A Clean Energy Bargain:
Analysis of The American Clean Energy And Security Act

Natural Resources Defense Council

September 2009
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www.nrdc.org/cap2.0

NRDC
THE EARTH'S BEST DEFENSE

KEY FINDINGS

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NRDC
THE EARTH'S BEST DEFENSE

KEY FINDINGS

- **ACES will boost our economy:** ACES will drive $300 billion of investments (through 2030) toward clean energy, creating hundreds of thousands of jobs in the process.

- **ACES is affordable:** The cost of ACES to American households will be less than a postage stamp per day.

- **ACES will make America more secure:** ACES can reduce oil imports by as much as 5 million barrels per day, improve our energy security, and reduce the risk of fuel price shocks.

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ACES WILL BOOST OUR ECONOMY

- According to NEMS-NRDC, ACES will drive an additional investment of $306 billion in low- or no-emissions electricity generation technologies between 2012 and 2030, which includes $103 billion redirected from conventional fossil-fuel generation. ACES will also drive $32 billion of additional investment to increase the efficiency of residential and commercial equipment.

- Clean energy investments create more jobs for Americans of all skill and education levels than comparable investments in fossil-fuel energy sources
  - –The Political Economy Research Institute (PERI), and independent unit of the University of Massachusetts, found that clean energy investments:
    - Create 3.2 times as many jobs as fossil fuel investments
    - Create 5.5 times as many jobs for workers with few educational credentials or work experience, and 75% of those jobs provide opportunities for advancement

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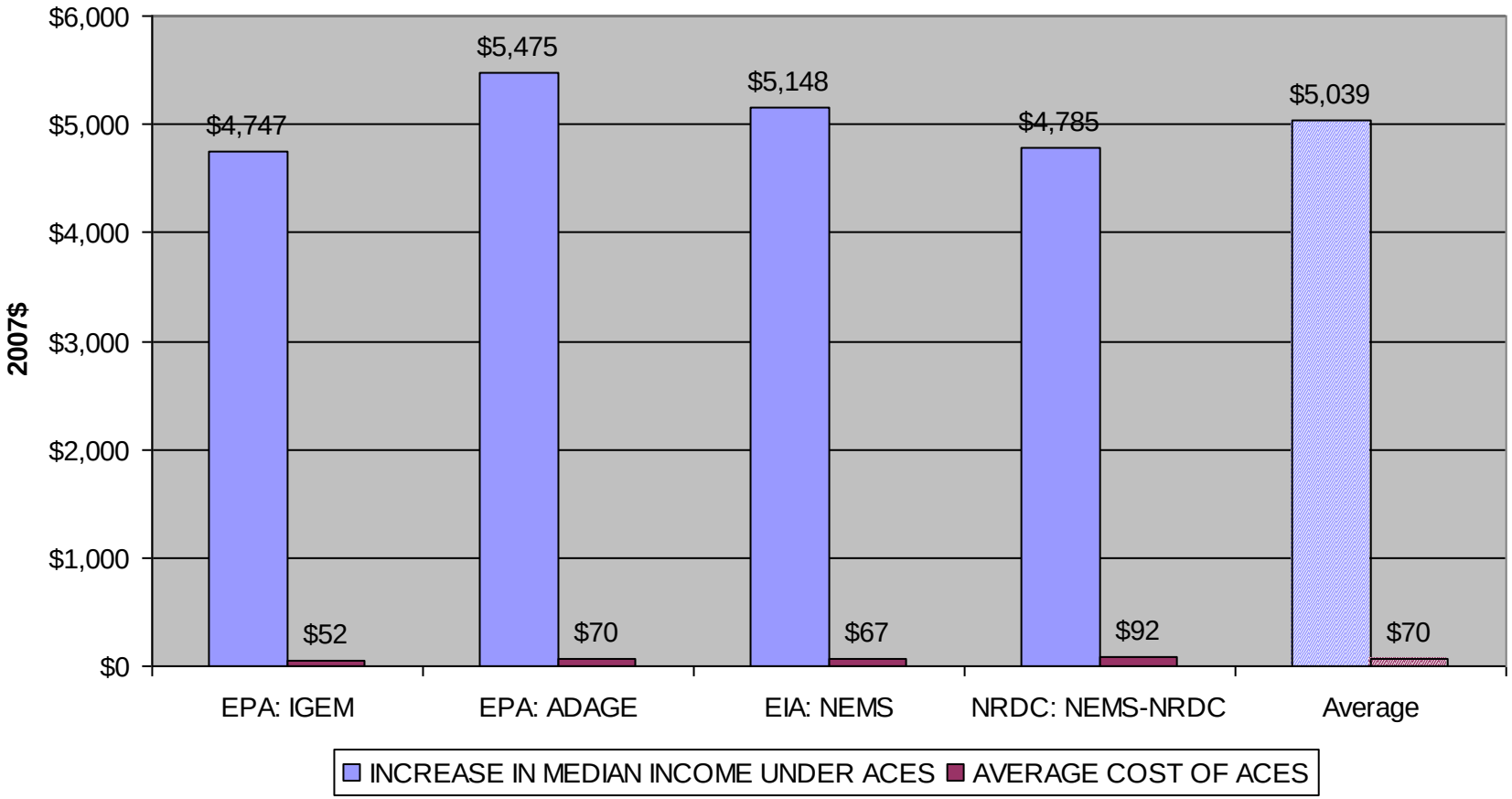
ACES IS AFFORDABLE

INCREASE IN AVERAGE 2012-2030 MEDIAN ANNUAL INCOME PER HOUSEHOLD FROM 2009 LEVELS AND AVERAGE ANNUAL COST PER HOUSEHOLD VS. BAU OVER 2012-2030



Comparing EPA, EIA, and NEMS-NRDC results, the estimates for average annual household cost of ACES range from $52 to $92, which translates to $0.14 to $0.25 per household per day. Meanwhile, median annual income levels per household over 2012-2030 under ACES are expected to be, on average, $4,700 to $5,500 higher than 2009 levels.

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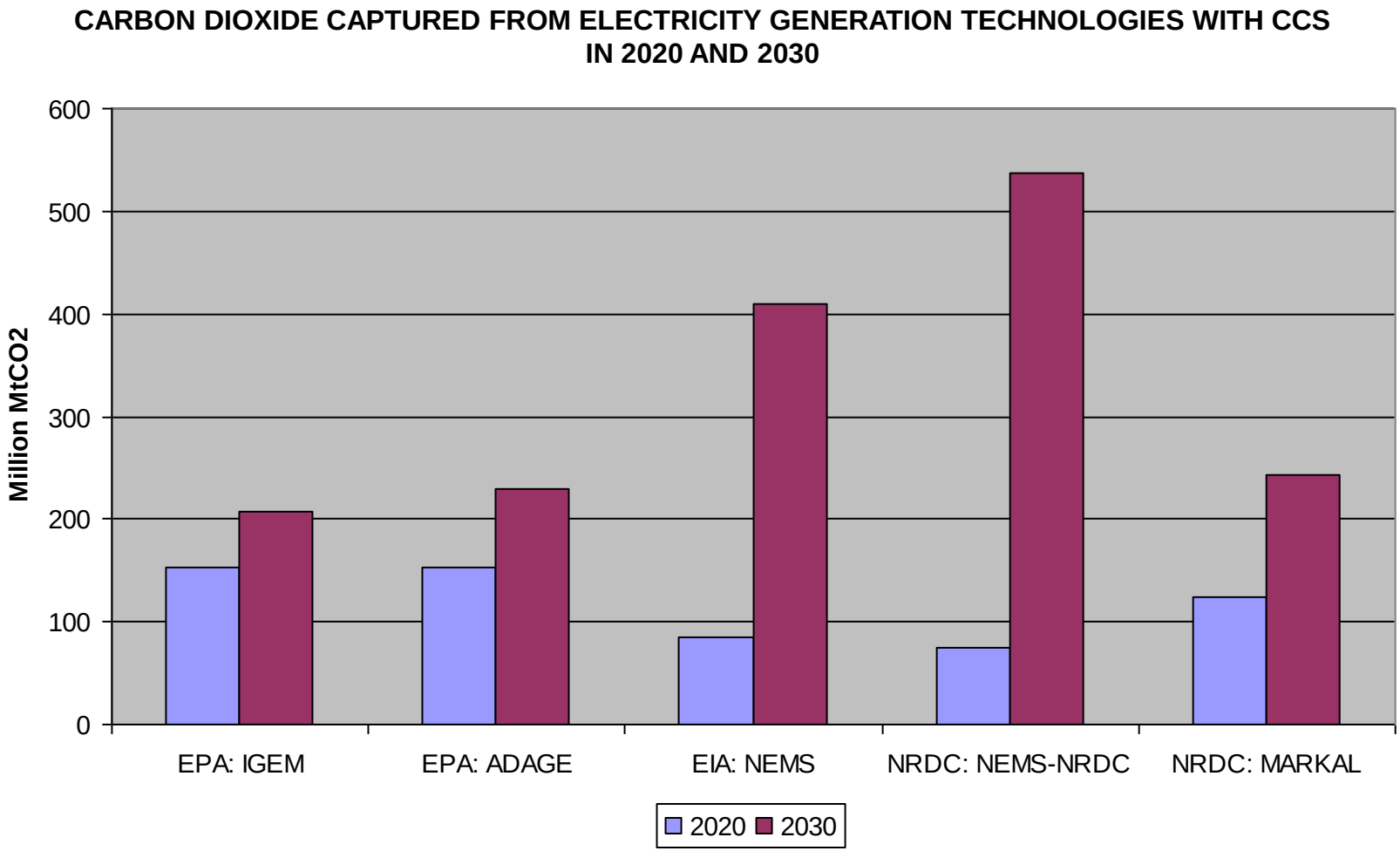
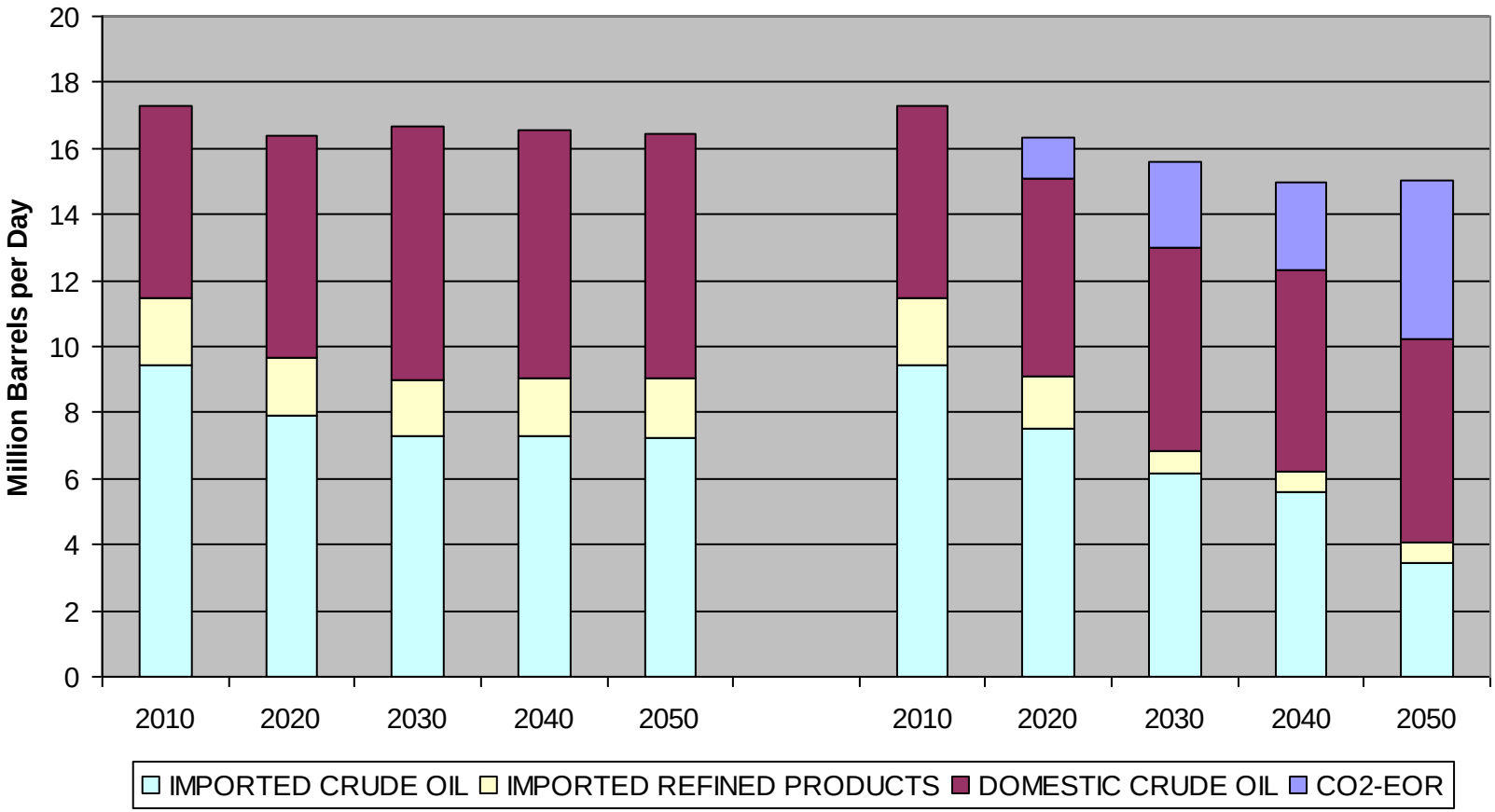
ACES WILL MAKE AMERICA MORE SECURE (1/2)



ACES WILL MAKE AMERICA MORE SECURE (2/2)

DOMESTIC AND IMPORTED CRUDE OIL AND REFINED PRODUCTS CONSUMPTIION FROM 2010 TO 2050, IN MARKAL



At today's oil prices, the cumulative value of these reduced oil imports through 2050 will be more than $2 trillion, significantly boosting the benefit of ACES to the U.S. economy.

