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America's Energy Security Options

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In an economy that relies so heavily on oil, rising prices at the pump affect everybody—workers, farmers, truck drivers, restaurant owners, students who are lucky enough to have a car. Businesses see rising prices at the pump hurt their bottom line. Families feel the pinch when they fill up their tank. And for Americans that are already struggling to get by, a hike in gas prices really makes their lives that much harder. It hurts.

President Barack Obama
March 30, 2011

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INTRODUCTION

Like clock-work, as US gasoline prices approached $4 a gallon in spring 2011, energy security moved to the forefront of the American political debate. Global oil prices have recovered from their collapse during the financial crisis more quickly than expected due to resilient developing-country demand and political instability throughout the Middle East and North Africa. As with past oil price spikes, politicians have been quick to offer silver bullet solutions to lower gas prices and make America more energy secure. But given the complexity of the US energy system and global energy markets, it is difficult for even informed observers to evaluate how far current proposals go in solving the country's energy security challenges.

To help inform the debate, we model a range of recent policy proposals, from expanded offshore drilling to new vehicle efficiency standards, analyzing their potential effect on US oil imports, gasoline prices, and energy expenditures, among other metrics, in a way that allows readers to compare the strengths and weaknesses of each. We then assess the potential impact of all the proposals combined to see whether what is currently being discussed is sufficient to address the issue.

We find that despite recent political rhetoric, when it comes to energy security there is no policy panacea. Current proposals vary widely in the time frame, magnitude, and nature of their impact. Rather than debate whether expanded domestic production, improved efficiency, or development of oil alternatives is the right course to take, the United States needs to start moving down all three roads simultaneously to significantly alter the country's energy trajectory.

Even if all proposals currently on the table are adopted, the United States will remain vulnerable to international oil-market disruptions for years to come, with all the attendant economic and national security consequences. We conclude by highlighting steps Washington can take to make the international oil market more stable and secure, something that's largely missing from the current policy debate.

AMERICA'S ENERGY SECURITY CHALLENGE

Americans are increasingly concerned about energy. In Gallup (2011) tracking polls over the past year, growth in the number of respondents who worry a "great deal" about the availability and affordability of energy has been far more rapid than for any other issue. In response, during the first five months of the 112th Congress alone, US senators and representatives introduced 26 bills intended to improve American energy security and 31 bills aspiring to make the United States energy independent. President Barack Obama has moved energy security to the forefront of his domestic policy agenda, releasing a Blueprint for a Secure Energy Future on March 30, 2011 (White House 2011c). On June 23, 2011, the administration announced that the United States would be releasing 30 million barrels of oil from the strategic petroleum reserve in an attempt to prevent high oil prices from undermining a nascent economic recovery. Energy security discussions, while still marginal, are increasing in frequency and prominence in international diplomatic forums like the G-20.

Yet energy security remains poorly defined as a policy objective (Levi 2010). A 2006 Council on Foreign Relations report describes energy security simply as "the reliable and affordable supply of energy" (Deutch, Schlesinger, and Victor 2006). A 2009 study from the RAND Corporation opts for a detailed and qualitative description of the various ways in which US energy use (oil in particular) impacts the county's economic and foreign policy objectives (Crane et al. 2009). The US Chamber of Commerce quantifies energy security through its Index of US Energy Security Risk (Institute for 21st Century Energy 2010).[1]

Drawing on these studies and others, we offer the following framework for understanding America's energy security challenge before evaluating the effectiveness of current policy proposals in making the country more energy secure.

Economic Security

Energy, along with labor, land, and capital, is a basic ingredient in America's economic growth formula. As with other factors of production, increased energy costs not offset through efficiency gains reduce the economy's growth potential. Over the past century the energy intensity of the US economy (the amount of coal, oil, natural gas, and other forms of energy required to produce each dollar of output) has declined by 75 percent thanks to improvements in energy efficiency and a structural shift from agriculture and manufacturing to service-sector activities (figure 1). But the amount of money Americans spend on energy as a share of national income has not seen a commensurate decline. US expenditures on fossil fuels (either domestically produced or imported from abroad) has averaged between 2 to 3 percent of GDP for most of the past 100 years, with the exception of the early 1980s and the last few years, when fossil fuel costs exceeded 5 percent of GDP (figure 2). If one includes energy transformation costs (e.g., petroleum refining and power generation), wholesale and retail margins, and non–fossil fuel expenditures, the share of national income spent on energy grew from 8 percent in 1971 to 14 percent in 1981 and then again from 6 percent in 1998 to 11 percent in 2008 (Bureau of Economic Analysis 2011a, EIA 2010a). For context, this is similar in scale to recent health care cost escalation. Between 1998 and 2008, US health care costs increased by $1.2 trillion while energy costs increased by $1 trillion (EIA 2010a, Centers for Medicare & Medicaid Services 2011).

As shown in figure 2, most of the volatility in American energy expenditures over the past 50 years has come from oil price fluctuations. Events abroad have largely determined the price of oil in the United States. The oil industry was born in the United States (Yergin 1991) and America is still the world's third largest oil producer (BP 2011). Yet domestic supply has not kept pace with domestic demand, and the United States now imports more than half the oil it consumes. As US imports account for just under one-quarter of global oil trade, the country plays an important role in shaping the global oil market. But the market is also strongly affected by the other two heavyweights, the Organization of Petroleum Exporting Countries (OPEC) and emerging Asia.

OPEC, the oil producers' cartel formed in 1960, accounts for 42 percent of global oil production and 70 percent of global proven reserves.[2] OPEC attempts to maximize its members' oil revenue through production quotas (Gately 2007, Gately et al. 2004). This requires identifying and targeting a "goldilocks" global oil price—one high enough to meet OPEC's

1. All three studies reject "energy independence" as a policy goal, despite its use in Washington political discourse, with the view that it is neither feasible nor desirable for the United States to be isolated from global energy markets (a view we share). David Greene of the Oak Ridge National Laboratory takes issue with this characterization, arguing that while "energy autarky" may not be feasible or desirable, "energy independence" is achievable if the economic costs of oil dependence for the United States are small enough to "have no effect on its economic, military or foreign policies" (Greene 2010). According to Greene, the United States was energy independent between 1991 and 1998.

2. Includes Canadian oil sands reserve estimates beyond those listed as "under active development" by the Canadian government.

current revenue needs but low enough to avoid demand destruction or development of oil substitutes that would threaten medium- and long-term revenue prospects. It also requires maintaining meaningful amounts of spare capacity, something too expensive for an individual oil company without the ability to impact global prices. As a result OPEC, and within OPEC Saudi Arabia in particular, has served as a sort of "central bank of oil," increasing supply when prices get "too high" and reducing supply when prices get "too low" (McNally and Levi 2011).

Yet while OPEC has the ability to combat price volatility, the cartel and individual OPEC member states have also been a leading source of instability in global oil markets. An OPEC oil embargo during the 1973 Arab-Israeli helped drive the first major oil price spike of the 20th century (Yergin 1991). Individual OPEC countries are among the world's more politically unstable states, with 75 percent of OPEC oil production in 2010 coming from countries classified as either "high risk" or "very high risk" by the Economist Intelligence Unit's Political Instability Index.[3] And there have been two major wars between OPEC members—the Iran-Iraq war and Iraq's invasion of Kuwait. Taken together, OPEC embargos, unrest within individual OPEC producers, and outright war between OPEC member states have been responsible for roughly 70 percent of geopolitical or conflict-related global supply disruptions since 1950 (Beccue and Huntington 2005), while over the same period they accounted for less than 40 percent of global supply.

OPEC supply shocks were primarily to blame for the four largest oil price spikes between 1970 and 2000 (Hamilton 2011, Hamilton 2009a, Kilian 2009). But OPEC as well as non-OPEC supply remained relatively stable during the 2000–2008 price spike. That spike was driven primarily by the other oil-market heavyweight: emerging Asia, China in particular. Figure 3 shows the difference in the International Energy Agency's (IEA) 2002 and the Energy Information Administration's (EIA) 2003 global oil demand projections for 2008 and actual demand that year. Their forecasts for global supply were quite accurate, within 0.9 percent for IEA and 0.1 percent for EIA, which isn't too surprising as most of the new production capacity slated to come online by 2008 was already in the pipeline when the reports were published.

But emerging Asia grew much faster than expected. In the case of China, which accounted for a large portion of the global demand surprise, economic growth got more energy-intensive (Rosen and Houser 2007). As prices rose above the $25 to $30 (in 2011 dollars) projected by EIA and IEA, so did export revenue, economic growth, and energy demand in oil-exporting countries, which further increased prices. Crude averaged $78 a barrel in 2007 and $104 a barrel in 2008 (also in 2011 dollars). Given global supply constraints, these prices destroyed enough demand in OECD countries, both through improved efficiency and lower economic growth, to make room for increased demand in China and the Middle East (Hamilton 2009a), a phenomenon known as "demand-rationing."

Demand and supply shocks result in seemingly outsized swings in global oil prices because oil demand and supply are both highly inelastic in the short term (Hamilton 2009b, Greene and Ahmad 2005, Goldman Sachs 2010a). In the United States, over 70 percent of oil consumption takes place in the transportation sector, where fuel substitutes are limited and Americans' ability to drive less is constrained by the limited availability of mass transit alternatives. In developing countries demand elasticity is even lower. In China, rapid income growth offsets some of the impact of higher oil prices, and industry (still the majority of Chinese oil demand) is often able to pass price increases along to foreign consumers. In the Middle East, economic growth increases along with oil prices and oil export revenue is used to reduce the price of gasoline and diesel for domestic consumers. On the supply side, new oil production projects take years to develop and bring online. The only short-term buffers are consumer inventories and OPEC spare capacity—both of which were burned through relatively quickly between 2000 and 2008.

Oil price spikes, caused by either supply or demand shocks, impact US economic security in the following ways:

1. **Reduced Income:** Given Americans' limited short-term ability to change the car they drive or how often they drive it in the face of higher oil prices, households generally absorb higher oil costs (up to a point) and cut spending in other areas. This has the same effect as a reduction in total household income and can significantly impact economic growth.
2. **Increased Uncertainty:** In addition to reducing the amount of money Americans have to spend, sudden oil price movements create uncertainty about just where they should spend it. Consumers delay purchases (particularly automobiles) and businesses delay investment decisions (particularly in manufacturing, transportation, and logistics) where future oil price is an important consideration. This impacts economic growth beyond the direct income effects of higher prices.
3. **Dislocation Costs:** Oil price movements change not only consumer and business decisions about the future but

3. The index is available at http://viewswire.eiu.com.

also the value of the decisions consumers and businesses have made in the past. An SUV purchased when gasoline costs $1 per gallon looks a lot less attractive with prices at $4 per gallon. If the SUV's owner is forced to sell the vehicle before he would have at $1 gas, and at a lower resale price, that creates economic inefficiency. Likewise for the SUV manufacturer left with underutilized manufacturing assets or the logistics company that has to make significant changes to its distribution networks.

4. **Wealth Transfers:** As the United States is a large oil importer, rising oil prices increase the US trade deficit and decrease US terms of trade (the amount of imports a country can purchase with its export revenue). While this transfer of wealth to oil-producing countries does not necessarily reduce global economic growth, it reduces US national income and relative weight in the global economy.[4] In 2008 net US oil imports accounted for 47 percent of America's trade deficit, while trade with China accounted for only 32 percent (figure 4).

5. **Monetary Tightening:** All else equal, rising oil prices increase the odds that the Federal Reserve will raise US interest rates. While as a general practice central banks pay attention to core inflation (excludes food and energy) rather than headline inflation (includes food and energy), sustained oil price increases translate into core inflation as workers demand higher wages to make up for increased oil costs and businesses raise prices to cover both these wage increases and their own oil costs. In addition, with headline inflation outpacing core inflation for most of the past decade, some central bankers are now paying closer attention to food and energy prices when making interest rate decisions (Smaghi 2011).

The cumulative effect of these five factors depends importantly on the severity of the shock (how many barrels per day) and its duration. There are also differences between supply and demand shocks in how they impact the economy. Noting that oil shocks have preceded five of the past six US recessions (figure 5), the academic literature puts their cost at between 0.5 and 5 percent of GDP (Kilian 2009; Hamilton 2009a; Huntington 2005; Jones, Leiby, and Paik 2004; Leiby 2007). The current consensus among private-sector analyses is that a $10 and $20 sustained increase in crude oil prices translates into a 0.2 and 0.5 percent reduction in GDP, respectively (Goldman Sachs 2011; JP Morgan 2011; Morgan Stanley 2011; Deutsche Bank 2011; Credit Suisse 2011; Macquarie 2011).

It is important to note that the impact on the US economy of an increase in oil prices resulting from a supply or demand shock is fundamentally different than that from changes in domestic tax policy. Even at current prices, US drivers pay significantly less for gasoline and diesel than their counterparts in Europe or Japan due to differences in tax policy.[5] For example, the average US driver paid $0.41 per gallon in gasoline taxes in June 2011 while the average German driver paid $4.89 per gallon. Fuel taxes are a domestic revenue transfer rather than an international wealth transfer, and they are generally implemented gradually and with sufficient advanced warning to avoid most of the economic damage associated with demand or supply shocks. To the extent that fuel taxes reduce oil demand, they may in fact make an economy more resilient to international oil-market disruptions.

National Security

Oil affects American foreign policy, defense posture, and domestic security in addition to its economy. Oil-supply concerns shaped World War II's trajectory and awoke US policymakers to the fact that in the most extreme military conflicts, countries' ability to physically secure enough oil to power their militaries can potentially decide outcomes (Yergin 1991). Today, the US military accounts for only 2 percent of US oil consumption. So the oil requirements of conflicts like those taking place in Iraq and Afghanistan do not begin to test the adequacy of current domestic oil supply (the logistics of getting that oil to the battlefield is a significant security issue but a separate point). Ensuring reliable supply to the rest of the US economy, however, is also a national security concern and an important objective of the US defense community.

The fact that OPEC countries account for half of global oil exports (figure 6) combined with the cartel's history of using oil as a geopolitical weapon against the United States leaves many US defense planners nervous about potential American vulnerability. Fortunately, producer embargoes have had limited effectiveness in achieving their policy objectives in the past (Crane et al. 2009), and with certain OPEC members depending on oil revenues to maintain political stability in the face of the Arab Spring and the cartel's coherence faltering (discussed below), the odds of a politically driven supply embargo are low. A terrorist attack that disables critical oil

4. The precise impact of rising oil prices on the US current account balance depends on a wide range of factors covered well in (Kilian, Rebucci, and Spatafora 2009).

5. See www.eia.gov/emeu/international/prices.html for a list of current global oil product prices.

infrastructure, however, is a risk policymakers are more concerned with in the wake of September 11.

US economic vulnerability to international oil-market disruptions can limit America's ability to pursue other foreign policy objectives, such as democratization or human rights protection, with major oil-exporting states. The fact that Washington has sanctioned large oil producers, such as Iraq, Libya, and Iran, even when global oil supply is tight, suggests this constraint might be less significant than often suggested.[6] It remains a prominent concern within the foreign policy community nonetheless. Oil-export revenues have also enabled some countries, Iran and Venezuela in particular, to pursue policies contrary to US interests, though countries without oil wealth (e.g., North Korea) have pursued similar paths (Crane et al. 2009).

Growing demand in developing countries has created concerns among some in the West that a scramble for resources looms between established and emerging oil consumers. Increased overseas investments by Chinese and Indian oil companies in recent years and news reports of these companies signing "equity deals" with oil-producing states have fed such fears. These investments have not had a noticeable impact on the fungibility of the global oil market to date (Houser 2008). But if they become more pervasive in the years ahead, long-term Chinese or Indian supply contracts could potentially constrain America's ability to adapt to future supply disruptions. Oil dependence can shape Chinese and Indian policy towards oil-producing states just as it has in the United States.

Finally, oil use also impacts US national security by contributing to global climate change (Verrastro et al. 2010). Noting it will "contribute to food and water scarcity, will increase the spread of disease, and may spur or exacerbate mass migration" and "act as an accelerant of instability or conflict," the Department of Defense (2010) in its *2010 Quadrennial Defense Review* highlights climate change as a key factor shaping the global security landscape.

Quantifying these national security costs, which are additional to the economic costs already discussed, is extremely challenging. Estimates have ranged from $13 billion to $149 billion per year, not including the potential costs of an Iranian nuclear program or of missed opportunities to advance democracy or human rights. RAND's 2009 study estimates that the US defense budget could be reduced by 12 to 15 percent if oil security was no longer a consideration (Crane et al. 2009).

The Challenge Going Forward

There is both good news and bad news for US energy security in the years ahead. The good news is that US oil imports are already declining. Increased domestic oil output, expanded biofuels production, and the 2012–16 vehicle efficiency standards are projected to reduce net US oil imports from 11 million barrels per day (bpd) in 2008 to just under 9 million bpd by 2035 (EIA 2011a). If Outer Continental Shelf (OCS) reserves prove to be at the higher end of current estimates, net oil imports could decline to as little as 8 million bpd by 2035, even without opening additional areas of the OCS for exploration. An upside surprise in onshore tight oil production,[7] which some industry observers now predict, would reduce US oil imports even further. Increased domestic production will be augmented by new unconventional oil supply from Canada imported by pipeline.

The bad news is that with demand growth in developing countries set to remain strong for years to come (figure 7) and non-OPEC supply growth outside the Western Hemisphere projected to remain relatively constrained (figure 8), both EIA and IEA believe global oil prices will rise in the years ahead (EIA 2011a, IEA 2010a). That means that while US oil imports will decline in quantity, the amount of money Americans spend on imported oil will continue to increase in absolute terms and decline only modestly as a share of GDP. Given that biofuels and domestic oil prices move in tandem with the price of imported crude, US vulnerability to global demand shocks or supply disruptions (increasingly likely given the picture painted by figures 7 and 8) will remain relatively unchanged based on current projections.

PROPOSED POLICY RESPONSE

Recent policy proposals respond to this challenge by seeking to (1) further increase domestic US oil production, (2) further reduce US oil demand through energy efficiency, and/or (3) develop and promote alternative fuels to displace oil consumption. For this analysis, we have selected a range of representative policy proposals in each group and analyze their potential impact, both individually and in combination.

