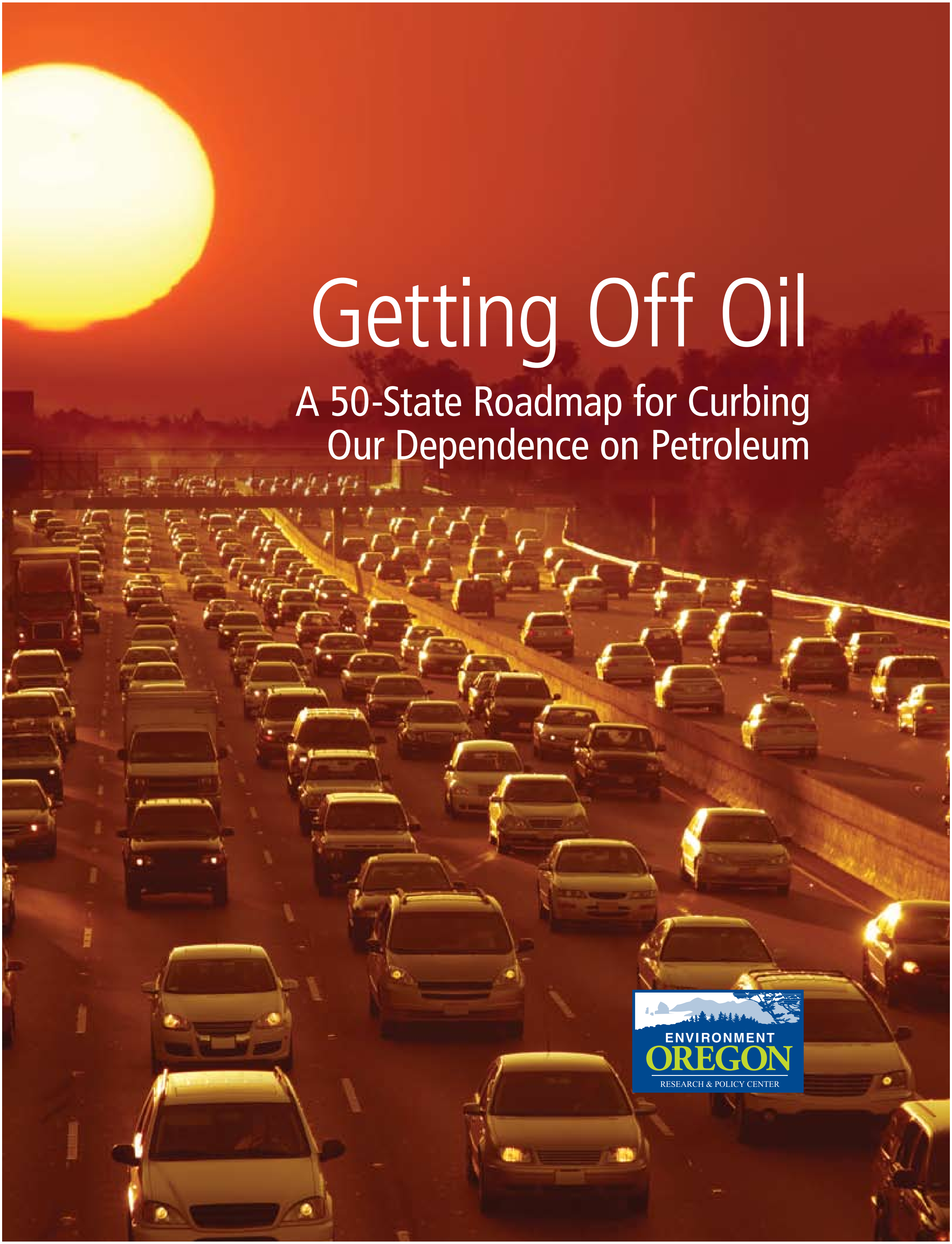

Getting Off Oil

A 50-State Roadmap for Curbing Our Dependence on Petroleum

ENVIRONMENT OREGON
RESEARCH & POLICY CENTER

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Executive Summary

America's dependence on oil inflicts a heavy toll on our environment. There are many technologies and policy tools, however, that can curb America's dependence on oil.

By taking strong action to cut down on energy waste and shift to cleaner sources of energy, America could reduce its consumption of oil for energy by 1.9 billion barrels of oil per year by 2030—31 percent of today's oil use—while achieving President Obama's goal of reducing oil imports by one-third by 2025 and putting the nation on track to ending its dependence on oil.

America's dependence on oil inflicts a heavy toll on our environment—harming our air, water and land. And with oil companies now having to go to greater lengths—and take greater risks—to satisfy the world's demand for oil, the environmental impact of oil consumption will only increase in the years to come.

- *Global warming* – Oil consumption is the number one source of carbon dioxide—the most important global warming pollutant—from the U.S. economy. America's emissions of global warming pollution from oil burning alone exceed the total emissions of every nation in the world other than China.

- *Air pollution* – Combustion of gasoline in motor vehicles produces nearly one-third of the nation's air emissions of nitrogen oxides and more than one-fifth of emissions of volatile organic compounds. These two pollutants are responsible for the ozone smog that threatens the health of millions of Americans. Oil refineries are also major sources of toxic air emissions.

- *Oil spills and leaks* – Oil spills impose massive damage on the environment. Over the past decade, more than 1 million barrels of oil products have leaked from petroleum pipelines, while there are approximately 7,300 reports each year of leaking underground oil storage tanks, which threaten the safety of groundwater supplies.

- *Rising environmental threats* – As oil from easy-to-reach reservoirs has run out, oil companies have increasingly used riskier and more environmentally destructive methods to obtain oil. Production of oil from Canada's tar sands has destroyed vast areas of boreal forest, polluted local waterways with toxic substances, and increased global warming pollution. In the United States, the risks of deepwater offshore drilling were demonstrated by the BP Deepwater Horizon disaster, while oil companies hope someday to use processes similar to those used in Canada's tar sands region to produce oil from shale in the American West.

America has the tools to curb our dependence on oil, starting now. By taking strong action on a variety of fronts, the United States could reduce its use of oil for energy by 31 percent below 2008 levels by 2030.

The benefits of an oil reduction strategy would accrue to all sectors of the economy and every region of the United States.

- Oil consumption would be reduced by 35 percent in the transportation sector, 31 percent in homes, 39 percent in businesses, and by 9 percent in the industrial sector relative to 2008 levels. (See Table ES-1.)

- Each of the 50 states would experience significant reductions in oil consumption, ranging from a 4 percent decline in fast-growing Nevada to a 46 percent drop in Michigan. (See Figure ES-2.)

