Growth:** Calibrated to AEO 2010
- **Cost of New Power Technologies:** Consistent with AEO 2010
- **State RPS and Climate Programs:** Calibrated to AEO 2010 with finalized regulations like RGGI.
- **International electricity imports and exports:** Calibrated to AEO 2010
- **Limits on new wind additions in 2012 and new nuclear builds**: Consistent with AEO 2010

Previous Updates Carried Over to IPM 2010:

- **Natural gas supply curves:** Same assumptions as IPM 2009 ARRA.
- **Cost of Climate Policy Uncertainty:** An increase to the capital charge rate for new coal plants (consistent with AEO 2009). This change is only applied in the reference case, not in the policy or sensitivity runs.
- **CCS in Baseline:** Reflecting updated financial incentives including ARRA, 2 GW of CCS capacity are projected for 2015 in the baseline.

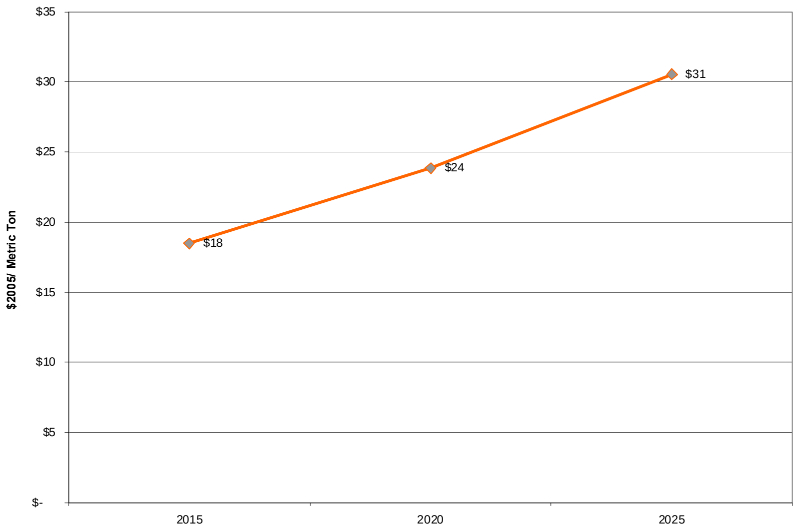
Comparison to Previous IPM Analyses:

- **Electricity Demand:** The reference case electricity demand forecast is lower than in previous EPA analyses of legislative proposals (but slightly higher than in the H.R. 2454 analysis), reflecting revised economic growth and recently enacted laws supporting energy efficiency.
- **New Capacity:** Since overall electricity demand is lower, fewer new power plants are needed than in past EPA modeling with IPM.

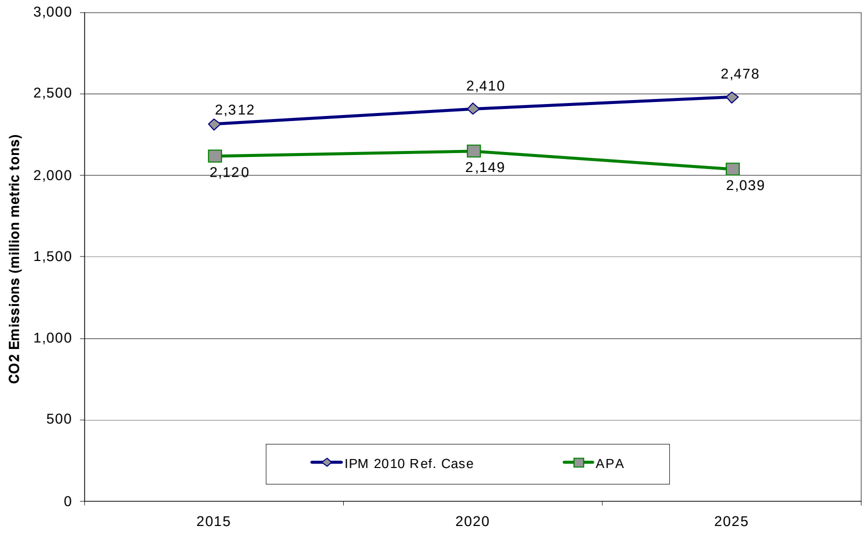
Note: See Appendix for more detail on updates to IPM. For more detail on the all of the assumptions used in EPA's application of IPM, please see more detailed documentation for IPM at http://www.epa.gov/airmarkets/progsregs/epa-ipm/index.html.

GHG Allowance Prices and Power Sector CO_2 Emissions (IPM)*

Core Scenario GHG Allowance Price (from ADAGE Scenario 2)*

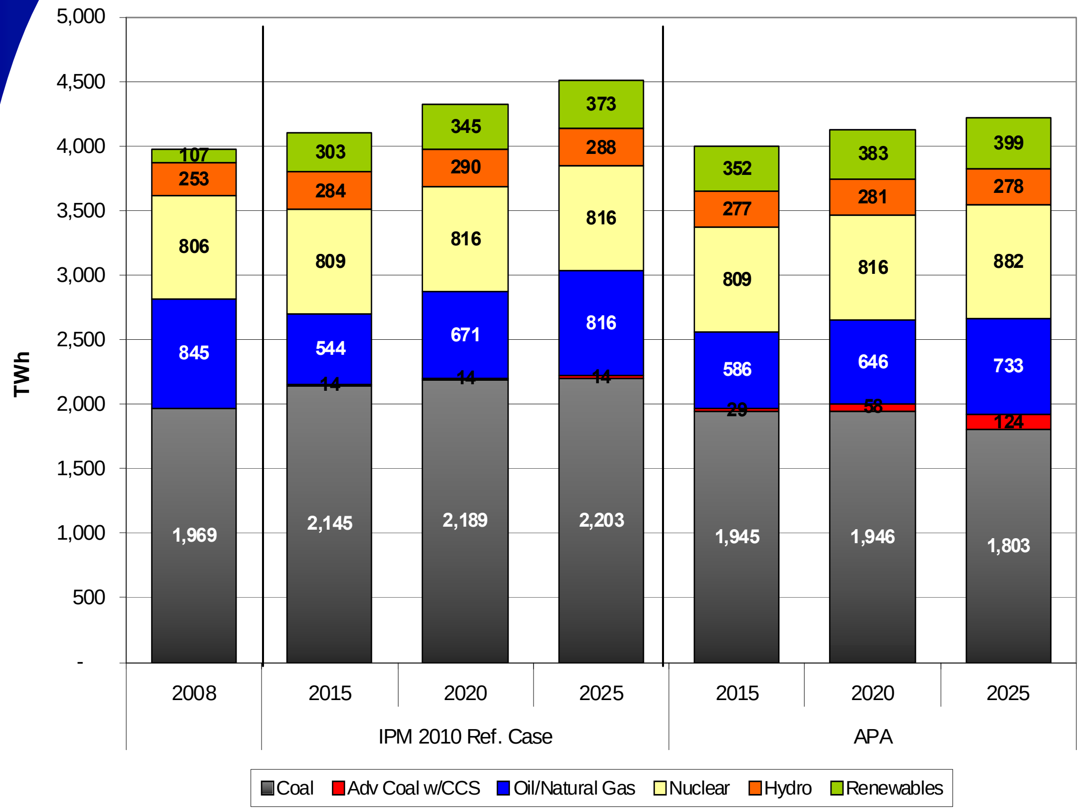


Power Sector CO_2 Emissions



* Allowance prices for the core IPM scenario are taken from the ADAGE APA core scenario (Scenario 2). IPM 2010 Reference Case is generally consistent with AEO 2010, although projections are not identical because IPM is a power sector model and has slightly different treatment of key assumptions and variables.

Electricity Generation Mix (IPM)

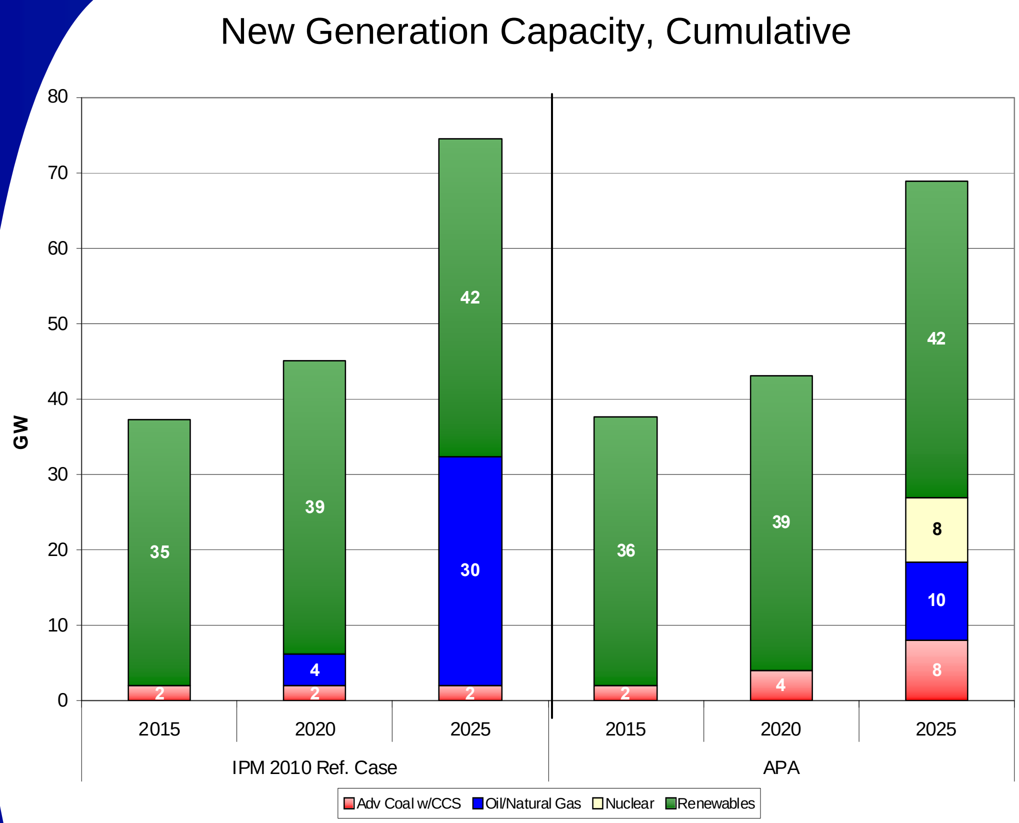


- An increase in renewable energy in both the reference case and APA scenario is largely driven by ARRA provisions.
- Renewables generation only increases by less than 10 percent between the reference case and the APA scenario. Most of this increase is attributed to biomass co-firing which grows by around 35 percent by 2025.
- Electricity demand declines gradually resulting in an increase in natural gas generation in APA in 2015. In later periods, natural gas generation is lower in APA than in the reference case.
- The difference in electricity generation between the reference case and policy case is around 300 TWh in 2025. This difference is equivalent to the amount of electricity used by more than 20 million (around 30%) single family homes in the US annually.*

2008 data from EIA's Electric Power Annual (for electric utilities, independent power producers, and CHP electric power). IPM 2010 Reference Case is generally consistent with AEO 2010, although projections are not identical because IPM is a power sector model and has different treatment of key assumptions and variables.

*EIA. 2005 Residential Energy Consumption Survey. Table 3. http://www.eia.doe.gov/emeu/recs/recs2005/c&e/detailed_tables2005c&e.html.

New Generation Capacity (IPM)



- The IPM 2010 reference case includes a sizeable amount of new renewables expected to be built in the short-term in response to financial incentives in ARRA. Allowance prices encourage deployment of some additional low- or zero- carbon energy (including nuclear and renewables) by 2025.
- Early deployment funding (wires charges) and a bonus allowance provision for captured and sequestered CO_2 emissions result in a total of 15 GW of CCS capacity, of which 6 GW are new and 9 GW are retrofits. This is in addition to the 2 GW in the reference case.
  - The 6 GW of additional new capacity with CCS by 2025, were determined exogenously and forced in IPM to reflect early deployment funding. No additional new CCS capacity is built on an economic basis.
  - 9 GW of CCS retrofits to the existing coal fleet are also deployed, facilitated by the bonus and wires charges (retrofits to existing facilities are not reflected in the graphic). The total amount of retrofits meets IPM's CCS retrofit penetration limit (while the limit on new CCS capacity penetration is not reached).*
- In addition, 8 GW of nuclear capacity is built in 2025 attributable to the investment tax credit and other financial incentives for nuclear power. The increased amount for loan guarantees was not included in the modeling. The model would possibly have added more nuclear if it had been accounted for. The amount of new nuclear capacity is well below the combined nuclear/CCS penetration limit throughout the entire IPM modeling period.