Accelerate Gulf of Mexico Leasing and Permitting

Since taking control of the US House of Representatives in January 2011, congressional Republicans have made increasing

6. We thank Frank Verrastro of the Center for Strategic and International Studies for this point.

7. Tight oil refers to a type of unconventional oil currently being produced in the United States, North Dakota in particular, using hydraulic fracturing techniques similar to those employed in shale gas development.

domestic oil production one of their top legislative objectives. In particular, Republican leadership has focused on returning the rate at which new leases and drilling permits are issued for Gulf of Mexico (GoM) oil and gas development to pre–oil spill levels. In March 2011, the House passed three bills intended to achieve that objective—the Restarting American Offshore Leasing Now Act (US House of Representatives 2011), Putting the Gulf of Mexico Back to Work Act (GPO 2011a), and Reversing President Obama's Offshore Moratorium Act (GPO 2011b). While the corresponding Senate bill, the Offshore Production and Safety Act of 2011 (GPO 2011c), failed due to lack of Democratic support, the House bills attracted between 21 and 33 moderate Democrats in that chamber, and oil-state Democrats in the Senate have signaled their support for scaled-back versions of the House bills.

Given the range of legislative proposals and the difficulty in assessing their exact impact on GoM oil and gas production, we opt instead to simply return to EIA's pre–oil spill estimates of lease and permit approval rates and GoM exploration costs. This should provide a reasonable upper-bound estimate of what any of the individual pieces of legislation would be able to achieve.[8]

Increase Offshore Access

The Western and Central regions of the GoM are currently the only parts of the Outer Continental Shelf open to new exploration and development. A month before the explosion at Deepwater Horizon, the Obama administration released plans to open waters along the Atlantic coastline, northern Alaska, and eastern Gulf of Mexico to exploration (Broder 2010). Following the oil spill, however, the administration suspended new deepwater drilling activity in the GoM and Alaska and canceled a lease sale off the coast of Virginia (Straub 2010). The Reversing President Obama's Offshore Moratorium Act, which passed in the House, and the Offshore Production and Safety Act of 2011, which failed to pass in the Senate, would open much larger swaths of the OCS than President Obama's pre-spill plan, areas estimated by the Minerals Management Service (now part of the Bureau of Ocean Energy Management, Regulation and Enforcement) to contain more than 2.5 billion barrels of oil and 7.5 billion cubic feet of natural gas (BOEMRE 2006). We adjust offshore leasing availability in EIA's National Energy Modeling System accordingly to estimate the bill's impact.

There is considerable uncertainty surrounding reserve estimates for parts of the OCS currently closed to exploration and production. For an upper-bound estimate of the potential increases in domestic production from expanded offshore access, we have included EIA's High OCS Resource side case to the *2011 Annual Energy Outlook*, in which total OCS reserves are twice as high as current BOEMRE estimates (EIA 2011a).

Enhanced Oil Recovery

In addition to drilling new wells, domestic oil production can be expanded by increasing output from existing wells. Enhanced oil recovery techniques allow companies to move beyond the 10 to 40 percent recovery rates possible through conventional production methods. Most enhanced oil recovery is achieved by injecting either steam or gas into the well to allow oil to flow more easily to the surface. Carbon dioxide (CO_2), often used in gas injection, is currently sourced from naturally occurring reservoirs or industrial facilities.[9] Coal-fired power plants are the largest source of CO_2 emissions in the United States but are not currently equipped to capture that CO_2 for enhanced oil recovery use. Cap-and-trade legislation, like the American Clean Energy and Security Act passed in the House of Representatives in 2009 and the American Power Act introduced in the Senate in 2010, creates an economic incentive to either retrofit existing coal-fired power plants with carbon capture and sequestration (CCS) equipment or replace them with new CCS-equipped plants.[10] EIA analysis of the American Power Act forecasts that between 51 and 105 gigawatts of coal-fired power generation would be CCS-equipped by 2035 as a result of the bill and that the CO_2 captured would increase US oil production by between 0.8 million and 1 million bpd (EIA 2010b).

Following the 2010 midterm elections, the odds of cap-and-trade legislation passing the Senate and making it to the president's desk are extremely thin. There continues to be, however, bipartisan interest in CCS in Congress (US Senate 2011). The most ambitious legislative proposal aimed at accelerating CCS deployment, and the proposal we chose for analysis, is the Carbon Capture and Sequestration Deployment Act of 2010 cosponsored by Democrat John Rockefeller of West Virginia and now-retired Republican George Voinovich of Ohio (Rockefeller 2010). The bill would raise $20 billion

8. In updating GoM production rates for the *2011 Annual Energy Outlook*, EIA incorporated (a) the impact of the moratorium and decreased subsequent leasing and permitting rates and increased exploration costs and (b) changes in discovery rates independent of the oil spill. We were unable to separate these two effects and thus include both in this analysis. The resulting estimates should therefore be treated as optimistic.

9. See http://fossil.energy.gov/programs/oilgas/eor for a good overview of the use of CO_2 for enhanced oil recovery.

10. Both bills created additional incentives for CCS through the provision of bonus allowances.

for CCS demonstration projects through a small surcharge on the sale of electricity generated with fossil fuels, extend $20 billion in loan guarantees to subsequent CCS-equipped power plants and industrial facilities, and provide a tax credit for CO_2 sequestered underground, including that used in enhanced oil recovery. All told, the bill aims to prompt the construction or retrofit of 82 gigawatts of CCS-equipped power plants independent of a cap-and-trade system.

Heavy Duty Vehicle Standards

In May 2010, President Obama issued a memorandum requesting the Environmental Protection Agency (EPA) and the National Highway Traffic Safety Administration (NHTSA) to develop greenhouse gas and fuel economy standards for heavy duty vehicles (HDVs), under the authority of the Clean Air Act and the Energy Independence and Security Act of 2007. In November of that year, EPA and NHTSA (2010a) released their proposed rule, which covers model years 2014 through 2017. While the president's memorandum called for the final rule to be issued by July 30, 2011, EPA and NHTSA did not deliver the rule to the White House for review until June 2, 2011. As a result, EPA and NHTSA do not expect the final rule to be issued until September 30, 2011.

EIA modeled the impacts of the proposed HDV rule as a side case to the *2011 Annual Energy Outlook* (EIA 2011a). As the final rule was not available in time for inclusion in this policy brief, we have adopted EIA's approach and assumptions.

Extended Light Duty Vehicle Standards

In the same May 2010 memorandum, President Obama called on EPA and NHTSA to begin work on extending the 2012 to 2016 greenhouse gas and fuel economy standards for light duty vehicles (LDVs) released the month earlier through model year 2025. Responding to the president's request, EPA and NHTSA (2010b) issued a notice of intent outlining the two agencies' plans for the rulemaking on September 30, 2010. They also released an *Interim Joint Technical Assessment Report*, which indicated the agencies would be exploring an average annual increase in corporate average fuel economy (CAFE) standards of between 3 and 6 percent for model years 2017 through 2025 (EPA and NHTSA 2010c).

As with the proposed HDV rule, EIA modeled the impacts of a potential 2017–25 LDV rule as a side case to the *2011 Annual Energy Outlook* (EIA 2011a). EIA explored the impact of both a 3 and 6 percent annual increase in CAFE standards to cover the range of potential outcomes of the final rule. As with HDVs, here we have adopted EIA's approach and assumptions.

Building Efficiency Improvements

While US oil demand is driven primarily through the transportation sector, 6 percent of petroleum supply is consumed in residential and commercial buildings (EIA 2010a). Citing the potential security benefits of energy savings in buildings, President Obama announced the Better Buildings Initiative in February 2011 (White House 2011a). The initiative seeks a 20 percent improvement in the energy efficiency of the country's commercial building stock by 2020 through tax incentives, low-cost financing, worker training, and innovation prizes.

This level of efficiency improvement is achievable with current technology and at low or negative cost (Houser 2009). It is noneconomic barriers, such as a lack of information and principal-agent problems, that pose the greatest challenge to building efficiency improvement efforts. While it is impossible to assess based on current information the potential effectiveness of the Better Buildings Initiative in overcoming these barriers, we include it in our analysis with the assumption that the 2020 target is met, to illustrate the ways in which building efficiency improvements impact US energy security relative to other policy options.

Advanced Biofuels Development

Noticeably absent from the current energy security debate are proposals to accelerate the development and deployment of biofuels. There are two reasons for this. First, existing policy support for biofuels is quite strong. The Renewable Fuels Standard (RFS), enacted through the Energy Policy Act of 2005 (GPO 2005) and strengthened in the Energy Independence and Security Act of 2007 (GPO 2007), requires 36 billion gallons of biofuels be blended into the domestic transportation fuel mix each year by 2022.[11] Of this 36 billion gallon mandate, only 15 billion can be met through conventional biofuels such as corn ethanol. Of the remaining 21 billion gallons, 16 billion must come from cellulosic ethanol and 5 billion from noncellulosic advanced biofuels, including biodiesel.

While conventional and noncellulosic advanced biofuels production has kept pace with the RFS mandate, industry's ability to develop and produce cellulosic ethanol has lagged behind the aggressive targets set out in the RFS. As a result, EPA has been forced to issue waivers for the cellulosic mandate (as allowed for in legislation). For 2011, EPA adjusted down the cellulosic ethanol target from 250 million gallons to 6.6 million gallons (EPA 2010). In its *2011 Annual Energy Outlook*,

11. For more information on the RFS, see www.epa.gov/otaq/fuels/renewablefuels/index.htm.

EIA projects that the United States will be able to achieve only 26 billion of the 36 billion gallon RFS mandate in 2022 due to cellulosic ethanol production constraints (EIA 2011a).

Second, as congressional attention has focused on reducing the country's budget deficit, taxpayer support for biofuels production are increasingly under attack. On June 16, 2011, the Senate voted to repeal the volumetric ethanol excise tax credit (VEETC) and ethanol import tariff (E&E News 2011) when just months before the incentives had been extended as part of the December 2010 compromise tax package (E&E News 2010). Going even further, some Senate Republicans are now looking to block federal funding for flex-fuel vehicles and ethanol infrastructure.

The one area where both the administration and members of Congress are looking to increase biofuels policy support, rather than scale it back, is advanced research and development. In its Blueprint for a Secure Energy Future released in March 2011, the White House calls for the construction of four cellulosic ethanol biorefineries over the next two years and greater military procurement of advanced biofuels to help drive down cost (White House 2011c). As an upper-bound estimate of what a concerted biofuels R&D effort could deliver, we analyze the energy security impact of an increase in cellulosic ethanol availability sufficient to achieve existing RFS targets.

Natural Gas Vehicle Deployment

Rapid development of unconventional natural gas resources such as shale gas in recent years has dramatically altered the domestic US energy landscape and significantly reduced the current and projected cost of natural gas. EIA's *2009 Annual Energy Outlook* forecast domestic natural gas production of 19.7 trillion cubic feet and natural gas spot prices of $7.71 per million British thermal units (BTU) in 2020 (EIA 2009). Two years later, EIA revised up its 2020 natural gas production forecast by 20 percent and reduced its price forecast by 35 percent (EIA 2011a).[12] The gap between US oil and natural gas prices has reached historic levels, prompting both policymakers and industry leaders to explore options for using natural gas as an oil substitute in the transportation system.[13]

Most legislative proposals have focused on incentivizing the use of compressed or liquefied natural gas in heavy duty fleet vehicles such as long-haul trucks. We selected the New Alternative Transportation to Give Americans Solutions Act of 2011 (known as the NAT GAS Act) for analysis as it is currently the most advanced of the various legislative proposals pertaining to the use of natural gas for transportation, with 186 cosponsors in the House as of June 2011 (GPO 2011d). The bill increases and extends tax credits for the manufacture, purchase, and operation of natural gas–powered vehicles, conversion of conventional vehicles into natural gas vehicles, and installation of natural gas fueling stations.

Estimating the number of existing heavy duty vehicles that will take advantage of the tax credits made available under the bill for conversion to natural gas is challenging. As a result, we decided to analyze two natural gas vehicle scenarios: one where no conversion takes place and where we adopt EIA's assumptions about vehicle preference and supply constraints and the other where 10 percent of existing vehicles are converted by 2017 when the tax credit expires and where we loosen vehicle preference and supply constraint assumptions. This should provide reasonable upper and lower bounds on the legislation's potential impact.

Electric Vehicle Deployment

In addition to replacing oil as a transportation fuel with natural gas or biofuels, there is growing interest both in the White House and Congress to reduce American oil consumption through the development and deployment of electric vehicles. In his 2011 State of the Union Address, President Obama set a goal of 1 million electric vehicles on US roads by 2015 (White House 2011b). The administration has invested heavily in electric vehicle R&D and extended loan guarantees to advanced battery manufacturers. A number of electric vehicle bills have been introduced in Congress in recent years, but most are focused exclusively on near-term R&D and deployment.

In the interest of selecting an electric vehicle proposal of comparable time horizon to the vehicle efficiency and natural gas vehicle proposals included in this policy brief, we analyze the Electrification Coalition's Electrification Roadmap (Electrification Coalition 2009). The roadmap calls for increasing and extending current tax credits for the purchase of electric vehicles through 2018, for loan guarantees for electric vehicle manufacturers, and for new tax credits for public charging stations and electrical grid infrastructure.

There is considerable uncertainty about both future battery cost and consumer acceptance of electric vehicles. As with natural gas vehicles, we address this uncertainty by analyzing two scenarios that represent our view of the upper and lower bounds for potential deployment. In the lower-bound case, we use EIA's current assumptions about future

12. Prices are in real 2009 dollars.

13. See, for example, the Pickens Plan advocated by oil man T. Boone Pickens, www.pickensplan.com/theplan.

battery cost and consumer attitudes, assumptions that under current policy result in only 400,000 plug-in electric and fully electric vehicles on the road by 2015—well below the president's target and only 2 percent of the total vehicle stock by 2035 (EIA 2011a). For the upper-bound scenario, we use battery cost assumptions from Argonne National Laboratory's battery cost model, which were incorporated in the EPA's notice of intent for the 2017–25 light duty vehicle efficiency rulemakings (EPA and NHTSA 2010b) and which are considerably more optimistic than EIA's assumptions. We also change the consumer preference parameters so that prospective buyers are just as likely to purchase an electric vehicle as a conventional vehicle of comparable size, performance, and life-cycle cost.

Carbon Tax

While cap-and-trade legislation in the United States appears to be dead and buried, there is renewed interest in a carbon tax, largely as a result of its revenue-raising potential. For its 2011 fiscal summit, the Peter G. Peterson Foundation (2011) invited six think tanks from across the political spectrum to submit "comprehensive plans" to meet America's budget challenges. Four of the six recommended a carbon tax, including the conservative American Enterprise Institute (AEI). AEI recommends a carbon tax starting in 2013, reaching $26 per ton of CO_2 equivalent in 2017 and increasing at 5.6 percent per year thereafter. While not intended as an energy security proposal per se, we analyze the impact of the AEI carbon tax proposal on US oil production and consumption.

SCOPE AND METHODOLOGY

As mentioned in the introduction, we compare the potential impact of the above proposals, both individually and in combination, on US energy security to provide the policy community and public more broadly with a better sense of what current proposals can realistically achieve. While all sources of energy come with some security concerns, we focus primarily on oil, as it is the focus of current policy proposals. In a few cases, policies aimed at increasing US oil security create new energy security concerns, which we highlight and discuss. For our analysis we employ RHG-NEMS, a version of EIA's National Energy Modeling System (NEMS) maintained and operated by the Rhodium Group in New York.[14] EIA uses NEMS for its *Annual Energy Outlook* as well as to analyze specific energy and environmental legislation when asked to do so by the US Congress.[15] While it has its limitations, NEMS is the most detailed model of the US energy sector currently available. It also has the benefit of being a completely open source, so the technology and market assumptions developed by EIA staff are subject to close scrutiny by market participants and the policy community. The resulting input helps EIA to continue improving the model.

All proposals are measured against the reference case in the *2011 Annual Energy Outlook* (EIA 2011a). It is important to note that this is just one scenario for how US energy markets will evolve. This approach is useful for evaluating the relative impact of a specific policy or group of policies. But as with all forecasts, any estimates of the absolute value of US oil imports, gasoline prices, or energy expenditures, particularly in the out-years, should be taken with a grain of salt. Relatively small unforeseen changes in the US economy or global energy markets can have a significant impact on what US energy needs look like in the years ahead.

We adopt the technology and market assumptions in the *2011 Annual Energy Outlook*, except in two cases. In our upper-bound estimates for Increased Offshore Access, we adopt the recoverable oil reserve estimates from the *2011 Annual Energy Outlook*'s High OCS Resource side case. In the upper-bound estimates for Electric Vehicle Deployment we use Argonne National Laboratory's battery cost forecasts. In both cases, the impact of the policy proposals is measured against a baseline where those specific assumptions are also modified.[16] NEMS' ability to accurately assess the impact of current policy proposals falls short in two areas of particular relevance to our analysis. First, the international oil market response to any change in US oil production or consumption is extremely hard to forecast. OPEC could choose to counteract a price decline resulting from increased US production or reduced US demand by curbing output, which could offset any price gains reported in the model. Even in the absence of any OPEC reaction to changes in America's oil supply/demand balance, price changes depend on marginal production costs around the world, which are unclear and constantly changing. As a result, any of our estimates of the impact of individual policy proposals on global oil prices should be taken with caution. Second, as mentioned previously, rapid changes in the unconventional oil production landscape in the United States may not be appropriately captured in NEMS. While these developments are not the result of policy, they can

14. More information on RHG-NEMS is available at www.rhgroup.net/energysecurity.

15. Documentation on the NEMS model is available at www.eia.doe.gov/oiaf/aeo/overview.

16. A more detailed discussion of our methodology is available at www.rhgroup.net/energysecurity.

change a given policy's impact on US oil supply and demand. In discussing our findings, we highlight areas where an upside surprise in US unconventional oil production, tight oil in particular, could significantly change a policy's impact.

To score each policy using the US Chamber of Commerce's Index of Energy Security Risk we adopt the methodology developed by Michael Levi and Trevor Houser to assess the 2010 American Power Act"[17]

We do not, in this brief, assess the cost-effectiveness of current proposals or their aggregate impact on US consumers or the federal budget. Recent studies, such as the National Energy Policy Institute and Resources for the Future report *Toward a New National Energy Policy* (Krupnick et al. 2010), provide a good assessment of the relative cost effectiveness of different types of energy security policies, though none analyze the specific proposals addressed here.