Figure ES-1. Oil Savings under the Policies Profiled in this Report

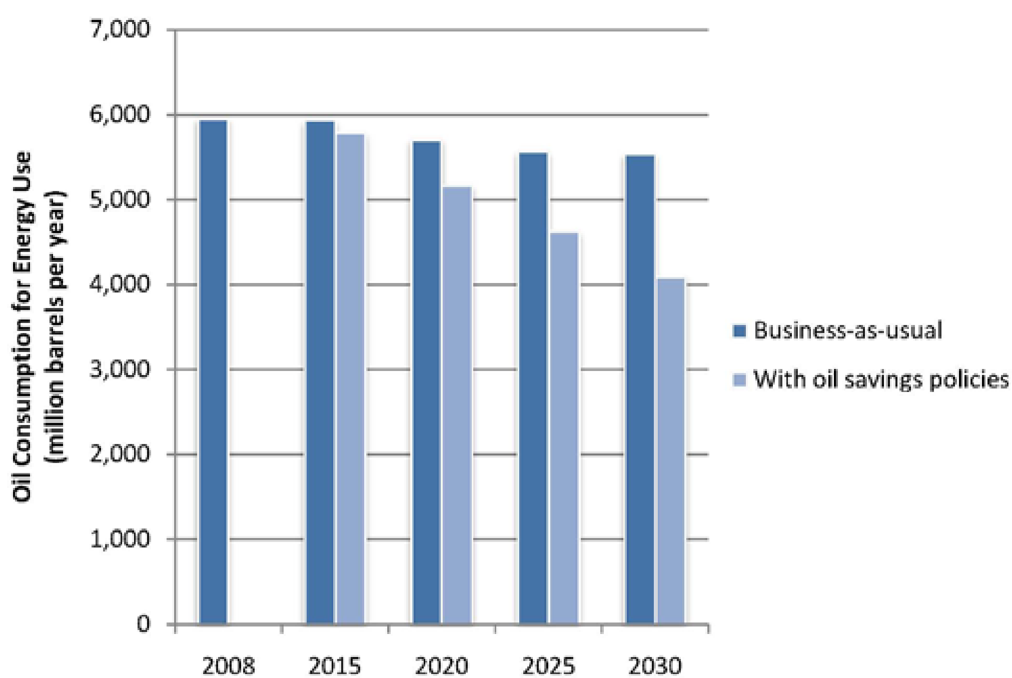


Table ES-1. Percentage Reduction in Oil Consumption for Energy Use from 2008 Levels by 2030 with Oil Savings Policies

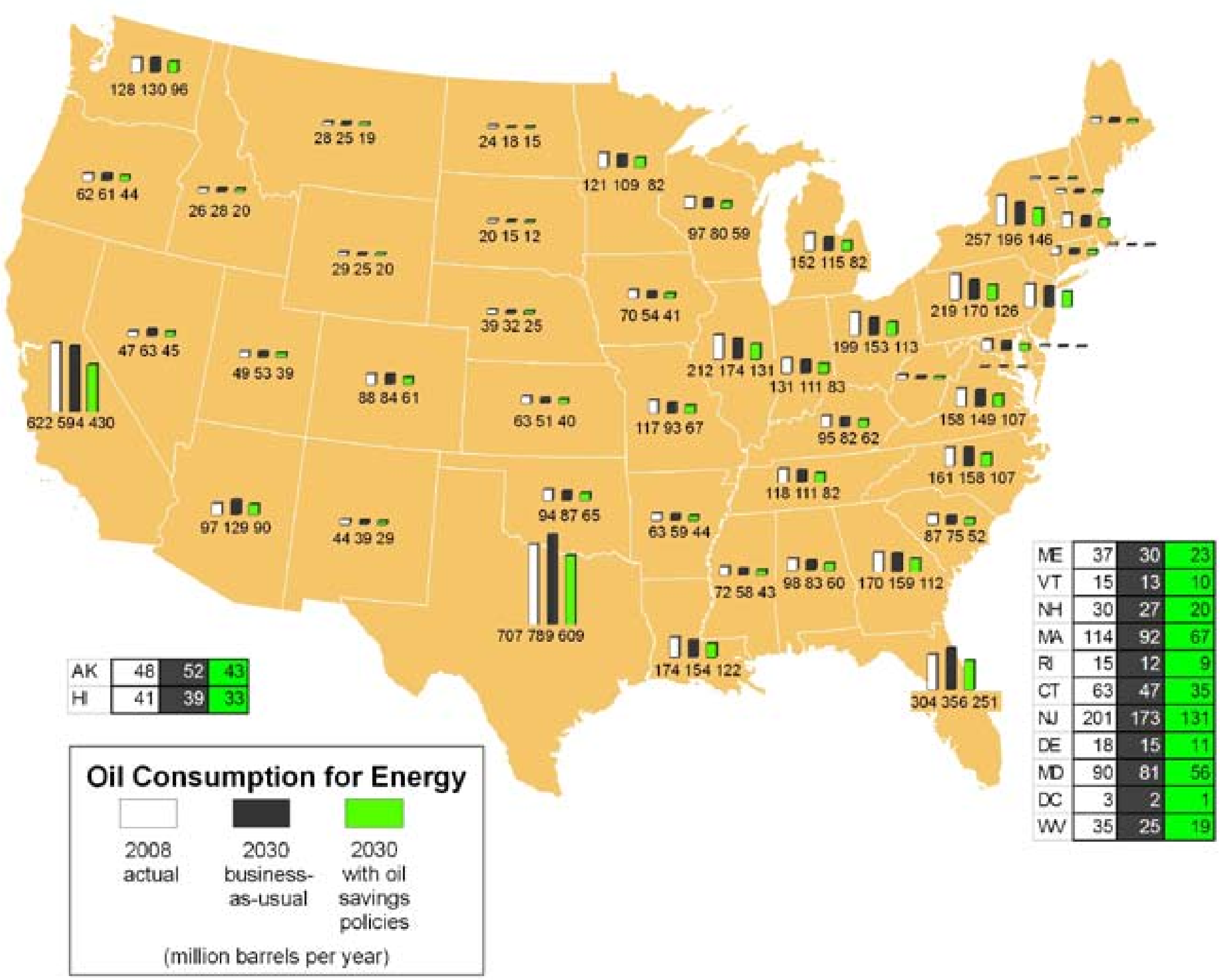
Sector	% reduction from 2008 consumption in 2030
Transportation	35%
Residential	31%
Commercial	39%
Industrial	9%

The policy steps that are needed to achieve these reductions in oil consumption include:

- Fuel economy improvements in light-duty vehicles consistent with achievement of a **62 miles per gallon** fuel economy/global warming pollution standard by 2025.

- Aggressive efforts to **put millions of plug-in electric vehicles** on the road through light-duty vehicle global warming pollution standards and other strategies.

Figure ES-2. Oil Consumption by State under Business-as-Usual and Oil Savings Policy Case



- Requiring the sale of **energy-efficient replacement tires** for cars and light trucks.
- Encouraging the development of **vibrant communities with a range of available transportation options**, including transit, biking and walking.
- Requiring large employers to work with their employees to **reduce the number of single-passenger automobile commutes** to workplaces.
- Transitioning to a system in which automobile drivers **pay for insurance by the mile** instead of at a flat rate—providing a financial incentive for reducing driving.
- **Doubling transit ridership** over the next 20 years through expansion of public transportation systems, while further increasing ridership through efforts to make transit service more efficient, more reliable and more comfortable.
- Establishing a **clean fuel standard** that reduces life-cycle global warming pollution from transportation fuels by 10 percent by 2020—encouraging a shift away from oil as a transportation fuel.
- **Promoting bicycling** through investments in bike lanes and other facilities for bicyclists.
- **Building high-speed rail lines** in 11 federally designated corridors, providing an alternative to air and car travel.
- **Improving the fuel economy of heavy-duty trucks, airplanes and trains**.
- **Retrofitting existing homes and businesses** to save energy, **and adopting strong building energy codes** to ensure that new homes are as energy efficient as possible.
- Setting strong standards and creating strong incentives for the **replacement of inefficient industrial boilers and process heat systems with high-efficiency models**.
- **Curbing oil use in the federal government** through improved energy efficiency and a shift to cleaner fuels.

To catalyze these changes—and protect Americans from the environmental, economic and national security costs of continued dependence on oil—the United States and individual state governments should set aggressive goals for oil savings and mobilize the resources needed to achieve those goals.

Introduction

More than one year ago, the BP Deepwater Horizon rig off the Gulf of Mexico exploded and collapsed into the sea, triggering an ecological catastrophe of profound proportions. For the next several months, stories of oiled birds and tar balls on Gulf Coast beaches dominated media coverage, while thousands of Americans watched live on the Internet as BP struggled to cap the gushing well.

On one level, the BP Deepwater Horizon disaster was not an unusual event. Over the course of the last few decades, America and the world have seen a string of oil-related disasters—from the Exxon Valdez spill of 1989 to the San Francisco Bay oil spill of 2007. The production, transportation and consumption of oil imposes widespread environmental harm—including habitat disruption caused by oil pipelines, groundwater pollution from leaking underground storage tanks, and smog alerts triggered by automobile emissions—taking place all across America, on a nearly daily basis.