Note: New capacity additions less that 1 GW of capacity are not indicated. IPM 2010 Reference Case is generally consistent with AEO 2010, although projections are not identical because IPM is a power sector model and has different treatment of key assumptions and variables.
* See appendix for more detail on EPA's technology penetration limits applied in IPM, post-retrofit capacity of CCS includes associated de-rating and/or energy use of CCS system.

Analysis of CCS Technology

- The CCS early deployment provisions, along with the bonus allowance provision for CCS, incentivize penetration of new coal capacity with CCS technology and retrofits of existing plants with CCS capacity.
  - New coal with CCS is projected to penetrate starting in 2015 in response to the bill's early deployment program and the financial incentives as part of the bonus. The amount of new coal with CCS in the policy scenario has been "hardwired" (or forced) to reflect the financial incentives of this bill.
  - Existing coal plants do not find it economic to retrofit with CCS without the CCS bonus and funding from the wires charges. This may be in part attributable to the additional incentives for nuclear power, with which CCS competes. When the CCS incentives are eliminated, more nuclear capacity is added relative to the core policy case.
- The CCS bonus provision is modeled as a fixed incentive in IPM. APA directs EPA to conduct a reverse auction to set the per-ton value of bonus allocations beyond the first 20 GW, which could potentially optimize the incentive necessary to spur additional deployment of CCS. The total bonus is set as a portion of all allowances, starting at 0.8% of allowances and rising to 10% through 2034.
- Provisions in APA provide incentives for CCS, nuclear power, and renewables simultaneously which may end up having unintended consequences. The combined effects of these multiple incentives may potentially act against each other, at least in the near-term. In addition, the cumulative impact of such incentives may distort the carbon price signal and raise the total cost of emissions abatement, especially where these incentives displace low-cost energy efficiency improvements. The consequences will have greater impact in the longer term, beyond the time period modeled in IPM.
- Because of considerable uncertainty regarding technology cost and performance, the reverse auction approach for CCS would help determine the appropriate incentive for the technology without over or under incentivizing.
- Cost assumptions are basically uniform nationwide in IPM, but in reality, there is likely to be more variability in risk profiles, capital costs, and transport/storage costs that would result in a wider range of CCS costs than IPM currently reflects.*

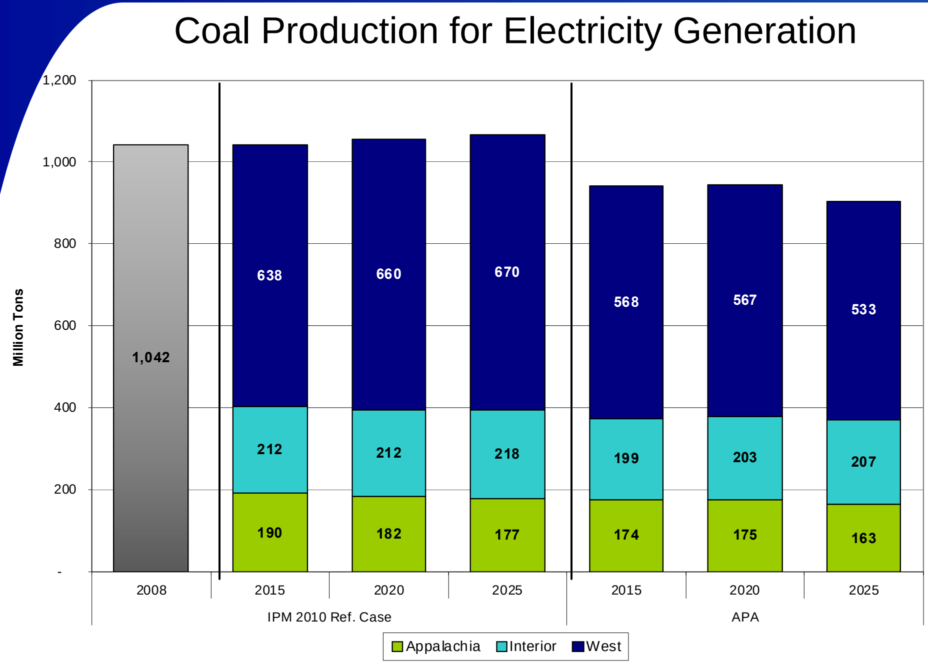
* The next version of the EPA reference case using IPM will reflect more regional variability for CCS costs, particularly transportation and storage costs, and updated capital costs. For more detail on the assumptions used in EPA's application of IPM, please see more detailed documentation for IPM at http://www.epa.gov/airmarkets/progsregs/epa-ipm/index.html.

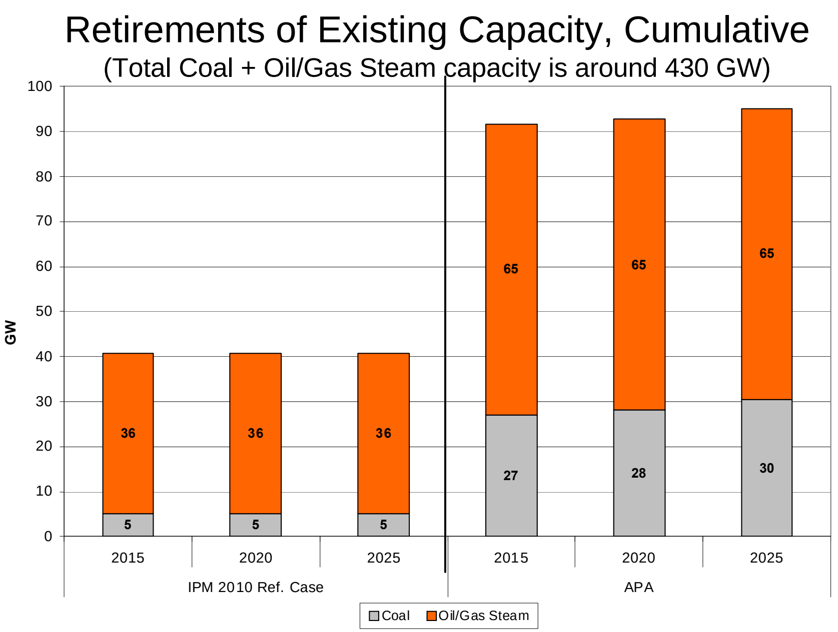
Effects of the Bonus Allowances

- **The bonus allowances for CCS has notable effects on markets**
  - Allowance prices are lower in scenarios that include bonus allowances because the bonus allowances encourage the use of CCS that would otherwise be uneconomic. The carbon reductions provided by these technologies allow the economy to reach a given emission cap at lower prices for carbon allowances.
  - The lower allowance prices, in turn, lead to lower electricity prices largely by limiting the effect of allowance costs on generation costs at fossil-fueled power plants.*
- **The bonus programs are not cost-free**
  - By giving the energy sector incentives to reduce carbon using uneconomic technologies, bonus allowances substitute high-cost for low-cost emission reductions. The net effect is to increase the costs of meeting a given cap.
  - By keeping electricity prices lower than they otherwise would have been, bonus allowances indirectly reduce consumers' incentives for saving energy. Without those energy-saving actions, the total cost of meeting a given emission cap is higher.
  - These inefficiencies lead to "deadweight losses" and are not factored in the power sector modeling.
- **The tendency of bonus allowances to drive up the total costs of meeting the cap could be mitigated or even reversed if the impact on the deployment of CCS led to lower costs for those technologies. That possibility, however, has not been modeled.**

* In competitive markets, lower allowance prices cut electricity prices by reducing marginal generation costs. In cost-of-service areas, lower costs for purchasing allowances keep average generation costs down, and those lower costs are passed on to consumers.

Coal Production for Electricity Generation & Retirements of Existing Capacity (IPM)

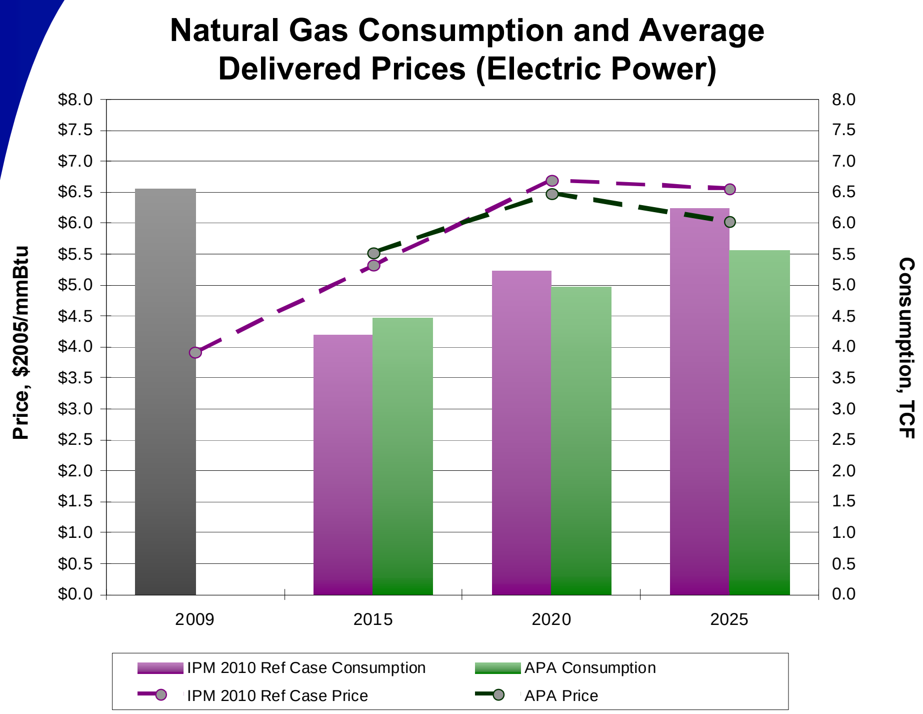




- Roughly 25 GW of additional existing coal capacity and 29 GW of additional oil/gas capacity are projected to retire under the policy scenario by 2025. Relatively low allowance prices and relatively high costs to build new technology make existing coal cost-competitive in the shorter-term.
- These results show greater amounts of coal and oil/gas steam retirements in the updated policy scenario. Electricity demand reductions achieved, in part, by the by the allowance price that represents the cost of emitting CO_2, the energy efficiency provisions, and incentives for CCS decrease the need for the less efficient existing stock of coal-fired power.
- In reality, uneconomic units may be "mothballed," retired, or kept running to ensure generation reliability. The model is unable to distinguish among these potential outcomes. Most of these are marginal units with low capacity factors.
- Most uneconomic units are part of larger plants that are expected to continue generating. Currently, there are roughly 115 GW of oil/gas steam capacity and 315 GW of coal capacity.

Note: Regional coal production data includes coal production for power generation only. Historical data is from EIA's AEO 2010. Coal production (in terms of tons) does not correlate to generation perfectly because different grades of coal have greater heat content (e.g. bituminous coal has greater heat content than sub-bituminous coal). In addition, coal production data shown here does not include coal imports, which increase over time in IPM. IPM 2010 Reference Case is generally consistent with AEO 2010, although projections are not identical because IPM is a power sector model and has different treatment of key assumptions and variables.

