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Assessing the American Power Act: The Economic, Employment, Energy Security, and Environmental Impact of Senator Kerry and Senator Lieberman's Discussion Draft

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INTRODUCTION

On May 12, 2010, Senators John Kerry (D-MA) and Joseph Lieberman (I-CT) released details of their proposed American Power Act, a comprehensive energy and climate change bill developed over the preceding nine months by the two senators, chairmen of the Senate Foreign Relations and Homeland Security Committees respectively, along with Senator Lindsey Graham (R-SC).[1] With US unemployment just below 10 percent and the sunken Deepwater Horizon drilling rig's ruptured well pouring thousands of barrels of oil into the Gulf of Mexico each day, the senators promised that if passed the bill will: (1) reduce US oil consumption and dependence on oil imports; (2) cut US carbon pollution 17 percent below 2005 levels by 2020 and over 80 percent by 2050; and (3) create jobs and restore US global economic leadership. In this policy brief we evaluate the effectiveness of the proposed American Power Act in achieving those goals. Our key findings include (summarized in Appendix 1):

> **Energy Sector Changes:** Through an economywide carbon price and individual technology incentives, the American Power Act would significantly alter the way the United States produces and consumes energy. The share of total energy demand met by fossil fuel sources of supply would fall from 84 percent today to 70 percent in 2030. Renewable and nuclear energy would grow from 8 percent of US energy supply today to 16 and 14 percent respectively in

1. Details of the American Power Act are available online at http://kerry.senate.gov/americanpoweract/intro.cfm. Senator Graham did not ultimately participate in the release of the draft legislation.

2030. Over the next two decades, 106 gigawatts of renewable power, 78 gigawatts of nuclear power, and 72 gigawatts of carbon capture and sequestration would be built, replacing or retrofitting an aging fleet of coal-fired power plants. The legislation would also improve energy efficiency in homes, businesses, and vehicles, reducing overall energy demand by 5 percent relative to business as usual in 2030.

Energy Security Implications: The American Power Act would reduce US oil imports by 33 to 40 percent below current levels and 9 to 19 percent below business as usual by 2030. This will cut US spending on imported oil by $51 billion to $93 billion per year and by lowering global oil prices, reduce oil producer revenues by $263 billion to $436 billion annually by 2030.

Environmental Impact: The American Power Act would establish an economy-wide carbon price starting at $16.47 per ton in 2013 and growing to $55.44 dollars per ton in 2030, though different sectors of the economy would face this price at different start dates and through different mechanisms. The combined effect would be a reduction in greenhouse gas emissions from covered sources (85 percent of all emissions) of 22 percent below 2005 levels by 2020 and 42 percent by 2030 including international offsets. Economy-wide emissions (including offsets) are 17 percent below 2005 levels by 2020 and 31 percent by 2030.[2]

Employment Effects: The American Power Act prompts $41.1 billion in annual electricity sector investment between 2011 and 2030, $22.5 billion more than under business as usual. Given that the United States is currently below full employment with most economists projecting a slow labor market recovery, this investment is more stimulative than inflationary in the first decade, resulting in an average annual increase in US employment of 203,000 jobs above business as usual, with the net of the jobs lost in fossil fuel production and as a result of higher energy prices between 2001 and 2020. In the second decade of the program, higher energy and product prices offset the employment gains from new investment. The potential employment benefits of increased US competitiveness in clean energy exports, unlocking profitable investment opportunities in energy efficiency, and spillover from clean energy innovation into other sectors are not quantified in this analysis.

Impact on Consumers: By pricing carbon, the American Power Act raises the price of fossil fuels and electricity generated with fossil fuels for businesses and consumers. Households see a 2 to 5 percent increase in energy prices between 2011 and 2020, depending on fuel type, and a 3 to 7 percent increase between 2021 and 2030. Energy efficiency improvements offset some or all of these energy price increases. In our analysis, households see somewhere between a $136 increase and a $35 dollar decrease in annual energy expenditures, depending on future improvements in vehicle efficiency. The American Power Act also returns much of the revenue raised through the sale of pollution permits to households, with further mitigates the impact of higher energy prices.

The nation-wide assessment in this policy brief is descriptive only. Forthcoming analysis will evaluate state and regional impacts and identify areas in which the legislation could be changed to better achieve energy security, environmental, employment, and economic goals.

SCOPE AND METHODOLOGY

We analyzed the American Power Act using the US Energy Information Administration (EIA)'s National Energy Modeling System (NEMS).[3] NEMS is what EIA uses for their Annual Energy Outlook (AEO), as well as to model energy and climate change legislation when asked to do so by the US Congress. We used the AEO 2009 reference case as the business-as-usual scenario,[4] and assessed the impacts of the American Power Act through 2030 (the AEO 2009 modeling window). The day before the American Power Act was released, EIA published the final AEO 2010 (EIA 2010a). We were unable to switch over to the new baseline in time for this report, but incorporated the updated technology cost estimates from the AEO 2010 in our analysis.[5] Evaluating the employment effects of energy and climate change legislation has not, in the past, been a primary focus of NEMS. Given that job creation is one of the principle objectives Senators Kerry and Lieberman seek to achieve with their proposal, we enhanced the model to provide a more accurate picture of the bill's potential employment impacts. Our methodology is discussed in the section on employment below.

2. The American Power Act includes some complimentary measures to reduce emissions from non-covered sources, such as a separate program for hydrofluorocarbons (HFC) gases. We do not include these in our analysis.

3. Documentation on the NEMS model is available online at http://www.eia.doe.gov/oiaf/aeo/overview/.

4. The Annual Energy Report 2009 includes the provisions of the American Recovery and Reinvestment Act and is available online at http://www.eia.doe.gov/oiaf/archive/aeo09/index.html (EIA 2009).

5. Specifically, we used AEO 2010's capital costs for power generation technology, which included a 13 percent increase in the cost of nuclear power plants and a 5 to 6 percent increase in the cost of carbon capture and sequestration over AEO 2009 capital cost assumptions.

Using this framework, we modeled the major provisions in titles I–IV of the legislation:

Title I—Domestic Clean Energy Development: Provides incentives for the deployment of nuclear power, carbon capture and sequestration (CCS), renewable energy, clean vehicles, and energy efficiency. This title also includes offshore drilling provisions, but in our analysis these provisions would not materially alter the levels of development projected by EIA under business as usual and are not included in the model.

Title II—Greenhouse Gas Pollution Reduction: Establishes economywide greenhouse gas (GHG) pollution reduction targets but sector-specific regulations. Beginning in 2013, the electric power sector must purchase pollution permits (called emission allowances) to cover their annual greenhouse gas emissions, thus creating a market price for carbon. This obligation extends to natural gas and the industrial sector starting in 2016. The power and industrial sectors can use offset credits to cover up to two billion tons of their collective compliance obligation, 25 percent of which can come from international sources.[6] The transportation sector purchases allowances at a set price equal to the average market price for the power and industrial sectors pay for emission allowances at the end of each quarter. This title sets a $25 ceiling on allowance prices in 2013, which increases by 5 percent annually, adjusted for inflation. There is also a price floor of $12 in 2013 that increases at a rate of 3 percent annually, adjusted for inflation.[7] The Environmental Protection Agency (EPA) holds 3.6 percent of all allowances in a strategic reserve to be sold at the ceiling price if it's reached.

Title III—Consumer Protection: Sixty-five percent of the value of the allowances created by title III is used to offset the impact of higher energy prices on US consumers. In the first few years of the program, this is mostly through the provision of free allowances to electricity and natural gas local distribution companies (LDCs), who are instructed to use them for the benefit of rate payers. Later in the program, allowance revenue is returned directly to consumers as a rebate. In all years, 15 percent of allowance value is provided to low-income households.

Title IV——Job Protection and Growth: For the first decade, industry is required to purchase allowances, the revenue raised from qualifying energy-intensive and trade-exposed industries is returned to them in the form of a rebate to mitigate a potential loss of international competitiveness resulting from higher energy prices. These rebates are provided in a way that rewards the cleanest and most efficient firms in a given industry in order to maintain the pollution reduction incentive created by a carbon price. Starting in 2026 these rebates begin to phase out. If, by that time, other countries have not taken action to reduce GHG emissions stringent enough to meet criteria laid out in the bill, the president is instructed to establish a program though which imports of energy-intensive goods into the US would face the same carbon price as those produced domestically. Title IV also includes incentives for heavy vehicles to switch from oil to natural gas and instructs the Environmental Protection Agency to establish motor vehicle standards for model years after 2016 that "reflect the greatest emission reductions and fuel efficiency improvement achievable." While we model the natural gas incentives in our core scenario, we elected to assess the impact of the vehicle standards instruction to EPA through an alternative scenario in which corporate average fuel economy (CAFE) standards post-2016 increase at the average annual rate between 2011 and 2016 (referred to as the "CAFE scenario" in this policy brief).