On another level, however, the Deepwater Horizon disaster represented something entirely new. It was an illustration of the extreme lengths to which the oil industry is willing to go to feed our nation's—and world's—growing thirst for petroleum. Americans marveled at the technology that enabled BP to position a rig dozens of miles off the Louisiana coast, work in ocean waters nearly a mile deep, and extract oil from a formation several miles below the ocean floor—even as they raged over BP's inability to stop the gusher.

The world's growing demand for petroleum has captured Americans' attention in another way as well: through rising gasoline prices. Higher gas prices effectively take billion of dollars out of the pockets of American families and transfer that money to oil companies and oil producing nations. As the holder of just 2 percent of the world's proven oil reserves, Americans face a future of increased competition with nations such as China—which has become the largest international market for new automobiles—for scarce supplies of oil.[1]

Environmental devastation. Economic uncertainty. Dependence on potentially unfriendly foreign nations for critical energy supplies. Every year, the stakes of America's high-risk bet on oil as a major source of energy for our economy continue to rise. That is why there is no better time than the present for America to commit itself to ending our dependence on oil—once and for all.

We already have the technology to use oil more efficiently and to replace a significant share of the oil we use with cleaner alternatives. We also have many policy tools available to help speed the transition away from oil.

Of course, getting off oil presents risks and challenges of its own. But the environmental toll of oil dependence—not to mention the economic and national security challenges—make the risks involved in adopting new technologies, new fuels, and new practices ones very much worth taking.

This report reviews many of the policy strategies America can use to reduce our dependence on oil. These steps are just the beginning of a long process of rebuilding our economy that will take decades.

For nearly 40 years, U.S. presidents have pledged to break America's dependence on oil. With the environmental and economic cost of oil dependence becoming intolerable, our political leaders have an opportunity today to finally make it happen.

The Environmental Toll of America's Dependence on Oil

Americans are familiar with the economic and national security toll of our nation's dependence on oil. For more than three decades, Americans have dealt with periodic spikes in oil prices as well as the gnawing sense that our dependence on oil enriches and empowers nations that do not have our best interests at heart.

The environmental toll of oil dependence makes headlines only on rare occasions—such as 2010's BP oil spill in the Gulf of Mexico. But every day, America's dependence on oil inflicts severe damage on our environment and our health. Every step in the process of producing and consuming oil—from the burning of gasoline in car engines all the way back to its extraction from the earth—creates unacceptable impacts on our environment. Those impacts are felt not only in oil production zones such as Alaska and the Gulf Coast, but also in communities across America.

With easy-to-produce sources of oil becoming more difficult to find, oil companies are pursuing more difficult and riskier methods of producing oil. If America continues its dependence on oil, the environmental impacts of oil production are likely to intensify in the years to come.

Burning Oil Fouls Our Air

Americans burn oil in our vehicles and, in some parts of the country, to keep us warm in our homes. Petroleum powers the vast bulk of our transportation system—buses, trucks, trains, ships and pipelines—and is a major fuel for industry.

Oil combustion contributes to many of America's biggest pollution problems—from the threat of global warming to the smog and soot pollution that threatens the health of millions of Americans.

Global Warming

America's dependence on oil contributes to global warming. In fact, our use of oil is responsible for a greater share of America's global warming pollution than our use of any other fuel. In 2008, petroleum consumption in the United States produced

42 percent of the nation's emissions of carbon dioxide, the leading global warming pollutant.[2] America's emissions of global warming pollution from oil burning alone exceeded the *total* emissions of every nation in the world other than China.[3]

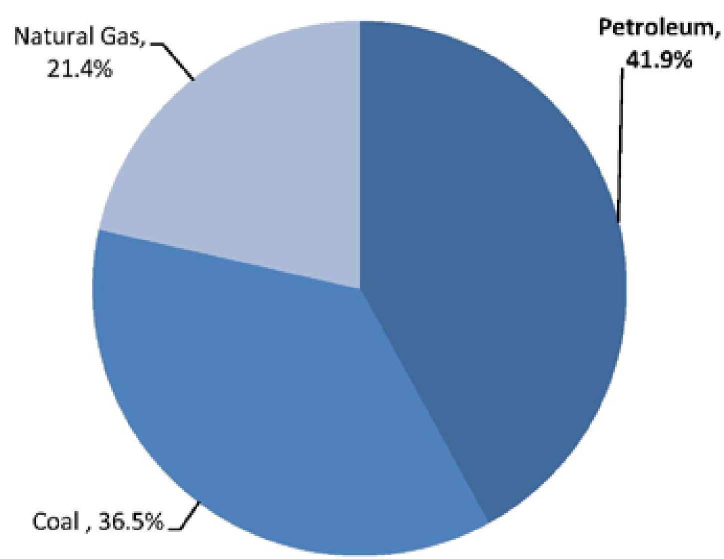
The effects of global warming are already beginning to be felt in the United States and around the globe. The average temperature in the United States has increased by more than 2° F over the last 50 years, and temperatures could increase by an additional 7-11° F by the end of this century if global warming pollution continues unabated.[5] As a result of rising temperatures, snow cover has decreased over the Northern Hemisphere over the past three decades, with the greatest reductions in the spring and summer.[6] The volume of early spring snowpack in the mountain West and Pacific Northwest has declined significantly on average since the mid 20th century, with the greatest losses occurring in more temperate areas subject to earlier spring snowmelt.[7]

Sea level has risen by nearly 8 inches (20 cm) globally since 1870 as ice caps have melted and the ocean has expanded as it has warmed.[8] Meanwhile, extreme weather events, such as heavy precipitation, have become much more common in recent years. A 2007 Environment America Research & Policy Center analysis found that the number of extreme precipitation events had increased by 24 percent over the continental United States between 1948 and 2006, with the greatest increases coming in New England (61 percent) and the Mid-Atlantic (42 percent).[9]

Smog and Soot

Petroleum combustion is a major source of health-threatening air pollution that

Figure 1. Shares of U.S. Fossil Fuel-Related Carbon Dioxide Emissions by Fuel[4]



jeopardizes the health of millions of Americans. Oil combustion produces nitrogen oxide (NO_x) and volatile organic compound (VOC) emissions, which create ozone smog, and particulate matter pollution, which creates soot. Nitrogen oxides are a byproduct of the combustion of gasoline, while VOCs come both from vehicle tailpipes and by evaporation of VOCs from car engines and fueling systems. Some vehicle engines, particularly diesel engines, also produce particulate matter—tiny particles smaller than the width of a human hair that can infiltrate the lungs and cause serious health problems.

In 2008, highway vehicles (which are almost exclusively powered by oil) produced:

- 32 percent of all NO_x emissions in the United States;
- 22 percent of all VOC emissions; and
- Between 1 and 4 percent of particulate matter emissions.[10]

Smog and soot pollution harms the health of millions of Americans, causing cardiovascular problems, strokes, heart attacks, respiratory infections, inflamed lung tissue, and asthma attacks.[11] Polluted air can even be fatal. One study by the California Air Resources Board found that breathing in fine particulate soot kills 18,000 Californians prematurely every year.[12]

The American Lung Association's 2010 *State of the Air* report found that over 175 million people (59 percent of Americans) live in places with air pollution so severe that it is often dangerous to breathe. According to the report, the most polluted cities are in California and the Rust Belt, but smog and soot also dirty air in cities on the East Coast and in the South.[13]

Processing and Transporting Oil Damages America's Air, Land and Water

When most Americans think of the environmental impacts of oil, they think either of air pollution from cars and trucks, or of oil spills such as the BP disaster in the Gulf of Mexico. However, there are many steps between the extraction of oil from the ground and its use in our vehicles and factories that can cause serious environmental harm. Refining, transporting and storing oil all impose serious damage on our air, water and land.