Power Sector Natural Gas Consumption and Prices (IPM)



		N. Gas Consumption and Prices			
		2009	2015	2020	2025
Nat. Gas Consumption (TCF)	Ref. Case	6.6	4.2	5.2	6.2
	APA		4.5	5.0	5.6
Nat. Gas Price, Delivered ($2005/mmBtu)	Ref. Case	$3.92	$5.32	$6.69	$6.56
	APA		$5.52	$6.48	$6.03

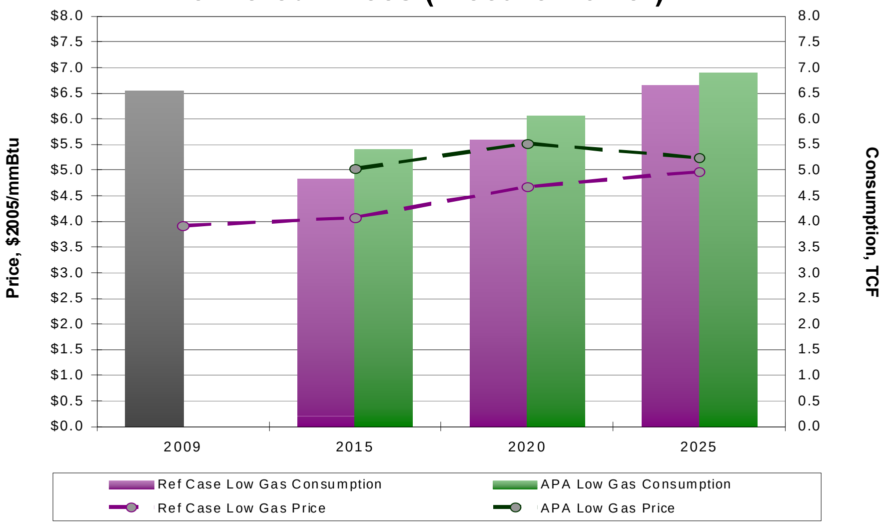
Lower natural gas prices are the result of decreases in natural gas demand in 2020 and 2025. This is due, in part, to the power sector's response to the emissions cap. Gas prices reflected here do not include the cost of CO_2 allowances.

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 the policy (the ADAGE model is the economy-wide model that EPA uses to reflect this dynamic). To the extent that natural gas demand increases (decreases) outside the power sector, the price impacts reflected here may be a bit lower (higher) than if the total demand for natural gas were reflected in IPM. Demand for natural gas in ADAGE is projected to decrease by 2% in 2015, 4% in 2020, and 8% in 2025. Note that ADAGE does not model the "Powering Vehicles with Natural Gas" provisions of the APA which may increase natural gas demand. ADAGE models the natural gas LDC allocation as mitigating the natural gas price increase for households but not for other natural gas consumers. If ADAGE were to model the natural gas LDC allocation as mitigating the price increase for all consumers, this would place an additional upward pressure on natural gas demand.

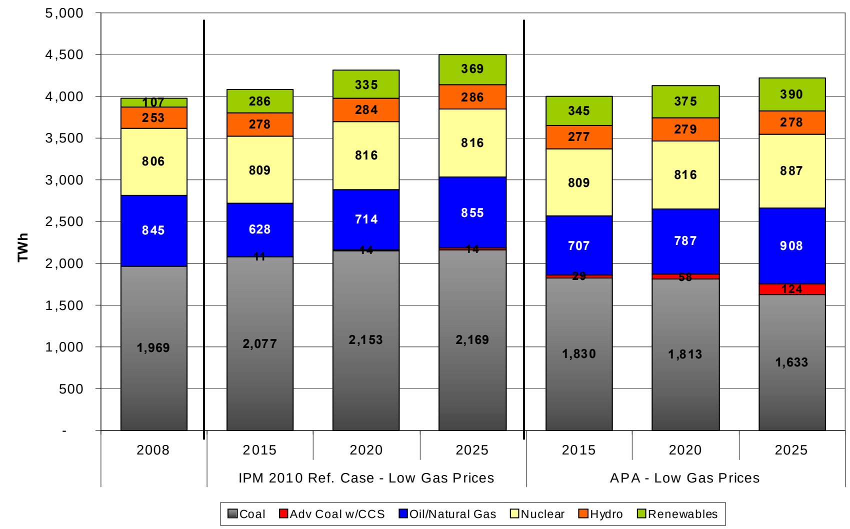
* Source of 2009 natural gas data is EIA Electric power Monthly Table 2.4.A. Total is for electric utilities and independent power producers only.

Sensitivity – Higher Natural Gas Supply

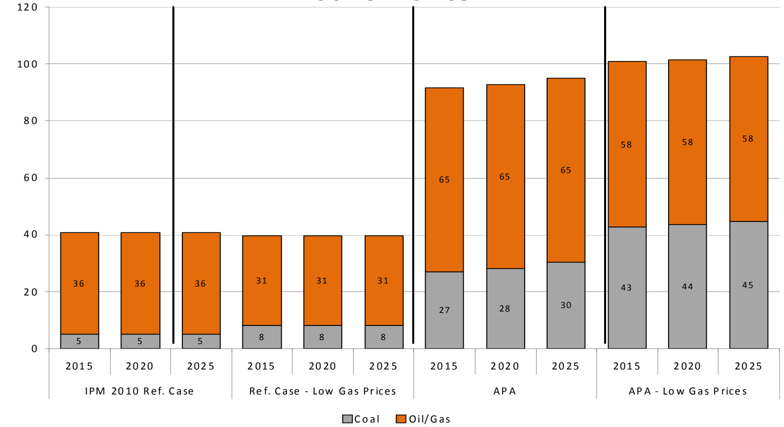
Natural Gas Consumption and Average N. Gas Delivered Prices (Electric Power)



Generation Mix



Retirements



- Recent projections of natural gas supply forecast a potentially significant increase in unconventional gas availability in the near-term.
- Greater supply and lower natural gas prices increase the use of natural gas throughout the entire period in the policy sensitivity, where in the past there were decreases in gas consumption. It also results in significantly less coal generation by 2025.
- There are more coal retirements and fewer oil/gas steam retirements relative to the policy scenario when natural gas prices are lowered.
- This sensitivity was modeled using the allowance price and demand response from ADAGE Scn. 2.

Offsets Usage & Limits

Offsets Sensitivities

Side Scenarios (IGEM)

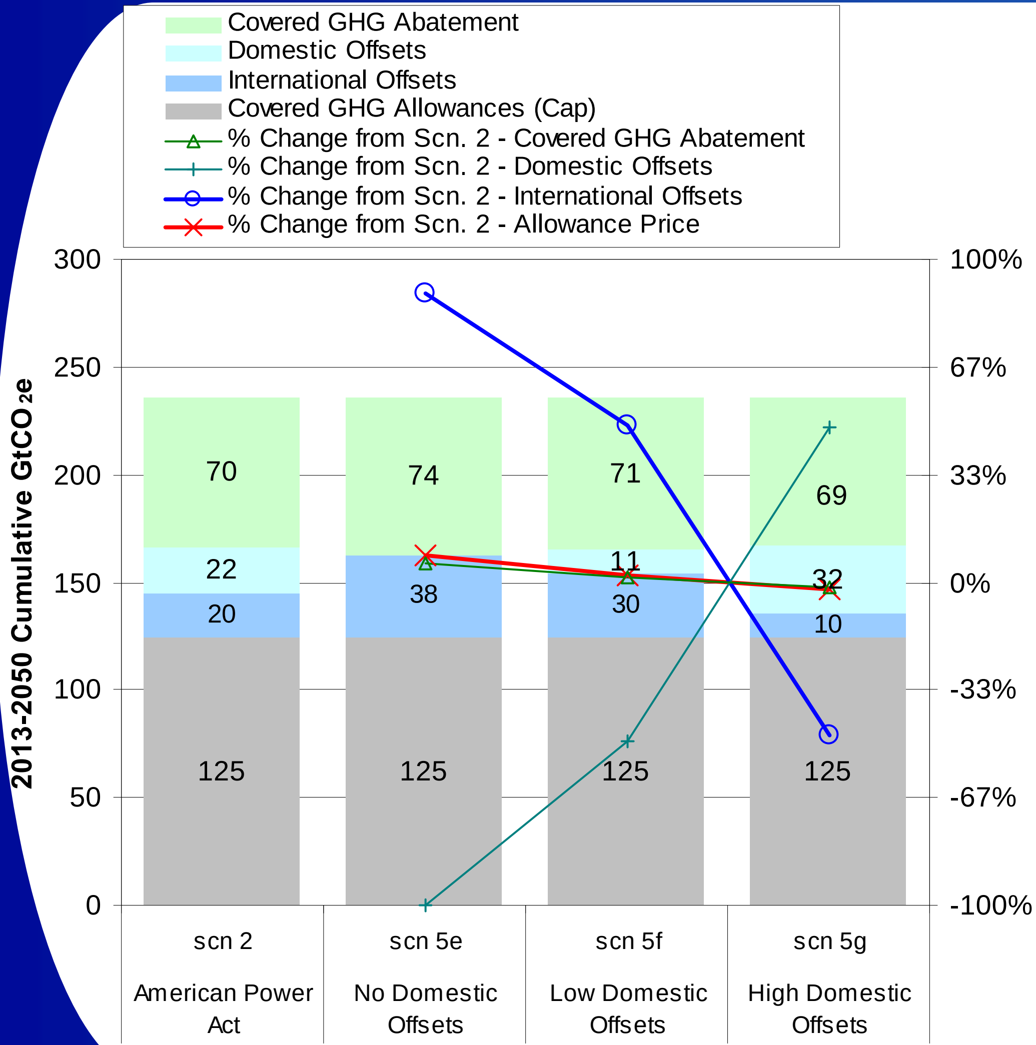
Several factors could influence the availability and price of domestic and international offsets. These factors include, but are not limited to, the structure of international offsets markets and timing for their establishment, the rules governing domestic offsets markets, and responses of domestic and international offsets providers. Several side scenarios are included here to further explore the relationship between offset supply, allowance price, and the quantity of abatement from covered sectors. A reduced form version of the IGEM model was used for these side scenarios. These scenarios can be compared to scenario 2, which places no restrictions on offsets beyond the overall limits on domestic and international offset usage included in the bill.

Side Scenarios

- **Scenario 5b – International Offsets Delayed 10 Years**
  - U.S. covered entities are not allowed to purchase international offsets for the first 10 years.
- **Scenario 5c – International Offsets Delayed 20 Years**
  - U.S. covered entities are not allowed to purchase international offsets for the first 20 years.
- **Scenario 5d – No International or Domestic Offsets**
  - U.S. covered entities are not allowed to use domestic or international offsets.
- **Scenario 5e – No Domestic Offsets**
  - U.S. covered entities are not allowed to use domestic offsets.
- **Scenario 5f – Low Domestic Offsets**
  - Domestic offset potential is reduced by 50%.
- **Scenario 5g – High Domestic Offsets**
  - Domestic offset potential is increased by 50%.

2013-2050 Cumulative Covered U.S. GHG Emissions & Abatement

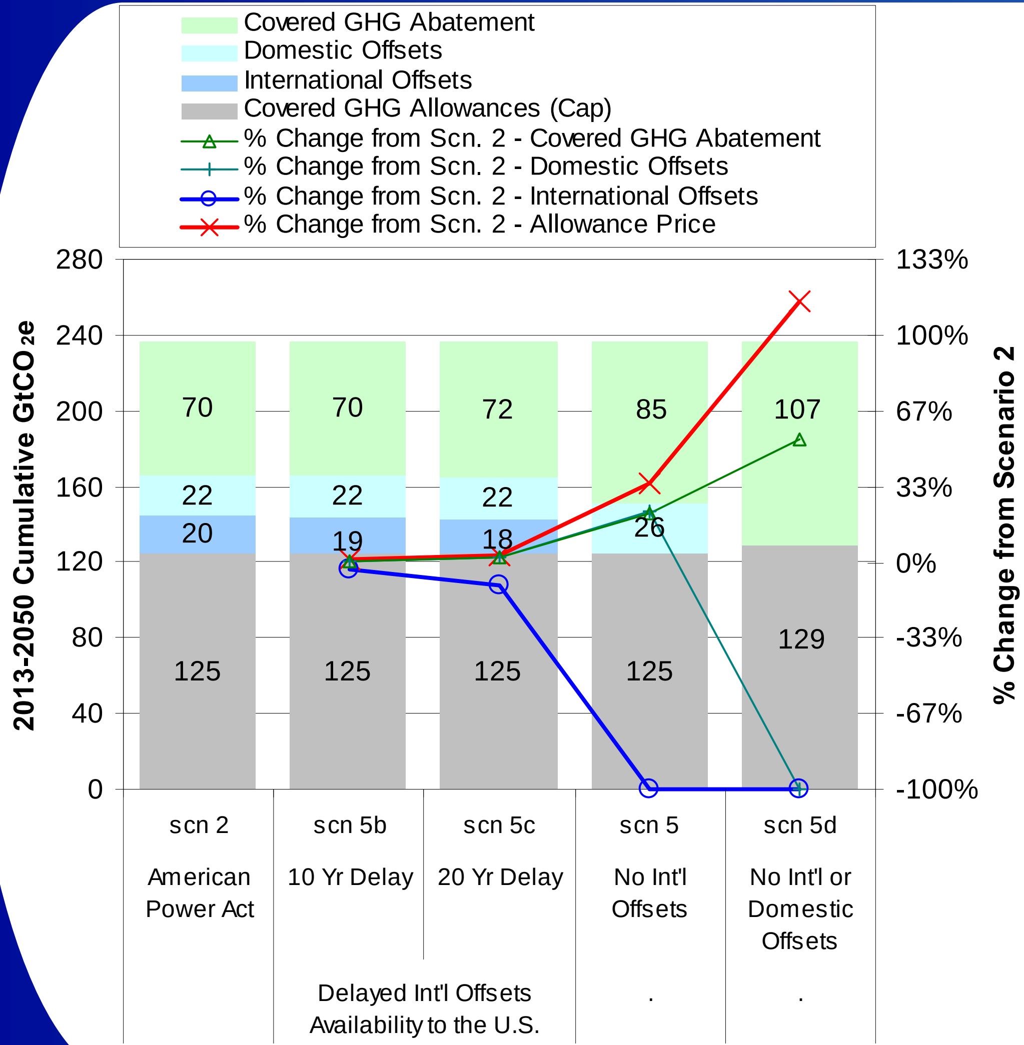
Domestic Offset Sensitivities (IGEM)