WHAT CURRENT PROPOSALS DELIVER

The energy security proposals analyzed in this policy brief fall into three categories: those that increase domestic oil production, those that improve energy efficiency, and those that promote fuel substitution, with the exception of a carbon tax, which does all three. Each approach shapes US energy security in different ways. We summarize our findings below.[18] We separate our discussion of policy impacts into near-term (2011–15), medium-term (2016–20) and long-term (2021–35) effects.

Increased Production

Of the three policies aimed at increasing domestic oil production, Accelerating GoM Leasing and Permitting has the most significant near-term impact, increasing domestic output by 202,000 bpd on average between 2011 and 2035 (figure 9). Over the longer term, Increasing Offshore Access has the potential to do more—up to a 613,000 bpd increase in average annual domestic production between 2021 and 2035 if higher-end reserve estimates turn out to be correct. A significant increase in onshore unconventional oil production not currently forecast in the reference case would likely erode some of these offshore gains as the resulting lower prices would make marginal offshore oil projects uneconomic. While not quite as significant, Enhanced Oil Recovery increases production by a healthy 97,000 bpd on average between 2011 and 2035 (figure 9).[19]

On balance, increased US production reduces the severity of future oil supply disruption because it decreases more politically volatile producers' share of global oil supply. In other words, if increasing the US share of global oil production reduces the Iranian share of global production (even if Iranian production grows in absolute terms), then all else equal the increase in global oil prices resulting from a disruption in Iranian supply will be lower as well.

Of the three policies aimed at increasing domestic oil production, Accelerating Gulf of Mexico Leasing and Permitting has the most significant near-term impact....

Increased US production also results in a modest decrease in global oil prices over the long term. Crude is $0.55 per barrel cheaper than the reference case between 2011 and 2035 in the Accelerating GoM Leasing and Permitting scenario and up to $1.04 cheaper in the Increased Offshore Access case (figure 10). This translates into a 0.5 and 3 cent reduction in gasoline prices, respectively. Net US imports decline by as much as 166,000 bpd between 2011 and 2035 (Accelerating GoM Leasing and Permitting) (figure 11) and as much as 578,000 bpd between 2021 and 2035 (Increased Offshore Access with high resource assumptions). The combination of lower quantities imported and lower global oil prices reduces US expenditures on imported oil by up to $5.6 billion a year between 2011 and 2035 (figure 12).

Lower oil prices also increase US oil demand, albeit very slightly (figure 13). This offsets some of the reductions in total US oil expenditures (figure 14). It also increases the economic impact of an oil price spike of a given magnitude (i.e., the impact on GDP of a $10 per barrel price spike is greater the more oil dependent the US economy becomes). As US oil expenditure gains under these policy scenarios occur only if oil prices decline, they are more vulnerable to reactionary OPEC production cuts than expenditure gains achieved through improved efficiency or fuel substitution.

In contrast with longer-term efficiency and fuel substitution policies, however, increased domestic production can play a critical role in alleviating near-term global oil supply

17. A full description of that methodology is available at www.slate.com/id/2257021.

18. More detailed results are available at www.rhgroup.net/energysecurity.

19. In our analysis the Carbon Capture and Sequestration Deployment Act of 2010, our Enhanced Oil Recovery policy, results in 52 gigawatts of additional CCS capacity between 2011 and 2035.

constraints. IEA predicts global supplies will stay tight through 2015, which increases the risk of further oil price spikes. Our Accelerating GoM Leasing and Permitting scenario would increase US oil production by up to 300,000 bpd during that period, which could have a meaningful near-term impact on global oil markets.

Improved Efficiency

Of the three efficiency scenarios, only one has a meaningful impact on US oil consumption—Extended Light Duty Vehicle Standards. As these standards do not take effect until 2017, it is a largely backloaded effect. But it has the most significant long-term impact on US oil imports, global oil prices, and US oil expenditures of any of the policies we analyze, at least at the higher end of the range of potential 2025 vehicle efficiency targets. US oil demand is reduced by between 719,000 and 1 million bpd on average between 2011 and 2035 (figure 13). Net imports are reduced by 553,000 to 791,000 bpd (figure 11) and domestic production falls by 80,000 to 88,000 bpd (figure 9) during that period. A drop in domestic biofuels supply makes up the rest. Crude oil prices drop by $1.58 to $2.33 per barrel (figure 10), which translates into a 6 to 10 cent decline in gasoline prices. Overall annual oil expenditures drop by $55 billion to $78 billion between 2011 and 2035 (figure 14 and table 1) and US spending on imported oil falls by $27 billion to $37 billion (figure 12).

Reducing the oil intensity of the US economy makes it less vulnerable to a given price spike (i.e., a $10 per barrel increase in oil prices has less impact on the US economy under the policy scenario than in the reference case). The decline in expenditures on imported oil both improves the US trade balance and reduces revenue to oil-producing states that pursue policies counter to American interests. While reactionary OPEC supply cuts could erode some of these gains, the reduction in physical quantity demanded would ensure the majority of change in expenditures, even if prices returned to reference levels.

The downside of the Extended Light Duty Vehicle Standards scenario is that, all else equal, it likely increases the riskiness of the global oil pool. Unless OPEC cuts supply in reaction to the policy, the reduction in US demand will most likely be met by a reduction in the highest cost sources of supply, and at the moment those tend to be located in more stable countries (Goldman Sachs 2010b). So while vehicle efficiency makes the US economy more resilient to a $10 increase in global oil prices, it may also increase the odds of a given supply disruption causing a $10 price increase. Given that our Extended Light Duty Vehicle Standards scenario reduces US oil and biofuels production only by 165,000 to 214,000 bpd between 2011 and 2035 compared with the reference case, we believe this effect would be quite small and overwhelmed by the economic security benefits of reducing the oil intensity of the American economy.

While the Extended Light Duty Vehicle Standards scenario does the most to reduce US oil expenditures, the Building Efficiency Improvements scenario curbs overall energy expenditures significantly. Between 2011 and 2035, Americans spend $43 billion less on energy (primarily electricity and natural gas) per year compared with the reference scenario, the second highest of the policies we analyze (figure 15). While this does less to buffer the United States against oil price spikes than a commensurate decline in transportation sector energy expenditures, the scenario does rank relatively well on the US Chamber of Commerce's Energy Security Risk Index (figure 16).

Fuel Substitution

Broadly speaking, oil demand in the transportation sector can be reduced either through improving efficiency or by replacing oil with another form of energy. In practice, the two approaches are not so distinct. For example, under EPA/NHTSA vehicle standards electric vehicles have higher efficiency ratings than their conventional light duty vehicle counterparts, and natural gas–powered trucks have lower efficiency (but also lower greenhouse gas emissions) than conventional heavy duty vehicles. As a result the Extended Light Duty Vehicle Standards or Heavy Duty Vehicle Standards change the rate of electric or natural gas vehicle deployment. Electric and natural gas vehicle deployment is less rapid under these policies, however, than under the Electric Vehicle Deployment and Natural Gas Vehicle Deployment scenarios.

The impact of the Electric Vehicle Deployment and Natural Gas Vehicle Deployment scenarios on US oil consumption depends a great deal on assumptions about market acceptance, infrastructure constraints, and, in the case of electric vehicles, battery cost.

The impact of the Electric Vehicle Deployment and Natural Gas Vehicle Deployment scenarios on US oil consumption depends a great deal on assumptions about market acceptance, infrastructure constraints, and, in the case of electric vehicles, battery cost. Both policies have a relatively modest impact on US oil demand and oil imports in the first decade, as it takes time to turn over the vehicle fleet (table 2). But over the long term, both policies deliver meaningful reductions (at least when compared with Heavy Duty Vehicle Standards or Building Efficiency Improvements), prompting a modest decline in global oil prices (figure 10). On average between 2011 and 2035 annual oil expenditures decline by between $8 billion and $28 billion in Electric Vehicle Deployment and by between $1 billion and $16 billion in Natural Gas Vehicle Deployment (figure 14). US oil imports are reduced by 88,000 to 297,000 bpd with Electric Vehicle Deployment and 9,000 to 186,000 bpd with Natural Gas Vehicle Deployment (figure 11).

While the magnitude is smaller, the way in which these changes in US oil consumption impact American energy security is similar to the Extended Light Duty Vehicle Standards scenario. Electric and natural gas vehicles, whether deployed through vehicle standards or dedicated policy, come with additional energy security considerations. Electric vehicles use rare earth metals and other materials for which there are short-term supply chain risks (Department of Energy 2010). While the country is currently awash in domestic natural gas, a change in the shale gas development outlook or significant linkages between the US and international gas markets could make natural gas less secure and affordable than it is today. In our view, the security risks surrounding electric vehicles are lower than natural gas vehicles, but at the levels of deployment assessed in this policy brief, both scenarios are lower risk than the status quo.

Unlike electric and natural gas vehicles, oil demand reductions achieved through biofuels deployment are largely additional to those achieved through vehicle efficiency standards. Under our Advanced Biofuels Development scenario, US oil demand is reduced by an average of 329,000 bpd between 2011 and 2035 (figure 13). Oil prices are $0.90 lower, which combined with the demand decrease reduces annual oil expenditures by $24 billion (figure 14). In the case of biofuels, however, this does not necessarily make the economy less vulnerable to oil price spikes. Since oil and biofuels are near-perfect substitutes, their prices are highly correlated. So an international supply disruption will push biofuels prices up alongside the price of oil. As the advanced biofuels will likely be more expensive than gasoline and diesel, overall US energy expenditures will increase.

When it comes to the US trade balance or revenue to foreign oil producers, biofuels' benefits are a bit clearer. Under the Advanced Biofuels Development scenario, US oil imports decline by 264,000 bpd on average between 2011 and 2035 (figure 11). That translates into a $13 billion decline in annual imported oil expenditures (figure 12).

But like electric vehicles and natural gas vehicles, biofuels are not without their own security concerns. With food prices rising right alongside oil prices in recent years and high food costs adding to political instability in some developing countries, there is growing debate about whether biofuels are an effective security strategy. In addition, agricultural markets come with their own supply concerns and price shocks, which can feed into oil markets at high enough levels of biofuels deployment. These are important questions and ones that we are actively exploring. But it is a topic far beyond the scope of this brief. We will just note that in general the concerns surrounding cellulosic ethanol production (the specific policy intervention we are analyzing here) are considerably lower than for ethanol derived from corn.

Carbon Tax

The big surprise coming out of this analysis is the impact of a carbon tax on US oil production and consumption. Carbon taxes are generally considered second-best approaches for reducing oil demand as they are primarily designed to reduce CO_2 emissions. Not only is oil less carbon-intensive than coal (though more carbon-intensive than natural gas) but also oil demand is less elastic. As a result, analysis of carbon pricing policies (whether tax or cap-and-trade) shows the most significant transformations in the power sector as coal-fired power plants are either retrofitted with CCS or shut down and replaced with natural gas or renewables (EIA 2010b). In comparison, changes to oil demand in the transportation sector are more modest.

The big surprise coming out of this analysis is the impact of a carbon tax on US oil production and consumption.

But it turns out that modest changes in the context of a carbon tax are relatively large changes when compared with other proposals currently on the table. Between 2011 and 2035, a carbon tax at the level proposed by AEI would reduce US oil demand by 652,000 bpd, higher than any other proposal except Extended Light Duty Vehicle Standards (figure 13). Because a carbon tax reduces demand for all parts of the oil barrel, not just gasoline, the change in US oil expenditures is larger per barrel of oil reduced—$64 billion per year in total between 2011 and 2035 (figure 14).

Even more surprising, a carbon tax reduces US oil consumption while simultaneously boosting US oil production—a feat no other policy we analyze can claim. Between 2011 and 2035, average annual domestic oil production is 167,000 bpd higher, on par with what the policies focused specifically on increasing supply deliver (figure 9). Most of this increase comes in the form of natural gas liquids, a byproduct of natural gas production that serves as an oil substitute in certain industrial applications and is thus generally classified under "oil production." More natural gas demand for power generation in the face of a carbon price means more domestic gas production, which means more natural gas liquids. The rest of the production increase comes from enhanced oil recovery using CO_2 captured from coal-fired power plants.

Taken together, the decline in consumption and increase in production resulting from a carbon tax shaves 663,000 bpd, or $32 billion per year, off the US oil import bill between 2011 and 2035 (figures 11 and 12). This helps the carbon tax score significantly higher than any of the other policies we analyzed using the US Chamber of Commerce's energy security risk index (figure 16).

The downside of a carbon tax is that while it reduces the cost of oil for the American economy, it raises the average cost of energy for the American consumer. Between 2011 and 2035, a carbon tax would raise overall annual US energy expenditures by $147 billion (figure 15). The vast majority of this would be a fiscal transfer, rather than an economic cost. That money could be given back to energy consumers or used to reduce the federal deficit (or some balance of both). AEI's carbon tax proposal specifically would raise upto $195 billion per year on average between 2011 and 2035. If completely dedicated to improving the federal government's balance sheet, the carbon tax alone would reduce the deficit by up to 20 percent over the next decade (CBO 2011).

All Together Now

Individually, the policies assessed in this brief would have only a modest impact on US oil imports or US oil expenditures, with the exception of Accelerated GoM Leasing and Permitting in the short term and the Extended Light Duty Vehicle Standards and Carbon Tax scenarios in the long term, where the effect is more significant. But what about an "all of the above" strategy where the ten policies we analyze are combined? We model the policies' collective impact both in the base case and with the more liberal OCS resource, natural gas and electric vehicle penetration, and battery cost assumptions used in the upper-bound scenarios of the various individual policies. The analysis is integrated so the interaction between various policies is captured.

Taken together, these various individual proposals have a meaningful impact on US oil production and consumption. In addition to the near-term supply relief from increased GoM production, total domestic oil output increases by roughly 1 million bpd, about 10 to 12 percent, between 2021 and 2035. Oil demand is reduced by 2.2 million to 2.8 million bpd during that period, or 12 to 15 percent. Together, increased domestic supply, efficiency, and fuel substitution curb US oil imports by 3.1 million to 3.8 million bpd by 2035. In the upper-bound (high) scenario, this would cut overall net US oil imports to 4 million bpd, reducing US dependence on imported oil (measured in physical terms) to its lowest point in the past 40 years (figure 17). America's annual imported oil bill would fall by between $127 billion and $148 billion between 2021 and 2035, taking a significant bite out of the country's trade deficit. Because global oil prices drop by $8 to $10 per barrel, foreign oil producer revenue could be reduced by up to half a trillion dollars per year in the long term.

It is important, however, not to overstate either the economic or national security benefits such a transformation would produce. For example, while half a trillion dollars lower than in the reference case, foreign oil producer revenue still grows by over a trillion dollars per year in absolute real terms between 2011 and 2035. While oil expenditures as a share of GDP return to late 1990s levels towards the end of our projection period (figure 18), the US economy will still remain vulnerable to international oil market disruptions, particularly in the short and medium term. So while a domestic energy policy agenda that combines increased domestic supply, improved efficiency, and development of oil substitutes is crucial, it is not a sufficient energy security strategy.

WHAT'S MISSING FROM THE POLICY DEBATE

As the United States will remain dependent on international oil supply for the foreseeable future and will continue to be economically vulnerable to global oil shocks, Washington needs a strategy for reducing the likelihood of those shocks and mitigating their economic impact. There is an active debate about the role financial investment in oil futures markets may have played in recent oil price volatility. This is an important question and one that we study closely. But as with the food versus fuel debate, it is a complicated subject that cannot be adequately addressed within the scope of this brief.[20] Improving the stability and reliability of global oil markets goes far beyond futures market regulation. The following areas

20. For a good overview discussion of the way financial investment in oil markets does and does not impact energy security, see *Improving Energy Market Regulation: Domestic and International Issues*, CGS/IIGG Working Paper, February 2011, available at www.cfr.org.

deserve particular focus. None of these suggestions are particularly new; they can be found in the policy recommendations section of most serious energy security reports. But they have yet to get the attention and emphasis they deserve.

Better Information

Given how central it is to the performance of the global economy, the quality of information about the global oil market is surprisingly poor. Lack of inventory and production data creates market uncertainty and increases short-term volatility. The United States is the only country that provides regular, detailed, and reliable oil data and EIA's *Weekly Petroleum Status Report* (the publication through which it is first released) is the single most important piece of information in the market. Other OECD members report oil data on a monthly basis to IEA, but there is a 40 to 50 day lag between the end of the reporting month and when the information is available to the market. The availability and quality of developing-country demand and inventory data are even worse. On the producer side, the picture is equally murky. Lack of clarity about OPEC output levels in particular drives market volatility. Following a particularly chaotic OPEC meeting in June 2011, Secretary General Abdalla Salem el-Badri complained that even among OPEC producers "everyone has his own data and information" (Blair 2011).

Realizing the importance of transparent and reliable oil statistics, ministers gathered at the International Energy Forum in 2002 launched the Joint Oil Data Initiative (JODI). The effort has made important progress in improving the quality and timeliness of global oil-market data but considerable work remains. Of the 98 countries providing data to JODI during the second half of 2010, only 55 did so in a timely manner and only 67 met JODI's minimum standard of completeness (JODI 2010).

Improving the quality of short-term market information will also help support better medium- and long-term planning. The oil price increases of the past decade were caused primarily by the failure of the market to accurately forecast developing-country demand and build enough production capacity to meet that demand at a reasonable price. EIA and IEA do terrific work helping market participants and policymakers plan for the future, but their greatest expertise lies in forecasting OECD supply and demand. It is in America's interest to support the development of similar analytical expertise within developing countries, China in particular, and to encourage greater collaboration between developed- and developing-country forecasters in assessing possible oil-market futures.