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NEMS-NRDC AND MARKAL DESCRIPTIONS AND DIFFERENCES

NEMS-NRDC

- NEMS is a forecasting model that EIA uses to develop its annual long-term projections for energy supply, demand, and prices
- It was developed by the U.S. Department of Energy
- It uses observed historical behavior in order to estimate how individual market participants will act going forward in response to changing market conditions and imposed constraints
- Results are presented on an annual basis through 2030
- NRDC hired OnLocation to perform the NEMS modeling using the March 2009 version of the model that has been modified for this effort, with the modified version known as NEMS-NRDC [Note: This version is similar, but not identical to the April 2009 Updated Release that includes EIA's modeling of selected provisions of the Stimulus Bill]

MARKAL

- MARKAL is a long-term cost-optimization model with perfect foresight that aims to minimize total societal costs through 2050 given imposed constraints
- It was developed by the International Energy Agency
- It illustrates what would happen if all market participants had perfect information and behaved rationally
- Results are presented in 5-year increments through 2050
- NRDC hired International Resources Group to perform the MARKAL modeling

NEMS-NRDC attempts to approximate what will happen under ACES, given real-world market imperfections, whereas MARKAL finds the ideal outcome given specified constraints (assuming we want to minimize total societal costs over the long-term). We can learn valuable lessons that can help us develop smart policies by comparing the results from NEMS-NRDC and MARKAL. Please see the appendix for more details on the model architectures and assumptions.

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NEMS-NRDC AND MARKAL: KEY ASSUMPTIONS AND NOTES (1/2)

- While NEMS-NRDC and MARKAL both reflect our efforts to model the impact of ACES, their results differ for four main reasons:

1) **Architecture:**
   - NEMS-NRDC uses historical behavior and assumes "stickiness" in markets to predict how individual market participants will behave going forward. Investment decisions are based on relatively short time horizons in an effort to reflect observed behavior.
   - MARKAL has perfect foresight. As a result, it chooses the outcome that minimizes the total cost to society over the full time period of the model, while adhering to limitations on the speed of change that are imposed in the model. In other words, it makes decisions based on finding the least cost path for the entire economy through 2050.

2) **Assumptions:** While NEMS-NRDC and MARKAL share many of the same assumptions, there are some exceptions.
   - NEMS-NRDC assumptions follow those presented in the Energy Information Administration's (EIA) Annual Energy Outlook (AEO) in order to facilitate a comparison between our results and those published by EIA.
   - In a few instances, some of the AEO assumptions do not best reflect the literature and thus we felt changes in MARKAL were warranted. These changes tend to center around electricity generation technologies, vehicle costs, and biomass supply.
   - Furthermore, MARKAL has less granularity of detail than NEMS-NRDC. So while that results in faster run times and therefore makes MARKAL a more nimble model with which to test sensitivities, NEMS-NRDC has the advantage of a much greater depth and complexity of input assumptions.

NEMS-NRDC AND MARKAL: KEY ASSUMPTIONS AND NOTES (2/2)

3) **Policies Modeled:** In both NEMS-NRDC and MARKAL, we modeled most of the major complementary policies in ACES, including the RES/EERS, CCS deployment incentives, and energy efficiency provisions.
   - However, there is one major provision that is reflected only in MARKAL: ACES does not mandate a reduction in driving, but does provide funding for projects/strategies to improve regional transportation efficiency, potentially resulting in reduced driving (often referred to as "vehicle miles traveled"). Whereas we take a conservative approach in NEMS-NRDC and do not reflect these impacts because they are not directly specified in ACES, our MARKAL modeling assumes that some reductions will occur.
   - One exception in which we modeled a provision not directly specified in ACES is vehicle efficiency standards. In both NEMS-NRDC and MARKAL the Obama vehicle efficiency standards announced earlier this year are included in the BAU baseline, and we assume that these standards are extended under ACES, reaching 42 mpg in 2020 and 55 mpg in 2030. (These extended standards are not fully achieved under NEMS-NRDC because the model projects that manufacturers will choose to pay fines rather than fully complying.)
   - In addition, due to differences in the model architectures, in some cases we use different approaches to model certain policies (see Appendix).

4) **Stimulus in Baseline:** MARKAL was calibrated to the March 2009 AEO Published Release. To reflect the stimulus, we reflected both the extended renewables tax credits and energy efficiency provisions. NEMS-NRDC just reflects the tax credits. As a result, the post-stimulus baselines for each model are slightly different, with MARKAL reflecting greater efficiency measures.

- NEMS-NRDC and MARKAL are both intended to reflect ACES, but there are significant differences in model architecture and in some assumptions. Generally, NEMS-NRDC provides a more conservative assessment of energy system responses to ACES, while MARKAL provides a more optimistic view.

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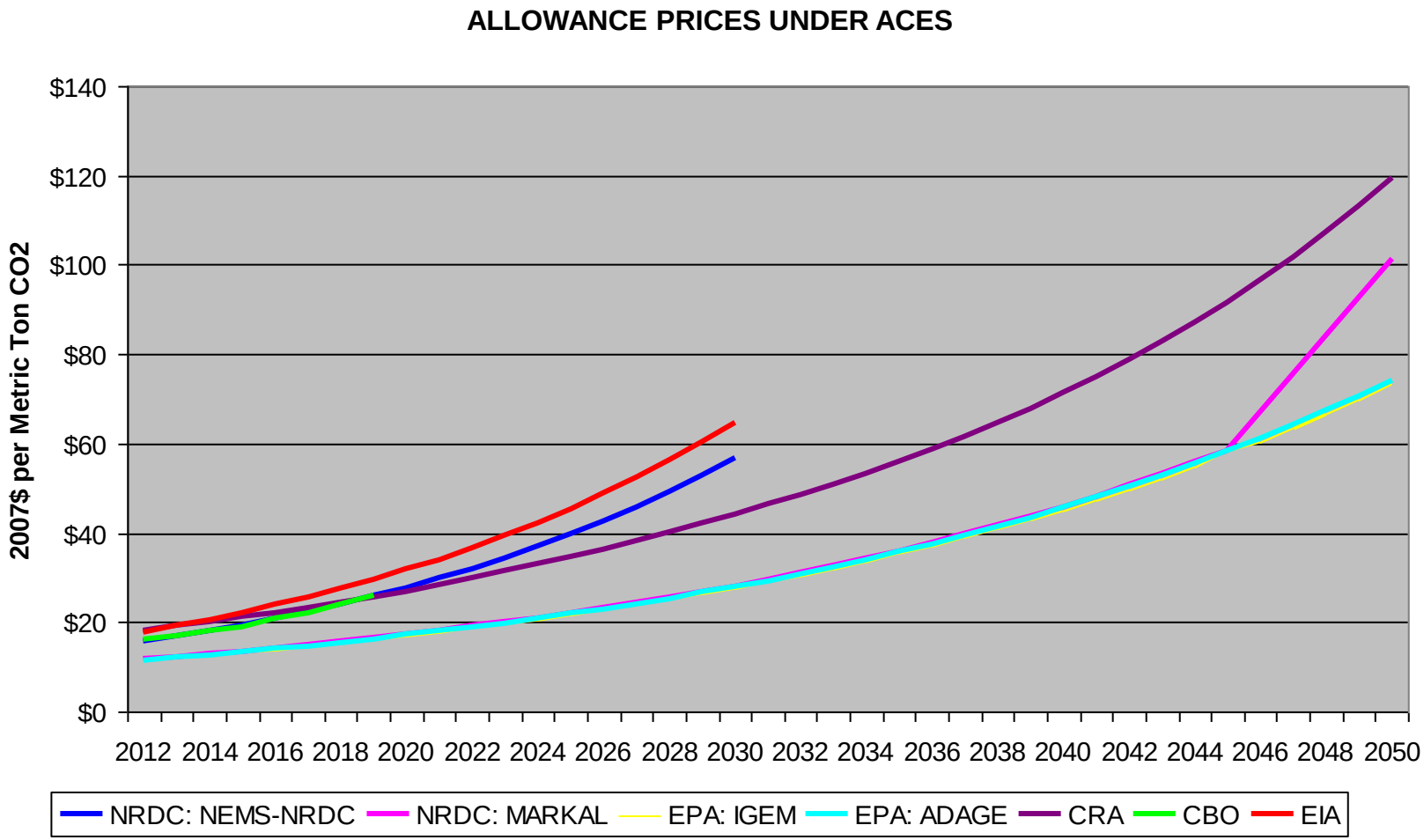
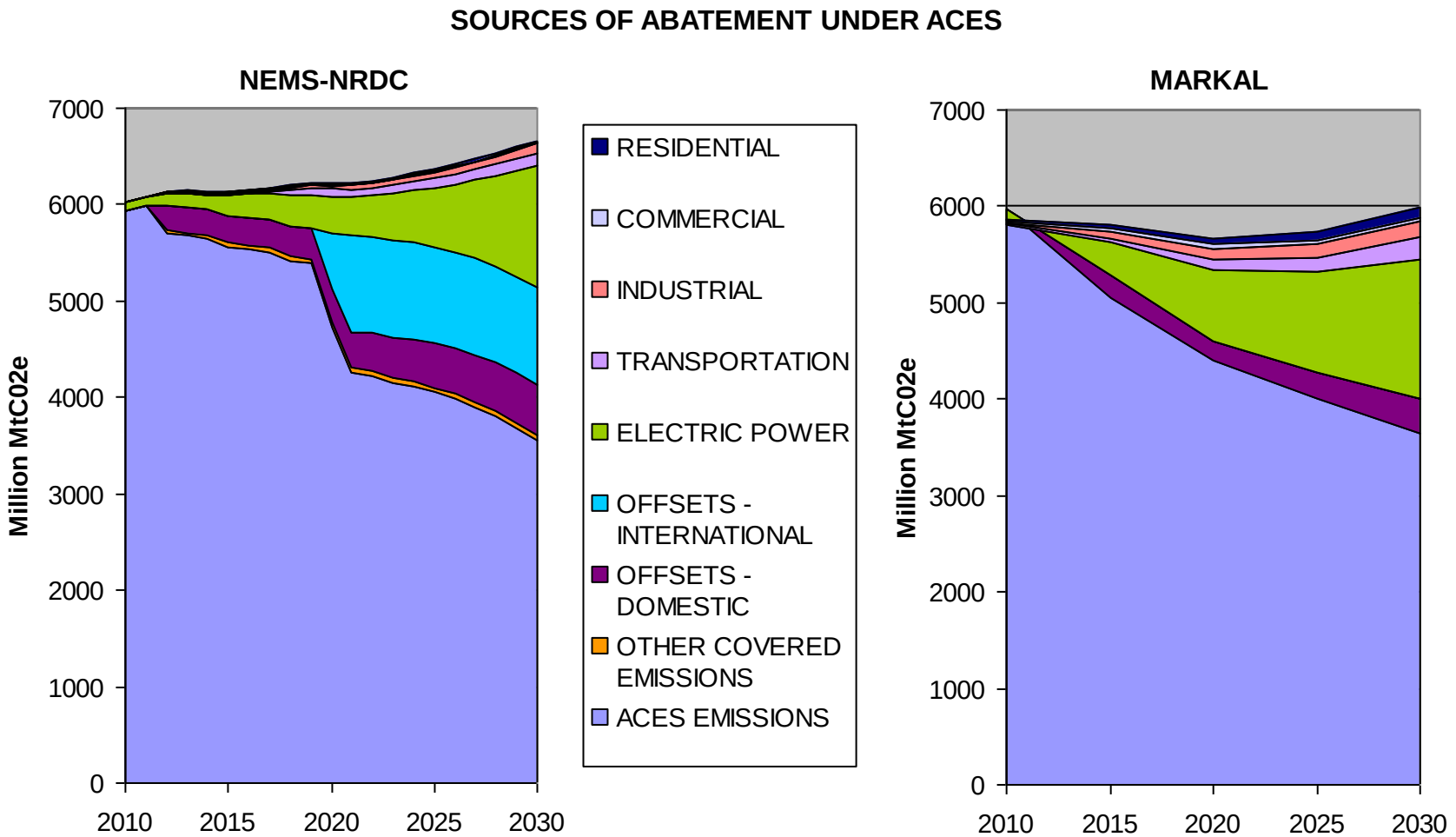
ALLOWANCE PRICES