- Since the annual limit on the usage of international offsets is non-binding in scenario 2, sensitivities that would be expected to impact allowance prices (e.g. changes in the availability of domestic offsets) have a smaller impact than expected, because international offsets usage, and thus the amount of abatement within covered sectors, can change.
- Because of the possibility of banking, the cumulative number of offsets available over the entire time horizon drives how the availability of offsets influences allowance prices, not the particular time path of when that cumulative amount of offsets is available.
- The 1.5 $GtCO_2e$ annual limit on domestic offsets translates into a 57 $GtCO_2e$ limit on cumulative domestic offset usage over the entire 2013 – 2050 time frame.
  - In the core policy scenario, cumulative domestic offset usage is 22 $GtCO_2e$, or an average of 571 $MtCO_2e$ per year, and the limit is non-binding.
- The 0.5 $GtCO_2e$ annual limit on international offsets translates into a 19 GtCO2e limit on cumulative international offset usage over the entire 2013 – 2050 time frame
  - If the domestic offset limit is non-binding, the annual limit on international offsets can be increased by the difference between the domestic offset limit and actual domestic offset usage, up to a maximum adjusted limit of 1.0 $GtCO_2e$ of international offset usage. This adjusted annual limit on international offsets corresponds to a 38 $GtCO_2e$ cumulative limit on international offset usage.
  - In the core policy scenario, cumulative international offset usage is 20 $GtCO_2e$, or an average of 522 $GtCO_2e$ per year, and the adjusted limit is non-binding.
- When domestic offsets are not allowed, international offset usage increases 89% up to the adjusted limit, covered GHG abatement increases 6%, and the allowance price increases 8%
- If domestic offset potential is reduced 50%, then international offset usage increases 49%, covered GHG abatement increases 1%, and allowance prices increase 2%.
- If domestic offset potential is increased by 50%, then international offset usage falls by 48%, covered GHG abatement decreases 1%, and allowance prices decreases 2%.
- Scenarios 5e and 5f would show considerably different results in they were run using the ADAGE model, as scenario 2 in ADAGE uses close to the maximum amount of international offsets allowed, so reducing domestic offset availability would force greater amounts of covered GHG abatement, and have a larger impact on allowance prices.
- See Appendix 3 for a discussion of domestic offsets modeling.

2013-2050 Cumulative Covered U.S. GHG Emissions & Abatement

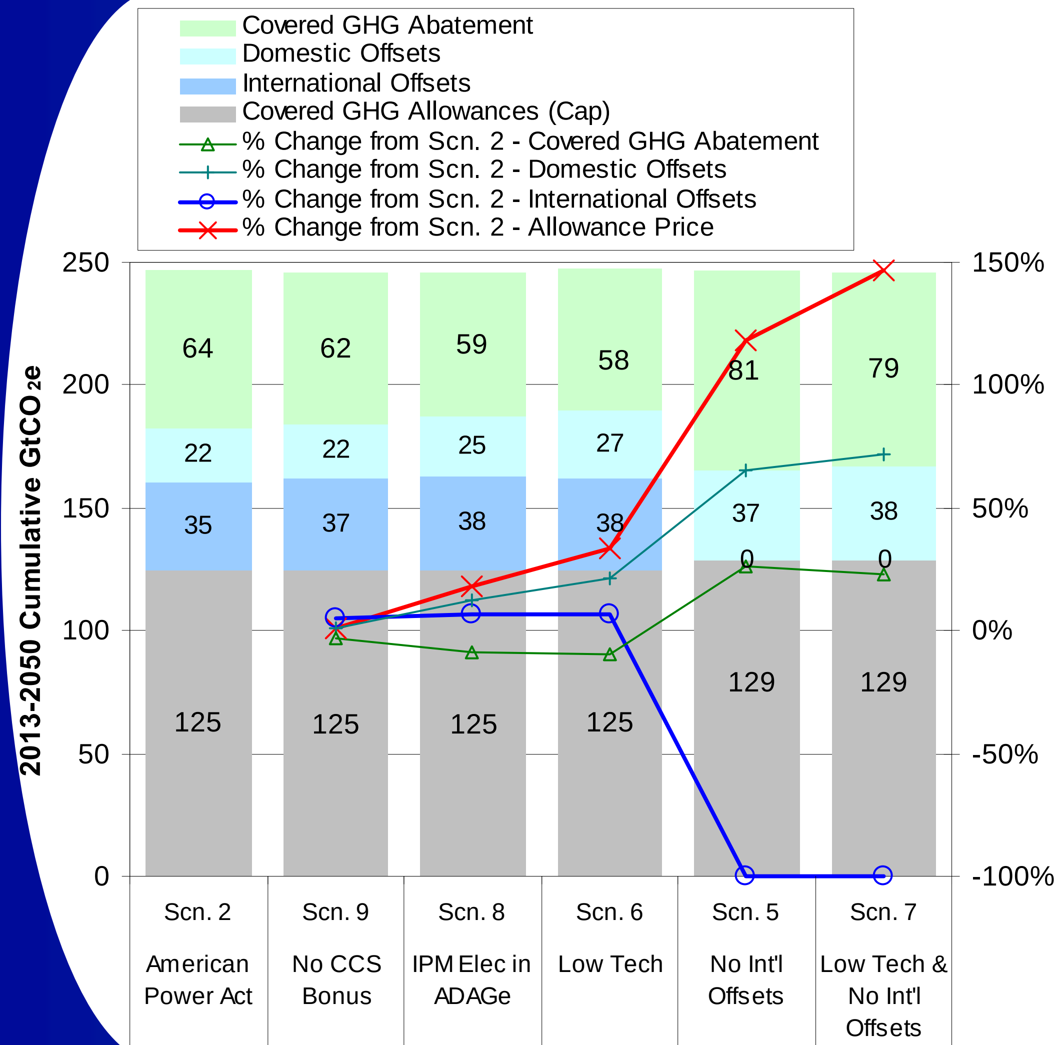
International Offset Sensitivities (IGEM)



- While the American Power Act clearly allows the usage of both domestic and international offsets, it is useful to examine scenarios where offsets are limited or not allowed in order to show the impact these provisions have on costs and sources of GHG abatement.
- In scenario 5d, where both domestic and international offsets are not allowed, covered GHG abatement is forced to increase 54%, and the allowance price increases 115%.
  - In this scenario, the price ceiling is exceeded, and the cumulative cap increases by 4 billion tons as reserve allowances are released through the cost containment reserve.
  - Because offsets are not allowed in this scenario, it is not possible to purchase offsets with the revenues from the sale of reserve allowances in order to refill the reserve, and the allowance price is thus able to exceed the price ceiling.
- In scenario 5, where international offsets are not allowed, domestic offset usage increases 22%, covered GHG abatement increases 22%, and the allowance price increases 34%.
- While eliminating all international offsets has a large impact on allowance prices, simply delaying international offset availability to the U.S. has a much more modest impact.
  - Delaying international offsets 10 years in scenario 5b decreases cumulative international offset usage by just 3% as international offset usage can be increased after the 10 year delay, and allowance prices only increase by 1%. A 20 year delay in scenario 5c reduces cumulative international offset usage 10% and increases allowance prices 3%. Note that these scenarios would have a greater impact on allowance prices in ADAGE, as international offset usage in later years could not increase in response to the limited availability in early years.
- Note that IGEM shows significantly less usage of international offsets than ADAGE in scenario 2, therefore, removing international offsets in scenario 5 has a much smaller impact on the IGEM allowance price than the ADAGE allowance price.
  - The reason ADAGE shows more international offsets usage is that domestic covered GHG abatement is more costly in ADAGE. This is partially due to the putty-clay capital representation in ADAGE compared to IGEM's perfectly mobile capital stock. Additionally, while reference case total GHG emissions are similar in ADAGE and IGEM, covered GHG emissions are higher in the ADAGE reference case compared to the IGEM reference case. This is in part due to the 5 year time steps in ADAGE and the representation of the coverage phase-in, compared to the annual time steps in IGEM.

2013-2050 Cumulative Covered U.S. GHG Emissions & Abatement

Technology and Offsets Sensitivities (ADAGE)



- In the core policy scenario, cumulative domestic offset usage is 22 $GtCO_2e$, or an average of 584 $MtCO_2e$ per year, and the limit is non-binding.
- In the core policy scenario, cumulative international offset usage is 35 $GtCO_2e$, or an average of 929 $MtCO_2e$ per year, and the adjusted limit on international offset usage is non-binding.
- In scenario 6, where nuclear and bioelectricity are held to reference levels and CCS is delayed, covered GHG abatement becomes more expensive and falls 10%, international offset usage increases 6% up to the adjusted limit, domestic offset usage increases 22%, and the allowance price increases 34%.
- In scenario 5, where international offsets are not allowed, domestic offset usage increases 65%, and covered GHG abatement increases 26% to make up for the lost international offsets, and allowance prices increase 118%.
  - In this scenario, the price ceiling is exceeded, and the cumulative cap increases by 4 billion tons as reserve allowances are released through the cost containment reserve.
  - While the price ceiling is exceeded, releasing the 4 billion reserve allowances does lessen the impact on allowance prices.
  - Because offsets are not allowed in this scenario, it is not possible to purchase offsets with the revenues from the sale of reserve allowances in order to refill the reserve, and the allowance price is thus able to exceed the price ceiling.
- In scenario 7, where nuclear and bioelectricity are held to reference levels and CCS is delayed, and where international offsets are not allowed, domestic offset usage increases 72%, and covered GHG abatement increases 23%, and allowance prices increase 146%.
  - As in scenario 5, the cap increase by 4 billion tons and the price ceiling is exceeded in this scenario.
- Imposing the IPM electricity sector emissions reductions in ADAGE in scenario 8 reduces covered GHG abatement by 8%, but increases international offset usage increases 7%, domestic offset usage by 12%, and allowance prices by 18%.
- Without CCS bonus allowances in scenario 9, covered GHG abatement falls by 3%, international offset usage increases 5%, domestic offset usage increases 1%, and allowance prices increase 1%.