Titles V and VI address international cooperation and efforts to adapt to the impact of climate change and are not included in our analysis. Title VII addresses compliance with the Statutory Pay-As-You-Go-Act of 2010 and we model the bill as budget neutral. A complete description of the provisions of the American Power Act included in this analysis and the methodology used, as well as additional modeling results, is available online at www.rhgroup.net/americanpoweract.

ENERGY SECTOR CHANGES IN THE UNITED STATES

By placing a price on carbon dioxide and other greenhouse gas emissions, providing incentives for low-carbon sources of energy supply and improving the efficiency of energy use through a range of mechanisms, the American Power Act would substantially alter the way energy is produced and consumed in the United States. By 2030, overall energy demand would be 5 percent lower than under a business-as-usual scenario (EIA's AEO 2009 reference case), though still 5 percent higher than today.[8] More significant is the change

6. The share of offsets from international sources can increase to 50 percent if there are insufficient domestic offsets available.

7. The floor and ceiling price are defined in 2009 dollars.

8. There are modest levels of efficiency improvement in the transportation, residential, commercial, and industrial sectors as a result of higher energy prices. In addition, we included the building codes contained in the American

Table 1 Energy consumption by source

		Business-as-usual		American Power Act	
quadrillion btu	**2008**	**2020**	**2030**	**2020**	**2030**
Petroleum	38.3	37.3	38.1	36.1	35.9
Natural gas	23.7	22.1	24.2	21.2	21.1
Coal	22.4	24.4	25.4	20.9	16.8
Nuclear power	8.3	9.1	9.3	10.5	14.7
Renewables	7.7	11.6	13.8	13.0	16.7
Hydropower	2.6	2.9	3.0	2.9	3.0
Biomass	2.3	3.0	3.6	4.4	4.7
Biofuels	1.5	2.6	4.0	2.5	5.0
Municipal solid waste	0.4	0.4	0.4	0.5	0.5
Wind	0.5	2.0	2.0	2.0	2.4
Solar	0.0	0.1	0.1	0.1	0.1
Geothermal	0.3	0.5	0.6	0.5	1.0
Other	0.2	0.1	0.0	0.1	0.1
TOTAL	100.5	104.7	110.8	101.8	105.4

Source: Authors' estimates of the impact of the American Power Act as modeled using the Energy Information Administration's AEO2009 version of the National Energy Modeling System.

in sources of energy supply. Fossil fuels, which now meet 84 percent of America's energy needs, fall to 70 percent of US energy supply by 2030 (table 1).[9] They are gradually replaced with nuclear and renewable energy, each of which accounts for 8 percent of US energy consumption today and could grow to 14 and 16 percent respectively in 2030.

Under the American Power Act, the United States builds 106 gigawatts of new renewable power generation capacity over the next two decades (figure 1). Much of this is due to the renewable energy incentives included in the Emergency Economic Stabilization Act (US House of Representatives 2008) and the American Reinvestment and Recovery Act (US House of Representatives 2009a) but an additional 24 gigawatts comes online as a result of the American Power Act. The majority of new renewable capacity is wind, accounting for 58 percent of the additions between 2008 and 2030 (table 2). Biomass comes in second at 23 percent, followed by solar at 13 percent. By 2030, renewables account for 18 percent of all power generation capacity, up from 12 percent today (table 2), and 21 percent of all electricity production, up from 10 percent today (figure 2)[10].

While renewable energy grows the fastest overall under the American Power Act, nuclear power sees the fastest growth relative to business as usual. Adding $36 billion in new loan guarantees and a 10 percent investment tax credit for plants put in operation by 2025 to a carbon price that already favors nuclear, the American Power Act results in 78 gigawatts of new nuclear power capacity over the next two decades, 68 gigawatts more than under business as usual. By 2030, nuclear accounts for 15 percent power generation capacity, up from 10 percent today (table 2). And because nuclear power has a higher capacity factor than most renewable sources, it accounts for 30 percent of all electricity generation in 2030, up from 20 percent today (figure 2).

Low-carbon fossil fuel power generation technologies are also widely deployed as a result of the American Power Act. In addition to the carbon price, the bill includes a number of incentives for carbon capture and sequestration (CCS). Qualifying CCS projects receive bonus allowances worth $96 per ton for the first 10 gigawatts, $85 per ton for the second 10 gigawatts and a value determined by EPA for plants after that. In addition, the bill imposes a small levy on electricity produced from fossil fuels to raise $20 billion for CCS demonstration projects. As a result, 72 gigawatts of CCS capacity are installed between 2008 and 2030, 53.7 gigawatts on coal-fired power plants and 18.3 gigawatts on natural gas (figure 1). And because natural gas emits less carbon than coal, even without CCS, another 40 gigawatts of natural gas generation capacity is deployed by 2030. All told, by 2030 more than half of all electricity produced in the United States comes from low-carbon sources (renewable, nuclear, and CCS), up from today's 29 percent (figure 2).

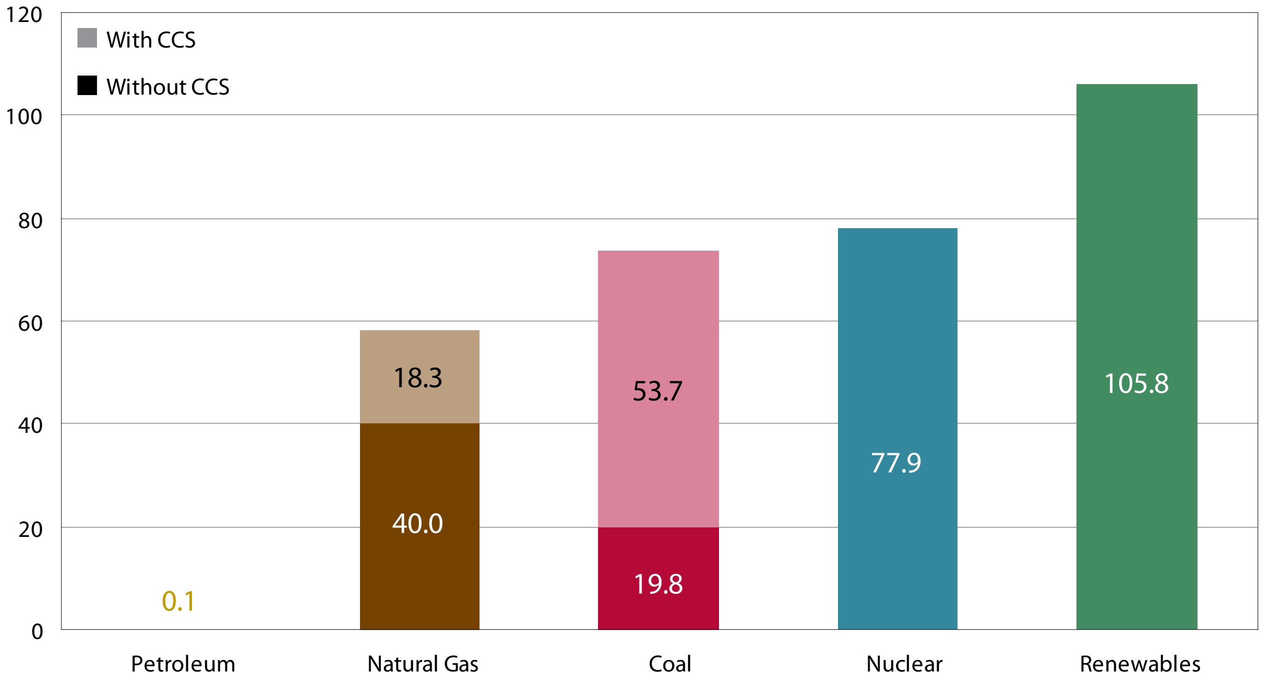
While the power sector experiences the most significant

Clean Energy Leadership Act (US Senate 2009) passed by the Senate Energy and Natural Resources Committee, provisions from which Senators Kerry and Lieberman have indicated will be married to the American Power Act on the Senate floor. We also assess the impact of allowance revenue earmarked for energy efficiency improvements on residential and commercial energy demand. For a complete description of provisions modeled see www.rhgroup.net/americanpoweract/.