SOURCES OF ABATEMENT



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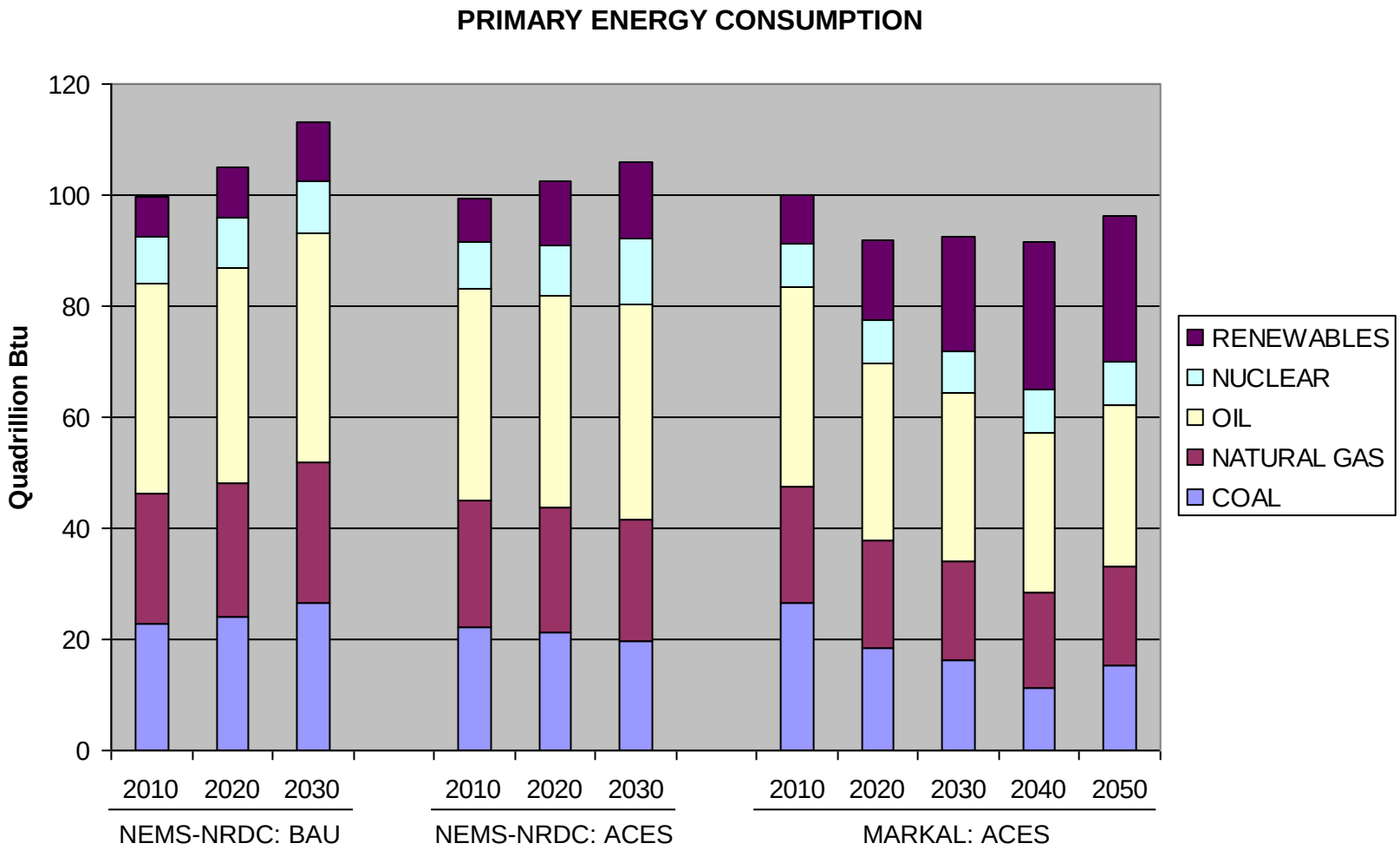
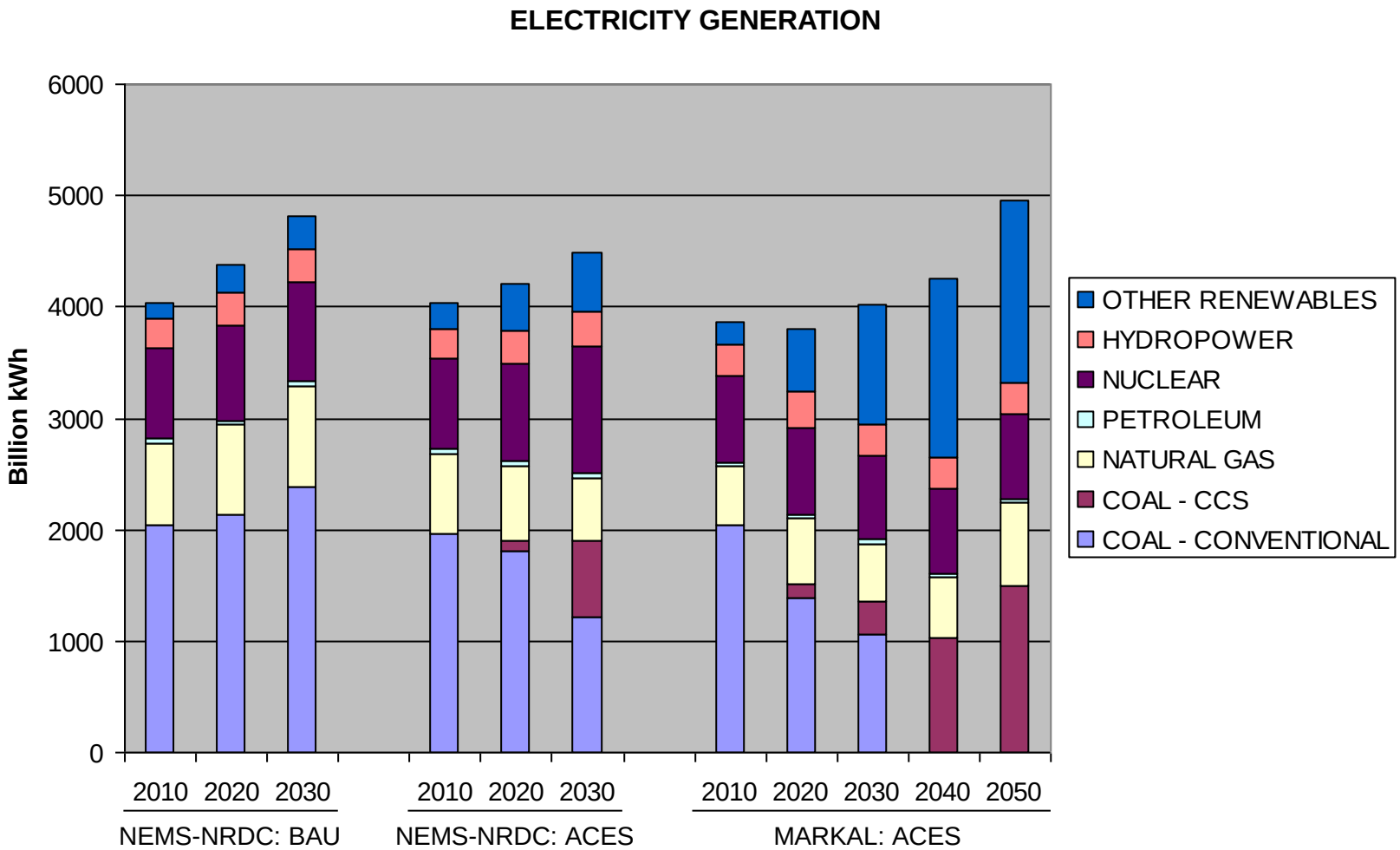
PRIMARY ENERGY CONSUMPTION



ELECTRICITY GENERATION



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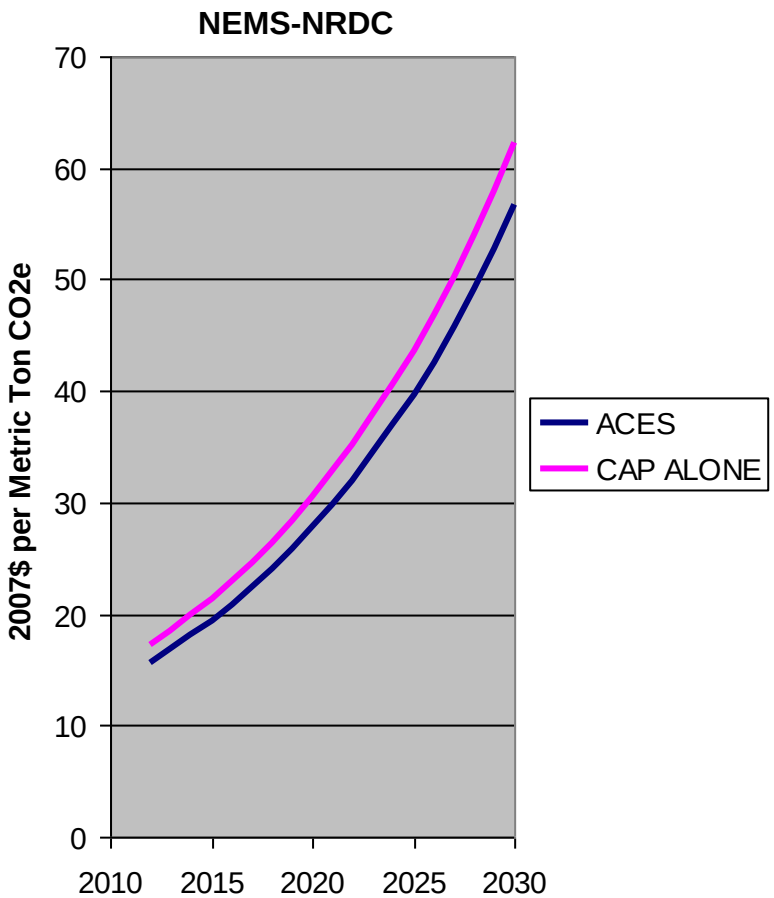
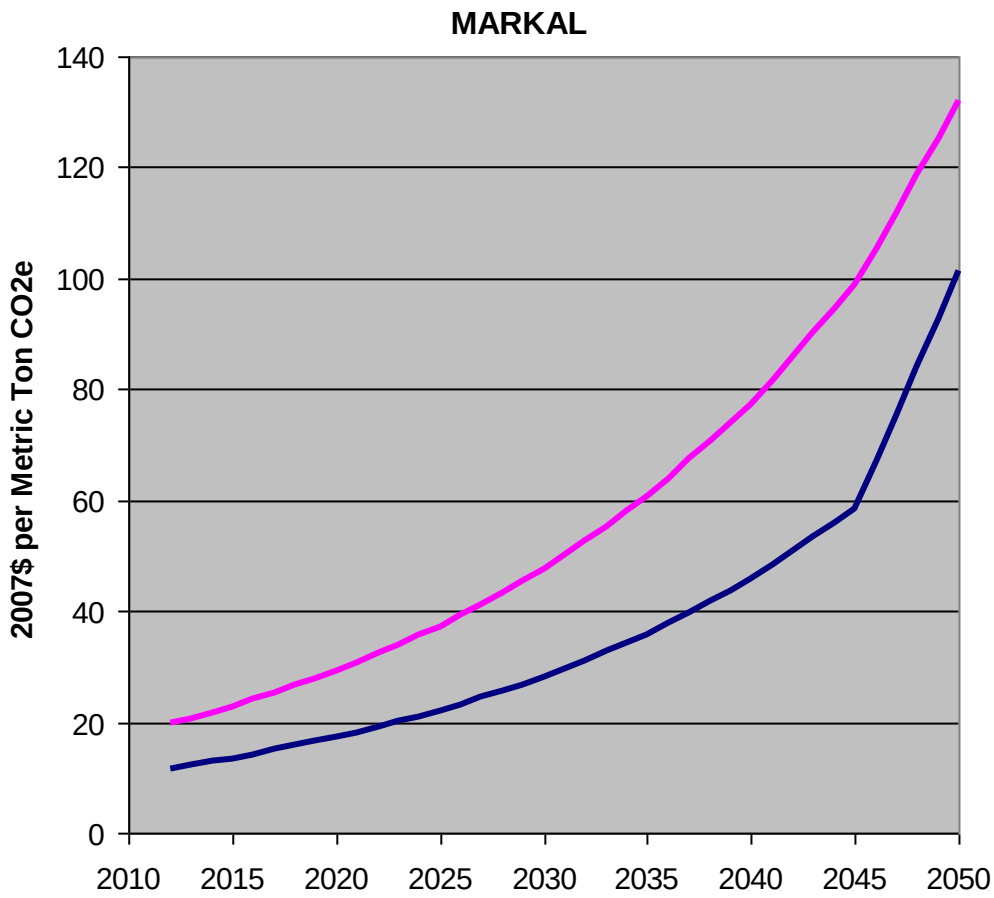
COMPLEMENTARY POLICIES

ALLOWANCE PRICES WITH AND WITHOUT COMPLEMENTARY POLICIES





Without the complementary policies included ACES that promote energy efficiency and a faster transition to a clean energy economy, allowance prices would be 10%-80% higher.