Refinery Pollution

Oil refineries are major air polluters, releasing a cocktail of toxic gases that can damage public health and the environment. In 2010, there were 137 refineries operating in the United States.[14] These refineries use physical, thermal, and chemical processes to convert crude oil into fuel, solvents, asphalt, propane, and many other products. In doing so, they emit nitrogen oxides and volatile organic compounds into the air, which combine in sunlight to form ozone, the biggest component of smog. In 2008, the petroleum industry was responsible for approximately 3.5 percent of the nation's VOC emissions and 2 percent of the nation's NO_x emissions.[15]

Ozone-forming gases are not the only pollutants emitted by oil refineries. In 2008, America's refineries emitted more than 18 million pounds of hazardous air pollutants, including chemicals linked to cancer and other serious health effects.[16] A study by the EPA in 1995 found that approximately 4.5 million people who lived within 30 miles of an oil refinery were exposed to benzene, which damages the blood and immune systems, at such high levels that they were at risk of getting cancer.[17] In addition to benzene, refineries emit xylene (damages the nervous system and kidneys), methanol (damages the nervous system), n-hexane (damages the reproductive system), toluene (damages the cardiovascular and nervous systems), and many other toxic substances.[18]

Transportation

Oil and petroleum products travel to and from refineries either via tanker or via pipeline—both of which have major impacts on the environment.

Tanker trucks and ships, like other heavy-duty vehicles, produce emissions that are linked to environmental and public health problems. Tanker ships have also been responsible for several devastating oil spills. The largest was the Exxon Valdez spill, in which an oil tanker crashed into a reef off Alaska's coast and dumped 10.8 million gallons of oil into the ocean. The spill spread across 1,300 miles of coastline, killing as many as 250,000 seabirds, 2,800 mammals, 900 bald eagles, and 300 seals.[19] Years after the spill, the oil continued to harm fish populations. For example, oil stuck on gravel and rocks wiped out more than a quarter of the pink salmon population in Prince William Sound by affecting the fish embryos.[20] Even today, the spill is not fully cleaned up. According to a study by the federal government, 26,600 gallons of oil remained in Prince William Sound in 2007.[21]

Not every tanker accident receives the international attention generated by the Exxon Valdez disaster, but major accidents are not uncommon. In April 2003, an oil barge ran aground in Buzzards Bay, Massachusetts, spilling 98,000 gallons of oil.[22] Approximately 500 birds died as a result of the spill, and, as of 2009, some areas of the bay remained closed to shellfishing.[23] In November 2007, 53,000 gallons of oil spilled in San Francisco Bay when an oil tanker ran into the Bay Bridge.[24] More than 6,000 birds died as a result of the spill and oil contamination was suspected of causing abnormalities and death among herring embryos.[25]

The nation's more than 175,000 miles of oil and "hazardous liquid" pipelines create a broader array of environmental problems, including damage to sensitive land and habitats, as well as impacts from leaking oil.[26]

Leaks from pipelines are among the most common sources of oil spills. Between 2000 and 2009, there were approximately 1,200 "significant" incidents at land-based oil or hazardous liquid pipelines, responsible for spilling a total of nearly 1 million barrels of oil or petroleum products into the environment.[27] One of the biggest pipeline spills occurred in early 2006, when a tributary of the Trans-Alaska Pipeline System leaked 267,000 gallons of crude oil onto the tundra of Alaska's North Slope. Built in the late 1970s and put through many of Alaska's wet winters, by 2006 the pipe had corroded and cracked, eventually forming a hole more than a quarter-inch wide. The oil that gushed out of the pipe was able to seep beneath the snow, where it went undetected for several days and eventually spread over two acres.[28]

Leaks also occur from pipelines at sea. Americans have known about offshore oil pipeline leaks since the Hubble Oil spill in 1967, in which an anchor was dropped on an underwater pipe off the coast of Louisiana, releasing 161,000 barrels of crude oil into the ocean.[29] In the 1990s, 1.6 million gallons of oil leaked in U.S. waters from offshore pipelines.[30] Offshore pipelines, like other offshore oil infrastructure, are also susceptible to damage caused by extreme weather, as occurred during Hurricane Ivan in 2004, when five offshore pipelines leaked an unknown amount of oil into the Gulf of Mexico.[31]

Oil pipelines impose a heavy toll on the environment even before they begin operation. Onshore oil wells are often located in remote areas, requiring the laying of pipelines through forests and environmentally sensitive areas to get the oil to refineries and other processing centers. Usually, bulldozers will flatten the land and uproot trees around the pipeline to clear cut a corridor 50 meters wide.[32] There is some concern in the scientific community that pipelines disrupt animal migration, especially the migration of caribou in Alaska.[33] Pipelines from offshore drilling also damage the environment onshore. Pipelines, plus the roads to them and processing facilities, destroy 24 miles of coastal wetlands a year in Louisiana.[34]

Storage

Oil and petroleum products contain a variety of toxic substances that can find their way into water if permitted to leak into the environment.

Petroleum bulk storage terminals can leak or rupture in severe weather. The failure of an oil storage tank in 2005's Hurricane Katrina, for example, led to the discharge of approximately 1 million gallons of crude oil into the floodwaters, affecting 1,700 homes over an area about a square mile. EPA tests from the neighborhood found that the oil had leached into the soil, contaminating it with toxic chemicals (polycyclic aromatic hydrocarbons, organic chemicals, and arsenic).[35]

A far more pervasive problem is with leaking underground storage tanks, which can contaminate both soil and groundwater with petroleum products. There are approximately 600,000 underground petroleum storage tanks in the United States, with approximately 7,300 reports of leaks each year.[36] Toxic chemicals in petroleum products—including several linked to cancer and other severe health impacts—can quickly migrate into drinking water, jeopardizing public health.[37]

Oil Extraction Damages Our Land, Air, Water, and Wildlife

Extracting oil from the earth is a disruptive, environmentally damaging process. Some of America's oil reservoirs are thousands of feet beneath the earth, while other reservoirs are buried deep beneath the ocean floor. Some of the oil is near the surface, but enmeshed in shale, which is a kind of sedimentary rock, or mixed with sand or clay in resources known as tar sands. Industrial processes to extract the oil from beneath the ground, beneath the ocean, or inside shale and sand are massive operations that are energy-intensive, produce dangerous toxic byproducts and waste, and harm the environment.

Declining Oil Supplies Means Drilling in Riskier Places

Oil companies have always prioritized extracting oil from the most accessible reservoirs. On-shore drilling in "conventional" reservoirs imposes its own set of environmental threats. But declining conventional oil supplies are forcing oil companies to explore and produce oil from new sources with new environmental threats.

As America's oil-dependent economy has grown, the amount of available oil near the surface or in easily-accessible places has dwindled, leading oil production in the lower 48 states to peak in 1970.[38] To close the gap between dwindling supplies of domestically available conventional oil and rising demand, America began rapidly increasing the amount of oil we imported from other countries. Now, with rising world oil demand straining global supplies of conventional oil, oil companies around the globe are increasingly exploring for oil in more difficult-to-reach places and producing oil from "unconventional" resources.

These changes in oil production bring

with them the potential for increased environmental harm.

"Unconventional" Oil from Tar Sands, Shale Formations, and Oil Shale

Tighter oil supplies and higher prices are driving new efforts to extract oil from various "unconventional" resources. Among these are tar sands—which have become a major source of oil from Canada—and two resources that sound similar but are quite different: oil shale and oil produced from shale formations.

Tar sands are deposits of sand, silt, clay, and a heavy, viscous oil called bitumen. Oil shale is a sedimentary rock that contains a hydrocarbon called kerogen. In addition, shale formations in parts of the country contain locked within them small pockets of oil and natural gas, which had long been economically and technologically difficult to extract, but which new technology has made accessible.

The sources of tar sands and oil shale must be heated to extreme temperatures to produce oil that can be used in vehicles and machinery. Compared to traditional oil production, tar sands and oil shale production requires more energy, more water, more machinery, and more chemicals.