At the international level, policy is moving in the right direction but moving too slowly. Multilateral forums like IEA, the International Energy Forum, and the G-20 all have oil-market transparency squarely on the agenda. EIA has stepped up its bilateral engagement, working with China's National Energy Administration to improve the quality of Chinese energy statistics and forecasting. But US national policy has shifted into reverse. In the face of rising oil prices, MENA instability and oil-market uncertainty, Congress and the White House opted to cut EIA's budget by 14 percent (EIA 2011b). In exchange for a meager $15 million in savings, or 0.004 percent of the US federal budget, the oil market will now either lose the following or see the quality of output significantly reduced:

1. updated estimates of US oil and gas reserves,
2. analysis of linkages between financial trading and physical energy markets,
3. refinery outage reporting and analysis,
4. oil and gas company financial analysis,
5. improvements to NEMS, the model used to forecast US energy supply and demand,
6. all international energy statistics, and
7. the *International Energy Outlook*, one of only two credible independent global energy supply and demand forecasts currently available.

Funding both EIA and IEA each year costs Americans less than they spend on petroleum each hour. If the information these two organizations produce is successful in reducing oil prices by just 1 percent over a 12-month period, US taxpayers earn a 600 percent return on their investment. While we are not assessing the relative cost effectiveness of various energy security policy options in this brief, it is safe to say that funding these two organizations wins hands down.

Stockpile Coordination

IEA was founded in response to the 1973–74 oil price spikes to coordinate the response of the major oil-consuming countries to future supply disruptions. IEA members agree to maintain 90 days worth of imported oil in inventories (either strategic petroleum reserves [SPRs] or corporate inventories) and coordinate the release of those inventories in the event of an oil supply disruption (IEA 2011a). Such coordination spreads the cost of and improves the effectiveness of a consumer-country inventory release. This is the case with the SPR release announced on June 23, 2011. Other IEA members will sell 30 million barrels of oil from strategic inventories in addition to the 30 million barrels provided by the United States.

Large developing-country oil consumers are in the process of building their SPRs. This can be a positive development for US energy security if it is done transparently in coordination with other oil consumers. IEA estimates that filling China and India's new SPRs will add an average of 240,000 bpd to global oil demand over the next five years (IEA 2011b). Yet official information from Beijing and Delhi as to the exact schedule for these inventory fills has been sparse, creating unneeded market uncertainty. And as China and India are not IEA members, no mechanism currently exists to coordinate SPR releases in the event of a significant supply disruption. While IEA has stated that China and India were consulted prior to the June 23 announcement, there is no indication that either country will be joining the effort, opting to free ride on the resulting oil price reductions instead. Enlisting Chinese and Indian cooperation in SPR management will only grow in importance in the years ahead if OPEC's ability to rapidly increase supply remains limited, as many analysts currently expect (McNally and Levi 2011).

The June 23 SPR release, only the third in IEA's history, also opens the door to a new form of strategic inventory management—one where oil is released to smooth oil price fluctuations, even if they are not caused by significant supply disruptions. The White House and IEA have both pointed to the disruption of Libyan supply as a principal reason for the inventory release. Yet Libyan oil was taken offline months before the announcement and is not projected to resume until well into 2012 if not 2013. A more important driver of the decision was likely concern that global supplies will tighten during the third quarter of 2011, increasing prices at a time when the economic recovery is still fragile. There is a compelling case to be made for this type of preemptive action, but it is a sharp departure from past practice and changes oil-market dynamics in important ways. Consuming countries need to have a public discussion about whether this is the right way to manage SPRs going forward so those investing in future oil production know what to expect.

Producer Engagement

Smart engagement with developing-country consumers can improve the market's ability to adequately plan for future demand and improve global SPR management. Smart engagement with foreign oil producers can improve the reliability and affordability of future oil supply. In recent years, OPEC has had increasing difficulty functioning effectively as a cartel. Only a handful of producers—Saudi Arabia, Kuwait, and the United Arab Emirates—hold the spare capacity required to perform basic cartel functions. That means that other OPEC members have little to gain from any increase in aggregate cartel production. Raising OPEC production quotas reduces oil prices. For Saudi Arabia, Kuwait, and the United Arab Emirates, lower prices are offset by higher output. But for Iran, Venezuela, and the others, there is only downside to such a move. This disparity was a principal reason for the breakdown of the June 2011 OPEC meeting.

Fortunately for global oil markets, the OPEC countries that do hold spare capacity are the ones more concerned that high oil prices will hurt the global economy—and thus long-term oil demand. This creates a window of opportunity for engaging these producers in serious dialogue about improving market information, demand forecasting, and management of both consumers' strategic inventories and producer's spare capacity. Such a dialogue has begun through the International Energy Forum and should be elevated within the G-20, which accounts for 80 percent of global oil demand and over half of global oil production (including 4 of the 5 largest oil producers—Russia, Saudi Arabia, the United States, and China).

Policy Reform

As mentioned earlier, oil prices swing wildly because in the short term both supply and demand are inelastic. Some of this inelasticity is inherent in the way oil is produced and consumed, but some of it is the artifact of policy. Subsidized gasoline and diesel prices decrease elasticity in developing countries, increase global oil prices, and ration demand away from developed countries. Tax policy in some producer countries, such as Russia, decreases supply elasticity by removing the incentive for companies to increase production in response to higher prices. Overall, policy uncertainty in developed countries hampers the development of new sources of oil supply or fuel and vehicle alternatives, which would increase both supply and demand elasticity.

International collaboration on energy policy in general has expanded in recent years through the International Energy Forum, the Clean Energy Ministerial, the Asia-Pacific Economic Cooperation (APEC) forum, IEA, G-20, and other forums. A greater focus on policies that reduce the global economy's vulnerability to oil shocks, and investment in international collaboration that helps advance those policies, will yield energy security dividends for the United States. Making significant progress on fossil fuel subsidies at the international level will require willingness to reform fossil fuel subsidies at home, including tax credits currently provided to US oil companies.

Technical Cooperation

Likewise, international cooperation that accelerates the development and deployment of oil-producing or oil-saving technologies is well worth the investment for the United States. Chinese companies are looking to replicate the US shale gas revolution at home, with the support of the US government. To the extent that this enables future Chinese fuel-switching from oil to gas, it will deliver gasoline price reductions in the United States. Similar technical cooperation on shale oil could have an even larger effect. Likewise, international cooperation on advanced battery research, such as that taking place through the new US-China Clean Energy Research Center, could make the difference between whether the domestic electric vehicle incentives analyzed in this brief result in the upper- or lower-bound estimates.

As with public energy market analysis work, only a sliver of the federal budget goes to international energy policy and technology cooperation. Yet the pot of money from which most of that funding comes was cut by one-third in fiscal year 2011 relative to fiscal year 2010. Public dollars spent to help reduce international oil demand or increase international oil supply make even more sense in a fiscally constrained environment given the potential US economic benefits and should be expanded rather than reduced in the years ahead.

Security Burden-Sharing

US energy security will continue to rest on the safety of oil-producing assets abroad and the security of global shipping lanes. But the cost of providing that safety and security does not need to fall on US taxpayers alone. Other oil-consuming countries have had the luxury of free riding US military spending that helps ensure tankers can move safely from port to port. But given US fiscal constraints, this may need to change going forward. Enlisting Chinese and Indian support in safeguarding critical sea-lanes of control can help lay the groundwork for broader security cost sharing in the years ahead. This is an extremely daunting undertaking but one that will be necessary over the long term and is deserving of greater focus today.

And as developing counties build out new oil supply infrastructure, it is in America's interest to help them do so in the securest way possible. In today's global oil market, a pipeline disruption between Kazakhstan and China can have the same impact on US oil prices as a hurricane in the Gulf of Mexico. As non-OPEC production gets pushed into higher cost and higher risk geographies and geologies, infrastructure security concerns will only grow.

Preparing for Success

A significant reduction in US oil imports, whether delivered through policy or market forces, will alter the global security environment in important ways. Less revenue to oil-producing states will help alleviate some security concerns (e.g., funding for Iran's nuclear program) but introduce others (e.g., potential political instability in oil-producing states). With developing countries responsible for a growing share of that revenue, the geopolitical landscape is sure to evolve (Verrastro et al. 2010). Preparing for the impact of a reduction in US oil dependence will be just as important as putting in place the policies that deliver that reduction in the years ahead.

CONCLUSION

While $4 per gallon gasoline has Washington scrambling for quick fix domestic energy policy solutions, there are no silver bullets, particularly in the near term. Even over the long term, any individual policy approach, whether improved vehicle efficiency or expanded offshore drilling, will have only limited effect on US oil imports and vulnerability to global oil market disruptions. President Obama's Blueprint for a Secure Energy Future includes a range of efficiency and oil substitution policies—from new light duty vehicle standards to electric vehicle incentives to advanced biofuels R&D. If the administration's biofuels push is successful enough to allow the existing Renewable Fuels Standard to be achieved (something we are skeptical about), then the policies laid out in the blueprint will be successful in achieving its goal of a 33 percent reduction in US oil imports between 2008 and 2025.[21]

What the blueprint is missing is a strategy for expanding domestic oil production, particularly in the near term when it could help head off price spikes resulting from constrained global supply. This has been the primary focus of congressional Republicans, but as shown in our analysis and summarized in figure 19, policy-driven domestic production alone (as opposed to that which will occur based on market forces alone) will be insufficient to significantly alter the country's energy future. An "all of the above" strategy is required, which combines increased domestic production (important in the near term) with long-term investments in energy-efficient vehicles and oil alternatives, whether electric, natural gas, or biofuels. A carbon tax, while still a long shot politically, would deliver further energy security gains and help reduce the deficit in the process.

21. Most of these gains will be achieved as a result of market forces or past policy initiatives. For more discussion, see *President Obama's Energy Security Blueprint*, April 21, 2011, www.rhgroup.net.

But even the most comprehensive package of domestic energy policy solutions will not meet the country's energy security challenge. A true "all of the above" strategy must include a concerted effort to improve the transparency and reliability of global oil markets, on which the United States will continue to depend for decades to come. The administration has made important steps forward through international forums like the G-20, the International Energy Forum, IEA, and the Clean Energy Ministerial, but much more needs to be done. Both the White House and Congress have dealt a serious blow to American energy security by cutting funding for EIA. This funding cut should be reversed and international energy engagement significantly expanded in the years ahead.

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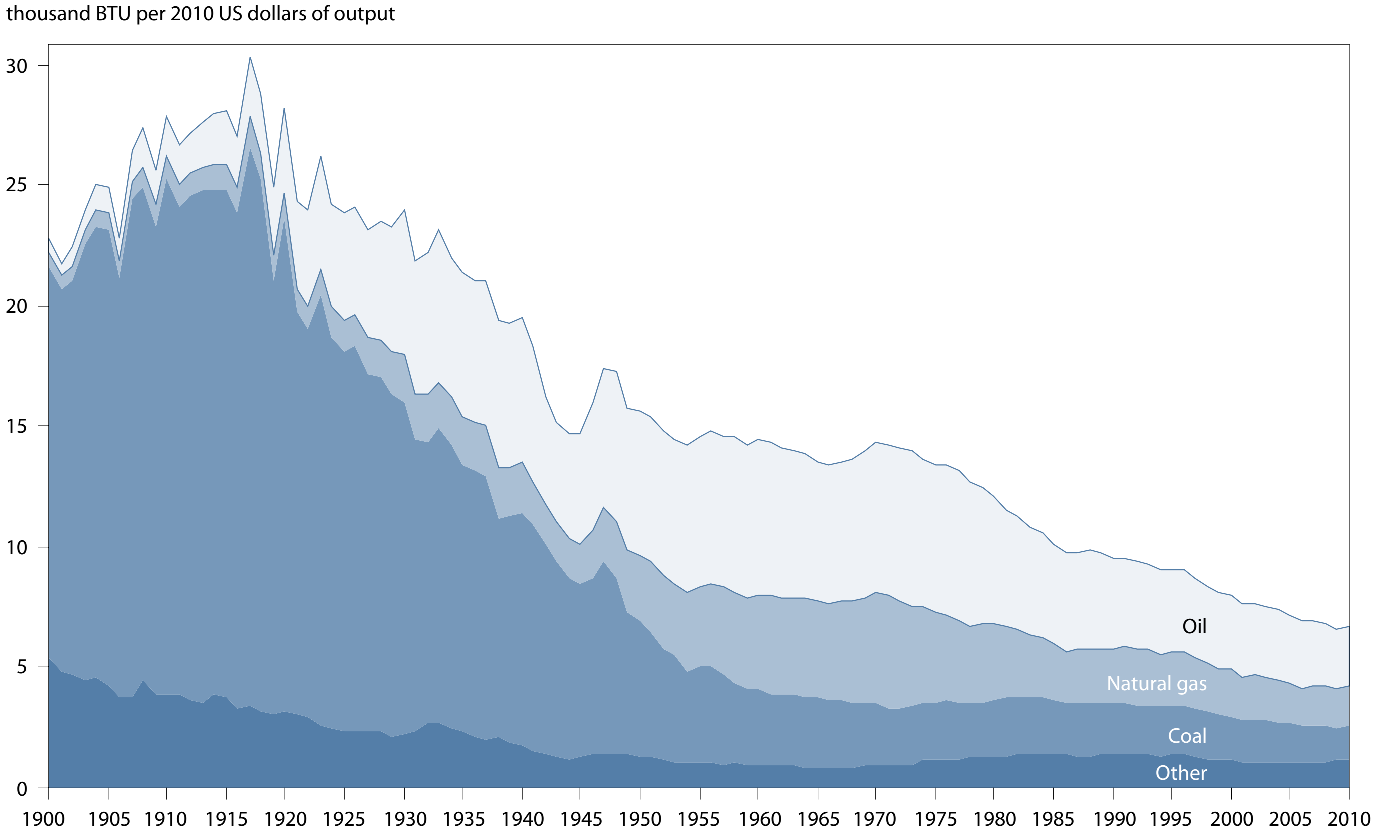
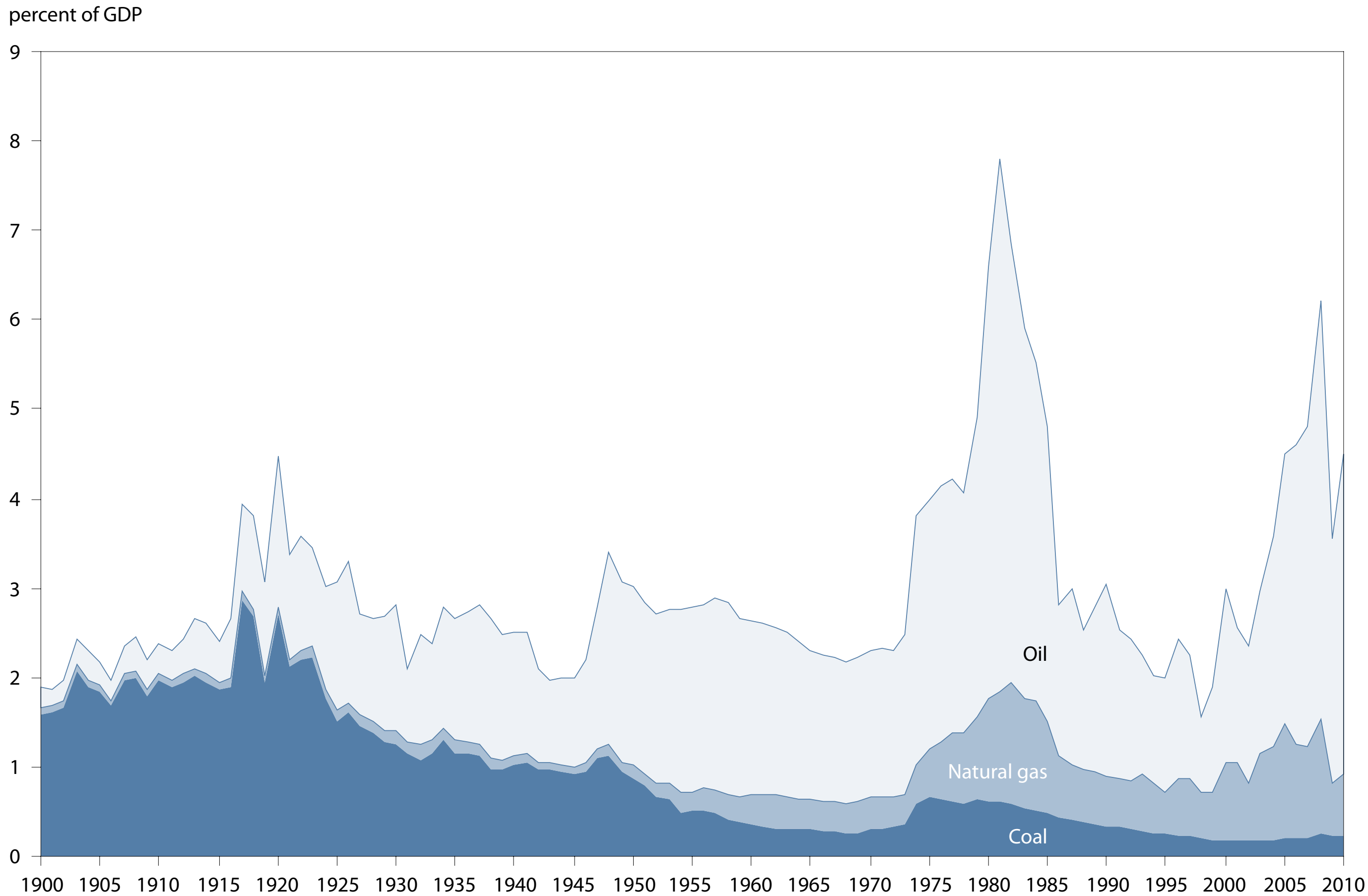
Figure 1 Energy intensity of the US economy, 1900–2010