9. Recent unconventional gas resource development in the United States has significantly changed the outlook for long-term natural gas prices and domestic supply. Some observers have argued that this development is not fully captured in the AEO 2009, which, while reflecting the current decline in natural gas prices, projects a rebound in gas prices in the years ahead. If the US gas market remains in surplus, as some analysts believe, and gas prices do not recover, the American Power Act could lead to greater deployment of the natural gas–fired power generation than our modeling suggests. We also do not include the "Merchant Generator Efficiency Incentives" of the American Power Act (Section 798) in our analysis, which could also incentivize coal to gas switching in the power sector.

10. The NEMS model forecasts power plant construction based on projected electricity demand and the relative cost of competing sources of electricity supply. There are considerable uncertainties surrounding cost, supply chain, and public acceptance of both CCS and nuclear power which account for a combined 47 percent of projected capacity construction under the American Power Act. Subsequent analysis will explore the impact of delayed or more expensive CCS and nuclear deployment on energy prices, employment and economic growth.

Figure 1 New investment in power generation
Million kilowatts gross capacity additions, 2010–2030



CCS = carbon capture and sequestration

Source: Authors' estimates of the impact of the American Power Act as modeled using the Energy Information Administration's AEO2009 version of the National Energy Modeling System.

changes as a result of the legislation during the first two decades, the bill includes incentives for reducing the amount of coal and oil consumed in the industrial, commercial, residential, and transportation sectors. By pricing carbon, the legislation creates incentives for purchasing more efficient vehicles, producing biofuels for transportation, and switching from fossil fuels to cleaner and more efficient energy use in homes and businesses. The legislation also includes a range of complimentary provisions including tax credits for natural gas heavy vehicles, building codes, and industrial energy efficiency research and development (R&D). Taken together these provisions reduce household demand for heating oil by 21 percent (compared with business-as-usual in 2030), curb industry coal demand by 13 percent and cut gasoline demand in the transportation sector by 5 percent. Under our CAFE scenario, gasoline demand is 14 percent lower in 2030 than under business as usual. Changes in transport, industry, and residential energy use resulting from the bill increase significantly after 2030 once economically viable emission reduction opportunities in the power sector are exhausted.

Energy Security Implications

Evaluating the impact of the American Power Act on US energy security is a somewhat subjective exercise as energy security is poorly defined in quantitative terms. Discussion in the United States tends to focus on American dependence on imported energy (though the reliability of domestic energy supply is also a security concern as demonstrated by the Northeast blackout of 2004 or Hurricane Katrina). The literature tends to group the security consequences of American oil dependence (which accounts for 84 percent of all US energy imports, the rest being natural gas from Mexico and Canada) into four categories (Crane et al. 2009 and Council on Foreign Relations 2006):

1. The economic toll of US oil consumption, particularly at the high and volatile oil prices of recent years.
2. The foreign policy impact of US economic ties to oil producing states, particularly those in the Middle East.
3. The security consequences of income transfers to oil producers, many of whom are considered "states of concern."
4. The international relations implications of competition for

Table 2 Power generation capacity by source

		Business-as-usual		American Power Act	
billion kilowatts	**2008**	**2020**	**2030**	**2020**	**2030**
Coal	315.3	333.3	344.5	313.3	331.6
with CCS	0.0	2.0	2.0	6.9	53.7
Natural Gas	428.6	421.8	511.8	406.2	435.0
with CCS	0.0	0.0	0.0	1.0	18.3
Oil	24.1	24.2	24.2	24.2	23.0
Nuclear power	100.6	110.3	109.8	128.4	177.4
Renewables	116.5	176.4	188.6	176.7	212.8
Hydropower	77.4	77.7	77.8	77.7	79.4
Geothermal	2.4	3.0	3.3	3.0	4.8
Municipal solid waste	3.8	4.7	4.7	5.1	5.1
Biomass	6.8	12.5	20.9	11.9	28.8
Wind	24.9	66.6	68.2	67.0	80.7
Solar	1.2	12.0	13.7	12.1	14.0
Other*	25.1	27.4	27.5	27.3	27.0
TOTAL	1010.2	1093.3	1206.2	1076.1	1206.8

CCS = carbon capture and sequestration

* Other includes pump storage and end-use generation not specified in NEMS.

Source: Authors' estimates of the impact of the American Power Act as modeled using the Energy Information Administration's AEO2009 version of the National Energy Modeling System.

oil resources between the United States and other major economies.

Our modeling can provide some quantitative insight into the effectiveness of the American Power Act in addressing numbers 1 and 3. Numbers 2 and 4 are primarily qualitative questions largely outside the scope of this paper.

Through a combination of improved efficiency and fuel switching to ethanol, biodiesel, natural gas, and electricity, the American Power Act (under the core scenario) reduces net US oil imports (imports minus exports) by 33 percent below 2008 levels and 9 percent below business as usual in 2030 (table 3). Lower US oil demand reduces global oil prices, the combined effect of which is a decrease in US expenditure on imported oil of $51 billion annually by 2030. NEMS models global oil production and US oil imports by region, but not by country (with the exception of Canada, Mexico, Brazil, and Russia). In tables 3 and 4 we've broken this down to the country level assuming that country's share of the region's oil exports to the US remains constant over time. National oil production and global trade flows two decades out are, of course, highly uncertain. But this approach provides a notional sense of how the reduction in US spending might be allocated across countries. The reduction in oil prices resulting from efficiency and fuel switching in the United States lowers oil producer revenue by $263 billion in 2030, split 50/50 between Organization of Petroleum-Exporting Countries (OPEC) and non-OPEC countries. Under our CAFE scenario net US oil imports are 40 percent lower than 2008 levels and 19 percent lower than business as usual by 2030 (table 4). US spending on imported oil is down $93 billion per year and oil producer revenue is down $436 billion per year by 2030 relative to business as usual.

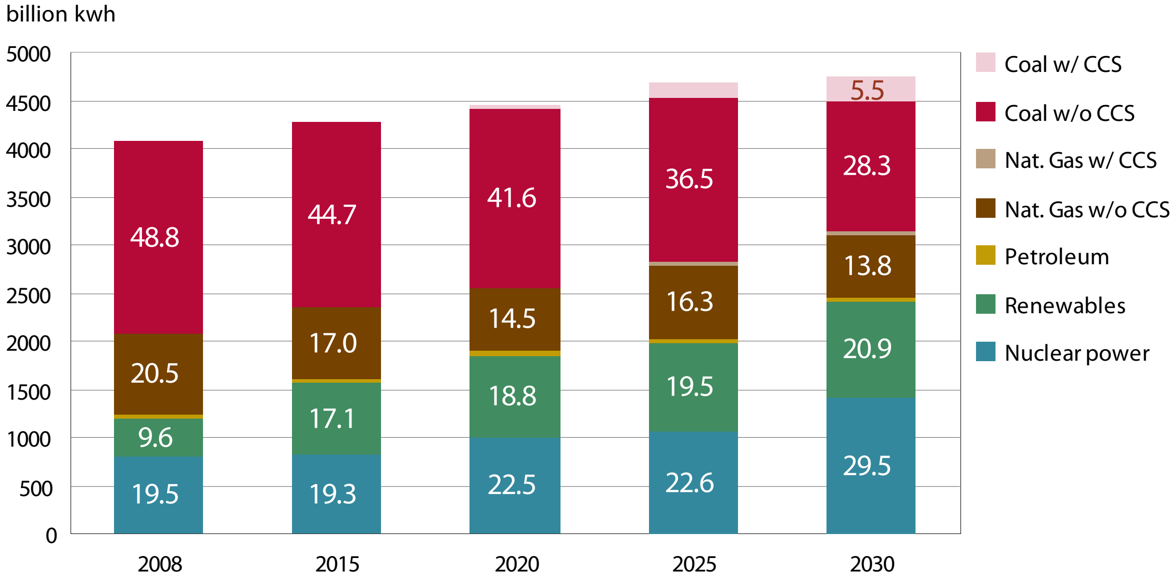
In the coming weeks we will analyze the impact of this reduction in oil producer revenue on the economic and political prospects for OPEC and non-OPEC countries alike and their relationship with other oil importing countries, speaking to numbers 3 and 4 above. For a more robust assessment of the effectiveness of the American Power Act in addressing number 1, we will analyze its impacts during different oil supply disruption scenarios as well as under the stable international oil market environment projected by the model.