Global Results:
Market for International GHG Abatement

Market for International GHG Abatement and International Offsets in APA

- International offsets are one of the most important cost containment features of both the House passed American Clean Energy and Security Act of 2009 (H.R. 2454) and the American Power Act.
- H.R. 2454 allows over one billion tons of international offsets annually, and the American Power Act allows up to one billion tons.
- Estimates of the cost and availability of international offsets are one of the most important factors determining estimates of the cost of these bills.
- Assumptions about the market for international offsets can have a major impact on the estimated costs of a bill.
- Assumptions about both the international reference GHG emissions path and about the policies adopted by other countries affect the international demand for GHG abatement.
  - Greater international demand for GHG abatement increases the cost of international GHG abatement, which in turn increases the cost of international offsets for the U.S., and increases domestic allowance prices.
  - Scenarios 3 and 4 explore the impacts of differing assumptions about developing country action, and scenario 2a looks at the effect of varying assumptions about international GHG emissions projections.
- Assumptions about GHG abatement potential (e.g. availability of REDD offsets, or amount of energy related CO_2 abatement potential), affects the international supply of GHG abatement.
  - Less international supply of GHG abatement increases the cost of international GHG abatement, which in turn increases the cost of international offsets for the U.S., and increases domestic allowance prices.
  - Scenarios 2b and 5a examine the impacts of differing assumptions about the supply of international GHG abatement.

Market for International GHG Abatement

Sensitivity Scenarios

Because the market for international GHG abatement has significant impacts on the U.S. use of international offsets, several side scenarios are included here to further explore the relationship between international GHG supply and demand, and the market for allowances under the APA. A reduced form version of the IGEM model was used for these side scenarios. These scenarios can be compared to scenario 2, which places no restrictions on offsets beyond those in the bill.

Additional sensitivities using the reduced form IGEM model:

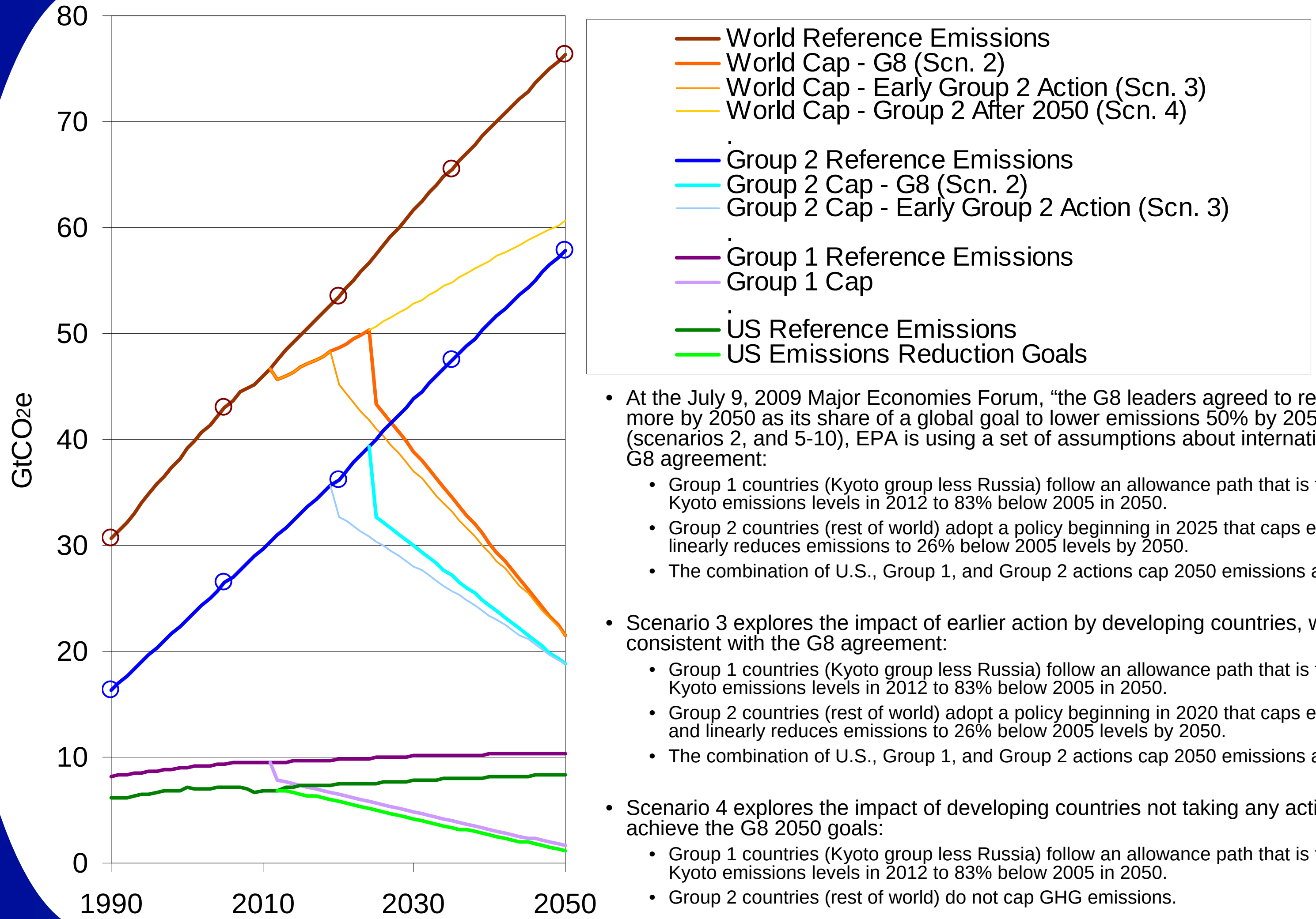
- **Scenario 2a – Slower International Reference Emissions Growth (CCSP Reference)**
  - For the purpose of analyzing the international offset market, international reference emissions are based on the CCSP SAP 2.1a GCAM reference scenario, instead of the GCAM Energy Modeling Forum 22 reference scenario used in other scenarios in this analysis.

- **Scenario 2b – Less International CO_2 Abatement Potential (CCSP MACs)**
  - For the purpose of analyzing the international offset market, international energy related CO_2 marginal abatement cost curves are generated by the CCSP SAP 2.1a era GCAM model, instead of the Energy Modeling Forum 22 era GCAM model used to generate the international energy related CO_2 MAC curves used for other scenarios in this analysis.

- **Scenario 2c – Slower International Reference Emissions Growth & Less International CO_2 Abatement Potential (CCSP Reference & MACs)**
  - For the purpose of analyzing the international offset market, international reference emissions are based on the CCSP SAP 2.1a GCAM reference scenario, instead of the GCAM Energy Modeling Forum 22 reference scenario used in other scenarios in this analysis.
  - For the purpose of analyzing the international offset market, international reference emissions are based on the CCSP SAP 2.1a GCAM reference scenario, instead of the GCAM Energy Modeling Forum 22 reference scenario used in other scenarios in this analysis.

- **Scenario 5a –No International REDD Offsets**
  - No reduced emissions from deforestation and degradation (REDD) offsets for the U.S. or for any other country.

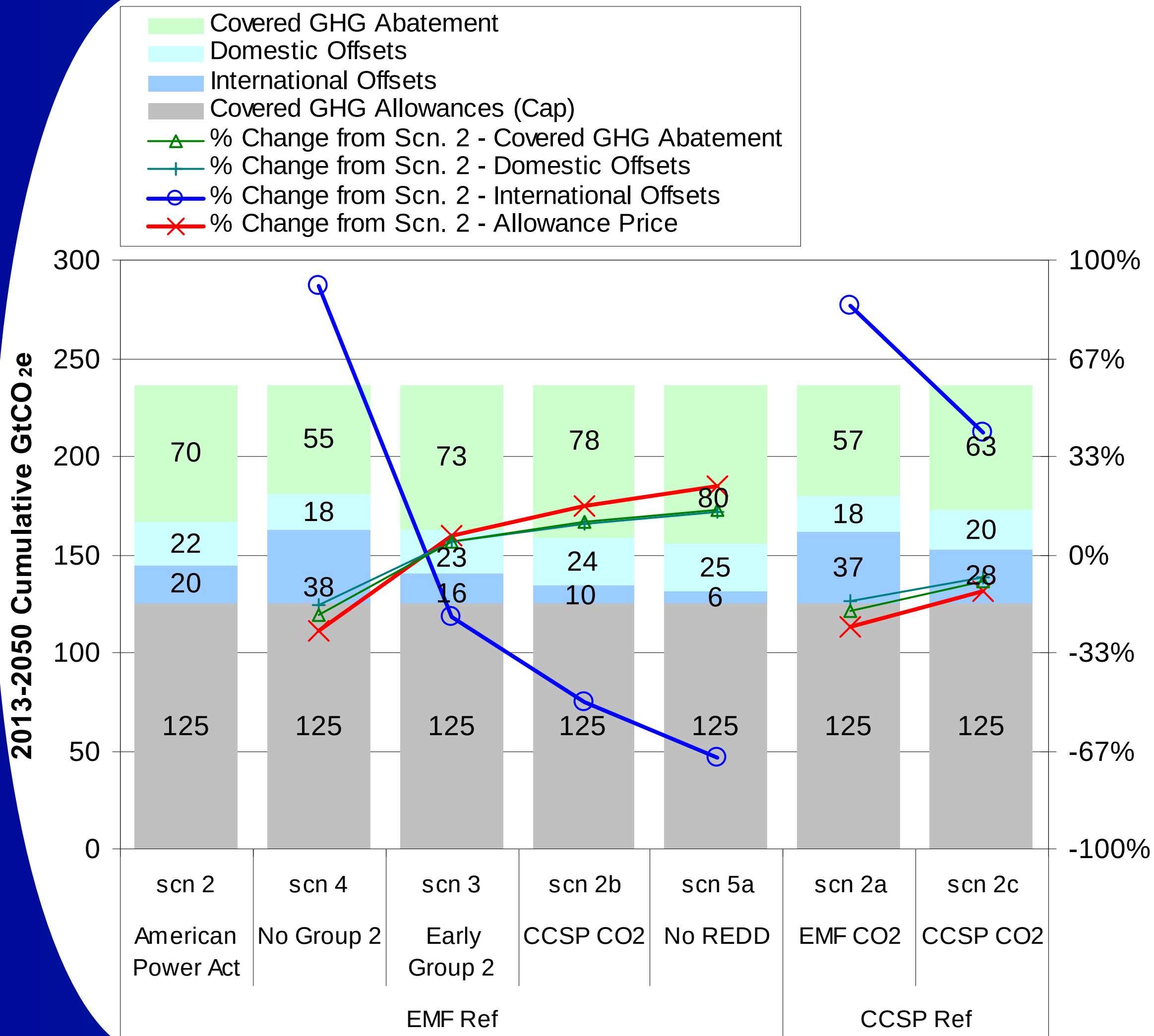
International GHG Reference Emissions & Climate Policy Assumptions



- At the July 9, 2009 Major Economies Forum, "the G8 leaders agreed to reduce their emissions 80% or more by 2050 as its share of a global goal to lower emissions 50% by 2050." For this analysis (scenarios 2, and 5-10), EPA is using a set of assumptions about international action consistent with the G8 agreement:
  - Group 1 countries (Kyoto group less Russia) follow an allowance path that is falling linearly from the simulated Kyoto emissions levels in 2012 to 83% below 2005 in 2050.
  - Group 2 countries (rest of world) adopt a policy beginning in 2025 that caps emissions at 2015 levels, and linearly reduces emissions to 26% below 2005 levels by 2050.
  - The combination of U.S., Group 1, and Group 2 actions cap 2050 emissions at 50% below 2005 levels.
- Scenario 3 explores the impact of earlier action by developing countries, with a 2050 target that is consistent with the G8 agreement:
  - Group 1 countries (Kyoto group less Russia) follow an allowance path that is falling linearly from the simulated Kyoto emissions levels in 2012 to 83% below 2005 in 2050.
  - Group 2 countries (rest of world) adopt a policy beginning in 2020 that caps emissions 15% below BAU levels, and linearly reduces emissions to 26% below 2005 levels by 2050.
  - The combination of U.S., Group 1, and Group 2 actions cap 2050 emissions at 50% below 2005 levels.
- Scenario 4 explores the impact of developing countries not taking any action, resulting in a failure to achieve the G8 2050 goals:
  - Group 1 countries (Kyoto group less Russia) follow an allowance path that is falling linearly from the simulated Kyoto emissions levels in 2012 to 83% below 2005 in 2050.
  - Group 2 countries (rest of world) do not cap GHG emissions.