BTU = British thermal units

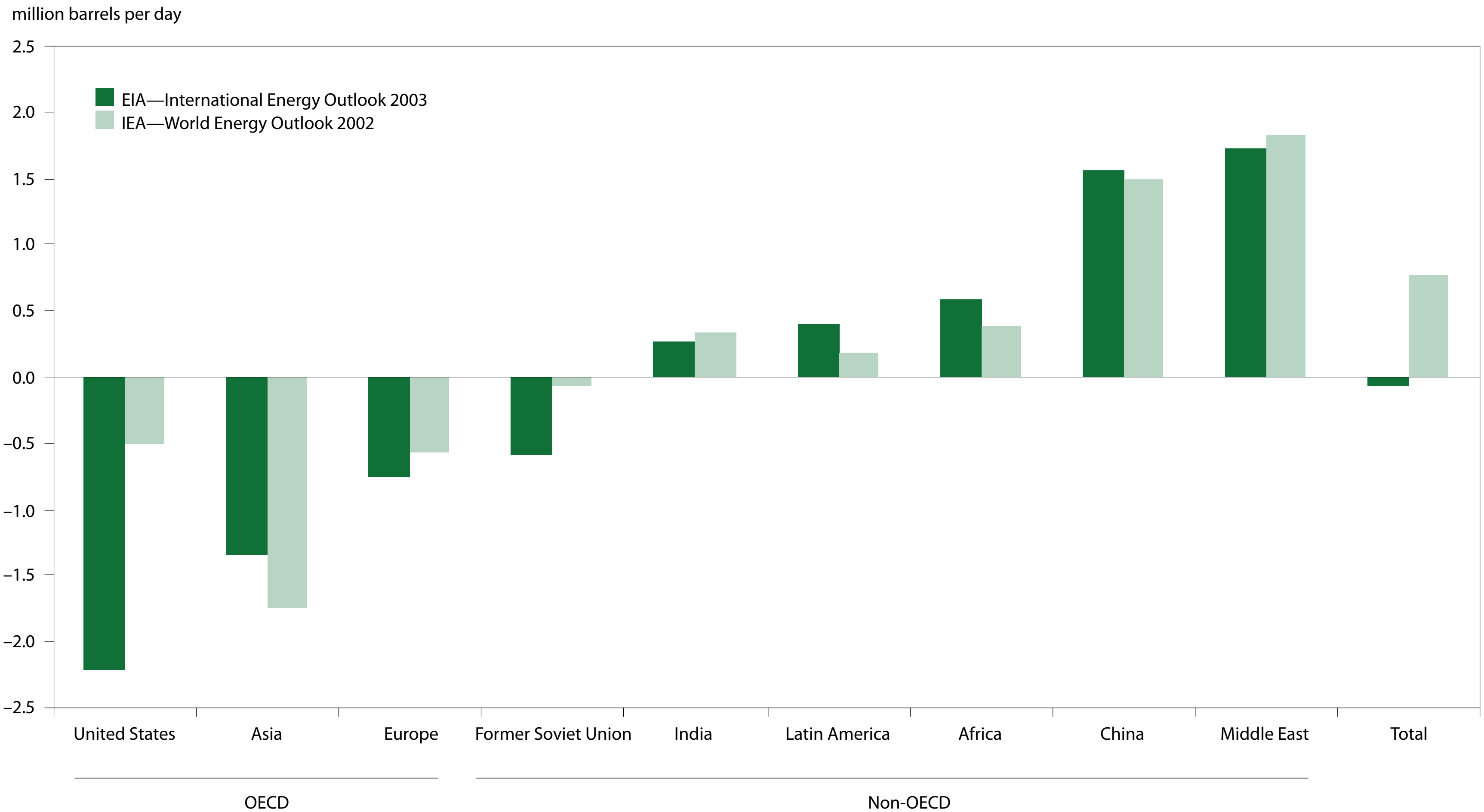
Sources: EIA (2010a); Schurr and Netschert (1960); Bureau of Economic Analysis (2011a).

Figure 2 Cost of fossil fuels, 1900–2010



Sources: EIA (2010a); Schurr and Netschert (1960); Bureau of Economic Analysis (2011a).

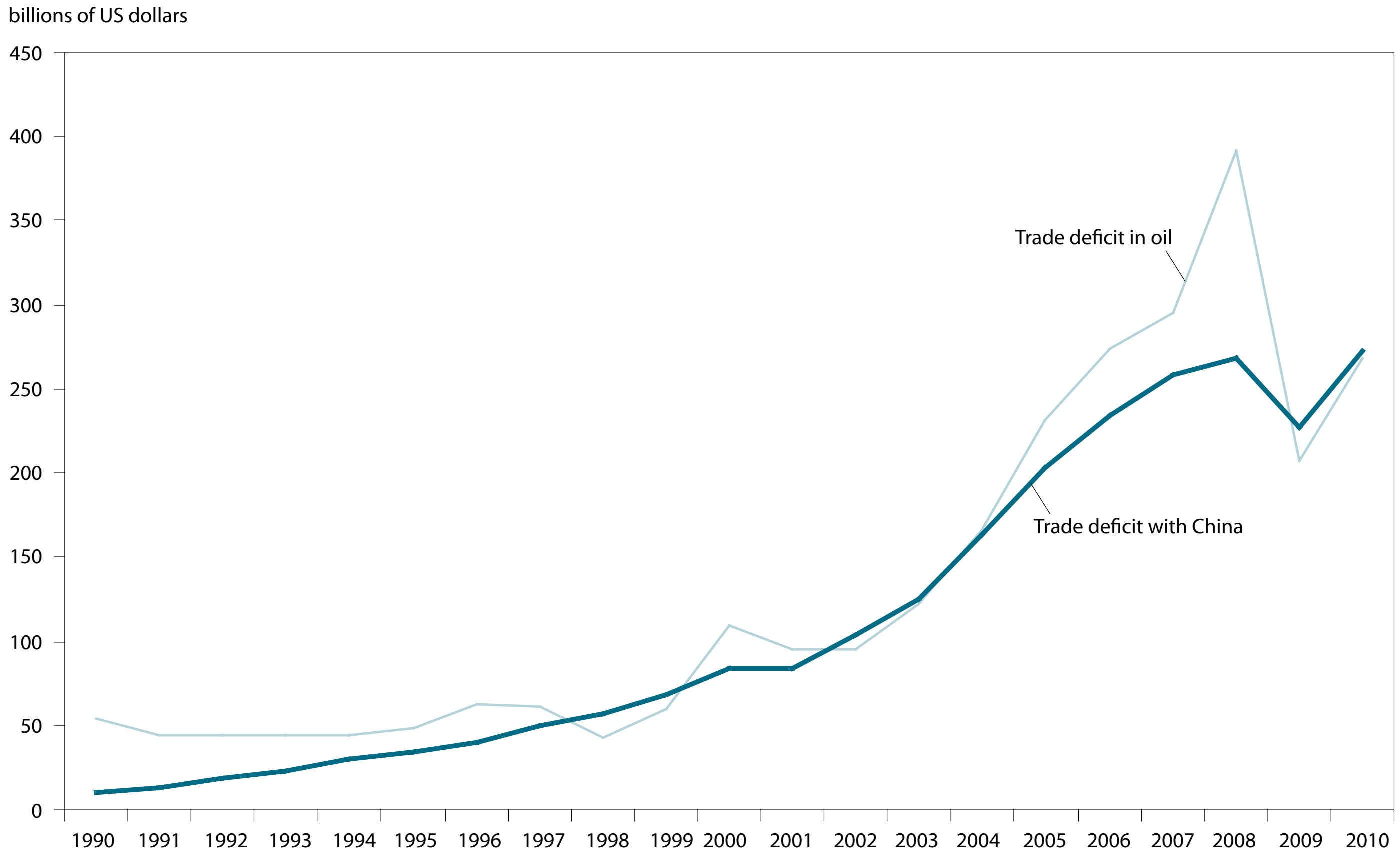
Figure 3 Difference between projected and actual 2008 oil demand



Note: Negative numbers indicate demand was less than expected. Positive numbers indicate demand was greater than expected.

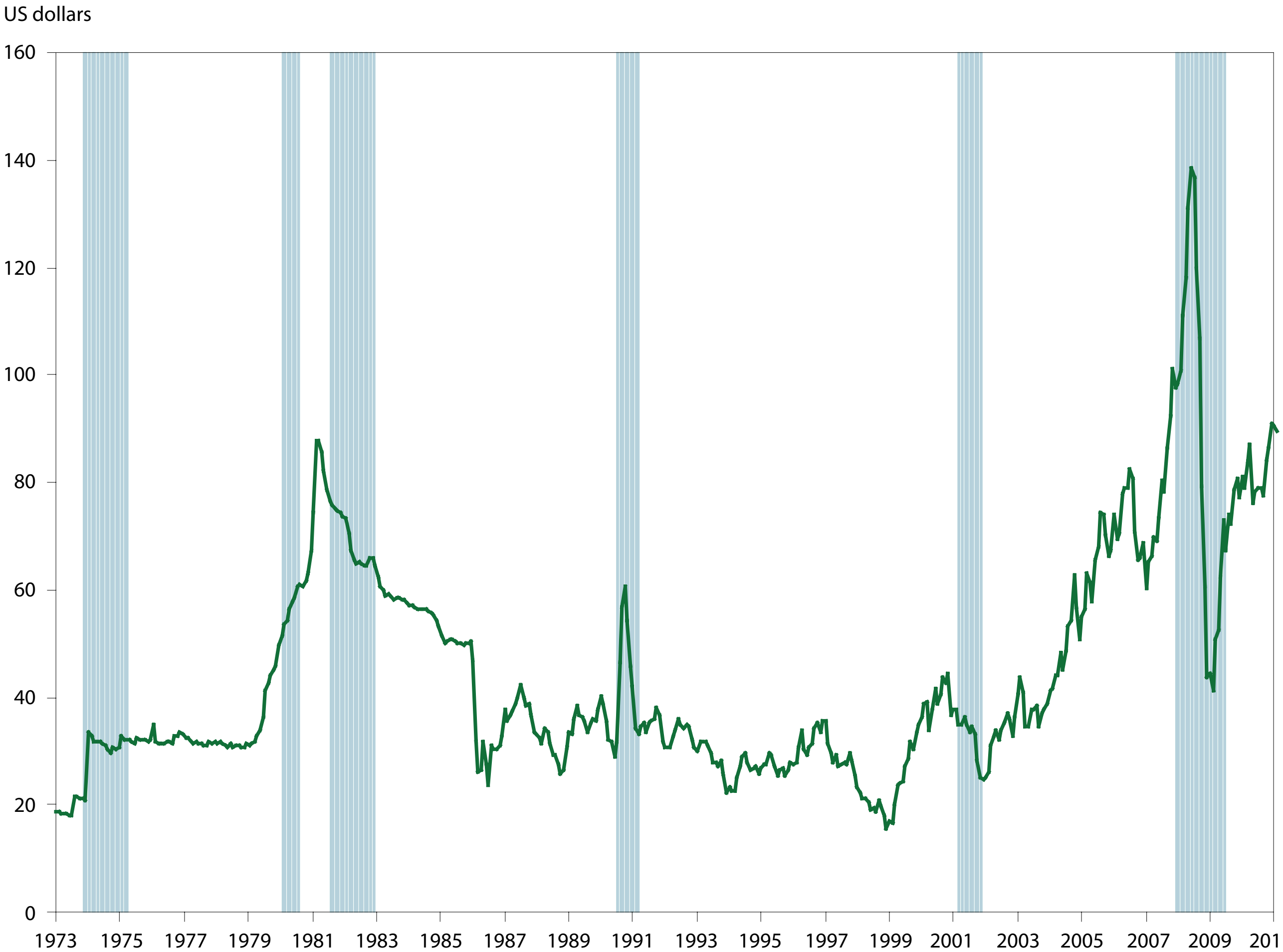
Sources: EIA (2003, 2010c); IEA (2002, 2010b).

Figure 4 US trade deficit in oil and with China, 1900–2010



Sources: EIA (2010a); Schurr and Netschert (1960); Bureau of Economic Analysis (2011a).

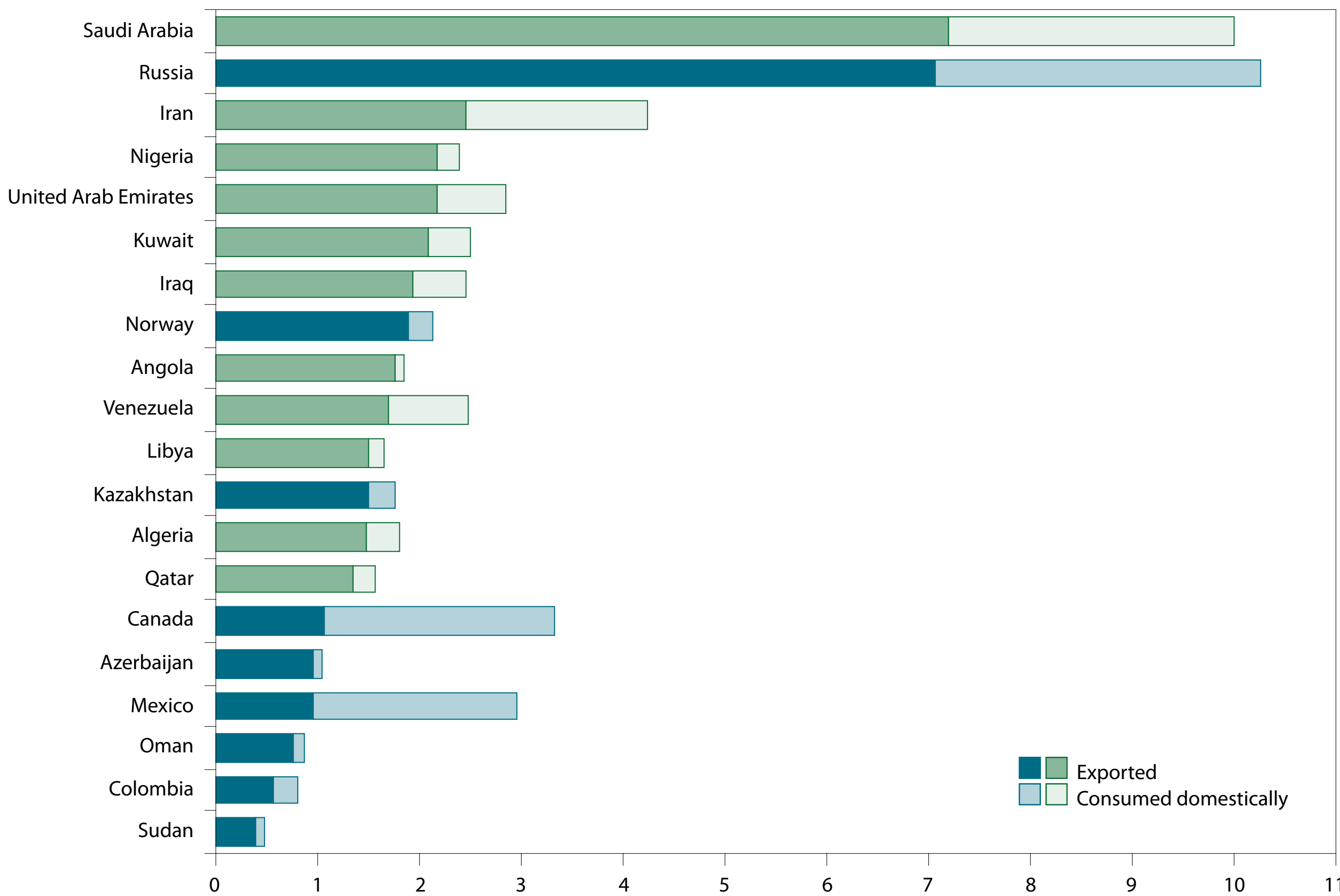
Figure 5 Oil price and US recessions, 1973–2011



Note: Verticle bars mark US recessions as defined by the National Bureau of Economic Research (NBER).

Sources: EIA (2011c); NBER (2011).

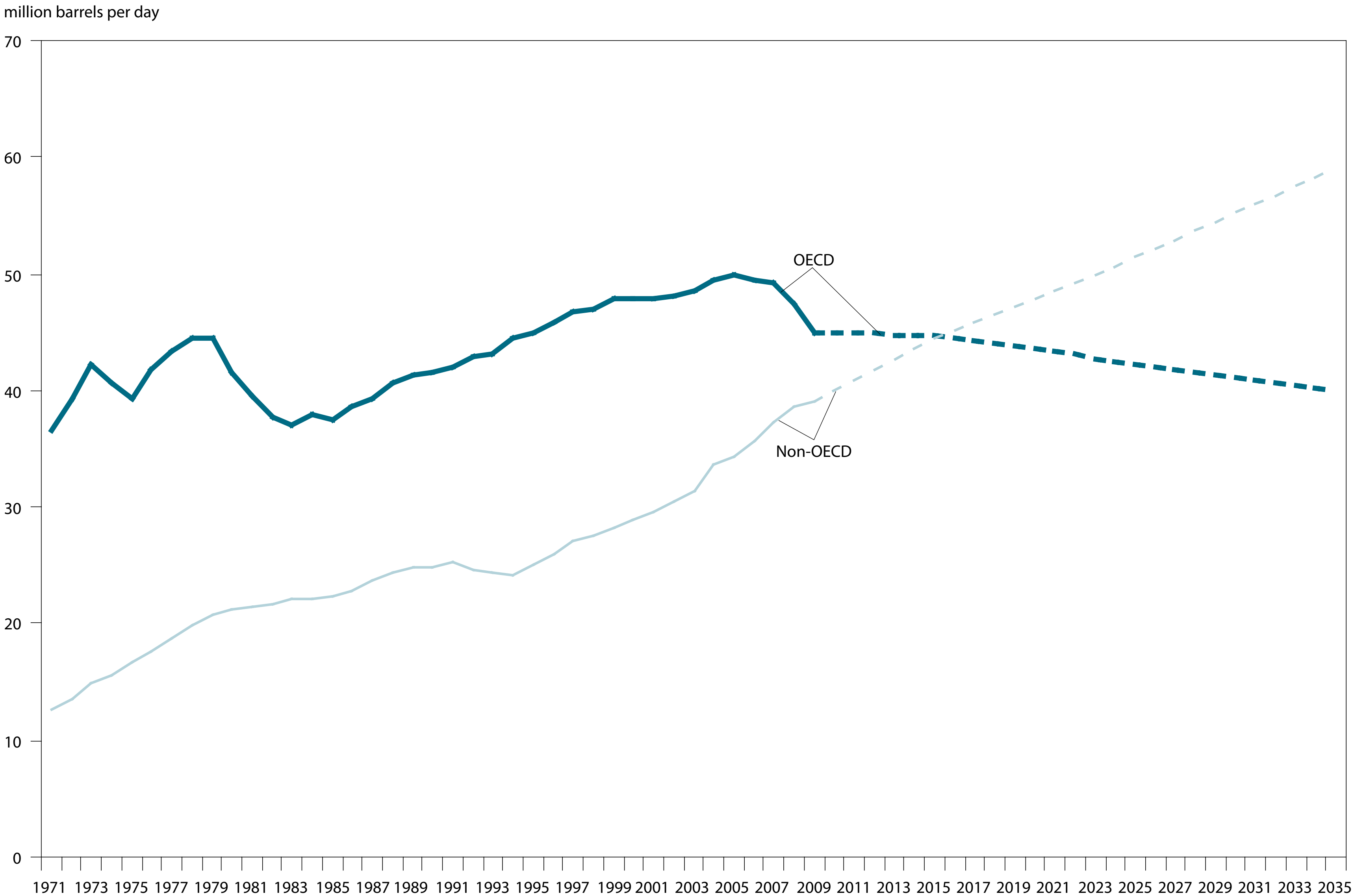
Figure 6 Top 20 oil exporters by volume, 2010



Note: Green bars are OPEC members and blue bars are non-OPEC.