Environmental Impact

The American Power Act sets out a goal of reducing US greenhouse gas emissions 17 percent below 2005 levels by 2020, 42 percent by 2030, and 83 percent by 2050. In our analysis, the bill achieves these goals for emission sources covered by the legislation, roughly 85 percent of US GHG emissions, through 2030 (the period we assess). If emissions from non-covered sources continue to grow on a business-as-usual trajectory, overall US emissions (including domestic offsets and sequestered carbon) will decline 8 percent below 2005 levels by 2020 and 17 percent by 2030. International offsets extend economywide emission reductions to 17 percent below 2005 levels by 2020 and 32 percent by 2030. The American Power Act includes a number of provisions to reduce emissions from non-covered sources, including a separate trading program for hydrofluorocarbon (HFC) gases, which we did not evaluate and which would further increase overall abatement.

It's also worth noting that US CO_2 emissions have declined far quicker during the past two years than the AEO 2009 projected. According to the EIA's April 2010 Monthly Energy Review (EIA 2010b), US CO_2 emissions in 2009 were 5,405 million tons, 5 percent lower than the AEO 2009 business-as-usual projections. This makes achieving the targets laid out in the American Power Act easier, but does not necessarily increase the overall level of abatement unless the recent drop occurred in non-covered as well as covered sources and these emissions remain at their new levels rather than rebounding as the economy comes out of recession.

Figure 2 Power generation by source



Note: Numbers within each column are percentages.

Source: Authors' estimates of the impact of the American Power Act as modeled using the Energy Information

Table 3 Energy security impact of the American Power Act: Core scenario

	2008	Business-as-usual in 2030	American Power Act in 2030	American Power Act vs. business-as-usual in 2030		
Country/region	**US oil imports, thousand barrels/day**	**US oil imports, thousand barrels/day**	**US oil imports, thousand barrels/day**	**US oil imports, thousand barrels/day**	**US oil imports, billion dollars/year**	**Producer revenue, billion dollars/year**
OPEC	4,903	3,429	3,100	–328	–21.6	–132.9
Saudi Arabia	1,471	992	898	–94	–6.2	–42.7
Venezuela	1,196	859	778	–81	–5.3	–9.4
Nigeria	575	373	338	–35	–2.3	–7.4
Iraq	603	407	368	–38	–2.5	–9.4
Algeria	284	258	230	–28	–1.8	–6.0
Angola	256	167	151	–16	–1.0	–6.9
Kuwait	202	136	123	–13	–0.8	–10.8
Libya	53	49	43	–5	–0.3	–5.1
Iran	0	0	0	0	0.0	–18.7
Non-OPEC	6,138	4,774	4,331	–443	–29.4	–130.3
Canada	1,758	1,486	1,350	–136	–9.1	–11.6
Mexico	1,190	773	700	–73	–4.8	–5.3
Russia	319	308	279	–29	–1.9	–22.8
Brazil	168	154	139	–15	–1.0	–9.1
Sudan	0	0	0	0	0.0	–1.2
Total	11,041	8,203	7,431	–771	–51.0	–263.1

Note: Real 2007 US dollars using average import price for all crude oil in 2030 forecast by NEMS. Production levels in 2030 based on regional forecasts by NEMS, disaggregated to the country level assuming a constant 2008 share of regional production, with the exception of Canada, Mexico, Russia, and Brazil, for which country-level forecasts are available in NEMS.

Source: Authors' estimates of the impact of the American Power Act as modeled using the AEO2009 version of the Energy Information Administration's National Energy Modeling System (NEMS).

Table 4 Energy security impact of the American Power Act: CAFE scenario

	2008	Business-as-usual in 2030	American Power Act in 2030	American Power Act vs. business-as-usual in 2030		
Country/Region	US oil imports, thousand barrels/day	US oil imports, thousand barrels/day	US oil imports, thousand barrels/day	US oil imports, thousand barrels/day	US oil imports, billion dollars/year	Producer revenue, billion dollars/year
OPEC	4,903	3,429	2,749	–679	–39.8	–217.5
Saudi Arabia	1,471	992	793	–198	–11.6	–71.7
Venezuela	1,196	859	692	–167	–9.8	–14.3
Nigeria	575	373	299	–73	–4.3	–11.3
Iraq	603	407	325	–81	–4.7	–15.8
Algeria	284	258	206	–53	–3.1	–9.1
Angola	256	167	134	–33	–1.9	–10.5
Kuwait	202	136	109	–27	–1.6	–18.1
Libya	53	49	39	–10	–0.6	–7.9
Iran	0	0	0	0	0.0	–31.3
Non-OPEC	6,138	4,774	3,874	–900	–53.5	–218.9
Canada	1,758	1,486	1,204	–282	–16.7	–17.7
Mexico	1,190	773	615	–158	–9.2	–8.1
Russia	319	308	252	–56	–3.4	–34.8
Brazil	168	154	122	–31	–1.8	–13.9
Sudan	0	0	0	0	0.0	–1.8
Total	11,041	8,203	6,623	–1,579	–93.3	–436.4

Note: Real 2007 US dollars using average import price for all crude oil in 2030 forecast by NEMS. Production levels in 2030 based on regional forecasts by NEMS, disaggregated to the country level assuming a constant 2008 share of regional production, with the exception of Canada, Mexico, Russia and Brazil, for which country–level forecasts are available in NEMS.

Source: Authors' estimates of the impact of the American Power Act as modeled using the AEO2009 version of the Energy Information Administration's National Energy Modeling System (NEMS).

The effectiveness of the American Power Act in meeting its stated emission reduction goals beyond 2030 is less clear. As described above, the legislation includes a price collar with a ceiling starting at $25 per ton and increasing at 5 percent per year adjusted for inflation, and a floor starting at $12 per ton and increasing at 3 percent per year adjusted for inflation. Our analysis shows the American Power Act resulting in a carbon price of $16.47 in 2013 (measured in real 2009 dollars, same as the price collar) which increases to $55.44 in 2030. On this trajectory, the carbon price would hit the ceiling sometime between 2030 and 2035. EPA has at its disposal an initial tranche of 4 billion allowances which are set aside in a strategic reserve to maintain the environmental integrity of the program in the event allowances prices hit the ceiling. As EPA sells allowances from the reserve into the market at the ceiling price, they are directed to replenish the reserve by using the revenue to purchase international offsets. The effectiveness of the ceiling, therefore, depends on whether international offset supply is sufficient and affordable enough for reserve replenishment given post-2030 domestic allowance demand.

By improving energy efficiency and creating incentives for nonfossil sources of energy, the American Power Act would also significantly reduce local air pollution. By 2030, mercury emissions from the power sector are expected to be 43 percent lower than under business as usual. Nitrogen oxide emissions are expected to be 34 percent lower and sulfur dioxide emissions 6 percent lower.

Curbing use of fossil fuels—particularly coal—cuts air pollution and all its impacts on human and ecological health and welfare. Many of those impacts—including reduced crop yields and impaired ecosystem services—are not easily quantifiable. They depend on wind direction and speed, temperature, air and soil biology, human and wildlife behaviors, and other factors that bear on how pollutants are dispersed and the exposure and susceptibility of biological systems. For pollutants and damages that can be quantified, the National Research Council (NRC) found that the average coal-fired power plant produces $156 million per year or 3.2 cents per kilowatt hour in adverse impacts unrelated to climate change (NRC 2010). Older, less efficient coal and oil plants produce more of these pollutants than newer plants and less carbon-intensive fuels. The NRC panel found that 10 percent of coal-fired plants produce 43 percent of air pollution damages. These plants are the likeliest to be retired earlier under climate legislation.

"By placing a price on carbon dioxide and other greenhouse gas emissions, providing incentives for low-carbon sources of energy supply and improving the efficiency of energy use through a range of mechanisms, the American Power Act would substantially alter the way energy is produced and consumed in the United States."

The majority of monetary damages arise from human illness and premature mortality, particularly from respiratory ailments. Based on NRC calculated damages per ton of two criteria pollutants—sulfur dioxide and nitrogen oxides—the American Power Act would reduce damages through 2030 from average coal plant emissions by nearly $5 billion (in 2007 dollars). The reduction in those damages is likely to be higher, however, and could rise as high as $8.7 billion based on estimated damages from plants with higher emissions close to human populations. The NRC estimates do not include adverse impacts on human welfare or ecological health, e.g., reduced visibility from particulates or reduced crop yields, fragmented forests, and impaired fisheries from acid rain deposition. The estimates also do not include adverse impacts from other pollutants such as mercury (cognitive impairment and increased risk of heart attack), arsenic (increased risk of cancer), and other heavy metals.