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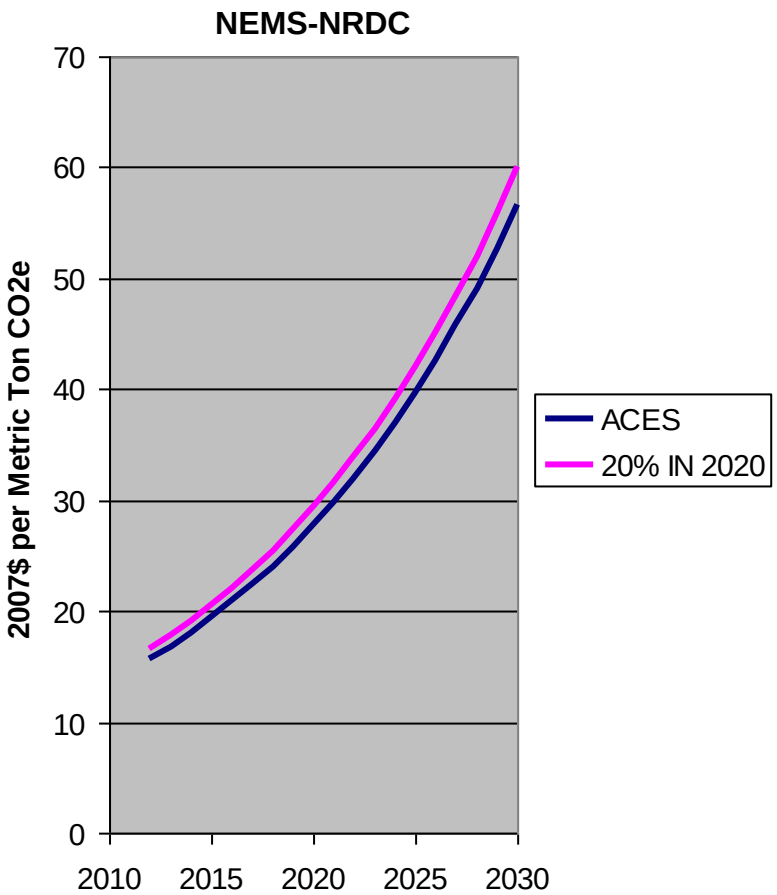
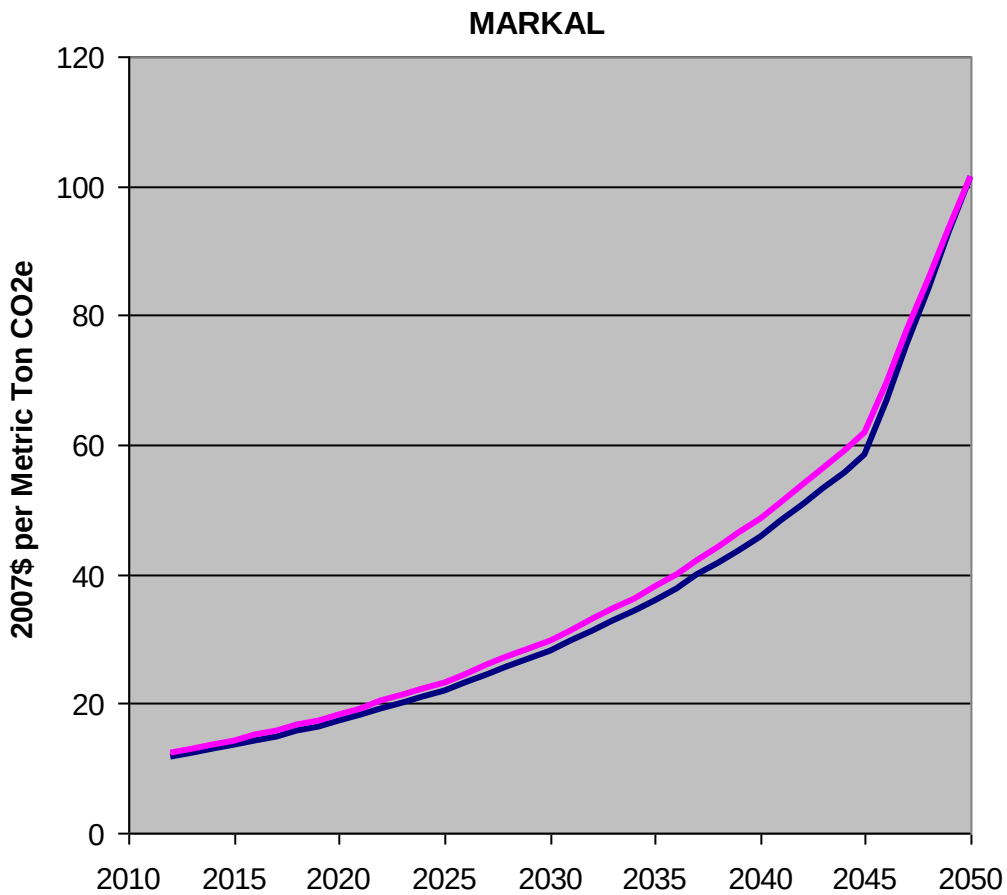
TIGHTER EMISSIONS REDUCTION TARGETS IN 2020

ALLOWANCE PRICES WITH DIFFERENT EMISSIONS REDUCTION TARGETS FOR 2020





Tightening the 2020 emissions reduction target from 17% below 2005 levels to 20% below resulted in allowance prices increasing 6% in both NEMS-NRDC and MARKAL.

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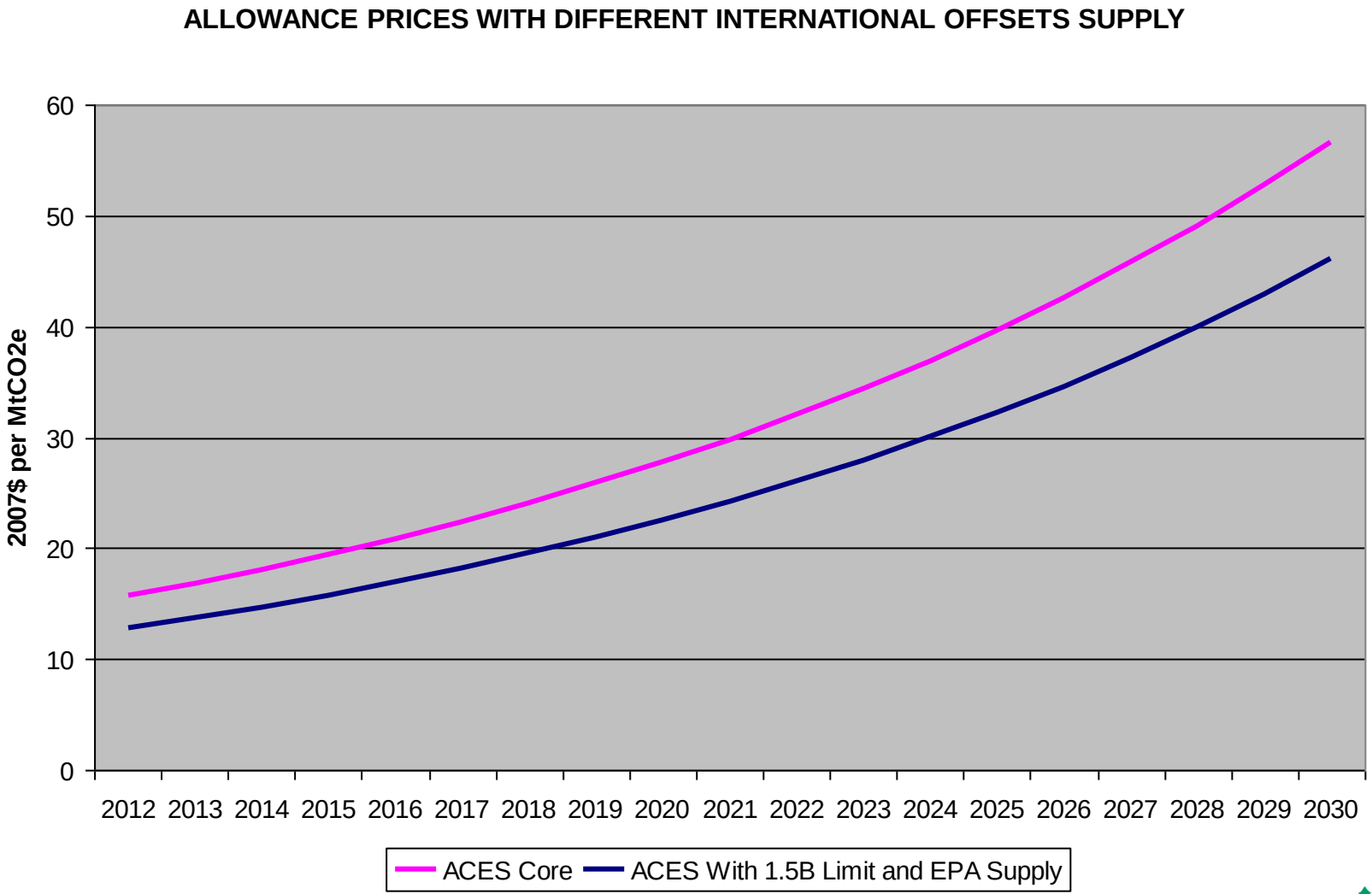
LOOSER OFFSETS LIMITS IN NEMS-NRDC (1/2)



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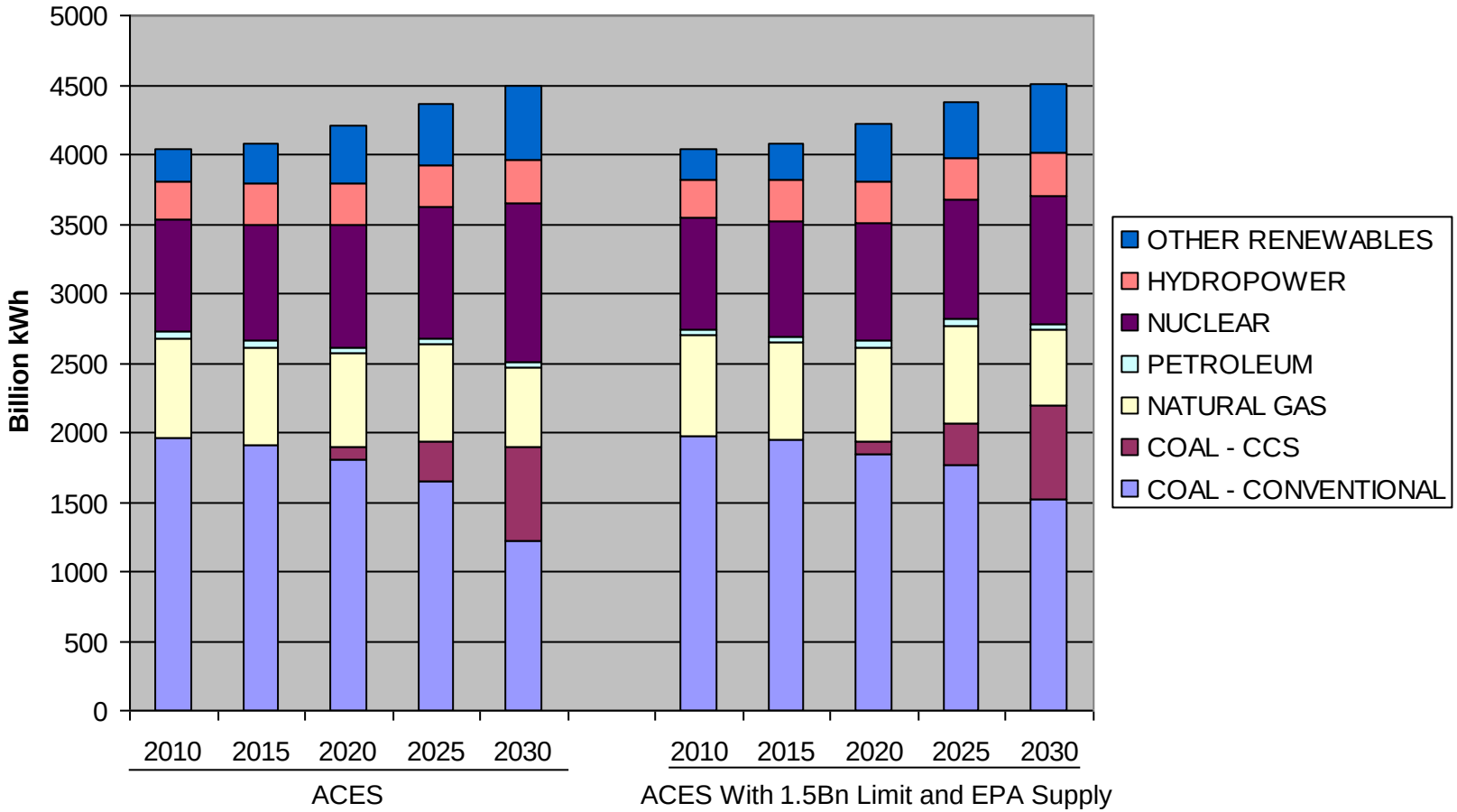
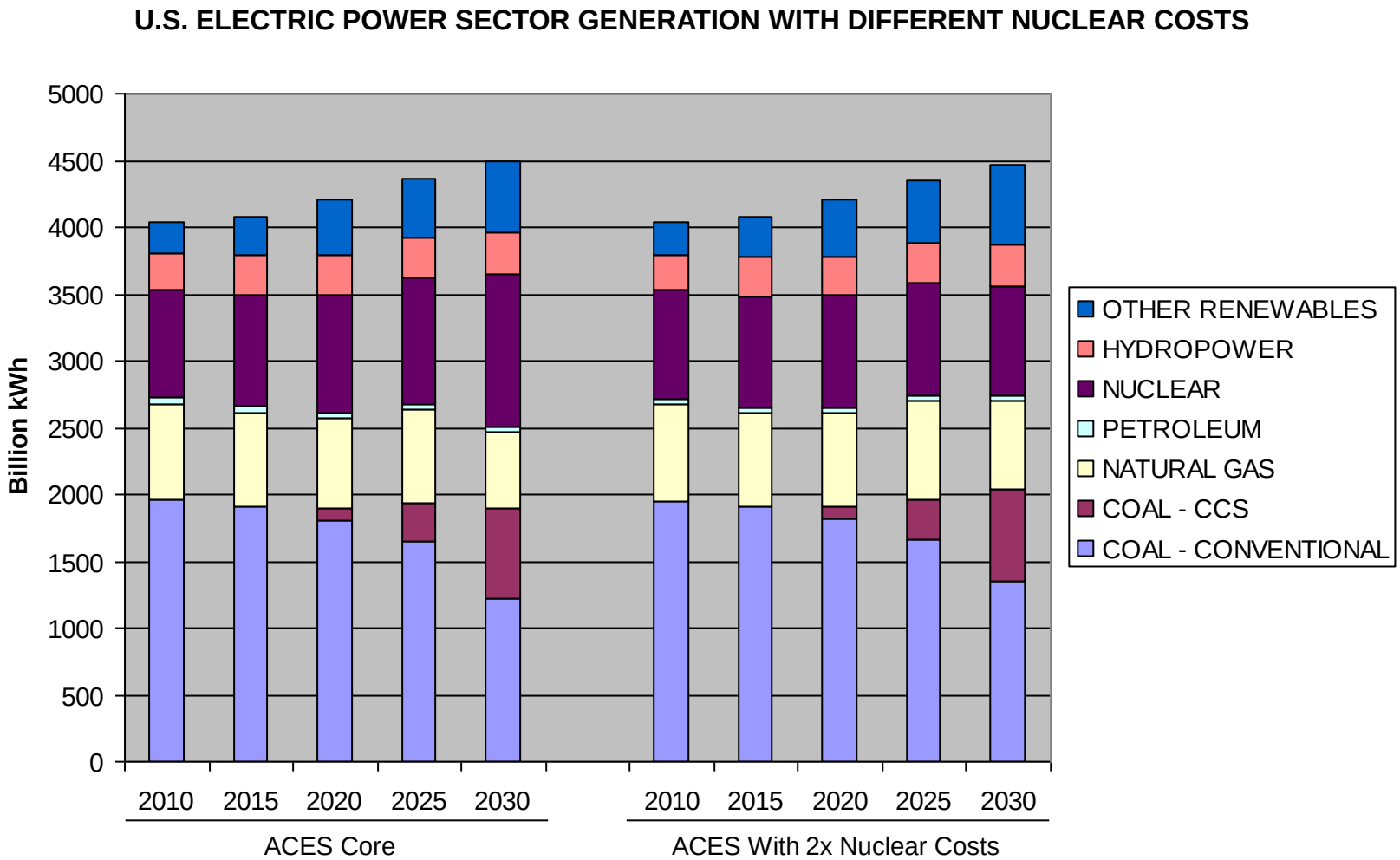
LOOSER OFFSETS LIMITS IN NEMS-NRDC (2/2)