Sources: BP (2011); JODI (2011).

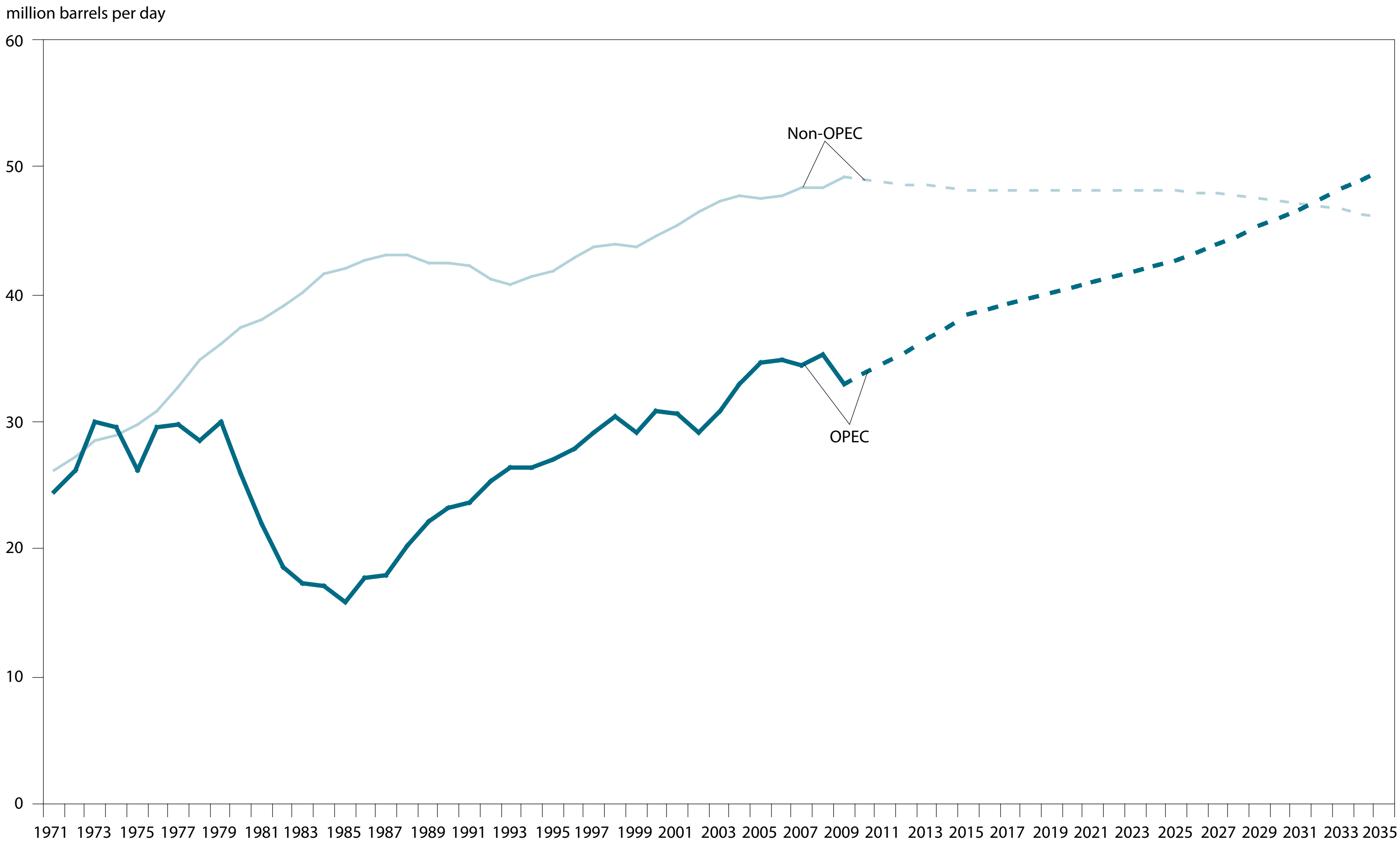
Figure 7 Global oil demand, 1971–2035



OECD = Organization for Economic Cooperation and Development

Sources: IEA (2010a, 2010b).

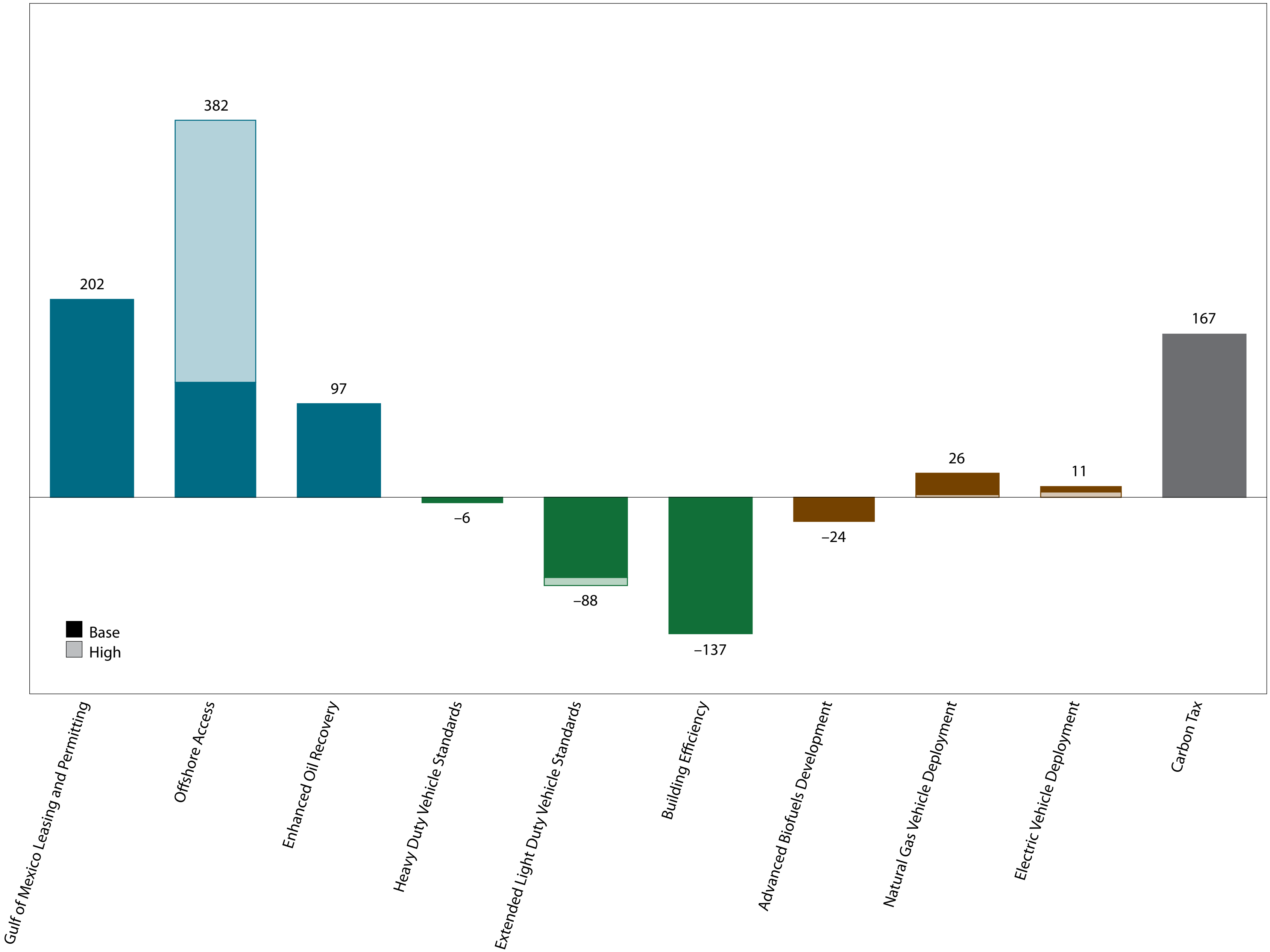
Figure 8 Global oil production, 1971–2035



OPEC = Organization of Petroleum Exporting Countries

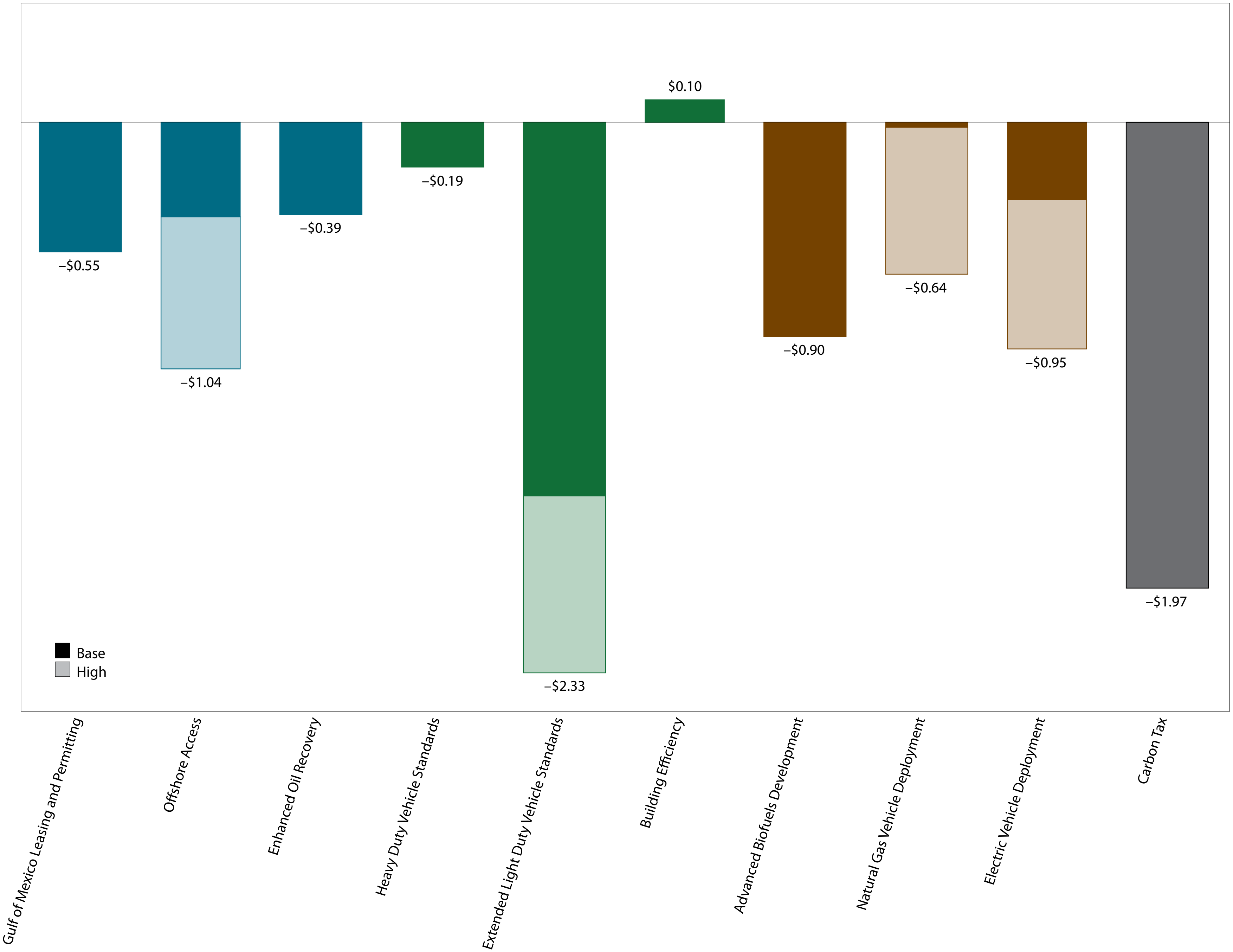
Source: IEA (2010a, 2010b).

Figure 9 Change in average annual US oil production, 2011–35 (thousand barrels per day)



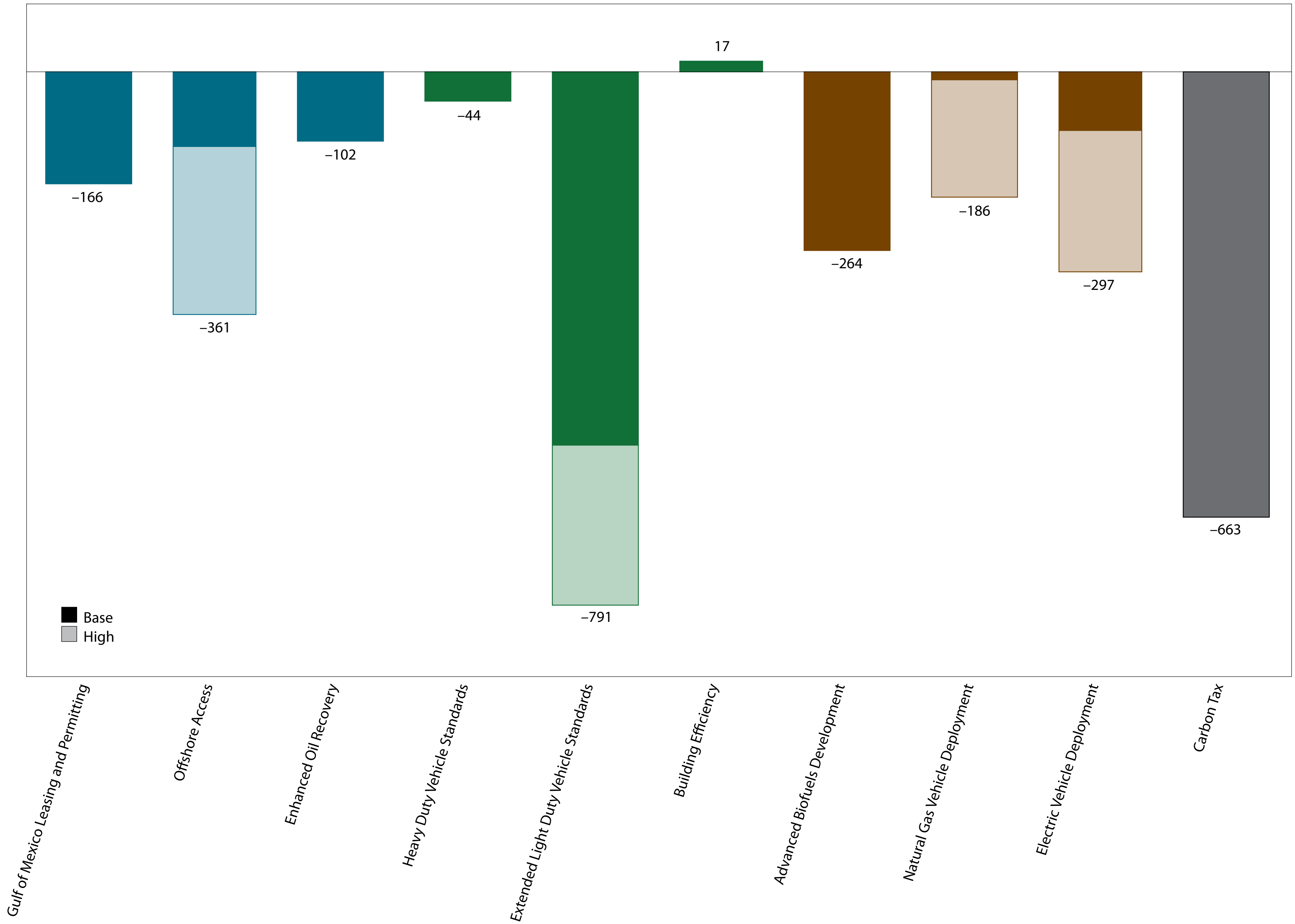
Source: Authors' calculations.