Also, thermoelectric plants—chiefly fossil and nuclear—draw more water in the United States than any other purpose, more than four times residential, commercial, and other industrial uses combined (US Geological Survey 2005). Total withdrawals by the sector for cooling have changed little since the mid-1970s. By placing a price on carbon, the composition of generators in the electric power sector shifts toward newer, more efficient thermal plants—fossil, nuclear and renewable—and toward technologies such as wind and solar panels that require little or no water to operate. While some low-carbon generators such as solar thermal and biomass plants can use as much water as the fossil plants that they replace, decarbonization in general results in net water savings through 2030.

Based on estimated gallon per kilowatt hour consumptive use of water by generator types (Baum et al. 2003 and USDOE 2008), the American Power Act would save a total of 292 billion gallons by 2030 or an average of about 11.7 billion gallons per year. This annual average savings is roughly 1.7 times US consumption of bottled water (Pacific Institute 2009). Peak annual water savings are five times higher and are sustained from 2014 through 2017.

Employment Effects

With unemployment hovering around 10 percent two and a half years after the recession began[11] and midterm Congressional elections approaching, job creation is at the top of the US political agenda and a principal frame through which politicians and the public will view the American Power Act. Unfortunately, existing analysis on the impact of energy and climate change policy on US employment is all over the map, forcing senators to rely primarily on anecdotal evidence and opinions of home state industries in forming their point of view on this important question.

Attempts to quantify the employment effects of energy and climate change policy fall broadly into two categories. The first is a bottom-up approach most recently popularized through efforts to evaluate the jobs impact of stimulus spending as part of the American Recovery and Reinvestment Act.[12] The Political Economy Research Institute (PERI) and Center for American Progress (CAP), for example, argued that $100 billion of clean energy spending would create 2 million jobs, four times more than the same amount spent in the oil industry (Pollin et al. 2008). This analysis looked only at the *gross* employment effects, ignoring the *net* effect after raising taxes or cutting government services in future years to offset near-term deficit spending. But as there was broad consensus at the time that a good dose of Keynesian stimulus was required, spending money on windmills rather than ditch digging meant meeting economic and environmental goals simultaneously.

The same analytical approach falls short when assessing the employment impacts of comprehensive energy and climate legislation.[13] The reason is that the investment in clean

11. The recession that began in December 2007 may have already ended but the National Bureau of Economic Research's Business Cycle Dating Committee has yet to date the trough. See http://www.nber.org/cycles/april2010.pdf.

12. We published an assessment of the employment impacts of various stimulus provisions using NEMS in February 2009, available online at www.piie.com (Houser, Mohan and Heilmayr 2009).

13. For example, a 2008 report by the US Conference of Mayors estimates the

energy and energy efficiency generated through such policy is paid for with higher energy prices rather than government borrowing. And these higher energy prices work against the job creation benefits of new green investment. Identifying the *net* employment impact of energy and climate legislation is a daunting task.

"Curbing use of fossil fuels—particularly coal—cuts air pollution and all its impacts on human and ecological health and welfare."

The second category of analysis takes a top-down approach, using either top-down computable general equilibrium (CGE) or macroeconomic models.[14] These models effectively capture what the bottom-up methodology used by PERI, the US Conference of Mayors, and others miss when it comes to comprehensive energy and climate policy—the impact of higher energy prices resulting from the switch to cleaner forms of energy. In most top-down models, more expensive energy means lower real wages because US workers have less money left over after paying for electricity, natural gas, and petroleum to buy other goods. And lower real wages prompt some workers to leave the labor market, reducing aggregate employment and further reducing consumer spending. That means lower industrial output from firms selling to US consumers and lower employment in those industries. In addition, energy-intensive industries in the United States may be put at a disadvantage vis-à-vis their foreign competitors as a result of higher energy prices if other countries don't adopt similar policies. This has the potential to reduce employment as well.

Yet while top-down models forecast jobs lost from higher energy prices, they don't accurately assess jobs created from the increase in investment likely to occur in the United States from pricing carbon (what the bottom-up models do well). For example, the input-output tables used in CGE modeling indicate the amount of investment, labor, and fossil fuels required by each industry to produce one dollar. These ratios are derived from economywide averages in whatever reference year is used in the model. So when policy raises energy prices and households and businesses improve efficiency in response, overall energy consumption falls and energy sector investment falls right along with it. This works okay for fossil fuel production like mining coal and pumping oil, but misses most of the story when it comes to power generation given the state of the electricity sector in the United States.

Continuing along business as usual for the United States means continuing to operate coal-fired power plants built decades ago for power generation. Over 95 percent of coal-fired generating capacity in the United States is more than 20 years old (EIA 2007). Pricing carbon would mean replacing these plants with natural gas, renewable energy, nuclear power, or retrofitting them for CCS. That all requires far more investment than maintaining the existing coal-fired power fleet, even if overall electricity demand falls moderately from efficiency improvements. Most top-down models are too aggregated to capture this turnover in the capital stock. And given the scale of power sector transformation described earlier, the amount of additional investment demand created by the American Power Act would be significant. Now the economically astute reader may point out that it's all fine and good to argue that pricing carbon will produce an increase in investment in power generation, but that investment needs to come from somewhere—and if the economy is at full employment a surge of investment demand will cause inflation. Both points are correct. But the economy is far from full employment, and in the AEO 2009, the United States doesn't return to full employment until 2020.

To reconcile these two approaches and capture the employment impacts of both new clean energy investment and higher energy prices resulting from that investment, taking account for the current economic conditions in the United States and state of the power generation capital stock, we made some enhancements to the NEMS model. NEMS is a hybrid model that combines a bottom-up engineering model of unrivaled technical detail and a top-down macroeconomic model that forecasts changes in GDP, consumption, investment, trade, industrial output, and employment.[15] NEMS provides the type of plant-level detail required to assess the change in power sector investment resulting from energy and climate change policy. In the AEO 2009 business-as-usual scenario, projected capacity additions in the power sector

number of "green jobs" that would be created in renewable energy and energy efficiency if 40 percent of power generation came from alternative sources by 2038. Their estimate of 4.2 million "green jobs" in 2038 does not account for jobs lost in fossil fuel industries or due to higher energy prices.

14. A recent report by the Congressional Budget Office (CBO 2010) published a review of studies from Resources for the Future (Ho 2009), the Brookings Institution (McKibben et al. 2009), and Charles River Associates (Montgomery et al. 2009) that assess the employment impacts of energy and climate change policy using top-down models.

15. Full documentation on the NEMS model is available online at http://www.eia.doe.gov/oiaf/aeo/overview/. A detailed description of the assumptions used in assessing the American Power Act and the employment-oriented modifications made to NEMS is available online at www.rhgroup.net/americanpoweract.

translate into $18.6 billion per year in investment, on average, between 2011 and 2030 (in real 2007 dollars). Under the American Power Act, power sector investment grows to $41.1 billion per year.[16]

In the version of NEMS operated by EIA, that change in investment is not passed on to the macroeconomic model, primarily because economic and employment forecasting is not what EIA uses NEMS for. In the version used for this analysis, any increase in investment above business as usual was passed to the macroeconomic model, which calculated the net impact on US employment given the higher interest rates, higher saving rates, increased capital inflows from abroad, and US dollar appreciation resulting from a shift in investment demand. Because the economy is not at full employment, because the construction of new power plants happens first and higher energy prices follow, this increase in investment demand modestly stimulates economic growth and job creation in the first decade. Between 2011 and 2020, average annual employment in the US increases by 203,000. In figure 3 we break down the mix of factors shaping the labor market response to the legislation during this period.

Clean energy investment: Starting on the left-hand side of the chart we show the number of jobs created from the increase in investment in new nuclear, renewable, and CCS power generation capacity, as well as increased production of biofuels, relative to business as usual. These estimates are derived from a detailed assessment of how $1 spent installing and operating each energy technology is divided between industrial sectors (e.g., between construction labor, steel production, engineering services, equipment manufacturing, etc.) and those industries' employment multipliers.[17]

Reduced fossil fuel demand: From this we subtract the number of jobs lost through lower demand for fossil fuels and foregone construction of new fossil fuel power generating capacity. This includes direct, indirect, and induced jobs as well.

Higher energy prices: We further subtract the jobs lost when households have less money to spend on other goods because energy has become more expensive.

Revenue recycling: Under the American Power Act, a significant share of the emission allowances is auctioned and this share grows over time. The revenue from these auctions is used to invest in energy efficiency, transportation infrastructure, clean energy R&D and adaptation, or is returned to consumers to offset higher energy prices. The employment impact of each of these uses of allowance revenue is added to the running net jobs total.

Macroeconomic effects: The final adjustment to get to our 203,000 net jobs number is listed in figure 3 as "macroeconomic effects." This includes changes in consumer demand for nonenergy goods that are more expensive because of higher energy costs, reduction in investment in nonenergy sectors because additional investment in power generation has pushed up interest rates, and changes in the US current account position resulting from a net increase in US investment demand.