U.S. ELECTRIC POWER SECTOR GENERATION WITH DIFFERENT INTERNATIONAL OFFSETS SUPPLY



HIGHER NUCLEAR COSTS IN NEMS-NRDC



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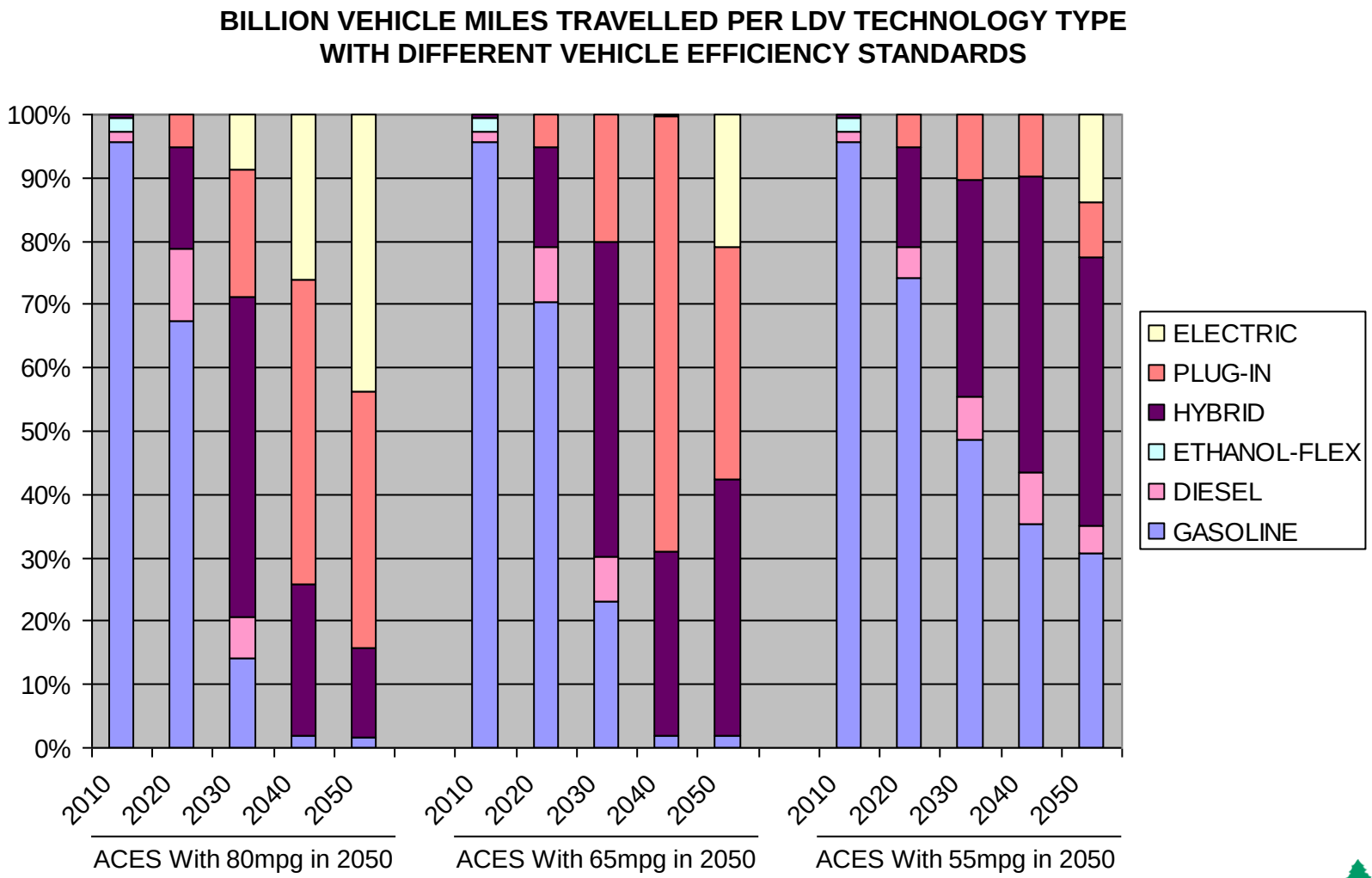
LOWER VEHICLE EFFICIENCY STANDARDS IN MARKAL (1/3)



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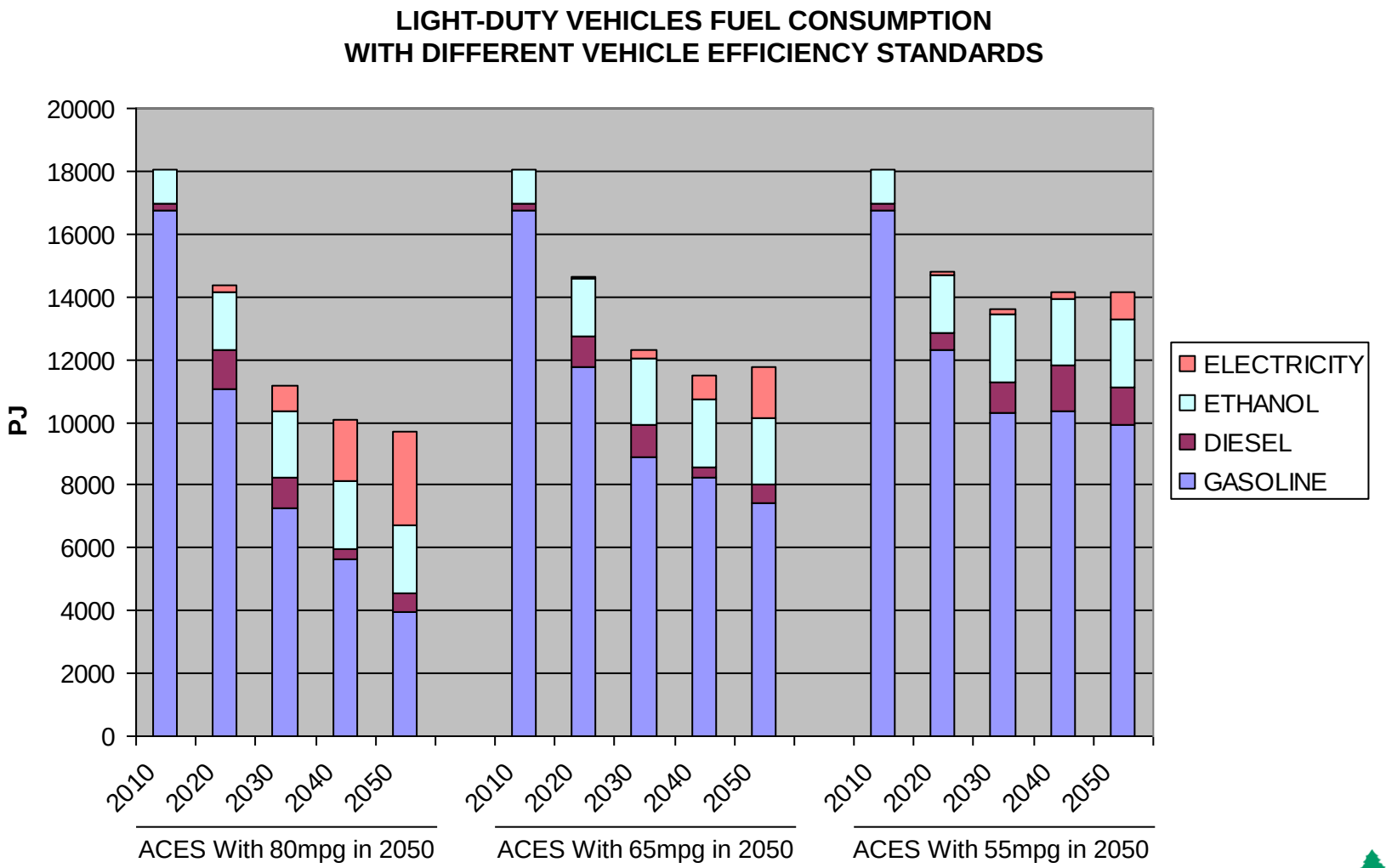
LOWER VEHICLE EFFICIENCY STANDARDS IN MARKAL (2/3)