2013-2050 Cumulative Covered U.S. GHG Emissions & Abatement

International GHG Abatement Demand and Supply Sensitivities (IGEM)

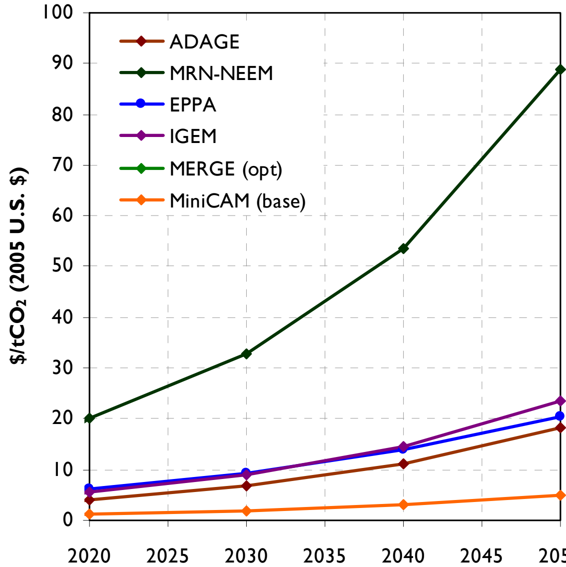


- This figure shows how varying assumptions about international policy, reference emissions, and abatement potential affect the supply and demand for international GHG abatement, having large impacts on both how the U.S. meets the APA GHG emissions caps and on the price of allowances in the U.S.
- In scenario 4, as developing countries do not adopt climate policies, the price of international offsets falls. Subsequently, the U.S. increases international offset usage up to the limit, domestic offset usage and covered GHG abatement fall, and domestic allowance prices fall.
- In scenario 3, as developing countries adopt policy in 2020 instead of in 2025, demand for international GHG abatement increases. Subsequently, the U.S. uses 21% fewer international offsets (whose price has risen). Domestic offset usage and covered GHG abatement increase 4% and 5% respectively. Allowance prices increase by 7%.
- In scenario 2b, with less international energy related CO_2 abatement potential, international offset usage falls 50%, increasing the need for domestic abatement and increasing allowance prices 16%.
- In scenario 5a, as REDD offsets are not available globally, international offset usage falls 69%, domestic allowance prices increasing by 23%.
  - A situation in which domestic forestry offsets are available but international forestry offsets are not could result in leakage of emissions abroad as agricultural activities and forest clearing shifts from the U.S. to Group 2 countries. In addition, limitations on international or domestic forestry offsets could result in unaccounted emissions due to the expansion of bioenergy production because combustion of renewable biomass is exempt from submitting emission allowances. The IGEM results do not account for the impact of these potential sources of leakage on global CO2 emissions in limited or unavailable offsets scenarios.
- Because reference GHG emissions for developing countries are growing more slowly in scenario 2a, those countries must abate less to meet their caps. This lower demand for GHG abatement internationally decreases the price of international offsets, increasing their usage 85%, and decreasing allowance prices 24%.
- Finally, scenario 2c shows the results of using both the lower international emissions growth and the lower international energy related CO2 abatement potential from the CCSP era GCAM model that were used for previous EPA analyses of H.R. 2454. International offset usage increases by 41%, and allowance prices fall by 12%.

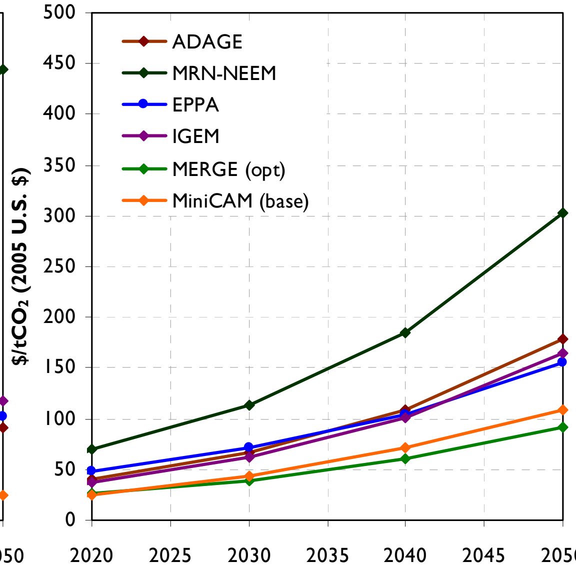
Literature Review
& Near Term Incidence Analysis

Comparing Costs of Three Possible U.S. Emissions Targets through 2050 (EMF 22)

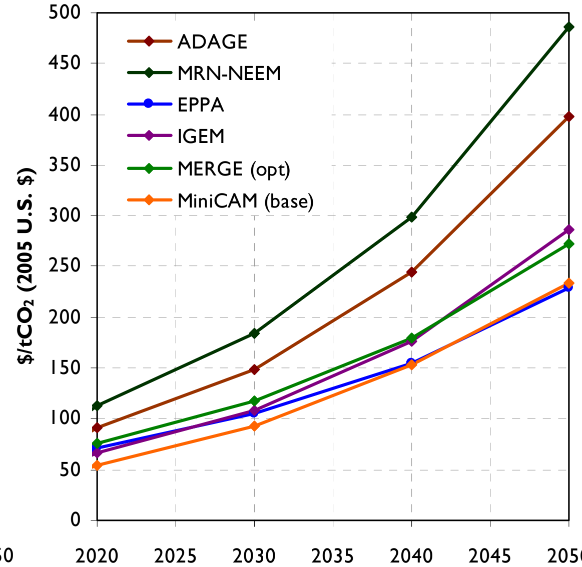
To put the EPA models (ADAGE and IGEM) in context, we compare the results of the Energy Modeling Forum (EMF) 22 analysis (Fawcett, et al. 2009) of three emission goals that span a wide range of possible U.S. 2050 targets. Caps are based on CO_2-equivalents (CO_2-e), covering all Kyoto gases. These scenarios were not intended to represent any specific bill, and no domestic or international offsets are allowed. Domestic emissions (before subtracting abatement from offsets) under the American Power Act would fall between the 203 and 287 $GtCO_2e$ cases.



287 $GtCO_2$-e



203 $GtCO_2$-e



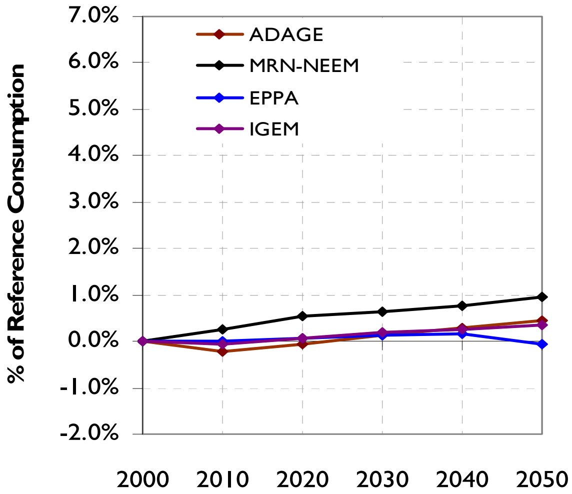
167 $GtCO_2$-e

- 287 $GtCO_2e$: ADAGE, IGEM and EPPA predict a similar rise in allowance prices. The cost of allowances rises from approximately $4 to $6 per ton in 2020 to $20 to $25 in 2050. However MiniCAM predicts only a small increase in allowance prices ($1 to $5), while MRN-NEEM predicts allowance prices will rise from $20 in 2020 to nearly $90 in 2050.
- 203 $GtCO_2e$: The models predict allowance prices in 2020 that range from $25 to $70 and that allowance prices grow to a range of $90 to $300 in 2050.
- 167 $GtCO_2e$: The models predict allowance prices in 2020 that range from $55 to $115 and that allowance prices grow to a range of $230 to $485 in 2050

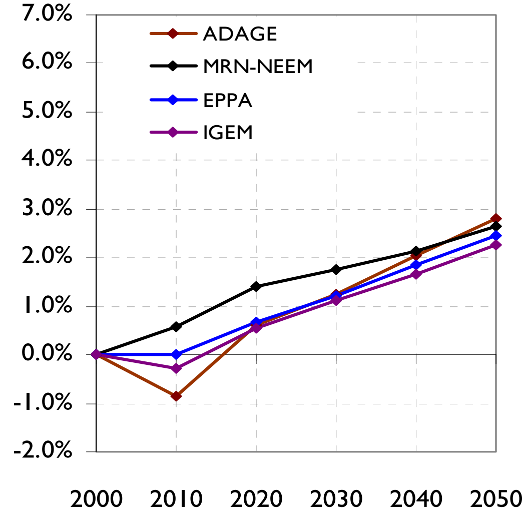
Comparing Costs of Three Possible U.S. Emissions Targets through 2050 (EMF 22)

Changes in consumption approximate changes in consumer welfare

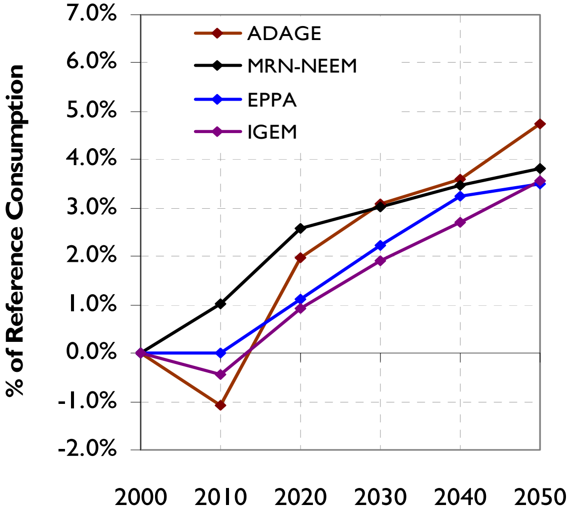
Annual Consumption Losses across Scenarios



287 $GtCO_2$-e



203 $GtCO_2$-e

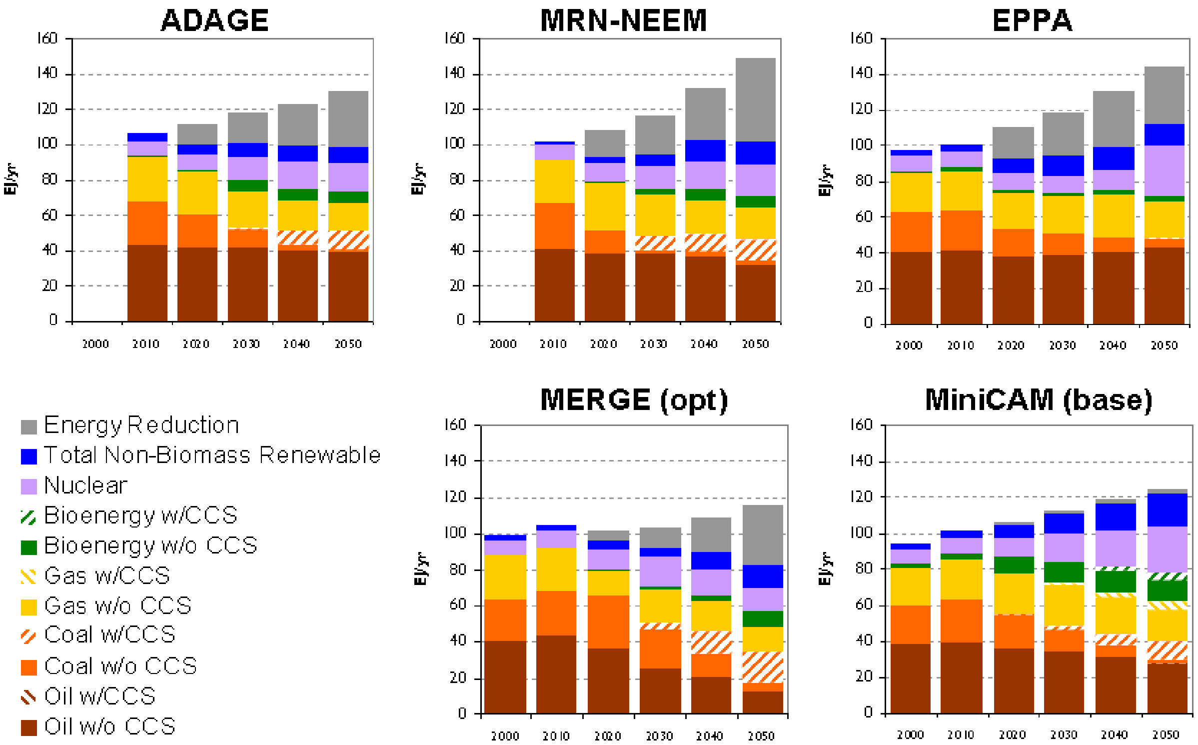


167 $GtCO_2$-e

- 287 $GtCO_2e$: Annual consumption losses remain below 1% for all models through 2050.
- 203 $GtCO_2e$: Annual consumption losses are all 1.4% or below in 2020 and rise to between 2.25% to 2.8% in 2050.
- 167 $GtCO_2e$: Annual consumption losses are between 1% and 2.6% in 2020 and rise to between 3.5% to 4.75% in 2050.