Figure 10 Change in average annual oil price, 2011–35 (2009 US dollars per barrel)



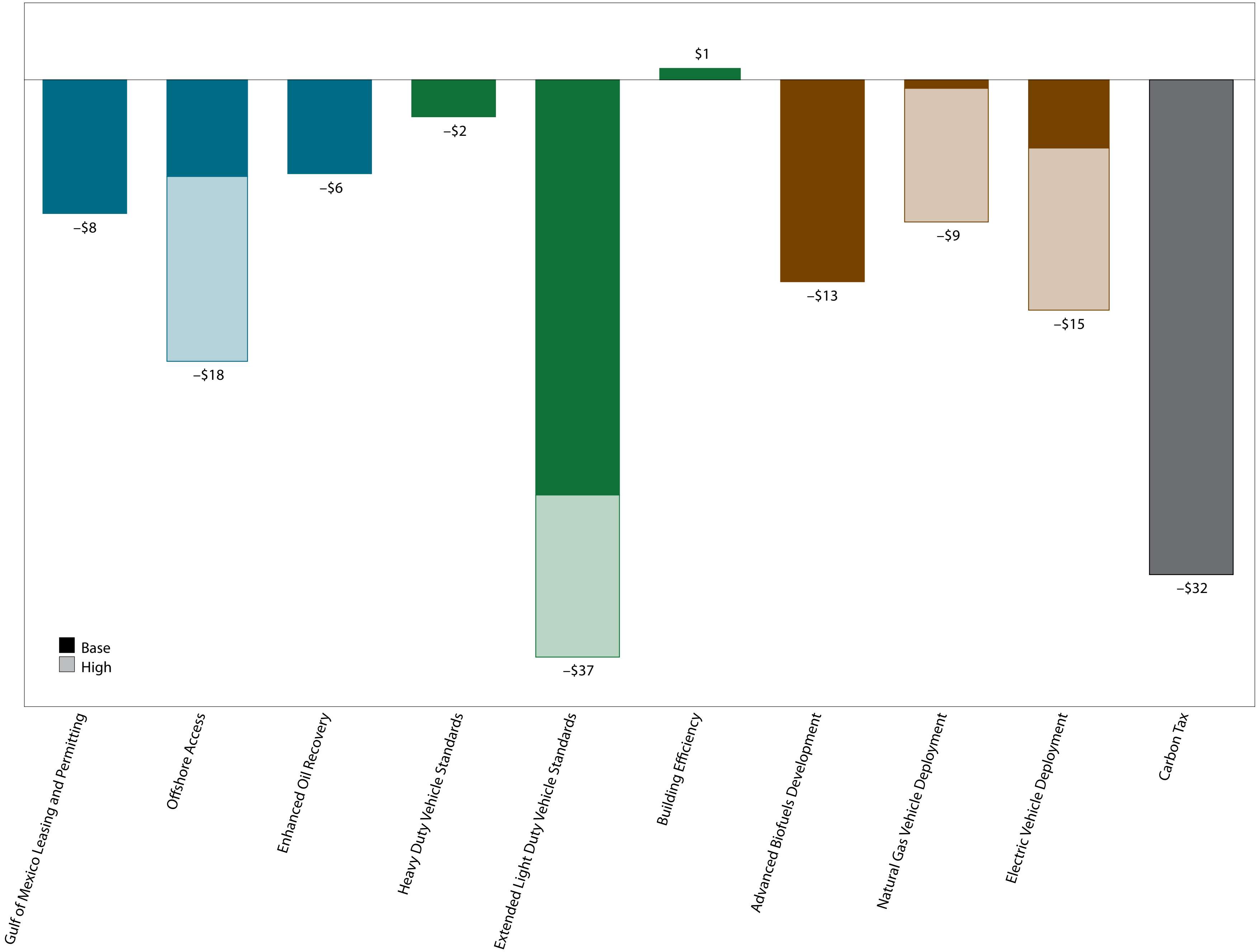
Source: Authors' calculations.

Figure 11 Change in average annual US net oil imports, 2011–35 (thousand barrels per day)



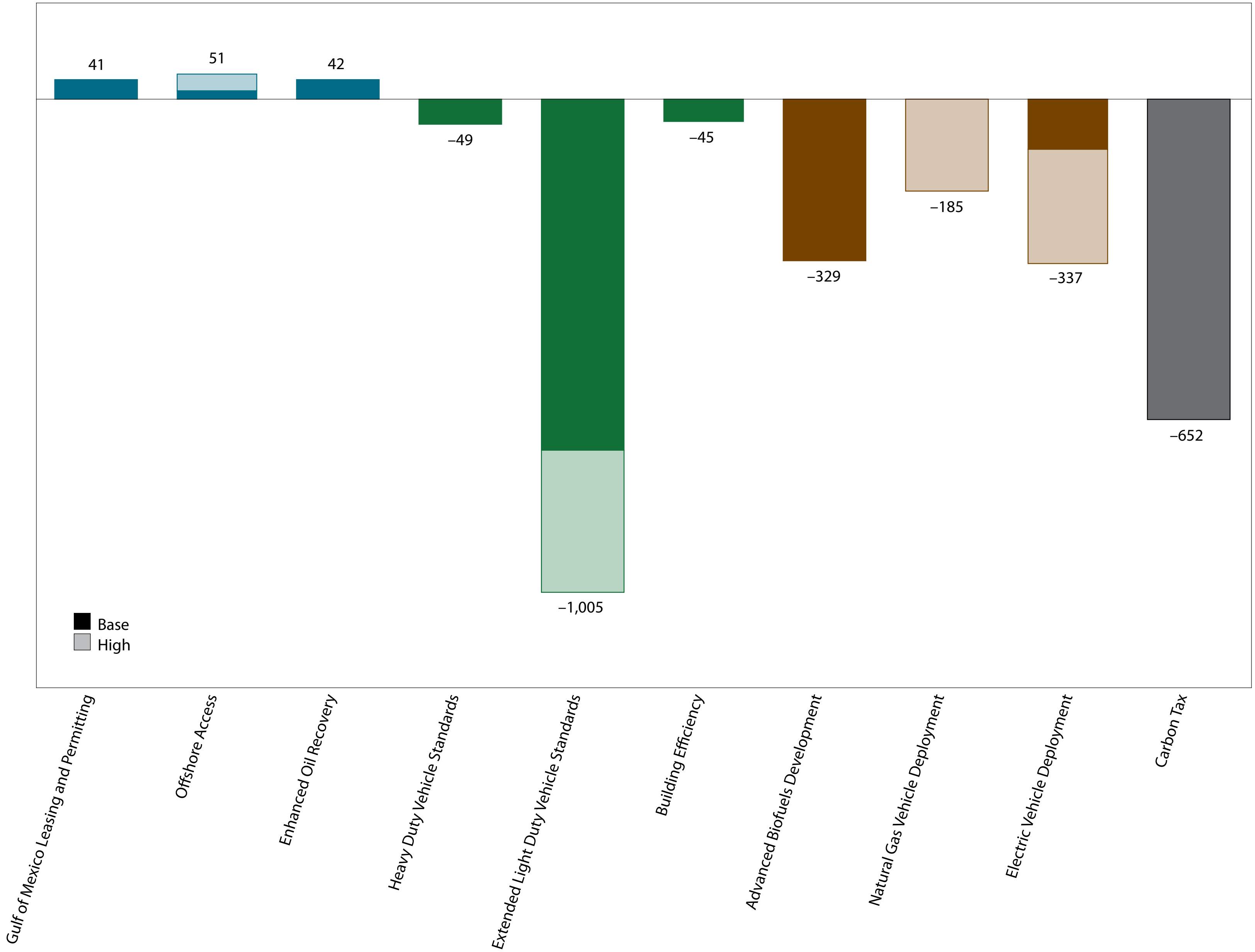
Source: Authors' calculations.

Figure 12 Change in average annual US imported oil expenditures, 2011–35 (billions of 2009 US dollars)



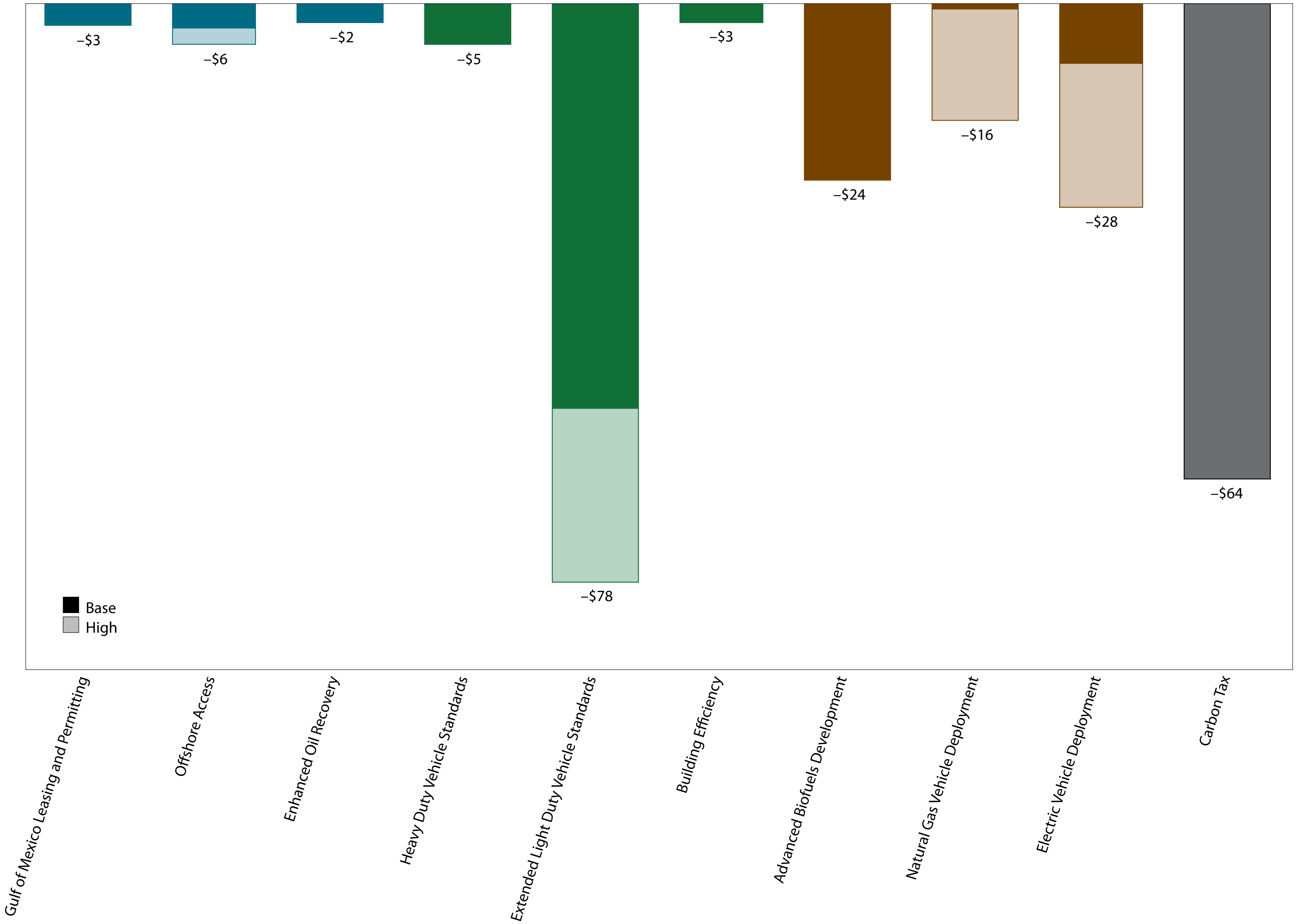
Source: Authors' calculations.

Figure 13 Change in average annual US oil demand, 2011–35 (thousand barrels per day)



Source: Authors' calculations.

Figure 14 Change in average annual US oil expenditures, 2011–35 (billions of 2009 US dollars)



Source: Authors' calculations.

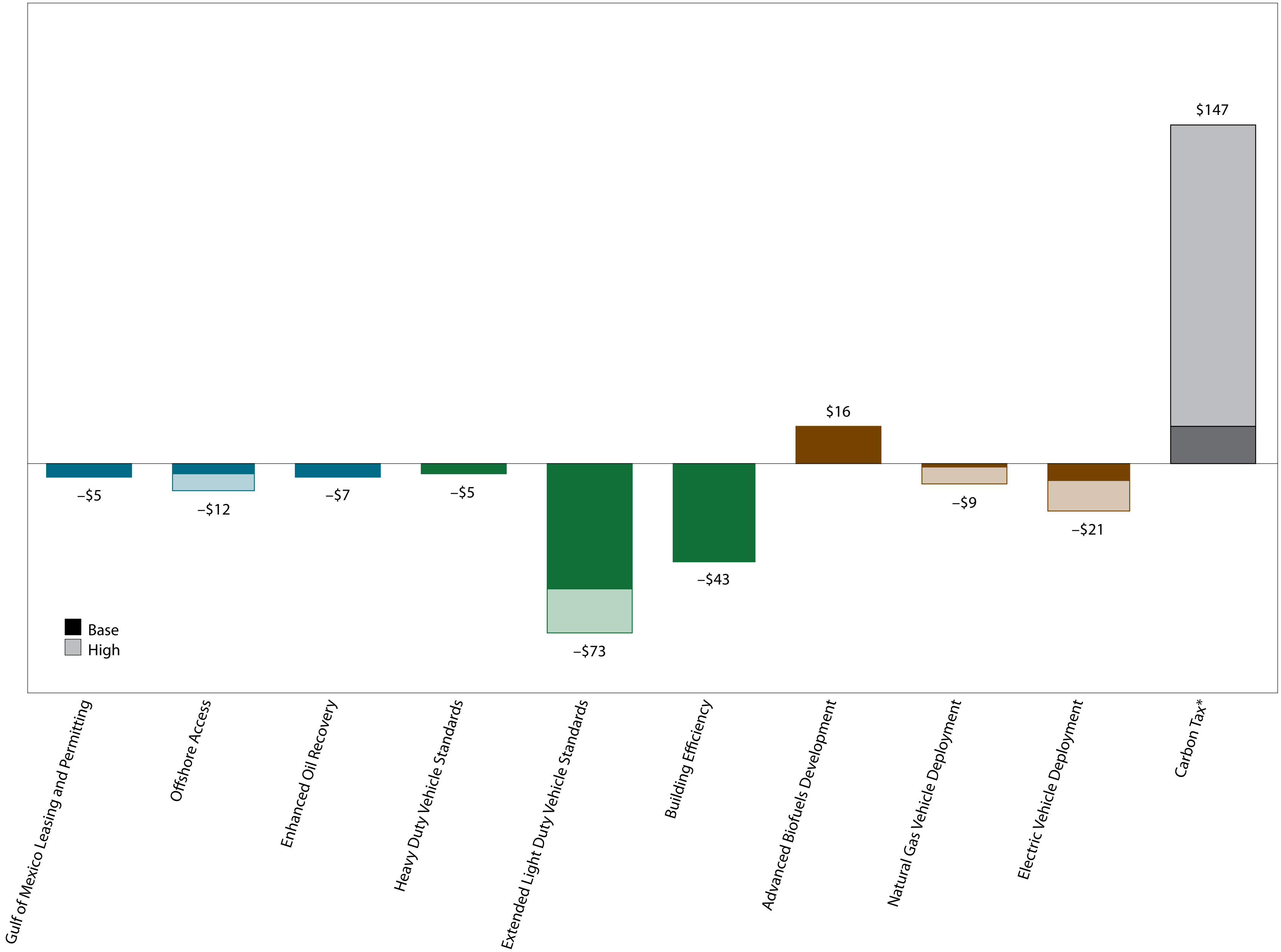
Table 1 US oil expenditures, 2011–35

	Annual average (billions of 2009 US dollars)				
	2011–2015	2016–2020	2021–2025	2026–2030	2031–2035
Accelerate GoM Leasing and Permitting	769	875	927	967	1006
Increase Offshore Access	771	874	922 – 927	954 – 966	983 – 1,004
Enhanced Oil Recovery	771	874	929	970	1002
Heavy Duty Vehicle Standards	770	869	924	967	1002
Extended Light Duty Vehicle Standards	773	872 – 875	872 – 883	834 – 871	819 – 885
Building Efficiency Improvements	771	874	930	971	999
Advanced Biofuels Development	763	825	898	957	998
Natural Gas Vehicle Deployment	763 – 771	854 – 874	915 –9 31	956 – 973	992 – 1,006
Electric Vehicle Deployment	766 – 767	862 – 865	908 – 920	933 – 962	953 – 1,003
Carbon Tax	754	840	878	882	885
All Policies	729 – 738	736 – 767	723 – 766	714 – 771	700 – 768

	Reduction from reference (billions 2009 US dollars and percent)									
	2011–2015		2016–2020		2021–2025		2026–2030		2031–2035	
	Absolute	Percent	Absolute	Percent	Absolute	Percent	Absolute	Percent	Absolute	Percent
Accelerate GoM Leasing and Permitting	2.4	0.3	0.2	0.0	3.2	0.3	5.1	0.5	3.7	0.4
Increase Offshore Access	—	—	0.3 – 3.6	0. 0– 0.4	3.3 – 9.1	0.4 – 1	4.9 – 6.7	0.5 – 0.7	5.9 – 10.4	0.6 – 1.0
Enhanced Oil Recovery	—	—	1	0.1	1.5	0.2	2.5	0.3	7.1	0.7
Heavy Duty Vehicle Standards	0.8	0.1	5.7	0.7	7.1	0.8	5.3	0.6	7.6	0.8
Extended Light Duty Vehicle Standards	—	—	0.2 – 3.0	0.0 – 0.3	48.0 – 59.1	5.2 – 6.4	101.3 – 138.5	10.4 – 14.2	124.8 – 190.1	12.4 – 18.8
Building Efficiency Improvements	0.2	0	1.2	0.1	0.6	0.1	1	0.1	10.4	1.0
Advanced Biofuels Development	8.5	1.1	50.1	5.7	33.2	3.6	15.7	1.6	11.9	1.2
Natural Gas Vehicle Deployment	0.5 – 8.1	0.1 – 1.1	0.7 – 20.8	0.1 – 2.4	–0.2 – 15.3	0.0 – 1.7	–0.3 – 16.4	0.0 – 1.7	3.9 – 17.9	0.4 – 1.8
Electric Vehicle Deployment	3.7 – 5.3	0.5 – 0.7	9.5 – 13.3	1.1 – 1.5	11.0 – 22.9	1.2 – 2.5	10.0 – 39.5	1.0 – 4.1	6.8 – 56.8	0.7 – 5.6
Carbon Tax	17.4	2.3	34.6	4.0	52.9	5.7	90.4	9.3	124.6	12.3
All Policies	32.8 – 42.0	4.4 – 5.5	107.9 – 141.4	14.1 – 16.1	165.0 – 208.3	21.6 – 22.4	201.7 – 245.6	25.6 – 26.2	241.6 – 294.0	29.6 – 31.5

Source: Authors' calculations.