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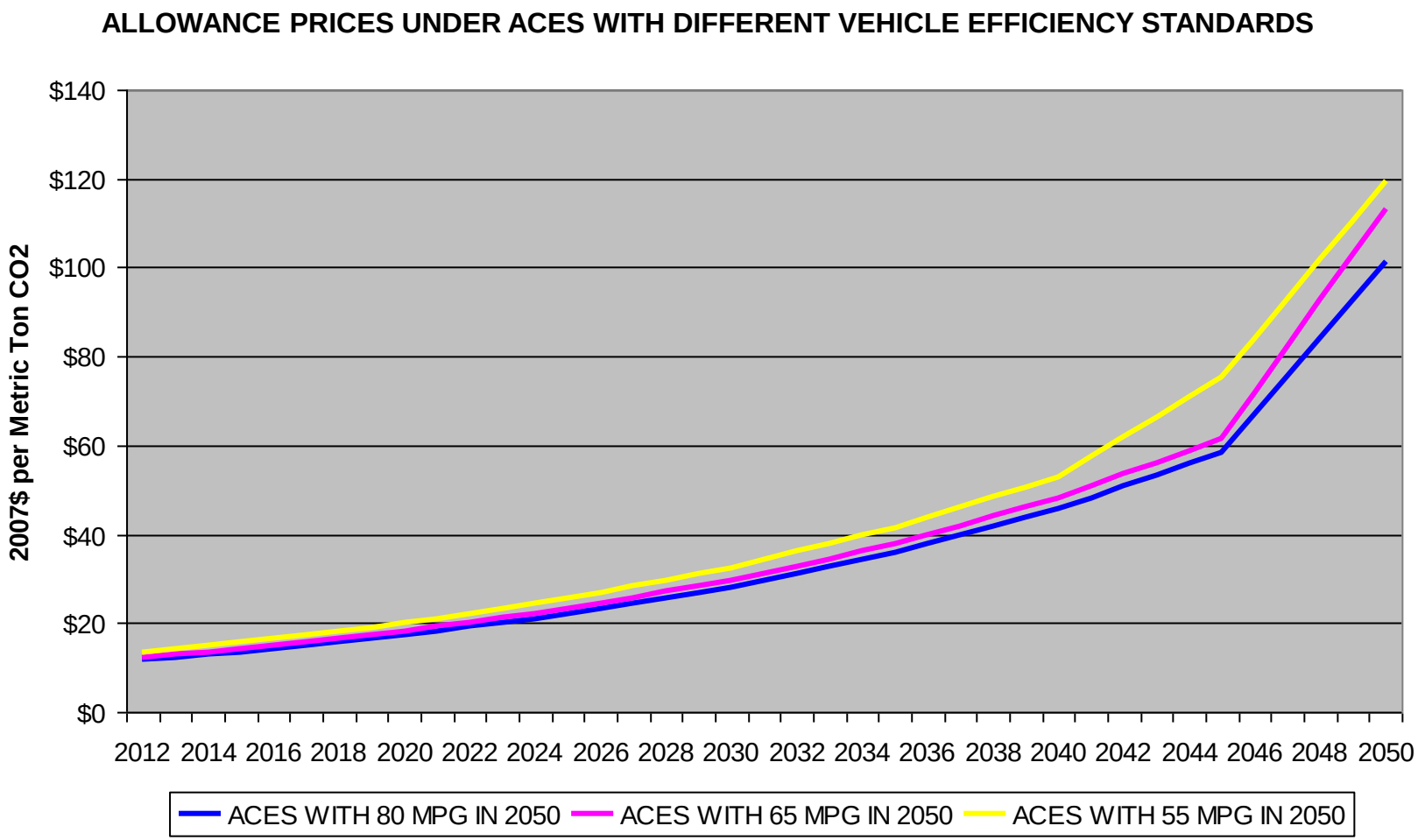
LOWER VEHICLE EFFICIENCY STANDARDS IN MARKAL (3/3)



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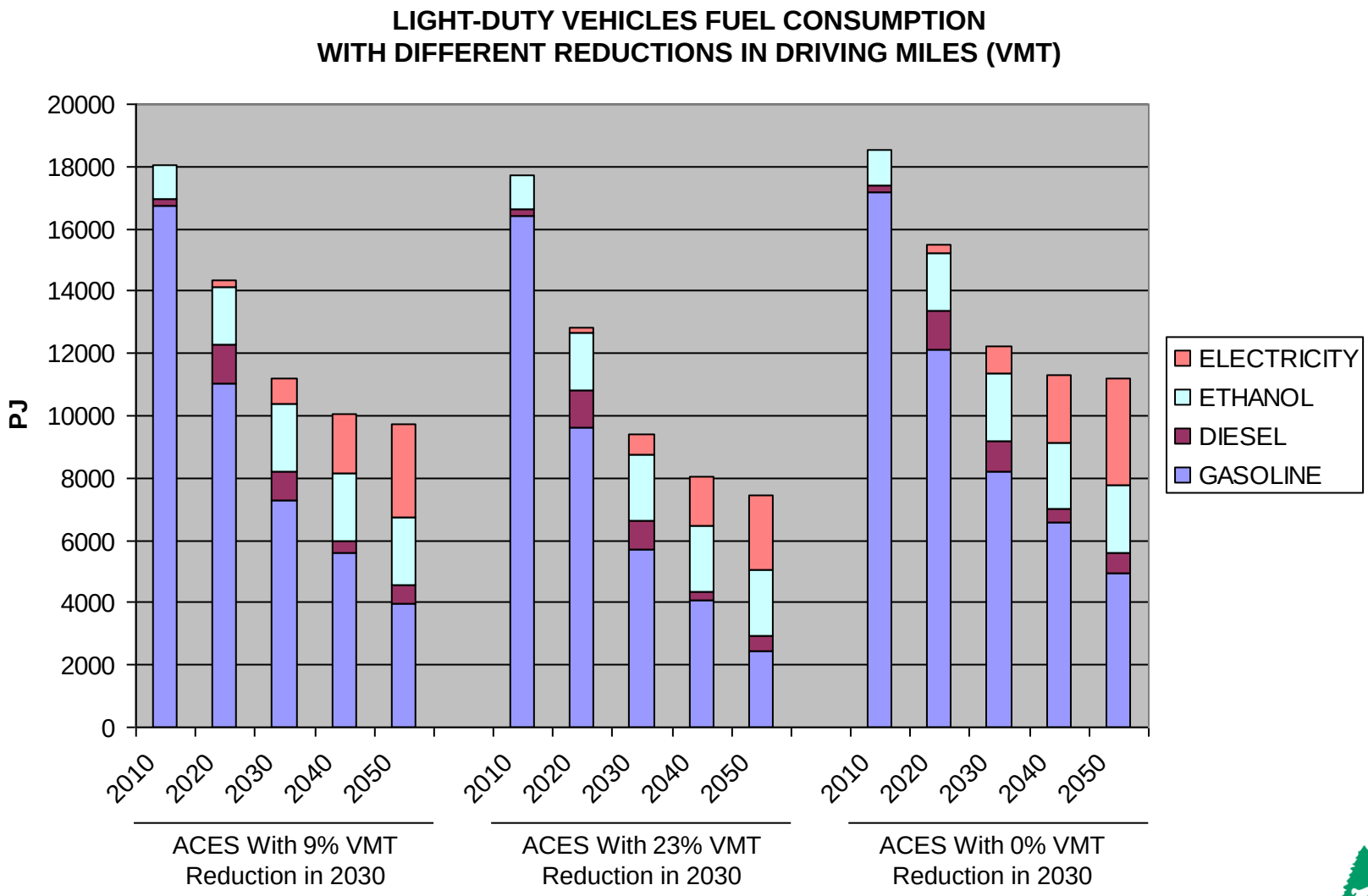
VARYING REDUCTIONS IN DRIVING MILES IN MARKAL (1/2)



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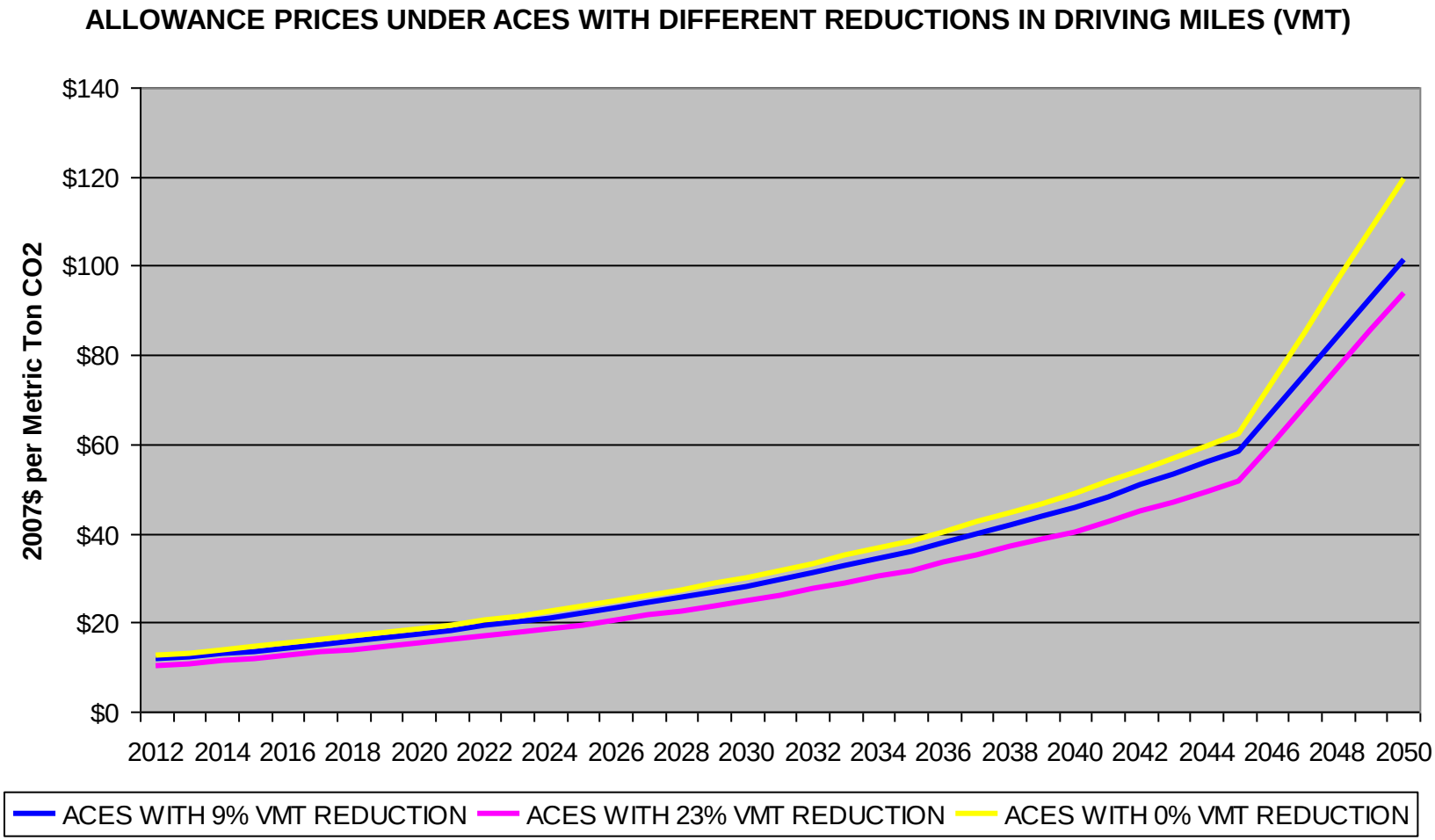
VARYING REDUCTIONS IN DRIVING MILES IN MARKAL (2/2)



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MAIN IMPLICATIONS

- ACES is affordable
  - NRDC, EIA, and two EPA models all estimate that the total annual consumption loss per household will average less than $100 through 2030
  - Allowance prices are likely to be in the $10-20 range in 2012, rising to $25-65 in 2030
- Emissions reduction targets could be increased to 20% in 2020 with little impact on allowance costs
- Complementary policies are an important component of cost containment
  - Allowance prices average 10-80% higher in a cap only case
- A large share of abatement will come from the electric power sector – with some models also showing a large dependence on offsets
  - Quality controls on offsets will be critical to ensure environmental integrity
- Long-run costs are minimized by strong investment in renewables and energy efficiency
  - Strong complementary policies to accelerate deployment of efficiency and renewables are needed to ensure a least-cost solution

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NEMS-NRDC: MODEL INTRODUCTION

- The National Energy Modeling System (NEMS) was developed by the Department of Energy's Energy Information Administration (EIA) for use in:
  - –Annual Energy Outlook projections
  - –Congressional, as well as agency, requests for analysis
- NEMS has also been used extensively outside of EIA
  - –Various national laboratories studies
  - –Various associations and special interest groups
  - –Program offices within DOE for R&D benefits estimation
- NEMS performs an annual simulation to the year 2030 with limited foresight
- Modular structure allows each sector to be represented by methodology and data that fit it best
  - –Optimization techniques used for electricity capacity expansion and dispatch as well as petroleum refining and coal supply
  - –Extensive technology representation for many sectors
  - –Econometric approach for others
- The version of NEMS used by NRDC is referred to as NEMS-NRDC