Comparing Primary Energy Use through 2050 in the EMF 22 Models

Primary Energy Usage – EMF-22 203 $GtCO_2e$ Scenario



- Under the 203 $GtCO_2e$ EMF-22 policy scenario, all models show reductions in primary energy from the reference scenario. In one model (MiniCAM), the reduction in energy consumption is small, representing less than 2% of reference energy consumption in all periods. The other models show a more substantial reduction, ranging in 2030 from 14% of reference energy in ADAGE to 21% of reference energy in EPPA.
- These reductions in energy capture both efficiency improvements and reductions in energy services. The degree to which a model exhibits a reduction in energy use depends on its technology availability and consumer response in terms of willingness to reduce energy-consuming activities. The inclusion of more advanced end-use technologies in particular can result in reduced energy consumption, as consumers switch to more efficient technologies to meet the same level of service.

- Imposing a climate policy not only changes total primary energy consumption, but also the energy supply mix. All of the five models that include nuclear energy, bioenergy, and non-biomass renewables show increased use of these fuels under a policy. All of the models include CO_2 capture and storage as a means of reducing the emissions associated with fossil fuels but the degree to which it is used varies widely. In the EPPA model it enters only in the final period at a very low level. In other models, it enters as early as 2030. Low-carbon sources (fossil fuels with CCS, bioenergy, nuclear, and non-biomass renewables) account for between 39% (EPPA) and 62% (MERGE) of total primary energy supply in 2050 in the 203 $GtCO_2e$ scenario. In contrast, these technologies accounted for between 12% (ADAGE, MRN-NEEM) and 28% (MiniCAM) of total primary energy supply in 2050 in the reference scenario.

Comparing Costs of Three Possible U.S. Emissions Targets through 2050 (EMF 22)

- **Different Models, Different Baselines and Assumptions**

	EPA	MIT	CRA	EPRI	PNNL
Model	ADAGE,IGEM	EPPA	MRN-NEEM	MERGE	MiniCAM
Baseline Used for EMF 22	AEO 2008 Early Release*	AEO 2009 Early Release	AEO 2008 Early Release	Own baseline	Own baseline
Nuclear Assumptions	Capacity grows at 150% 2005 levels	Not permitted to expand in the base case (Advanced Nuclear available in 2020)	Capacity limited but growing over time (3 GW in 2015; 100 GW in 2050)	New capacity in 2020: capacity limited but growing over time subject to uranium supply constraints	Soft constraints in 2020; after 2020 allowed to grow unconstrained (Advanced nuclear case)
CCS Assumptions	Available in 2020	Available in 2020	Available in 2015 but with capacity limits	Available in 2020; allowed to triple each decade	Available in 2020

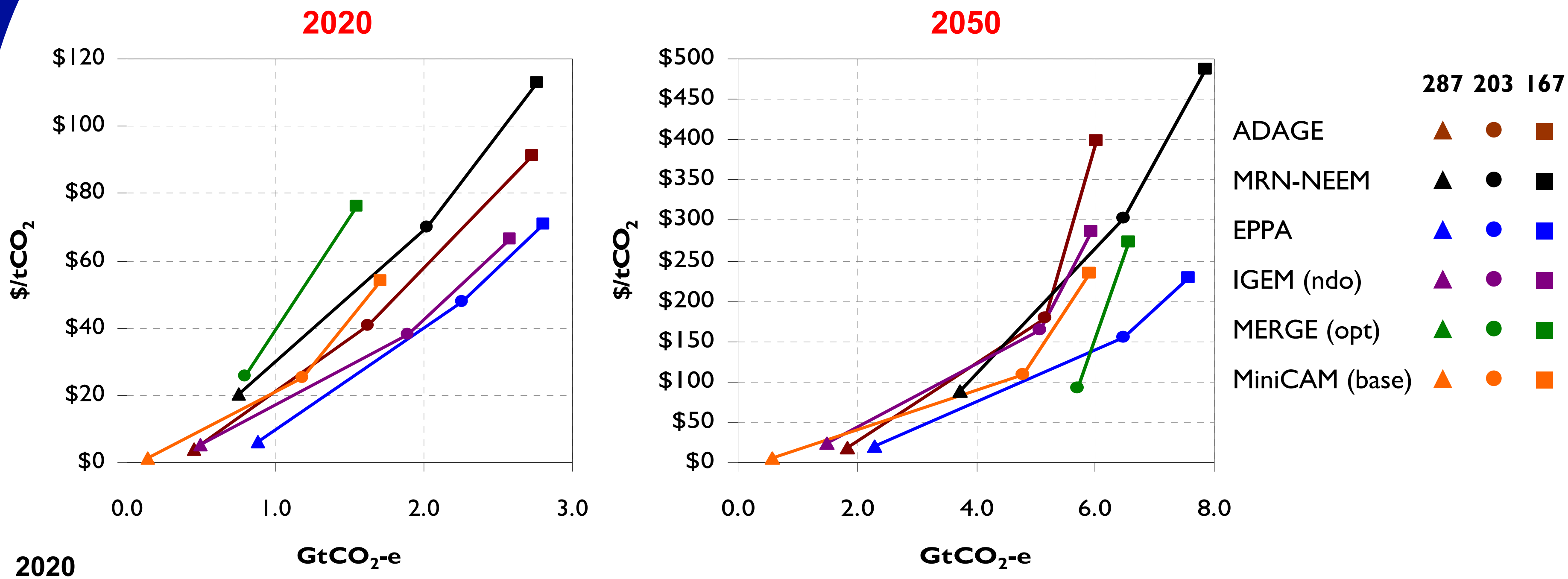
*** AEO 2008 Early release was used by the EPA models for EMF-22. The baseline in EPA's analysis of the American Power Act is AEO 2010.**

Common messages from the models

- The majority of the cost-effective reductions come from the electricity sector.
- Greater technical availability and lower costs for both nuclear power and CCS reduce the cost of reaching the GHG emissions caps.

Comparing Costs of Three Possible U.S. Emissions Targets through 2050 (EMF 22)

Marginal Abatement Cost Functions (MACs) in 2020 and 2050



2020

- All models, except MERGE, require abatement of less than 1 $GtCO_2$-e to reach 287 bmt – MACs range from $1-$6, except for NEEM, which reaches $20.
- All models require abatement between 0.8-2.25 GtCO2-e to reach the 203 bmt – MACs range from $25-$70.
- All models, except MERGE and MiniCAM, require abatement between 1.55-2.8 GtCO2-e to reach 167 bmt – MACs range from $55-$113.

2050

- All models, except MERGE, require abatement between 0.6-3.75 GtCO2-e to reach 287 bmt – MACs range from $5-$25, except NEEM which reaches $90.
- All models require abatement between 4.8-6.5 GtCO2-e to reach 203 bmt – MACs range from $90-$180, except NEEM, which reaches $300.
- All models require 6-8 GtCO2-e to reach 167 bmt – MACs range from $230-$485..

Household Distributional Issues

- The ADAGE and IGEM models assume a single representative agent household. To determine the near term cost of the APA across households in different income brackets, we conduct a separate incidence modeling exercise that is calibrated to ADAGE results.

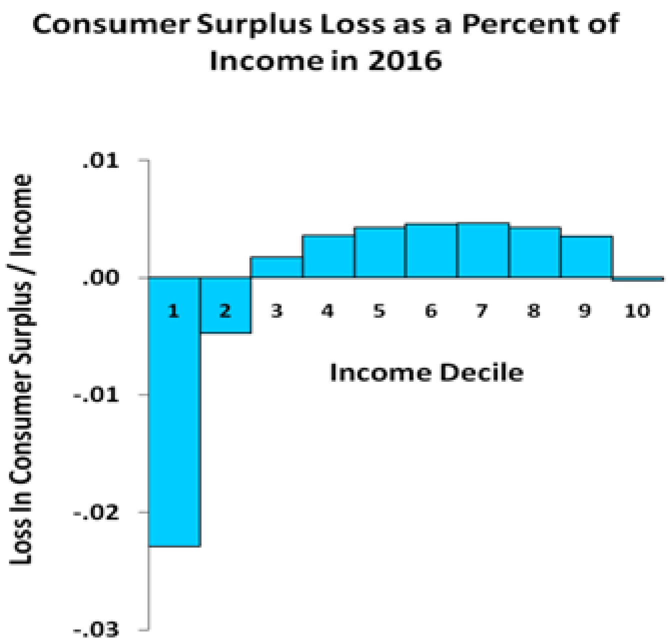
- To put these results in context, we first briefly review the findings of studies that account for the distribution of the costs of a cap-and-trade program across households in different income categories (Dinan and Lim Rogers 2002; Rose and Oladosu 2002; CBO 2003; Parry 2004; Metcalf 2009).
  - A GHG cap-and-trade policy increases the price of energy-intensive goods and direct energy expenditures to the extent that the energy used results in relatively high GHG emissions. The increase in price creates an incentive for more efficient use of such energy and development and use of energy technology and sources that emit less or no GHGs. The majority of this price increase is ultimately passed onto consumers.
  - Before accounting for how allowances are allocated or auction revenues are distributed, lower income households are disproportionally affected because they spend a higher fraction of their incomes on energy-intensive goods and direct energy expenditures.
  - The way the value of allowances is allocated affects the distribution of the cost of the policy. If allowances are auctioned, the auction revenue can be used to influence the distribution of costs.
  - Providing allowances gratis (i.e., grandfathering) to firms that operate in competitive markets tends to be very regressive. This is because the value of these allowances flows to households in the form of increased equity value or capital gains. These assets are held primarily by high-income households.
    - Higher income households may even be better off with a GHG policy if this allocation method is used.
  - If the allowances are auctioned and the revenues are redistributed by lowering payroll or corporate taxes, the policy tends to be less regressive than when allowances are grandfathered.
    - Reducing distortionary taxes also reduces the overall cost of the cap-and-trade policy (Fullerton 2009).
  - However, lowering payroll or corporate taxes is more regressive than when the auction revenues are distributed in equal lump-sum rebates to households. Distributing the revenues lump sum to households is often the least regressive cap-and-trade policy analyzed and is usually shown to be progressive.
    - But by providing lump-sum compensation rather than reducing distortionary taxes the overall cost of the cap-and-trade policy is higher.

Household Distributional Issues

- Some cap-and-trade approaches use allowance value to mitigate increases in the prices of certain goods. For example, some approaches return allowance value to consumers through local distribution companies (LDC) based on how much electricity or fuel they consume.
  – The overall distributional impacts of these policies are not always clear. These approaches may increase the overall cost of the policy because they require greater emission reductions by other sectors of the economy, which in turn leads to higher prices of other goods.
  – The direct effect of preventing electricity and fuel prices from rising will likely benefit lower income households more than higher income households, but the incidence of the indirect effect (higher prices for other energy-intensive goods) may counter the direct effect to some extent.
- Recent studies show how the distribution of the cost of a cap-and-program differs across regions given alternative methods of distributing allowance value (Burtraw et al. 2009, Hassett et al. 2009).
  – For instance, a cap-and- (taxable) dividend policy that results in a ~$21/metric ton CO_2 price is estimated to result in an average welfare gain of 2.7% for the households with incomes in the lowest 20th percentile nationally. However, regionally this varies from 1.1% to 3.8%.
  – Regional differences result from differences in pre-existing policies, levels of goods consumed, pricing of electricity, and the inputs used to produce goods (e.g. coal, natural gas).
- There are important caveats to the findings of climate policy incidence studies:
  – Most use annual household expenditures as a proxy for income. When a wealth measure is used instead, the distributional difference between low and high income households is less pronounced (Dinan and Lim Rogers 2002; CBO 2003). However, lower income households are still disproportionately impacted by the direct increase in goods prices relative to higher income households.
  – They typically do not consider the distribution of the benefits of reducing emissions.
  – They do not consider how expenditure patterns and demand for energy goods may change over time as a result of the policy.
  – They do not always consider the effect of the policy on the prices of non-energy goods.
- Regressivity and progressivity are normative concepts that do not have commonly agreed upon definitions.
  – In this discussion we refer to a progressive policy as one where the net cost of the policy as a percentage of income is lower for poorer households than it is for wealthier households. A regressive policy would have higher cost as a percentage of income for low income households. This is a common approach to evaluating the incidence of climate policy in the economics literature (e.g. Metcalf 2009 and Hassett et al. 2009).