Production of oil from shale formations presents a very different set of environmental challenges. New technology—horizontal drilling with the use of hydraulic fracturing—has opened these resources up for oil production. Unfortunately, hydraulic fracturing requires the use of vast quantities of water, as well as toxic chemicals with potential impacts on public health.

The economic and environmental costs of oil shale and tar sands production, and production of oil from shale formations, are much higher than traditional oil extraction.

Canadian Tar Sands and Western Oil Shale

In Alberta, Canada, the past decade has seen a dramatic ramp-up in production of oil from tar sands to supply American and world markets thirsty for oil. The environmental impacts of tar sands oil production are severe, and extend to the United States:

Wilderness destruction: Tar sand companies in Alberta have destroyed large swaths of boreal forest to build mines, processing facilities and tailings ponds, which are used to store the toxic refuse from mining operations. To date, more than 162 square miles of land have been disturbed for tar sands production.[39] While many of these disturbed lands will eventually be "reclaimed," they will be different than they were prior to tar sands production, with no peat lands and fewer lakes.[40]

Water pollution: Every day, Syncrude, Canada's largest tar sands producer, dumps 250,000 tons of toxic waste into tailings ponds.[41] These ponds are so toxic that they can be immediately fatal to wildlife. In one recorded incident, 500 ducks died by simply landing in a tailings pond.[42] Toxic waste is not limited to the tailing ponds, as much of it escapes the production site and affects the surrounding environment. A 2010 report by scientists at the University of Alberta and Queen's University in Ontario found that the oil operations released 13 toxic substances into the Athabasca River (a main river that cuts through Alberta's tar sands) and its watershed.[43] These pollutants included arsenic, lead, and mercury—all poisons highly toxic to the fish and mammals living in the watershed.[44]

Air pollution: The production of tar sands oil produces a range of air pollutants. According to a report by Environmental Defense Canada, the tar sands region of Alberta has seen a 33-fold increase in the number of exceedences of air quality standards since 2004, largely tied to an increase in hydrogen sulfide releases. Emissions of volatile organic compounds, sulfur dioxide and nitrogen oxides in the area have also increased in recent years.[45] The United States experiences some of the air pollution impacts of tar sands production at refineries that process tar sands oil. Tar sands oil is heavier and contains greater concentrations of some toxic metals than conventional oil, leading to the possibility of increased emissions of these substances near U.S. tar sands refineries.[46]

Water consumption: Tar sands production also damages the environment by consuming large quantities of water. Since as much as five barrels of water are needed to produce one barrel of bitumen, companies must pump or divert so much water out of rivers and lakes that the water level visibly declines. In Alberta, 349 million cubic feet of water are diverted out of the Athabasca River every year, contributing to declines in muskrat, waterfowl and fish populations.[47]

Global warming pollution: To turn bitumen into liquid oil, it must be heated to 900 degrees Fahrenheit.[48] This is a tremendously energy-intensive process, which results in tar sands oil having a greater impact on global warming than conventional oil. Estimates of the global warming impact vary, but range from a 5 percent increase in global warming pollution to as much as 60 percent increase per gallon of oil consumed compared with conventional oil.[49]

While there is no tar sands production in the United States as yet, the U.S. does have a similar resource that could one day become a source of oil—also at great environmental cost. The United States has the world's largest oil shale formation, buried beneath parts of Colorado, Utah and Wyoming. The oil shale resource in the United States is estimated to contain three times the amount of recoverable oil as the whole of Saudi Arabia.[50]

Many of the same environmental problems that result from tar sands production—from the discharge of toxic substances to waterways to the impact on air quality and global warming—are also potential issues with oil shale. Indeed, some impacts may be greater.

In situ mining, for example, produces oil from shale by cooking it at high temperatures while it is still underground. In the case of shale, it must be heated for two or three years, reaching 650-700 degrees Fahrenheit, to force the oil away from the rock, where it can then be pumped up to the surface.[51] *In situ* mining is especially dangerous because all the gases usually released into the atmosphere from shale and sand production can escape into the groundwater along with the oil itself.[52] Moreover, the energy consumption required would likely add to the greenhouse gas "footprint" of shale oil.

Production of Oil from Shale Formations

Not to be confused with oil shale—which is a form of rock—production of oil from shale formations requires the extraction of oil from small pockets contained in shale rock. Oil from shale formations is produced by drilling a well horizontally through the rock, then using water and chemicals to fracture the rock, enabling oil or gas to flow freely out of the well.

The process of hydraulic fracturing creates a variety of environmental problems. Based on the experience of hydraulic fracturing for natural gas, which uses a similar process as oil production from shale, the impacts on water and air are significant.

- Fracturing shale requires on the order of 2 to 8 million gallons of fluid for a single well, often representing a massive drain on local water supplies.

- Over an 18-month span, an investigation by the non-profit investigative journalism organization *Pro Publica* identified more than 1,000 cases in which hydraulic fracturing operations for natural gas have harmed water supplies. The incidents included surface "spills of fracturing fluid waste, cracking of underground cement and well casings meant to enclose the fracturing process, and methane gas traveling large distances underground through faults and fractures."[53]

- Chemicals used in hydraulic fracturing fluid and naturally-occurring minerals from underground can contribute to water contamination through leaks from improperly sealed wells, surface spills, or improper disposal. Many companies have protected the identities of the specific ingredients used in fracturing fluid as trade secrets. However, disclosures to date have revealed chemicals tied to acute and chronic health impacts from neurological damage to cancer—chemicals including diesel fuel, benzene, toluene and 2-butoxyethanol.[54] Additionally, the fracturing process releases naturally occurring metals and salts from the shale formation, many of which can threaten human health, including arsenic, barium, chromium, lead, strontium, and radioactive materials such as radium.[55]

The BP Deepwater Horizon oil spill in the Gulf of Mexico in 2010 illustrated the unique risks of drilling for oil in deep ocean waters. Credit: U.S. Coast Guard, Petty Officer 3rd Class Patrick Kelley

- In the state of Colorado, where hydraulic fracturing for natural gas has become increasingly common since 2003, regulatory officials have documented more than 1,500 surface spills of fracturing chemicals or wastewater. In one case, a waste pit leaked 1.6 million gallons of fracturing fluids near the western Colorado town of Parachute. The waste was particularly obvious because groundwater currents carried it to a large cliff, where it formed an unusual 200-foot frozen waterfall.[56]

- According to estimates by the New York Department of Environmental Conservation, constructing and operating a single hydraulic fracturing well generates more than 140,000 pounds of smog-forming emissions in the first year of operation.[57] Gas fields can become major sources of smog. For example, gas extraction activities in the Barnett Shale region of Texas generate 70 percent as much smog-forming pollution as all motor vehicles operating in the nine-county Dallas-Fort Worth Metropolitan area.[58] Wyoming's Sublette County, home to thousands of gas wells but only 9,000 people, has suffered from unhealthy levels of air pollution more commonly associated with big cities since a drilling boom that began in 2005.[59]