Source: OnLocation, Inc., Energy Systems Consulting

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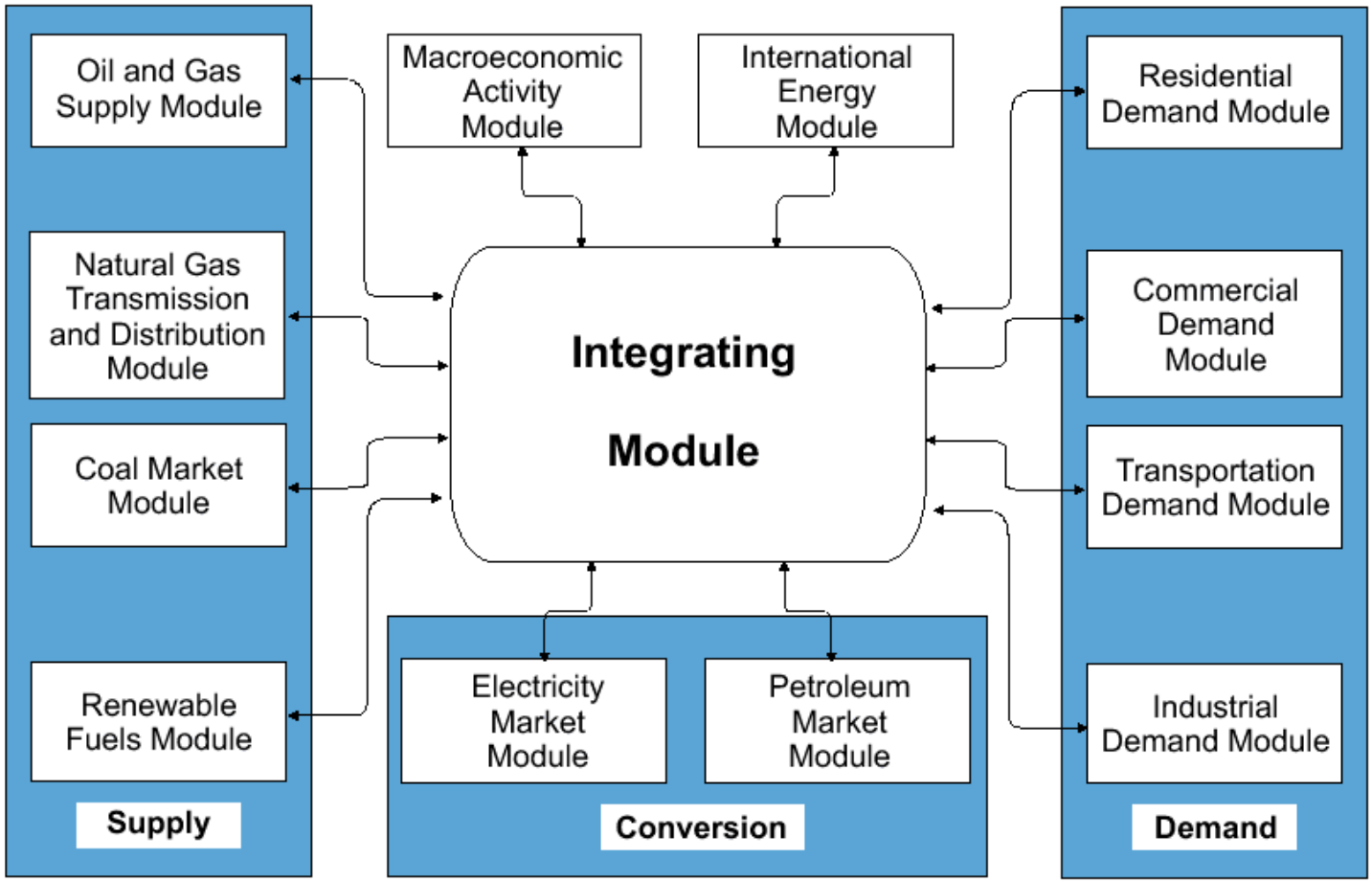
NEMS-NRDC: MODEL ARCHITECTURE (1/2)

- NEMS is a simulation model organized by energy producing, consuming, and conversion sectors.



Source: OnLocation, Inc., Energy Systems Consulting

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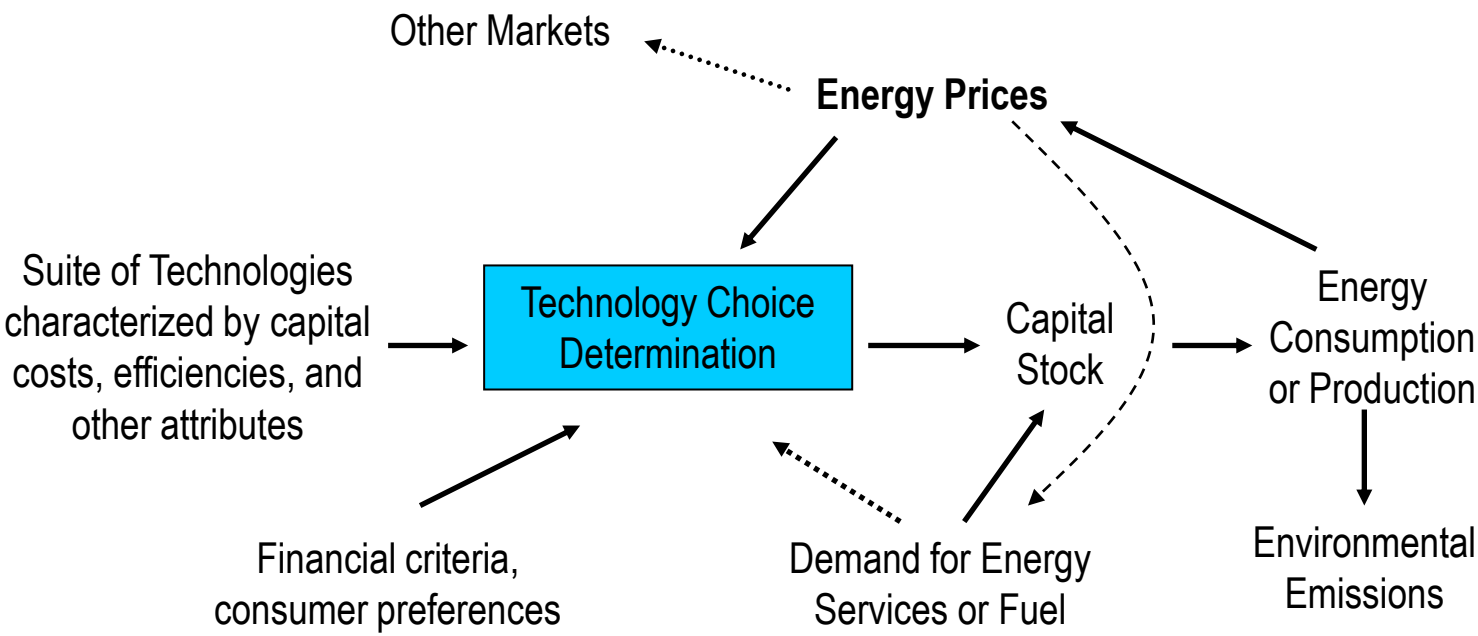
NEMS-NRDC: MODEL ARCHITECTURE (2/2)

- Although the various modules of NEMS use different specific structures, most have at their core the projection of technology market shares based primarily on ***economic*** criteria.



Source: OnLocation, Inc., Energy Systems Consulting

MARKAL: MODEL INTRODUCTION (1/2)

- Purpose
  - To provide a framework for “what if” evaluation of the mid-to-long-term evolution of an energy system, from a least-cost perspective
  - To identify the technologies that are to play key roles in this evolution
  - To quantify the ancillary implications of the policies and programs that shape this evolution
- Who is using it?
  - Globally: IEA, EIA, ETSAP, EFDA
  - Regionally: EC, BNL, EPA-ORD, NESCAUM, China, ASEAN
  - Nationally: UK DTI/ERC, US BNL/EPA-ORD, numerous EU countries (Germany, France, Italy, Spain, Switzerland, Denmark, Norway, Sweden, Belgium, etc.), SEE-8, Russia, several developing countries (e.g., China, India, South Africa, ASEAN, Colombia, etc.)
  - Other: several states (e.g., CA, CO, OH, TX), several European cities (e.g., Geneva, Torino, etc)

Source: International Resources Group

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MARKAL: MODEL INTRODUCTION (2/2)

- Model characteristics
  - –Evaluates all options within context of entire energy / materials system by:
    - Balancing all supply/demand requirements
    - Ensuring proper process/operation
    - Monitoring in detail each process's capital stock turnover
    - Adhering to user defined environmental & policy restrictions.
  - –Computes an equilibrium on energy markets that takes into account impact of policies on:
    - Energy and product prices
    - Technological development
    - Energy security (trade)
    - Attaining environmental goals
    - Consumer behavior (e.g., miles driven, warming/cooling homes)
    - Industrial output and profitability.

Source: International Resources Group

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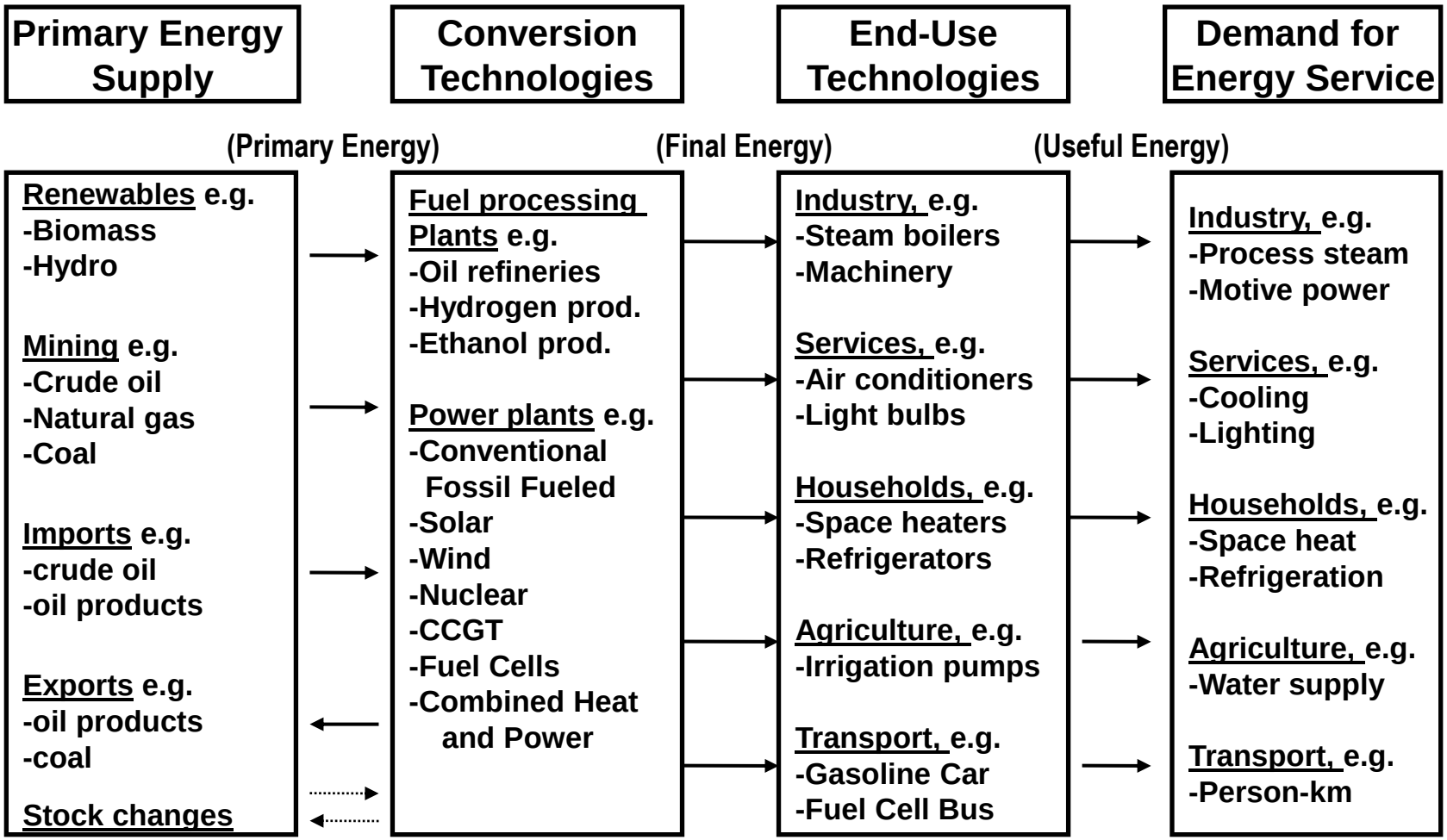
MARKAL: ENERGY PERSPECTIVE



Source: International Resources Group

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NEMS-NRDC: DESCRIPTION OF BASELINE

- In NEMS-NRDC, we use the Energy Information Administration's (EIA) March Annual Energy Outlook (AEO) 2009 published release (with some modifications to reflect the extended renewable tax credits specified in the stimulus bill) as our business-as-usual (BAU) reference case.

- The April AEO2009 updated release included changes to reflect stimulus bill provisions, as well as an updated economic forecast (reflecting the growing recession) and updated world oil prices. Because we did not perfectly replicate the changes made between the March and April releases of the AEO2009 in developing our BAU case, there are modest differences between our BAU case and the April AEO2009 updated release with the stimulus bill. For example, our BAU case forecasts slightly higher total primary energy consumption and energy-related carbon dioxide (CO2) emissions in 2030 relative to the AEO2009 updated release, by 2.0 percent and 3.5 percent, respectively.

- Otherwise, NEMS-NRDC used all of the same assumptions as AEO2009 Published Release, except for when we explicitly changed variables in our sensitivity runs (e.g., doubling nuclear overnight capital costs).