After 2020, the US economy is projected to be back at full employment and the additional power sector investment becomes more inflationary. In addition, free allocation of emission allowances to local distribution companies begin to phase out, which results in higher energy prices. The net effect is that after 2025, some of the employment gains in the first decade of the program are clawed back, bringing the 2011–30 average back in line with business as usual (average annual employment is 6,300 jobs higher than business as usual across the full two decade period modeled). While outside the window of this analysis, energy prices will likely continue to increase beyond 2030 as GHG abatement costs get higher. In most top-down analyses of the economic impacts of US energy and climate policy to 2050, the most significant decline from business as usual is in the out years (see EPA 2010).

On the flip side, there are three factors that our analysis doesn't cover that could improve the employment outlook of the American Power Act beyond 2020. These are factors that neither the existing top-down nor bottom-up approaches do a good job of capturing in a comprehensive manner.

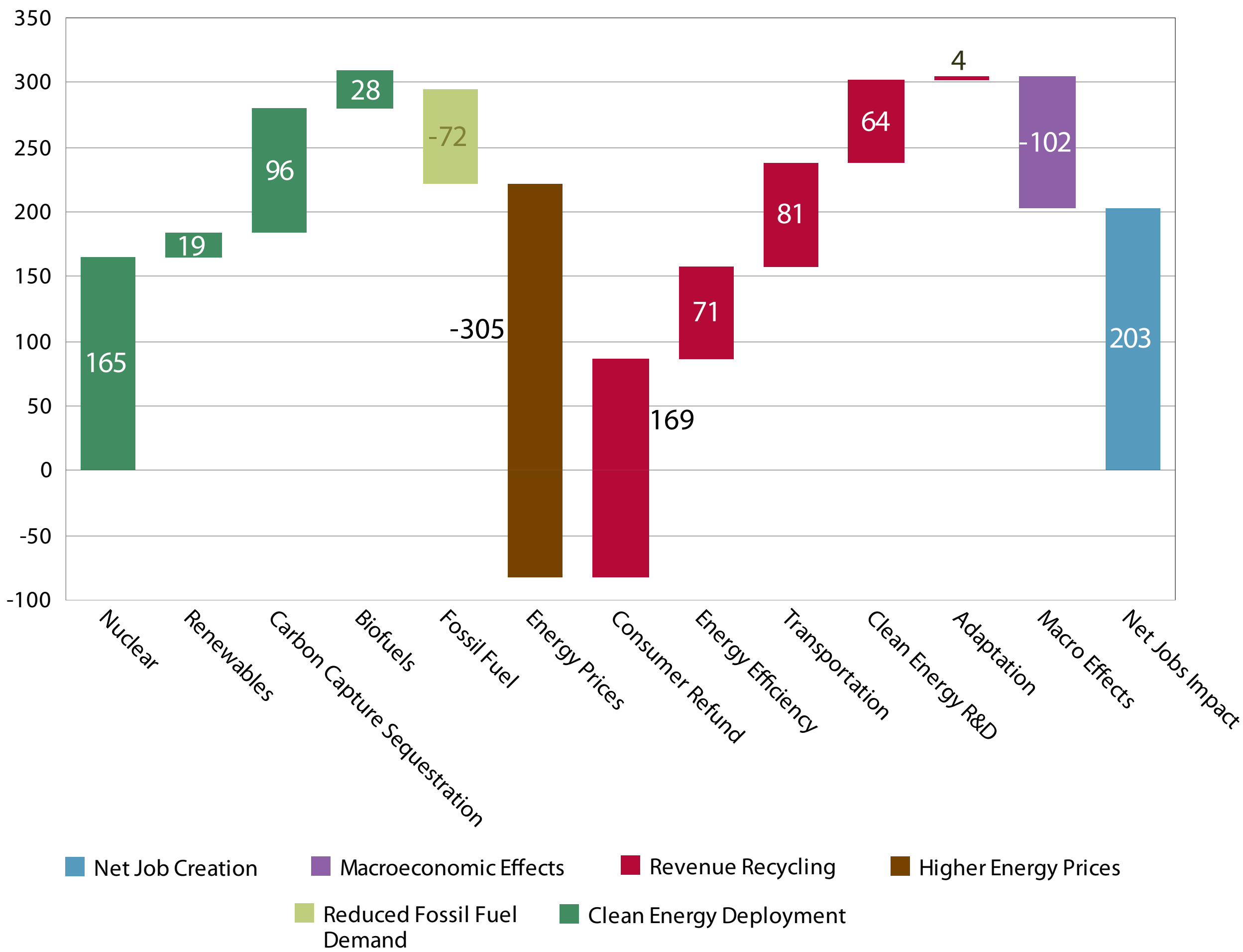
Market failures: In general, top-down models assume investment automatically flows to its most productive uses, i.e., that there are no imperfections in the market. Yet the energy sector is awash with market failures, primarily in the area of energy efficiency. Last year, the World Business Council on Sustainable Development, United Technologies Corporation, LaFarge Cement, and 12 other corporate leaders published an exhaustive catalogue of energy efficiency investments in the buildings sector that would provide an above-average rate of return but are not exploited because of a range of barriers, from

16. Power sector investment is calculated based on the capital cost and capacity addition estimates from NEMS. For more details on the methodology used for this analysis, see www.rhgroup.net/americanpoweract.

17. All categories include the direct (jobs created onsite at the plant), indirect (jobs created in companies supplying the plant with materials or services), and induced (jobs created when the employees spend their paychecks) employment effects of every dollar spent. For a complete description of the methodology used, see www.rhgroup.net/americanpoweract.

Figure 3 Employment Effects of the American Power Act

Thousand average annual jobs, 2011–2020



principal-agent problems in commercial real estate to lack of access to capital for residential efficiency improvements (WBCSD 2009). Working with this group we assessed the potential economic benefits of removing these barriers, and they are significant (Houser 2009). The American Power Act includes provisions, such as building codes, energy efficiency retrofits, and appliance standards that are likely to provide rates of return greater than the economywide average that would be welfare enhancing over the long term.

Export competitiveness: Top-down models are good at assessing the impact on incumbent industries from pricing carbon but struggle to forecast the emergence of new industries in response to that carbon price. So while a loss of jobs in energy-intensive manufacturing from higher energy prices is captured, the potential increase in US competitiveness in clean energy technology abroad from boosting demand at home isn't. The American Power Act includes significant funding for clean energy R&D to help increase US competitiveness.

Knowledge spillover: Finally, long-term economic growth depends largely on how fast a country develops technologically. Pricing carbon will force companies to innovate, whether by developing technologies that deliver energy or changing process and production methods to use energy more efficiently. This innovation will result in spillover effects that lower prices and increase production in other sectors. The question is whether the spillover effects from clean energy technology are greater than under the status quo. This is an important question that top-down models don't address. For example, if you assessed the economic impact of government investment in NASA using a top-down model, it would be welfare reducing because the commercial benefits of NASA-led innovation (e.g., Velcro) are not captured.

Table 5 Household energy prices: Core scenario

Average annual prices for liquefied petroleum gas (LPG), heating oil, gasoline, natural gas, and electricity, paid by households (real 2007 US dollars)		Business-as-usual		American Power Act		Difference	
	2008	2011–2020	2021–2030	2011–2020	2021–2030	2011–2020	2021–2030
LPG (dollars per gallon)	$2.43	$2.52	$2.92	$2.59	$3.07	2.8%	4.9%
Heating oil (dollars per gallon)	$3.32	$2.94	$3.54	$3.07	$3.80	4.6%	7.2%
Gasoline (dollars per gallon)	$3.17	$3.14	$3.71	$3.25	$3.95	3.4%	6.4%
Natural gas (dollars per tcf)	$13.34	$12.01	$13.46	$12.16	$13.97	1.2%	3.8%
Electricity (dollars per kilowatt hour)	$0.11	$0.11	$0.11	$0.11	$0.12	2.0%	3.3%

Source: Authors' estimates of the impact of the American Power Act as modeled using the Energy Information Administration's AEO2009 version of the National Energy Modeling System.