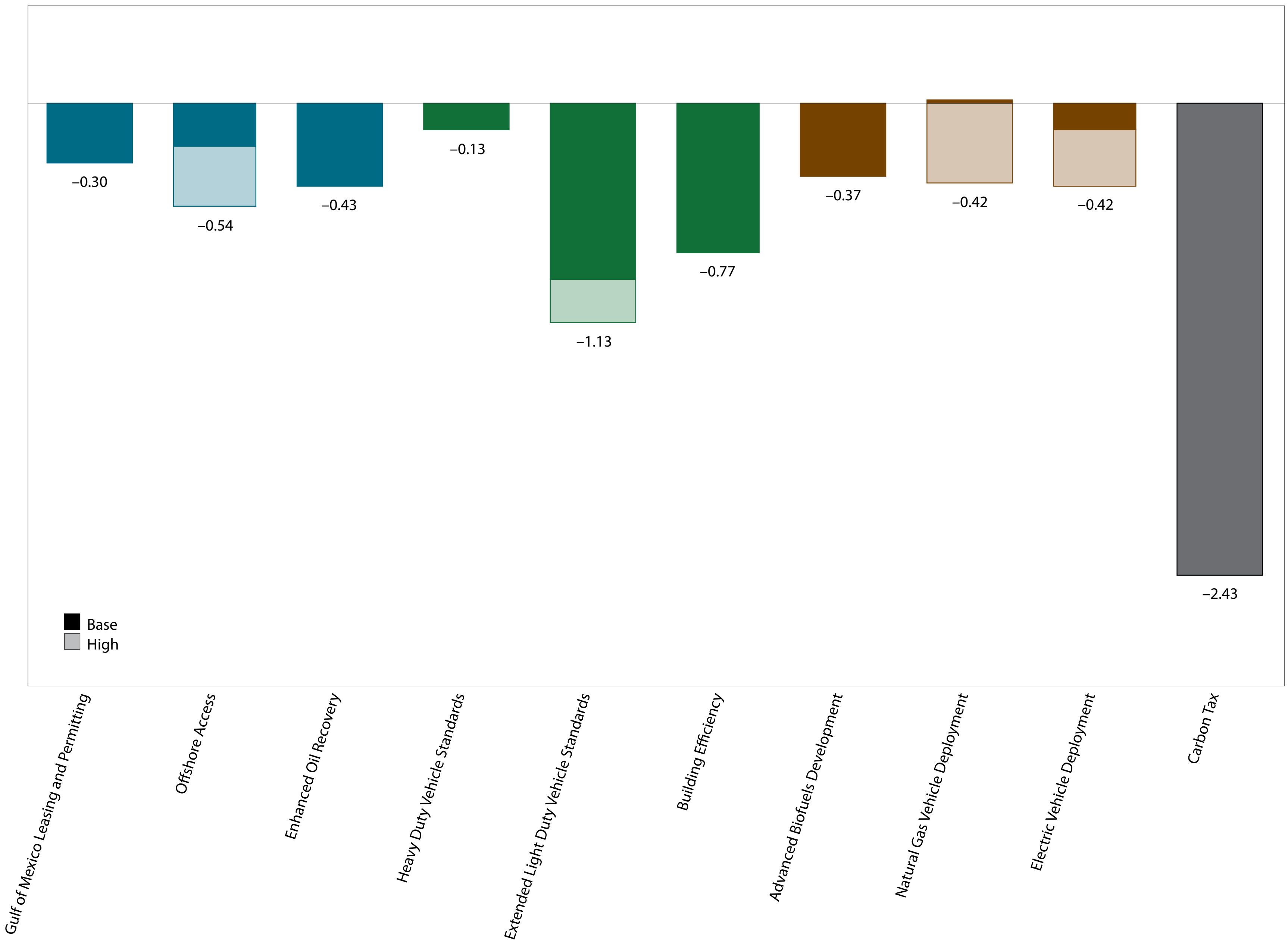
Figure 15 Change in average annual US energy expenditures, 2011–35 (billions of 2009 US dollars)



*Base case assumes all carbon tax revenue is returned to energy consumers. High case assumes all revenue is used for deficit reduction.

Source: Authors' calculations.

Figure 16 Change in US Chamber of Commerce Index of Energy Security Risk, 2011–30



Source: Authors' calculations.

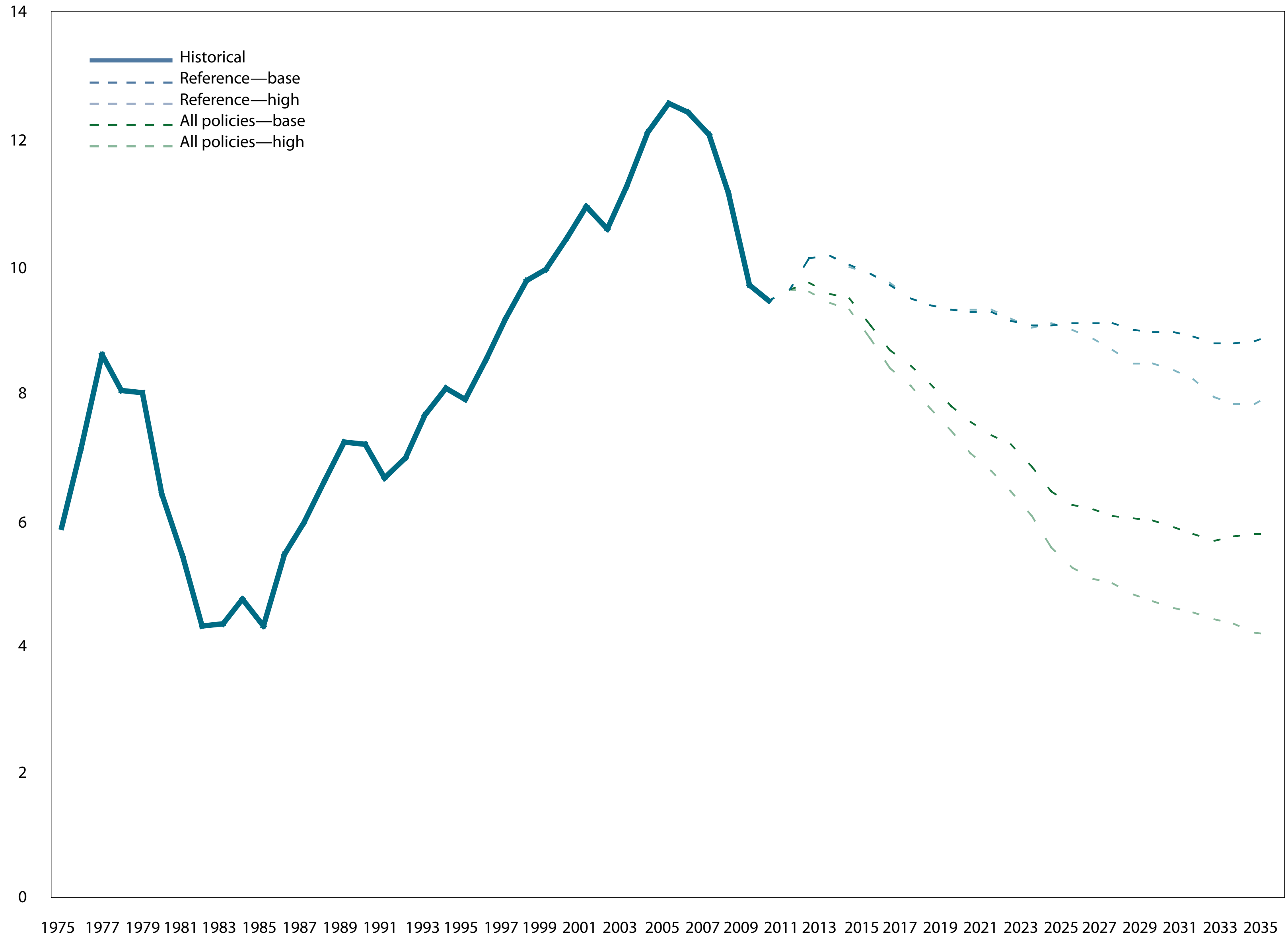
Table 2 US oil imports, 2011–35

Policy proposal	2011–2015	2016–2020	2021–2025	2026–2030	2031–2035
	Annual average (thousand barrels per day)				
Accelerate Gulf of Mexico Leasing and Permitting	9,776	9,342	8,884	8,722	8,688
Increase Offshore Access	9,928 – 9,930	9,351 – 9,386	8,614 – 8,937	7,845 – 8,728	7,364 – 8,716
Enhanced Oil Recovery	9,935	9,369	8,980	8,806	8646
Heavy Duty Vehicle Standards	9,918	9,334	9,028	8,950	8795
Extended Light Duty Vehicle Standards	9,931 – 9,940	9,401 – 9,428	8,446 – 8,581	7,532 – 7,919	6,967 – 7,618
Building Efficiency Improvements	9,921	9,421	9,136	9,060	8,793
Advanced Biofuels Development	9,806	8,898	8,634	8,815	8,772
Natural Gas Vehicle Deployment	9,810 – 9,919	9,167 – 9,392	8,922 – 9,099	8,797 – 8,991	8,621 – 8,797
Electric Vehicle Deployment	9,861–9,885	9,264 – 9,297	8,866 – 8,992	8,558 – 8,882	8,210 – 8,749
Carbon Tax	9,803	9,175	8,566	7,913	7,474
All policies	9,337 – 9,466	7,708 – 8,092	5,981 – 6,774	4,809 – 5,986	4,309 – 5,718

	Reduction from reference (thousand barrels per day and percent)									
	2011–2015		2016–2020		2021–2025		2026–2030		2031–2035	
	Absolute	Percent	Absolute	Percent	Absolute	Percent	Absolute	Percent	Absolute	Percent
Accelerate Gulf of Mexico Leasing and Permitting	156	–1.6	67	0.7	217	2.4	269	3.0	124	1.4
Increase Offshore Access	—	—	23 – 69	0.2 – 0.7	163 – 483	1.8 – 5.3	264 – 688	2.9 – 8.1	96 – 564	1.1 – 7.1
Enhanced Oil Recovery	—	—	40	0.4	121	1.3	186	2.1	165	1.9
Heavy Duty Vehicle Standards	14	0.1	75	0.8	73	0.8	41	0.5	17	0.2
Extended Light Duty Vehicle Standards	—	—	0 – 7	0.0 – 0.1	520 – 654	5.7 – 7.2	1,073 – 1,459	11.9 – 16.2	1,194 – 1,845	13.6 – 20.9
Building Efficiency Improvements	11	0.1	–13	–0.1	–36	–0.4	–68	–0.8	19	0.2
Advanced Biofuels Development	126	1.3	511	5.4	466	5.1	177	2.0	40	0.5
Natural Gas Vehicle Deployment	14 – 122	0.1 – 1.2	17 – 242	0.2 – 2.6	2 – 179	0.0 – 2.0	1 – 194	0.0 – 2.2	15 – 191	0.2 – 2.2
Electric Vehicle Deployment	47 – 72	0.5 – 0.7	111 – 144	1.2 – 1.5	108 – 235	1.2 – 2.6	110 – 433	1.2 – 4.8	63 – 602	0.7 – 6.8
Carbon Tax	129	1.3	233	2.5	535	5.9	1078	12.0	1338	15.2
All policies	467 – 594	4.7 – 6.0	1,317 – 1,711	14.0 – 18.2	2,327 – 3,115	25.6 – 34.2	3,005 – 3,724	33.4 – 43.7	3,094 – 3,619	35.1 – 45.7

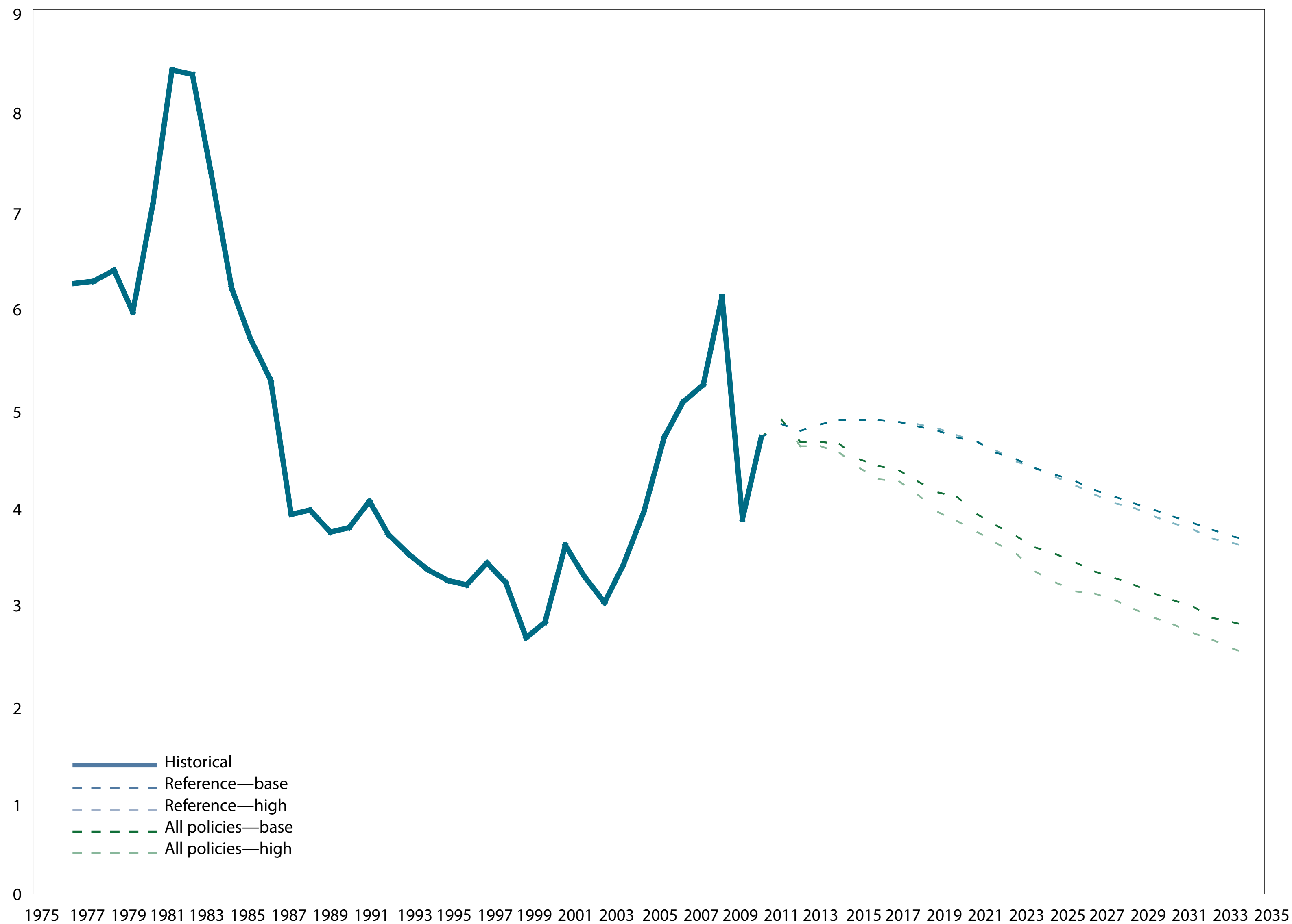
Source: Authors' calculations.

Figure 17 Net US oil imports, 1975–2035 (million barrels per day)



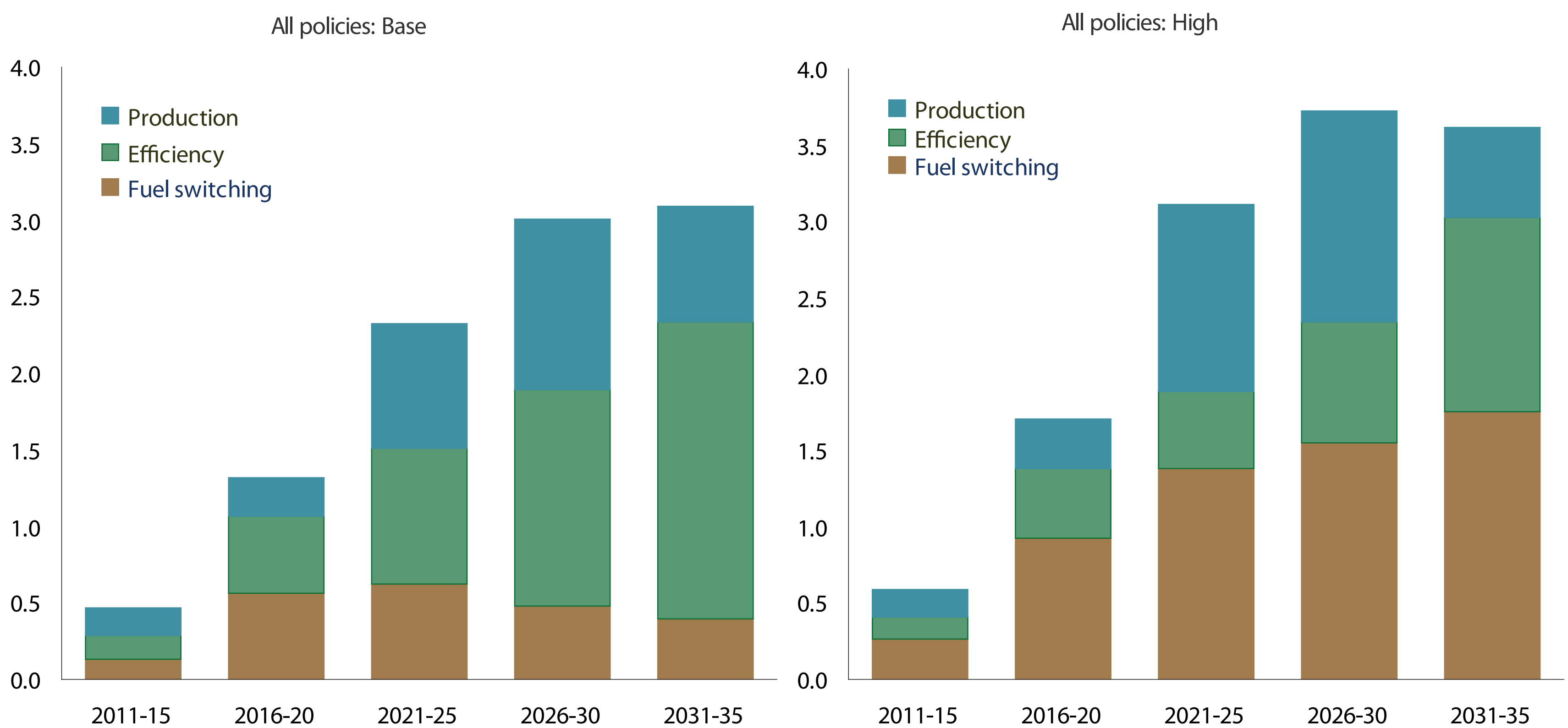
Source: Authors' calculations.

Figure 18 Oil expenditures, 1975–2035 (percent of GDP)



Source: Authors' calculations.

Figure 19 Annual average reduction in US net oil imports, 2011–35 (million barrels per day)



Source: Authors' calculations.