* AEO2009 generally reflects all current legislation and regulation that are defined sufficiently to be modeled as of November 5, 2008, including EISA 2007 and EPAct 2005. In addition, also reflect selected State legislation and regulations where implementing regulations are clear such as the October 2008 decision by the California Air Resources Board (CARB) on California's Low Carbon Fuel Standard (LCFS) requiring a 10-percent ethanol blend, by volume, in gasoline. For more information on what is included in AEO2009, please see: http://www.eia.doe.gov/oiaf/aeo/assumption/index.html

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NEMS-NRDC: ACES PROVISIONS MODELED

- The following provisions from the version of ACES that passed the House of Representatives were reflected in NEMS-NRDC:
  - Declining emission limits
  - Renewable Electricity Standard
  - Carbon capture and disposal incentives
    - Modeled using new logic developed by OnLocation that assumes that the incentive payments per ton of CO2 captured decline as a function of cumulative installed capacity
  - Energy efficiency provisions
    - Modeled by using the High Technology assumptions developed by EIA
  - Vehicle efficiency standards
    - Near-term fuel economy increases consistent with the national program for passenger vehicle efficiency announced by President Obama in May 2009 are included in BAU
    - ACES does not explicitly mandate higher vehicle efficiency standards, but it includes incentives that promote continued improvements in vehicle efficiency. ACES adds $25B to the EISA efficient vehicle manufacturer loan guarantees and also allocates another $28B in allowance value for automaker clean vehicle technology programs. These investments in clean, efficient vehicles paves the way for higher standards beyond those currently included in the base case
    - We imposed vehicle efficiency standards of 42mpg in 2020 and 55mpg in 2030, though NEMS-NRDC does not meet those levels and instead chooses to pay a fine instead of fulfilling those requirements
- Offsets supply in NEMS-NRDC was drawn from EPA curves, with one modification:
  - In our core NEMS-NRDC run of ACES, we assumed that international projects in avoided deforestation and forest management would not generate international offsets until 2020. We imposed that constraint to reflect a conservative view about the amount of time that developing countries will need before being able to produce and sell tradable offsets in those categories that meet the standards of the U.S. offsets program.

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MARKAL: DESCRIPTION OF BASELINE

- In MARKAL, BAU is also calibrated to the March AEO2009 Published release, and was modified to reflect:
  - The stimulus bill, including provisions for weatherization, the State Energy Program, the greening of General Service Administration-operated buildings, the removal of dollar caps in the investment tax credit for geothermal heat pumps and solar water heaters, and the extension of the renewable energy production tax credit
  - Higher overnight capital costs for geothermal generation technologies
  - Lower progress ratios for solar photovoltaic (PV) and onshore wind generation technologies
  - More constrained biomass supply
  - Slightly lower cost assumptions for more efficient light-duty vehicles (LDVs).
- In this case, total primary energy and energy-related CO2 emissions in 2030 are 1.9 percent and 4.6 percent lower, respectively, than in the EIA's April 2009 reference case.

MARKAL: ACES PROVISIONS MODELED

- The following provisions from the version of ACES that passed the House of Representatives were reflected in NEMS-NRDC:
  - Declining emission limits
  - Renewable Electricity Standard
  - Carbon capture and disposal incentives
  - Energy efficiency provisions
    - Modeled by increasing the efficiency of residential and commercial end-use devices by 5% per decade to reflect the impact of appliance standards, and decreasing demand in residential and commercial end-use categories to reflect the impact of building codes and other energy efficiency provisions
  - Vehicle efficiency standards
    - Near-term fuel economy increases consistent with the national program for passenger vehicle efficiency announced by President Obama in May 2009 are included in BAU
    - ACES does not explicitly mandate higher vehicle efficiency standards, but it includes incentives that promote continued improvements in vehicle efficiency. ACES adds $25B to the EISA efficient vehicle manufacturer loan guarantees and also allocates another $28B in allowance value for automaker clean vehicle technology programs. These investments in clean, efficient vehicles paves the way for higher standards beyond those currently included in the base case
    - We imposed vehicle efficiency standards of 42mpg in 2020, 55mpg in 2030, and 80mpg in 2050, which the model considers binding (unlike NEMS-NRDC, it meets the requirements instead of paying a fine)
- Offsets supply in MARKAL was drawn from EPA curves, with one modification:
  - We assumed that international projects in avoided deforestation and forest management would not generate international offsets until 2020. We imposed that constraint to reflect a conservative view about the amount of time that developing countries will need before being able to produce and sell tradable offsets in those categories that meet the standards of the U.S. offsets program.

NOTES TO SLIDES (1/5)

Slide 5:
The Department of Energy (DOE) estimates that over 60 percent of the oil discovered in the United States is considered "stranded" and uneconomical to recover conventionally. CO2-enhanced oil recovery (CO2-EOR) can yield up to 20 percent more oil of the original oil in place, extending the productive life of existing oil fields by 20 to 30 years. Oil field operators in western Texas, Mississippi, and Wyoming have been using this method for more than 30 years; they are currently producing more than 270 thousand barrels of oil per day. The DOE estimates that with ample supplies of CO2, between 45 and 64 billion barrels of domestic oil could be economically recovered.

The market for CO2-EOR, however, has been limited by available supplies of CO2. ACES will provide sufficient incentives to encourage capture of carbon dioxide on as much as 72 gigawatts of power generation capacity. As a result, the CO2 supply from the electric power sector alone is projected to meet the potential economic demand for CO2-EOR.[1]

Slide 6:
NRDC worked with Advanced Resources International, a specialist in CO2-EOR, to estimate the impact that carbon dioxide captured in the MARKAL model would have on EOR out to 2050. We estimate that 1.3 million barrels per day (MBD) of additional domestic oil production would result from EOR in 2020 under ACES, rising to 2.6 MBD in 2030 and 4.8 MBD in 2050.[2] With lower fuel demand and more oil produced domestically, we can import far less oil and strengthen our energy security. While the MARKAL model shows that growth in CO2-EOR partially substitutes for other forms of domestic oil production, ACES will result in a net reduction in oil imports of 2.1 MBD by 2030 and 5.0 MBD by 2050, with the United States eventually importing just 27 percent of the oil it needs, down from importing more than 60 percent of our oil needs today.

Slide 10:
Given these differences, much of the value of our overall effort comes from comparing the results of the two models. More specifically, whereas NEMS-NRDC attempts to forecast what would happen under ACES if market participants behave in a manner that mirrors past patterns, MARKAL finds the least-cost outcome and thus provides a roadmap for attaining our emissions reduction goals at the lowest long-term cost. For example, MARKAL shows that solar power can be a large source of cost-effective generation in the long run, which suggests that policies driving investments in solar power today can have major long-term benefits, despite the fact that these technologies are more expensive than other alternatives in the short run.

[1] Except in Alaska, where CCS is not expected to be deployed.
[2] Oil production and carbon sequestration potential will be site specific. Responsible operations are essential and sound regulations can help minimize any surface or subsurface risks

NOTES TO SLIDES (2/5)

Slide 12:
In MARKAL, allowance prices rise more rapidly than the discount rate between 2045 and 2050, due to an annual limit of 150 million tons of carbon placed on interperiod allowance banking. Without such a limit, the model purchases inexpensive international allowances in the 2015-2025 period and holds them until the 2045-2050 period. This amounts to assuming investors are willing to hold allowances for 30 years at a 5% annual return. The annual limit imposed results in a more reasonable rate of return on banked allowances, and forces the model to make investments in long-lived low-carbon infrastructure (especially power plants) toward the end of the model horizon.

Slide 13:
While MARKAL was calibrated to the March 2009 AEO Published Release, the March 2009 AEO does not reflect the stimulus bill. To account for its impact to create the baseline, we reflected provisions for weatherization, the State Energy Program, the greening of General Service Administration-operated buildings, the removal of dollar caps in the investment tax credit for geothermal heat pumps and solar water heaters, and the extension of the renewable energy production tax credit. Meanwhile, in NEMS-NRDC, whose foundation is also the March 2009 AEO Published Release, we just reflected the extension of the renewable energy production tax credit. As a result, the baselines of NEMS-NRDC and MARKAL differ from each other, with MARKAL showing lower baseline emissions.

We can draw an important implication from the choices observed in MARKAL: To minimize the long-term societal costs of meeting our emissions reduction targets, we should immediately begin accelerating investments in energy efficiency and transforming the electric power sector in order to shift to more sustainable solutions. This strategy would reduce compliance costs by overcoming nonmarket barriers that slow implementation of cost-effective energy efficiency measures and by accelerating experience-driven reductions in the cost of clean electricity generating technologies. An added benefit would be less reliance on offsets and the attendant concerns about their environmental integrity, plus the advantage of sending less money abroad and its resulting boost to our domestic economy.

Slide 15:
Note: Pumped storage is categorized with hydropower and accounts for 48 billion kWh of generation in 2020.

NOTES TO SLIDES (3/5)

Slide 17:
MARKAL shows a more significant increase in allowance prices under a cap alone because the complementary policies that differentiate the "ACES" case and the "Cap alone" case are more aggressive than those in NEMS-NRDC. For example, it reflects reductions in driving miles due to better transit (which is not explicitly specified in the bill, though funding for the planning of regional transportation efficiency is included in ACES, which could lead to reductions in driving miles).

Slide 19:
In our core NEMS-NRDC run of ACES, we assumed that international projects in avoided deforestation and forest management would not generate international offsets until 2020. We imposed that constraint to reflect a conservative view about the amount of time that developing countries will need before being able to produce and sell tradable offsets in those categories that meet the standards of the U.S. offsets program. As a result, the only international forestry offsets assumed to be available for purchase in the United States from 2012 to 2019 are those based on afforestation (though other types of offsets based on reducing direct emissions remain available). From 2020 onward, all three categories of international forestry-based offsets are assumed to be available on the market (afforestation, avoided deforestation, and forest management). For this sensitivity case we made two changes to international offsets supply: 1) We assumed that all offset categories would be available beginning in 2012 based on the EPA's supply curve; and 2) We raised the international limit to 1.5 billion tons from 1 billion tons since ACES provides that international offsets can be purchased up to 1.5 billion tons if domestic offset supply is insufficient to meet the domestic 1-billion-ton limit. When we make those two changes, allowance prices drop 19 percent.

Sensitivity analysis conducted by the EPA indicates that increasing the international offset limit to 1.5 billion tons accounts for the largest portion of this effect (although the EPA used a different model, our offset supply curves are based on the EPA's, so we expect that the relative effects would be similar). The EPA found that if no international offsets were allowed for the first 10 years in their model, allowance prices increased by just 3 percent. In another run, the EPA placed a firm limit on international offsets of 1 billion tons and allowance prices increased 11 percent compared to their core case in which up to 1.5 billion tons were allowed. As a result, we believe that most of the price decrease we see in our sensitivity run is due to the increase in the limit from 1 billion tons to 1.5 billion tons, as opposed to constraining certain types of international offsets through 2020.

Although the MARKAL model uses few offsets and manages to keep allowance prices low, that is because it invests more heavily and more quickly in energy efficiency and clean tech (because many of these investments actually turn out to be cheaper than offsets in the early years – e.g., McKinsey & Company estimates that many energy efficiency investments have a negative cost over the long-term (once fuel cost savings are taken into account). In that way, it immediately starts to reduce its emissions profile and requires fewer offsets in order to meet its allowance requirements.

NOTES TO SLIDES (4/5)

Slide 21:
Doubling nuclear overnight capital costs from the $3375/kW in our core NEMS-NRDC run of ACES results in more conventional coal, natural gas, and renewables, with negligible impacts on allowance prices.

Slide 22:
In our core ACES run of MARKAL, we assumed vehicle efficiency standards of 42 mpg in 2020, 55 mpg in 2030, and 80 mpg in 2050 (not specifically mandated in ACES). Allowing lower vehicle efficiency standards results in fewer electric and plug-in vehicles.

In NEMS-NRDC (not shown), we also assumed vehicle efficiency standards of 42 mpg in 2020 and 55 mpg in 2030. However, that model chose to pay a fine instead of meeting those standards (which is allowed in current CAFÉ standards).

Even though these vehicle efficiency standards are not mandated in ACES, we believe ACES will result in further reductions in gasoline consumption because incentives in the bill promote continued improvements in vehicle efficiency. ACES adds $25B to the EISA efficient vehicle manufacturer loan guarantees and also allocates another $28B in allowance value for automaker clean vehicle technology programs. These investments in clean, efficient vehicles paves the way for higher standards beyond those currently included in the base case. ACES also allocates allowances for clean vehicle manufacturing and vehicle electrification initiatives that will help commercialize vehicles that exceed currently proposed standards and thereby support on-going increases in the standards

Please note that for both NEMS-NRDC and MARKAL, both BAU and ACES runs include near-term fuel economy increases consistent with the national program for passenger vehicle efficiency announced by President Obama in May 2009. Therefore, any improvements as a result of that will not be reflected in either model as an improvement due to ACES.

Slide 25:
MARKAL assumes that transportation system policies will reduce driving miles, aka vehicle miles traveled (VMT), by 5% in 2020, 9% in 2030, and 12% in 2050 (all relative to BAU). Of this reduction in VMT, we assume that 15 percent will shift to public transit because smart growth policies will make it more accessible and convenient (the shift is split between 55 percent rail and 45 percent bus), with the remaining 85 percent representing a net reduction in VMT overall. Those assumed VMT reductions are similar in magnitude to what can be achieved through smart growth and land use planning strategies, as evaluated in the July 2009 Moving Cooler report. The report estimates that smart growth results in a 6–10 percent reduction in national light-duty VMT by 2030.

NOTES TO SLIDES (5/5)

Slide 25 (Continued):
We also ran two sensitivities, to see the impact of more aggressive reductions and no reductions. The more aggressive case is shown in the middle, with VMT reductions of 15% below BAU in 2020, 23% in 2030, and 31% in 2050.

While reductions in VMT are not mandated in ACES, it does provide funding for the planning of regional transportation efficiency, which we believe will lead to some reductions in VMT.

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