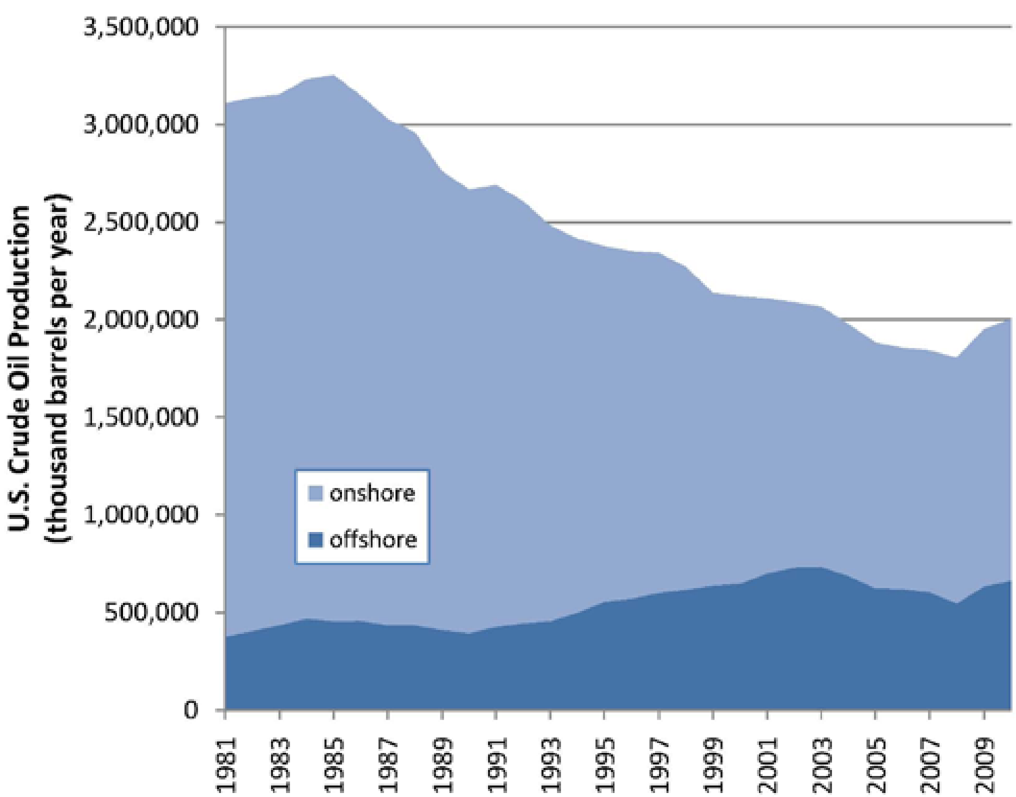
- In addition to smog, well drilling operations produce a variety of hazardous air pollutants, including diesel soot from thousands of truck trips and pump engines operating 24 hours a day, contaminants from processing the substances that come up out of the well, and fumes evaporating from waste water ponds, including benzene, methanol and formaldehyde.[60] These substances pose risks for acute and chronic health impacts, from dizziness to cancer.

Dangers of Offshore Oil Drilling

Offshore oil production damages the environment through harmful search and extraction methods that create dangerous byproducts. America's production of offshore oil is visible by the 4,000 rigs that dot the coast.[61] Some of these rigs extract oil from reservoirs tens of miles off the coast, buried thousands of feet beneath the sea floor. Methods for finding these deepwater reservoirs and pumping out their oil harm the environment in ways that are different and often more polluting than traditional oil extraction.

As oil reservoirs on land have become depleted and our demand for oil has increased, oil companies have produced more and more oil off our coast. Consequently, since 1981, onshore oil production in the United States has decreased by more than half, while offshore oil production has increased by more than 75 percent. (See Figure 2.) But as the easily accessible reservoirs off the coast are drained, oil companies are searching for and producing oil that is farther from shore and deeper underwater.

Figure 2. Onshore vs. Offshore Oil Production[62]



To scan and map the ocean floor for potential reservoirs, oil companies use seismic blasts that damage ecosystems and kill marine animals. These air gun arrays, used as sonar, emit high-decibel explosives heard underwater, sometimes for more than 1,800 miles.[63] Oil exploration ships will usually sound off blasts every 10 seconds.[64] The consistent, rippling bangs harm and kill fish eggs and larvae and impair the hearing and health of adult fish, making it harder for them to avoid predators and locate food and mates. The noise can also disrupt migratory patterns, forcing animals away from safe areas used for reproducing and foraging.[65] Scientists have been especially concerned that sonar blasts in the Chukchi Sea off the northwest coast of Alaska, which was recently opened for exploration, will deafen small fish and disrupt whale migration, communication and reproduction.[66]

Offshore oil drilling also creates dangerous byproducts. According to the National Research Council, construction and operation of a single well

Offshore Oil Spills Damage Marine Life

Oil from offshore spills spreads quickly across large areas, damaging all marine life in its path.

- **Sea birds and sea mammals:** These are the first animals to be harmed by oil because they reside at the ocean's surface.[75] Once spilled, oil, which is less dense than water, will move to rest on top of the ocean, creating a sheen.[76] Sea birds and sea mammals quickly find that any place they come down to rest or up for air is covered in crude oil. The oil will cover these animals' bodies and can cause fatal hypothermia because the oil inhibits their fur and feathers from keeping them warm. Birds covered in oil can often neither fly nor float, and many of them drown. Many birds and animals will also die by swallowing the crude, either by preening themselves or catching oil-covered prey.[77] The animals that do not die immediately will often die down the road from internal damage to their lungs, livers, stomachs, kidneys, other organs, and immune systems.[78]

- **Fish:** Fish are harmed or killed by ingesting oil (either directly or through the consumption of oil-covered prey), trying to breathe it through their gills, or having it lodge in their scales. This contact can damage their organs, change their heart and respiration rates, erode their fins, stunt their growth, and inhibit their reproduction.[79] The oil can also damage their eggs and change the ecosystem in ways that make it harder to survive (e.g., killing off their food source).[80]

- **Invertebrates:** Oil can harm and kill invertebrates by smothering them, altering their metabolic and feeding rates, and weakening their shells. Oil consumed by invertebrates also bio-accumulates up the food chain, poisoning the animals who prey on them.[81]

(offshore oil rigs often contain dozens of wells) will discharge between 1,500 and 2,000 tons of waste into the ocean.[67]

- Offshore oil rigs and exploratory ships use a toxic substance called **drilling mud** to cool the drill bit as it grinds away rock beneath the ocean floor. Drilling mud, which contains arsenic, benzene, zinc, radioactive materials, and other toxins, is often dumped overboard into the ocean, where it poisons the surrounding waters.[68]

- **Drill cuttings**—rock fragments extracted from the oil reservoir and drill hole, often with hydrocarbon residue—will also be dumped overboard, smothering the marine flora and fauna on the seafloor.

In addition to these routine forms of pollution, offshore drilling rigs are subject to catastrophic accidents. In April 2010, the BP Deepwater Horizon oil rig exploded in the Gulf of Mexico, dumping approximately 206 million gallons of oil into the ocean until it was capped three months later.[69] Traveling from the well, one mile beneath the ocean's surface and 40 miles off Louisiana's coast, the oil was able to cover 928 miles of beach.[70] To break up the oil, airplanes and ships dumped 1.82 million gallons of dispersants into the ocean, many of them highly toxic, carcinogenic and mutagenic.[71] Still, for months, the oil smothered birds, fish, turtles, and plants. As of November 21, 2010, scientists and beach cleaners had found 4,000 oiled birds, more than half of them dead.[72] Much of the oil is enmeshed in the sand, a couple feet below the surface and it creates tar balls on the shore.[73] The full extent of the damage is still unknown, but scientists predict that the oil will continue to damage the Gulf for years to come.

While the BP Deepwater Horizon incident was unusual in its severity, offshore oil spills are actually quite common. Over the course of the 1990s and 2000s, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) recorded 213 offshore oil spills of greater than 50 barrels (2,100 gallons)—that is more than 10 major spills a year.[74]

The increasing shift toward deepwater drilling makes the job of containing offshore oil spills all the more difficult. Following BP's Deepwater Horizon accident in 2010, the company struggled for weeks to obtain and position the equipment necessary to plug the well, and struggled with the challenges of repairing a leaking well using robots working under thousands of feet of water.

Emissions from Flaring

Oil companies poison the air around wells by burning off or releasing the natural gas trapped in reservoirs. All oil reservoirs contain a mixture of oil and natural gas, and when oil is extracted, the gas escapes. Oil companies may force the gas back into the reservoir or capture and sell it, or they may burn or release it into the atmosphere, spurring global warming.