Near Term Incidence Analysis

Scenario 2



Income Decile	Average Income (2005$)	Loss in Consumer Surplus Per Household in 2016 (2005$)
1 (lowest)	$6,900	-$158
2	$14,900	-$71
3	$22,200	$39
4	$29,700	$106
5	$37,900	$163
6	$47,500	$217
7	$58,900	$274
8	$74,000	$318
9	$97,200	$340
10 (highest)	$174,500	-$39
Average	$56,400	$119

- This graphic and table report the estimated cost in 2016 of the APA per household in ten income classes using an incidence model and methodology adapted from Burtraw et al. (2009). The allowance and electricity prices used in the incidence model come from Scenario 2 ADAGE results. The price changes for energy goods consumed by households and producers are estimated using the carbon content of the fuel and allowance price. The indirect price increases of other final goods are estimated based on the share of energy inputs used to produce them. The welfare cost in the incidence model is calibrated to the abatement cost forecast by ADAGE.
- The height of each blue bar shows the welfare cost (loss in consumer surplus) in 2016 as a percentage of household income, accounting for the distribution of the entire value of allowances to households. Households are grouped by income decile. Average household income increases moving to the right along the horizontal axis. The table provides the value of these losses in 2005$. The average household income in the table is for the period 2004 to 2008.
- The incidence model is intended to reflect detailed demographic differences across the population based on recent year consumer expenditure survey data. Focusing on a near term year, 2016, the first year that all provisions of the legislation take effect, preserves the underlying characteristics of the population sample in the data.
- The next slide reports the way the allowance value is assumed to be allocated in this analysis.

Note: EPA's January 29, 2010 "Supplemental Analysis of H.R. 2454" contained a similar incidence analysis (slide 70). However, the analyses are not comparable because of several changes to the underlying data and methodology between this analysis and the January analysis.

Near Term Incidence Analysis

Treatment of Allowance Value

Disposition of Allowance Value*	Share of 2016 Allowance Value	Treatment in Incidence Model	Treatment in ADAGE
Electricity Consumers (LDC)	30.00%	Effect on electricity prices and abatement behavior taken from ADAGE results.	Subsidy to household electricity consumption.
Merchant Coal	3.50%	Provided as shareholder dividend.	Lump-sum rebate to representative household.
Long Term Contract Generators	1.50%	Provided as shareholder dividend.	Lump-sum rebate to representative household.
Natural Gas Consumers (LDC)	7.20%	Abatement behavior of households reflected in ADAGE results. Allowance value used to reduce households burden proportional to their non direct electricity initial welfare losses.	Subsidy to household natural gas consumption.
Natural Gas Consumers (EE)	1.80%	Effect of lower demand and fuel prices captured by calibrating to ADAGE results.	Creates lower demand for natural gas.
Home Heating Oil & Propane Consumers (LDC and EE)	1.50%	Lump-sum non-taxable per-capita rebate.	Lump-sum rebate to representative household.
Trade-Exposed Industries	15.00%	Reflected in equilibrium abatement behavior in ADAGE.	Remove direct cost of holding allowances and indirect electricity price signal through rebate for allowances held and electricity price increases.
Refiners	3.75%	Provided as shareholder dividend	Lump-sum rebate to representative household.
Energy Refund	6.59%	Rebate to households with incomes below 150% of poverty line accounting for household size and loss in purchasing power. Up to 9.78% allocated for use, but not all is needed. Excess to deficit reduction.	Lump-sum rebate to representative household.
Working Families Relief	2.50%	Rebate to households with incomes $1,000 below 150% of poverty line to 250% of poverty line, with household size adjustment and phase out beginning at incomes $2,000 below 250% of poverty line.	Lump-sum rebate to representative household.
Clean Energy Technology Research and Development	2.00%	Lump-sum non-taxable per-capita rebate.	Lump-sum rebate to representative household.
Clean Vehicle Technology	1.00%	Lump-sum non-taxable per-capita rebate.	Lump-sum rebate to representative household.
Industrial Technologies Research and Development	1.00%	Lump-sum non-taxable per-capita rebate.	Lump-sum rebate to representative household.
State Energy Efficiency and Renewables	2.00%	Reflected in equilibrium abatement behavior in ADAGE.	Creates lower demand for energy goods.
Highway Trust Fund	3.07%	Lump-sum non-taxable per-capita rebate.	Lump-sum rebate to representative household.
TIGER Grants	2.30%	Lump-sum non-taxable per-capita rebate.	Lump-sum rebate to representative household.
CLEAN TEA	2.30%	Lump-sum non-taxable per-capita rebate.	Lump-sum rebate to representative household.
Cost Containment	1.50%	Not allocated.	Not allocated.
Deficit Reduction Fund	11.60%	6.81%: Share that is from direct allocation to deficit reduction and is presumably required for deficit neutrality. It is not allocated in the incidence model. 1.53%: Share that is the unused amount of the transportation infrastructure and efficiency set aside which is the amount in excess of the maximum dollar amount that can be allocated to these programs. It is not allocated in the incidence model. 3.21%: Share that is the unused allowance value from the Energy Refund and Working Families Relief program set-aside. This value is returned to households as a proportional income tax reduction.	Lump-sum rebate to representative household.

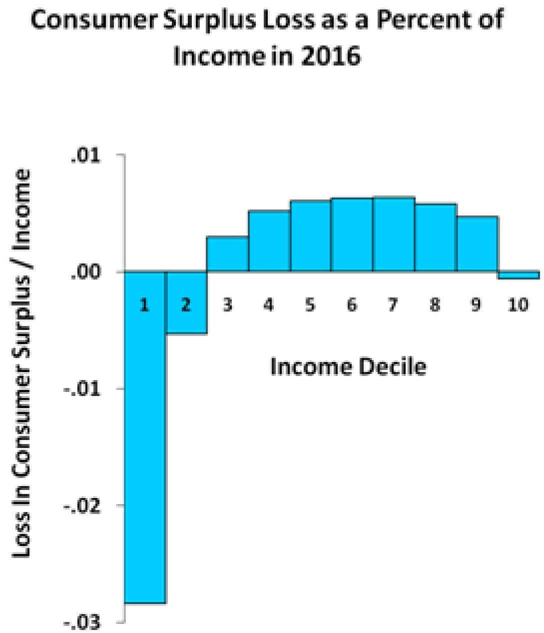
Near Term Incidence Analysis

Discussion

- The allocation strategy in Scenario 2, as modeled, leads to an increase in the welfare of households in the bottom two income deciles and in the top decile by more than the increased cost of goods and services resulting from the APA. The majority of the APA's costs as a portion of household income is borne by households in the fourth to ninth income deciles.
- The incidence analysis does not completely capture the incentive and incidence effects of the APA. This is because the APA provides flexibility in the ultimate use of some of the allowance value, the incentive effects of certain allowance uses are not captured in ADAGE, and there are no existing studies on the distributional consequences of certain uses of allowance value. A method of distributing the allowance value that differs from what is assumed in this analysis will yield different distributional results. For example,
  - The allowance value withheld explicitly for deficit reduction is assumed to be retained by the government to cover reductions in tax revenue in future years due to the Act. An alternative treatment of this share of the allowance value would be to represent the avoided future increase in other taxes that would otherwise make up for this shortfall. This approach would make the average cost per household appear lower in the near-term, although a full analysis using this approach would also show that the average cost per household would be higher in later years.
  - In this scenario more allowance value is allocated to the Energy Refund and Working Families Relief provisions than is needed in 2016. The unused portion of the allowances set aside to fund these two programs flows into the Deficit Reduction Fund. We assume that this unused portion is not needed to offset reduced tax revenues. Consequently, we assume that this excess amount is returned to households through a proportional income tax reduction. Returning the value to households by an equal lump-sum amount would look more progressive.
  - The electricity LDC allocation is modeled in ADAGE as lowering the electricity price, which leads to an increase in the amount of electricity consumed. However, the APA requires the LDC rebate be accounted for in the fixed portion of electricity bills, which may result in consumers not increasing their electricity consumption as modeled. If the incidence analysis assumed that industrial and commercial ratepayers do not adjust electricity consumption in response to the LDC rebate this would change the distributional results because producers would instead pass the value of the LDC rebate onto their shareholders. This approach would have similar distributional effects as providing allowances gratis to producers and lead to a decrease in the cost of the APA to higher income households (those that are shareholders) and increase the cost for lower income households.
  - Some of the allocations are treated as lump-sum to households even though they may affect the prices of goods and inputs. For example, research and development may lead to innovations that lower the cost of cleaner technologies. If the intensity of use of these cleaner technologies varies across income deciles, the distributional results will change.
  - Forecasting the effect on households of the allowance value used to fund transportation infrastructure is challenging as the incidence of these programs depends on which projects are funded and the timing of their completion. For example, the larger the share of the allowance value that is used to reduce the variable cost of mass transit, the better off lower-income households may be. If the share allocated to the Highway Trust Fund avoids gasoline tax increases, the incidence would mimic the lowering the gasoline tax.
- The incidence model is based on partial equilibrium analysis, which preserves detail but sacrifices certain dynamic properties. The greatest burden of policy would be expected in the near term before households adjust their durable good purchases and producers change their production processes. Modeling in a near term framework also reduces uncertainty regarding baseline consumption patterns (the findings can be viewed as an income shock). An analysis of the incidence of the policy over time would show the cumulative impact on households of changes in the flow of allowance value to different uses, and would fully represent how the Act affects household wealth.
  - Appendix 1 provides additional information on the assumptions of the incidence model and its linkages to ADAGE.

Near Term Incidence Analysis

Scenario 6: Reference Nuclear & Biomass/Delayed CCS



Income Decile	Average Income (2005$)	Loss in Consumer Surplus Per Household in 2016 (2005$)
1 (lowest)	$6,900	-$196
2	$14,900	-$79
3	$22,200	$66
4	$29,700	$155
5	$37,900	$230
6	$47,500	$299
7	$58,900	$375
8	$74,000	$432
9	$97,200	$456
10 (highest)	$174,500	-$103
Average	$56,400	$163

- The above graphic and table report the estimated distribution of the cost of the APA in 2016 under the assumptions of Scenario 6.
- The allowance price is higher and the cost of the APA to the average household is higher under Scenario 6 than Scenario 2. The distribution of the impact of the Act follows a pattern similar to Scenario 2, but with greater magnitude for all income deciles.
  - However, the limitations of the incidence model may affect the results more the greater is the allowance price. That is because at higher prices, the composition of the fuels and technologies used to produce goods may change significantly from what they are today.
- Because of the difference in the allowance price, there are some differences in the disposition of allowance value between Scenarios 2 and 6.
  - In 2016, 6.47% (versus 6.59 % for scenario 2) of the allowance values is needed to fund the Energy Refund program in 2016. This implies that there is slightly more unused allowance value from the low income households allocation which is ultimately deposited in the Deficit Reduction Fund. Furthermore, there are fewer allowances needed to fully fund the transportation programs (1.90%), and therefore there are more excess allowances from the transportation programs set aside that are deposited in the Deficit Reduction Fund.

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Contact Information

The analysis was conducted by EPA's Office of Atmospheric Programs.

Contact: Allen A. Fawcett
Tel: 202-343-9436
Email: fawcett.allen@epa.gov

The full analysis is available online at:
www.epa.gov/climatechange/economics/economicanalyses.html