Table 6 Household energy prices: CAFE scenario

Average annual prices for liquefied petroleum gas (LPG), heating oil, gasoline, natural gas, and electricity, paid by households (real 2007 US dollars)		Business-as-usual		American Power Act		Difference	
	2008	2011–2020	2021–2030	2011–2020	2021–2030	2011–2020	2021–2030
LPG (dollars per gallon)	$2.43	$2.52	$2.92	$2.58	$3.01	2.3%	2.9%
Heating oil (dollars per gallon)	$3.32	$2.94	$3.54	$3.05	$3.69	3.9%	4.1%
Gasoline (dollars per gallon)	$3.17	$3.14	$3.71	$3.24	$3.81	2.9%	2.7%
Natural gas (dollars per tcf)	$13.34	$12.01	$13.46	$12.13	$13.78	1.0%	2.4%
Electricity (dollars per kilowatt hour)	$0.11	$0.11	$0.11	$0.11	$0.12	1.7%	1.9%

Source: Authors' estimates of the impact of the American Power Act as modeled using the Energy Information Administration's AEO2009 version of the National Energy Modeling System.

Quantifying these potential long-term economic and employment implications of energy and climate change policy deserves attention from the research community and will be the topic of forthcoming joint analysis from the Peterson Institute for International Economics and the World Resources Institute.

Also, it's important to note that neither this analysis nor most economic modeling of energy and climate change policy incorporates the avoided economic toll of a change in the global climate from unabated greenhouse gas emission growth. While the costs of inaction are more difficult to quantify than the costs of action, they are likely to be substantial. Recent estimates of the cost of projected temperature increases under a business-as-usual scenario range between 5 and 20 percent of global GDP by 2100 (Cline 2009, Stern 2007, and Cline 1992). While US action alone will be insufficient to avoid these impacts, it will have a direct impact on global atmospheric concentrations by reducing US emissions and an indirect impact by increasing pressure on other countries to act. Evaluating the American Power Act in this context is an important area of additional research.

Impact on Consumers

By pricing carbon, the American Power Act raises the cost of fossil fuels, prompting firms and consumers to improve the efficiency with which they use energy or switch to low-carbon sources of energy supply. In our core scenario, heating oil prices are on average 13 cents per gallon higher than business as usual between 2011 and 2020 and 25 cents per gallon higher between 2021 an 2030 (table 5). Gasoline is 11 and 24 cents per gallon more expensive during the two periods. Natural gas prices are 1.2 percent higher between 2011 and 2020 and 3.8 percent higher between 2021 and 2030. Residential electricity prices go up by 2 percent and 3.3 percent respectively. In the CAFE scenario, energy price increases, particularly for transportation fuels, are lower because of a decrease in demand (table 6). Gasoline prices are only 9 cents higher than business as usual on average between 2011 and 2020 and 10 cents higher between 2021 and 2030.

Improved efficiency mitigates the impact of higher energy prices on household budgets to different extents in our two scenarios. In the core scenario, the average US household spends an average of $107 more on energy each year between

Table 7 Household energy expenditures: Core scenario

Average annual household expenditure on oil, natural gas, and electricity, including for transportation (real 2007 US dollars)		Business-as-usual		American Power Act		Difference	
	2008	**2011–2020**	**2021–2030**	**2011–2020**	**2021–2030**	**2011–2020**	**2021–2030**
Petroleum	$3,655	$3,405	$3,590	$3,498	$3,763	$93	$173
Natural gas	$573	$469	$481	$468	$463	–$2	–$18
Electricity	$1,311	$1,228	$1,313	$1,243	$1,322	$15	$9
Total	$5,539	$5,102	$5,384	$5,209	$5,549	$107	$165

Source: Authors' estimates of the impact of the American Power Act as modeled using the Energy Information Administration's AEO2009 version of the National Energy Modeling System.

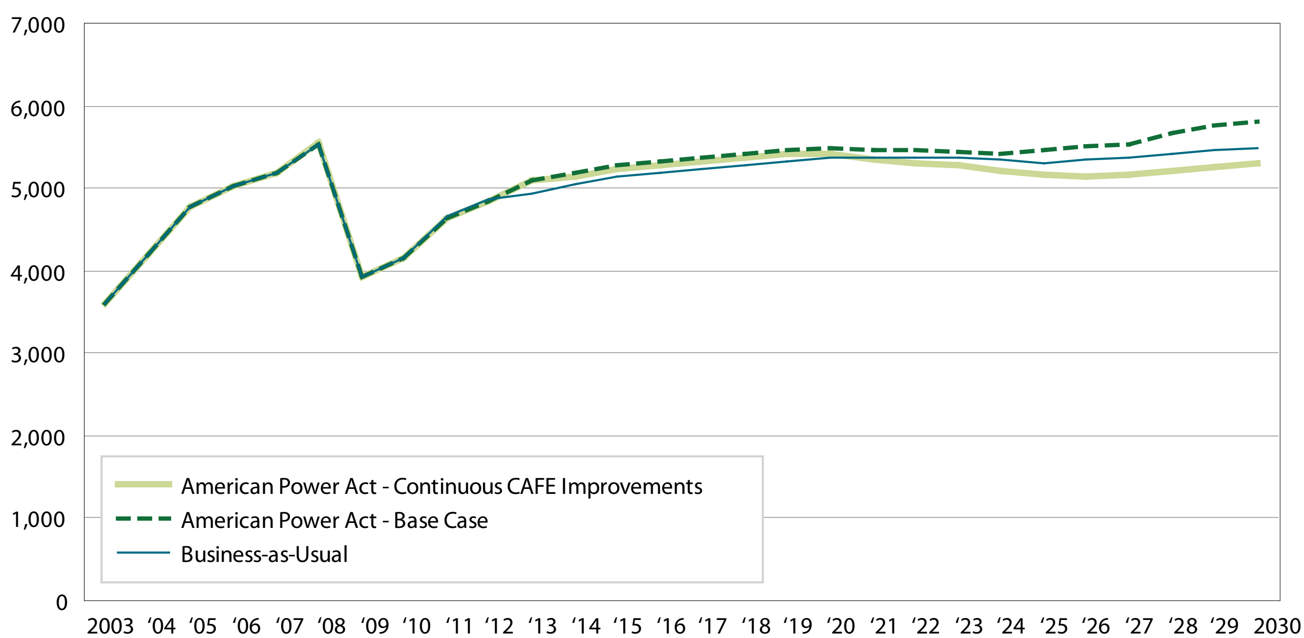
Table 8 Household energy expenditures: CAFE scenario

Average annual household expenditure on oil, natural gas, and electricity, including for transportation (real 2007 US dollars)		Business–as–usual		American Power Act		Difference	
	2008	**2011–2020**	**2021–2030**	**2011–2020**	**2021–2030**	**2011–2020**	**2021–2030**
Petroleum	$3,655	$3,405	$3,590	$3,469	$3,471	$65	–$119
Natural gas	$573	$469	$481	$467	$459	–$2	–$22
Electricity	$1,311	$1,228	$1,313	$1,241	$1,310	$13	–$3
Total	$5,539	$5,102	$5,384	$5,177	$5,240	$75	–$144

Source: Authors' estimates of the impact of the American Power Act as modeled using the Energy Information Administration's AEO2009 version of the National Energy Modeling System.

Figure 4 Average Annual Household Energy Expenditures

Real 2007 US dollars per household



Source: Authors' estimates of the impact of the American Power Act as modeled using the Energy Information Administration's AEO2009 version of the National Energy Modeling System.

2011 and 2020, $165 more between 2021 and 2030, and $136 more across the two decades than under business as usual (table 7). In the CAFE scenario, the average household spends $75 more per year on energy between 2011 and 2020 than under business as usual, but $144 less per year between 2021 and 2030 ($35 less on average between 2011 and 2030). The higher CAFE standards under this scenario, however, impose an additional cost on households that's not captured in this analysis by forcing the purchase of more expensive vehicles.

Households will also face higher prices for nonenergy goods as the firms producing them face higher energy costs. This and the increase in household energy expenditures (in the core scenario) are offset by higher income from an increase in employment in the first decade and the rebate of allowance revenue to consumers, which ramps up in the second decade. On the whole, real household consumption is slightly higher under the American Power Act than under business as usual during the period evaluated ($37 per year more on average between 2011 and 2030). Overall GDP is only moderately impacted—0.07 percent higher than business as usual on average during the first decade and 0.23 percent lower during next decade.

NEXT STEPS

In the interest of time, we have limited this analysis to a nationwide quantitative assessment of the impact of the American Power Act on US energy security, employment, household consumption, and the environment. In the coming weeks we will provide recommendations on how the legislation could be changed to better achieve the authors' goals in these areas. Also, nationwide averages gloss over important regional differences in the impact of policy to incentivize the deployment of clean energy technology and reduce GHG emissions. We are currently analyzing the impact of the American Power Act at a state level and will publish our findings in the weeks ahead. This analysis will break down impacts by industry and household income level. Finally, forthcoming work will assess the effectiveness of the American Power Act in buffering the US from oil supply shocks either domestically or in other parts of the world.