A National Oceanic and Atmospheric Administration (NOAA) report found that in 2008, oil producers worldwide burned approximately 139 billion cubic meters (bcm) of natural gas.[82] Oil flares are large flames, sometimes burning hundreds of feet high, and create billowing clouds of smoke.[83] American oil producers burn much less natural gas than the rest of the world, but still flare off approximately 2.3 bcm per year.[84]

Burning natural gas produces carbon dioxide, and is a major contributor to global warming. Natural gas flaring worldwide produces approximately 400 million tons of carbon dioxide every year—equivalent to half of Germany's total carbon dioxide output.[85] Some oil fields, many in sub-Saharan Africa, don't even burn their gas, but inject the methane straight into the atmosphere.

This is a major source of global warming, as methane is a greenhouse gas 20 times more potent than carbon dioxide.[86]

Flaring gas also releases nitrogen dioxide, sulfur dioxide, and other toxins into the air. These airborne toxins mix with precipitation and create acid rain, poisoning communities such as those in the Niger Delta.

Conclusion

America's dependence on oil is a leading cause of many of our nation's most intractable environmental problems—including air pollution, water pollution, global warming, exposure to health-threatening chemicals, and destruction of pristine habitats onshore and in marine environments. As oil becomes harder to find, the environmental toll of America's dependence on oil will only increase.

Thankfully, the nation has many tools that we can use to reduce our dependence on oil—safeguarding not only our economy and our national security, but our environment as well.

Breaking America's Dependence on Oil

For generations, politicians of both parties and all ideological persuasions have bemoaned America's dependence on oil. And yet, nearly four decades after the 1973 Arab oil embargo that first exposed the economic costs of the nation's dependence on oil, America still remains dangerously addicted to petroleum—with massive impacts on our environment.

With oil prices at or near $4 per gallon, and predictions that prices may go as high as $5 per gallon in the years to come, we now have an unprecedented opportunity to enact a serious and comprehensive set of policies that will put our country on the path to ending our oil dependence. Overwhelming majorities of voters are greatly concerned about the impact of rising oil prices on their families and support ambitious efforts to reduce oil consumption. The time is ripe for action at every level.

Breaking America's petroleum dependence will require immediate, strong action on several fronts. By getting the most out of every drop of oil we use through improved energy efficiency, shifting toward transportation systems that use less oil, and by substituting clean fuels where possible, America can achieve a dramatic reduction in our use of oil in the next two decades.

Saving Oil: The Opportunities

The first step to understanding how to break America's dependence on oil is to understand where and how we use it. While there are opportunities to reduce our consumption of oil throughout the economy, the biggest opportunities are in the transportation sector.

Transportation accounts for more than two-thirds (71 percent) of the oil the United States consumes every year, with industrial uses accounting for 22 percent, and residential use, commercial consumption and consumption for power generation accounting for the remaining 7 percent.[87] (See Figure 3, next page.)

Transportation

Approximately two-thirds of the oil America uses for transportation—and roughly 47 percent of the oil we use overall—is in the form of motor gasoline, nearly all of which is used to power light-duty vehicles, such as cars, pickups and SUVs. (See Figure 4.) Another 20 percent of the nation's transportation oil use is in the form of diesel fuel—used primarily for freight trucks and trains. Jet fuel for aircraft accounts for another 11 percent of oil use, with residual fuel—a kind of heavy oil used in ships—accounting for another 3 percent.[89]

Figure 3. Oil Consumption by Sector of the Economy[88]

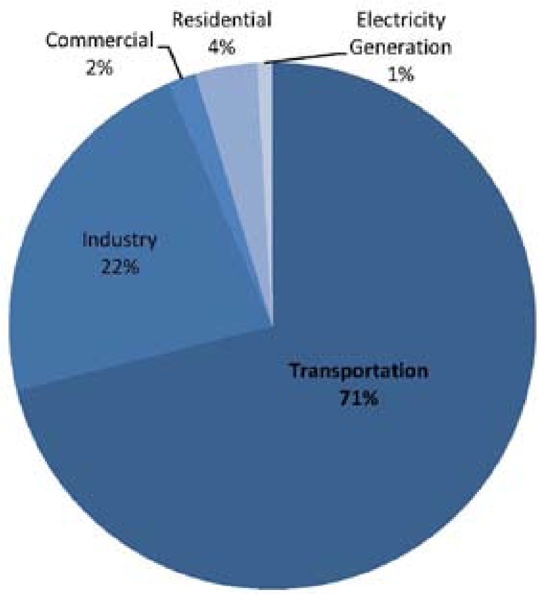


Figure 4. Oil Use by Type of Fuel in the Transportation Sector[90]

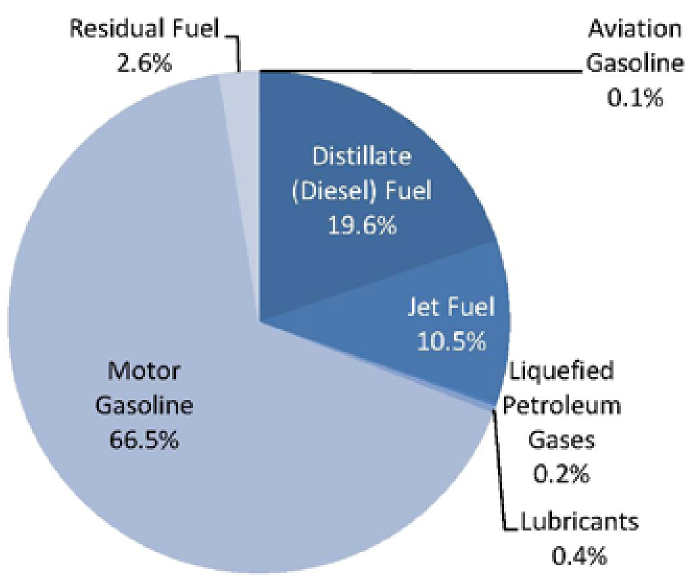
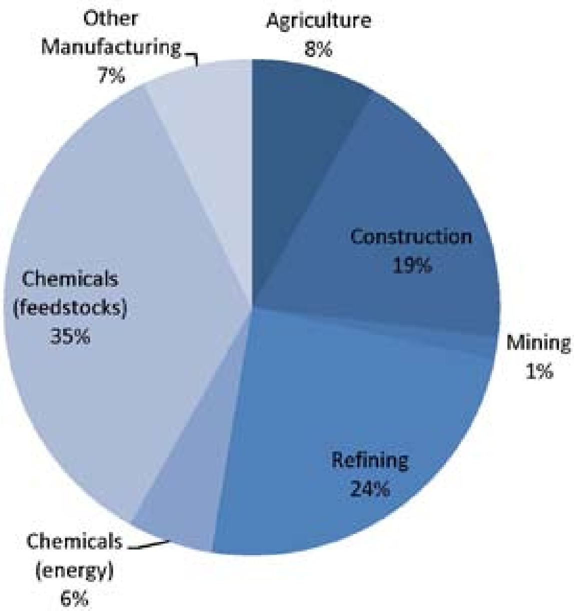


Figure 5. Industrial Consumption of Petroleum[91]



Industry

The industrial sector (which includes manufacturing, as well as activities such as construction, agriculture and mining) is the second-largest consumer of oil in the United States, accounting for 22 percent of total consumption. In specific areas of the country—particularly in states such as Texas and Louisiana, with their large petrochemical and refinery industries—the industrial sector is an even more important part of the oil consumption picture.

The two largest sources of oil consumption in the industrial sector are chemical manufacturing (particularly the use of petroleum as a feedstock for the manufacture of plastics and chemicals) and oil refining. (See Figure 5.)

Residential and Commercial Sectors and Electricity Generation

The direct combustion of oil in homes and businesses and the use of oil to generate electricity represent only around 7 percent of the nation's consumption of oil. But in certain local areas, oil consumption for these purposes is significant. The northeastern United States, for example, is heavily reliant on oil for space heating in homes and businesses. Hawaii, meanwhile (and to a lesser extent the northeastern United States), continues to use oil to generate electricity.