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Appendix

Assessing the Impact of the American Power Act

		Business–as–Usual (BAU)		American Power Act		Difference							
						2020 vs 2008		2020 vs BAU		2030 vs 2008		2030 vs BAU	
ENERGY DEMAND quadrillion btu	**2008**	**2020**	**2030**	**2020**	**2030**	**Value**	**Percent**	**Value**	**Percent**	**Value**	**Percent**	**Value**	**Percent**
Fossil Fuels	84.3	83.8	87.7	78.2	73.9	–6.1	–7.2	–5.6	–6.7	–10.4	–12.4	–13.8	–15.7
Nuclear	8.3	9.1	9.3	10.5	14.7	2.2	25.9	1.4	14.8	6.4	76.3	5.4	58.6
Renewables	7.7	11.6	13.8	13.0	16.7	5.3	69.7	1.4	11.6	9.1	118.6	2.9	21.2
Total	100.5	104.7	110.8	101.8	105.4	1.3	1.3	–2.9	–2.8	4.9	4.9	–5.4	–4.8
						2020 vs 2008		2020 vs BAU		2030 vs 2008		2030 vs BAU	
POWER GENERATION gigawatts installed capacity	**2008**	**2020**	**2030**	**2020**	**2030**	**Value**	**Percent**	**Value**	**Percent**	**Value**	**Percent**	**Value**	**Percent**
Fossil Fuels w/o CCS	768.0	777.3	878.4	734.8	699.2	–33.2	–4.3	–42.4	–5.5	–68.8	–9.0	–179.1	–20.4
Fossil Fuels w/ CCS	0.0	2.0	2.0	7.9	72.1	7.9	—	5.9	—	72.1	—	70.1	—
Nuclear	100.6	110.3	109.8	128.4	177.4	27.8	27.7	18.1	16.4	76.9	76.4	67.6	61.6
Renewables	116.5	176.4	188.6	176.7	212.8	60.2	51.6	0.3	0.2	96.2	82.6	24.2	12.8
Total	1010.2	1093.3	1206.2	1076.1	1206.8	65.9	6.5	–17.2	–1.6	196.6	19.5	0.6	0.1
						2020 vs 2005		2020 vs BAU		2030 vs 2005		2030 vs BAU	
ENVIRONMENTAL million tons, unless specified	**2005**	**2020**	**2030**	**2020**	**2030**	**Value**	**Percent**	**Value**	**Percent**	**Value**	**Percent**	**Value**	**Percent**
GHG emissions from covered sources**	6,128	6,290	6,631	4,797	3,555	–1,331	–21.7	–1,493	–23.7	–2,573	–42.0	–3,076	–46.4
Total GHG emissions**	7,303	7,416	7,952	6,086	5,006	–1,217	–16.7	–1,330	–17.9	–2,297	–31.5	–2,946	–37.0
Allowance price (2009 USD per ton)	NA	NA	NA	27.14	55.43	NA	—	NA	—	NA	—	NA	—
SO_2 from power generation	10.22	3.93	3.56	3.92	3.36	–6.3	–61.7	–0.0	–0.3	–6.9	–67.2	–0.2	–5.8
NOx from power generation	3.64	2.07	2.10	2.00	1.38	–1.6	–44.9	–0.1	–3.1	–2.3	–62.0	–0.7	–33.9
Mercury from power generation (tons)	51.49	29.18	28.64	25.21	16.43	–26.3	–51.0	–4.0	–13.6	–35.1	–68.1	–12.2	–42.6
						2011–2020 vs 2008		2011–2020 vs BAU		2011–2030 vs 2008		2011–2030 vs BAU	
EMPLOYMENT thousand jobs, unless specified	**2008**	**Average 2011–2020**	**Average 2011–2030**	**Average 2011–2020**	**Average 2011–2030**	**Value**	**Percent**	**Value**	**Percent**	**Value**	**Percent**	**Value**	**Percent**
Power sector investment (billion 2007 USD)	25.9	22.6	18.6	33.5	41.1	7.6	29.4	10.9	48.2	15.3	59.0	22.5	121.0
Clean energy-related employment***	979	1,224	1,325	1,532	2,044	553	56.6	308	25.2	1,066	108.9	719	54.3
Fossil fuel-related employment***	3,883	3,270	3,196	3,198	2,996	–685	–17.6	–72	–2.2	–888	–22.9	–200	–6.3
Total employment	136,993	144,021	151,254	144,224	151,260	7,232	5.3	203	0.1	14,267	10.4	6	0.0

(continued on next page)

Appendix

Assessing the Impact of the American Power Act *(continued)*

ENERGY SECURITY With (CAFE) and without (CORE) post-2016 CAFE improvements*	2008	2030	CORE 2030	CAFE 2030	CORE 2030 vs 2008 Value	CORE 2030 vs 2008 Percent	CORE 2030 vs BAU Value	CORE 2030 vs BAU Percent	CAFE 2030 vs 2008 Value	CAFE 2030 vs 2008 Percent	CAFE 2030 vs BAU Value	CAFE 2030 vs BAU Percent
US oil imports (net, thousand barrels per day)	11,041	8,203	7,431	6,623	–3,610	–32.7	–771	–9.4	–4,418	–40.0	–1,580	–19.3
US oil imports (net, billion 2007 USD)	389	371	320	277	–69	–17.8	–51	–13.8	–111	–28.6	–93	–25.2
OPEC oil revenue (billion 2007 USD)	1,273	2,034	1,901	1,817	629	49.4	–133	–6.5	544	42.8	–218	–10.7
Non-OPEC oil revenue (billion 2007 USD)	1,769	2,662	2,531	2,443	762	43.1	–130	–4.9	673	38.1	–219	–8.2
All producer oil revenue (billion 2007 USD)	3,042	4,696	4,433	4,260	1,391	45.7	–263	–5.6	1,217	40.0	–436	–9.3

CONSUMERS With (CAFE) and without (CORE) post–2016 CAFE improvements*	2008	Average 2011–2030	CORE Average 2011–2030	CAFE Average 2011–2030	CORE 2011–2030 vs 2008 Value	CORE 2011–2030 vs 2008 Percent	CORE 2011–2030 vs BAU Value	CORE 2011–2030 vs BAU Percent	CAFE 2011–2030 vs 2008 Value	CAFE 2011–2030 vs 2008 Percent	CAFE 2011–2030 vs BAU Value	CAFE 2011–2030 vs BAU Percent
Gasoline Prices (2007 USD per gallon)	3.17	3.43	3.60	3.52	0.43	13.6	0.17	5.0	0.36	11.3	0.10	2.8
Residential electricity prices (2007 US dollars per kwh)	0.108	0.110	0.113	0.112	0.004	4.0	0.003	2.7	0.003	3.2	0.002	1.8
Energy expenditures per household (2007 USD)	5,539	5,243	5,379	5,209	–160.3	–2.9	135.5	2.6	–330.5	–6.0	–34.7	–0.7

MACROECONOMIC Billion 2007 USD, unless specified	2008	Average 2011–2020	Average 2011–2030	Average 2011–2020	Average 2011–2030	2011–2020 vs 2008 Value	2011–2020 vs 2008 Percent	2011–2020 vs BAU Value	2011–2020 vs BAU Percent	2011–2030 vs 2008 Value	2011–2030 vs 2008 Percent	2011–2030 vs BAU Value	2011–2030 vs BAU Percent
Gross Domestic Product	13,984	16,386	18,850	16,397	18,831	2,413	17.3	11	0.1	4,846	34.7	–19	–0.1
Consumption per household (2007 USD)	81,244	88,150	95,699	88,165	95,736	6,921	8.5	16	0.0	14,492	17.8	37	0.0

NOx is a generic term for the mono-nitrogen oxides NO and NO_2
GHG = greenhouse gas
BAU = business-as-usual

* The CORE scenario assumes that corporate average fuel economy standards (CAFE) plateu in 2016 after the current rules end. The CAFE scenario assumes continued improvement in vehicle efficiency at the 2011–2016 average annual rates.
** includes international offsets
*** Includes direct, indirect and induced employment effects. For detailed methodology see www.rhgroup.net/americanpoweract

Source: Trevor Houser, Shashank Mohan and Ian Hoffman, 2010, Assessing the American Power Act: the Economic, Employment, Energy Security and Environmental Impact of Senator Kerry and Senator Lieberman's Discussion Draft, Washington: Peterson Institute for International Economics.