The biggest obstacle to curbing petroleum consumption is the vast investment we have made over the past century in building infrastructure that cements our dependence on oil.

As Americans, we've become used to rapid turnover of technology—for example, computers that were state of the art a decade ago are relics today. But when it comes to our energy system, it can take years—sometimes decades—to rebuild along sustainable lines.

Cars and light trucks last 12 to 15 years, locomotives and airplanes can last a couple of decades, and residential and industrial boilers can last 20 to 40 years. Transportation infrastructure, such as highways, lasts even longer, and communities can retain their basic form for hundreds of years.

Getting America off oil is a long term process, which is why it is important to take aggressive action now.

The Actions

In this report, we evaluate 17 public policies or measures with the potential to significantly reduce oil consumption in the United States. Together, these actions have the potential to leave America consuming 1.9 billion fewer barrels of oil per year in 2030 than we did in 2008—an amount equivalent to 31 percent of current U.S. oil consumption, or the amount of oil we currently import from OPEC nations each year. These measures are also sufficient to achieve President Obama's goal of cutting oil imports by one-third by 2025.

These actions will leave America in 2030 as a nation transformed—one in which we are getting much more value out of every drop of oil we consume, alternative fuel vehicles are common sights on American roads, and the long process of rebuilding our transportation system, communities and economy to be free from petroleum is well underway.

Rebuilding Our Transportation System

The task of breaking America's dependence on oil begins with rebuilding our transportation system. For more than 50 years, America's transportation policy has prioritized highways over railways, subsidies for driving over public transportation, and suburban sprawl over compact, mixed-use development. As a result, today most Americans are dependent on cars to get everywhere they need to go—and most of us live in communities where we have to do a lot of driving, whether it is to get to and from work or to pick up a bottle of milk. Moreover, our cars are almost entirely dependent on petroleum for fuel.

About this Report

Local, state and federal policies have great potential to help break America's dependence on oil. This report presents an analysis of the oil savings potential of clean energy policies across all 50 U.S. states. We used a uniform approach, estimating the oil savings that could result under 17 individual policy scenarios and one combined policy scenario in all 50 states against a consistent energy consumption baseline.

It is important for readers to understand that this analysis is not a projection of what *will* happen if these policies are adopted, but rather a presentation of scenarios of what *might* happen if anticipated trends in energy availability and prices become reality, if the policies discussed here are implemented properly and on the designated timeline, and if potential barriers to the implementation of these policies are surmounted. In short, this analysis is intended to help readers grasp the potential impact of the various policies and develop priorities among them, and is not a "crystal ball."

As with all such efforts, the estimates in this report are subject to limitations and are only as accurate as the assumptions on which they are based. We invite others to build on our efforts in order to create a greater understanding of the role that state and local efforts can play in curbing America's dependence on oil.

At the same time, other transportation vehicles—heavy-duty trucks, trains, ships and airplanes—are also highly dependent on petroleum.

Reducing the use of oil in our transportation system requires America to make several important changes:

- First, we need to improve the **energy efficiency** of transportation vehicles to get the most out of every drop of oil we consume.

- Second, we need to shift to **cleaner, alternative fuels** wherever possible—while also ensuring that the new fuels we use don't harm the environment or the climate.

- Third, we need to **improve the efficiency of our transportation system** by moving as much personal travel and freight movement as possible from modes of transportation that consume lots of oil to those that consume less.

- Fourth, we need to **provide transportation alternatives** so that the vast majority of Americans have real options other than driving.

- Finally, we need to **rebuild our communities and our economy** to reduce transportation demand. This means building new communities, and rebuilding existing communities, to bring destinations closer together, reducing the number of miles Americans must drive.

The following actions can help to make this new, less oil-dependent transportation system a reality, cutting oil consumption for transportation by **695 million barrels per year by 2020** and **1.7 billion barrels per year by 2030**, compared with 2008 consumption.[92]

(For more details on how we calculated the savings from these policies, please see the Methodology at the end of this report.)

Light-Duty Vehicle Fuel Economy and Global Warming Pollution Standards

The policy: Require new vehicles to achieve fuel economy and emissions performance equivalent to an average of 62 miles per gallon by 2025.

The savings (compared with business as usual case)**:**
- 130 million barrels of oil per year by 2020
- 395 million barrels of oil per year by 2030

(*Note: Savings estimated here are from conventional vehicles. This policy produces additional savings through increased use of electric vehicles; those savings are listed under "Deployment of Electric Vehicles," below.)*

Since 1975, the federal government has imposed minimum fleetwide fuel economy standards for light-duty cars and trucks. Those fuel economy standards led to a 40 percent reduction in fuel consumption per mile by light-duty vehicles between 1975 and 1987, curbing America's dependence on oil.[93] Over the course of the next two decades, however, vehicle fuel economy stagnated and even declined, as more Americans shifted from cars to less fuel-efficient light trucks.

Over the last several years, however, the United States has experienced a renaissance in the drive to reduce oil consumption in cars and light trucks. In 2010, the federal government launched new standards that call for a significant increase in vehicle fuel economy while, for the first time, limiting global warming pollution from vehicle tailpipes—a move brought about by the pioneering efforts of 14 states that had developed similar standards over the past decade. The new standards are designed to increase the average fuel economy of the vehicle fleet to 34 miles per gallon (mpg) by model year 2016.

Meanwhile, consumer concern about oil dependence is dramatically reshaping the automobile market. Analysis indicates that sales of hybrid cars have jumped more than 46 percent since March 2010, three times faster than the overall increase in car sales, while SUV sales have stagnated.[94]

The new standards on fuel economy and global warming pollution from cars will ensure that energy-saving technologies—from turbocharging to hybrid-electric drive—will find their way into more new vehicles. But there remains plenty of room for improvement. Technologies such the use of plug-in cars that run partially or entirely on electricity create the opportunity for a quantum leap in vehicle fuel economy and global warming emission performance.[95]

The Obama administration is now considering fuel economy and global warming pollution standards for 2017 and later years. Those standards should require new cars and light trucks to achieve the equivalent of 62 mpg fuel economy by 2025.

Beyond 2025, there will be opportunities to go further by increasing the use of electric vehicles, if we lay the appropriate groundwork. This scenario assumes that automobile manufacturers comply with a 62 mpg standard in equal parts by improving the efficiency of gasoline-powered vehicles and by increasing sales of electric vehicles. The estimated savings in this scenario include only those from vehicles with internal combustion engines. The details of and savings from the electric vehicle policy are described under "Deployment of Electric Vehicles," below.

The emergence of vehicles that operate on electricity—both plug-in hybrids and fully electric vehicles—creates the opportunity to reduce America's dependence on oil. Credit: Siena Kaplan

Deployment of Electric Vehicles

The policy: Use a variety of tools to encourage the deployment of vehicles operating on electricity, including federal light-duty fuel economy/global warming emission standards, financial incentives, programs to expand electric vehicle infrastructure, and minimum sales requirements for automakers, so that 22 percent of new light-duty vehicles sold in 2030 are electric vehicles.

The savings (compared with business as usual case)**:**

- 130 million barrels of oil per year by 2020
- 436 million barrels of oil per year by 2030

Electricity—used in both fully electric vehicles and gasoline-electric plug-in hybrids—is emerging as the most serious challenger to gasoline as the passenger vehicle fuel of the future. President Obama has called for a million electric vehicles to be sold in the United States by 2015. This ambitious goal would make the United States the clear global leader in this critical technology, reducing initial costs and greatly expanding the potential market for these high-tech vehicles. Major auto manufacturers are already beginning to roll out a wide variety of vehicles—from the all-electric Nissan Leaf to the plug-in hybrid Chevrolet Volt—that use electricity as a source of power.

The federal government already provides tax incentives for the purchase of plug-in vehicles, but there are several steps local, state, and federal governments can take to further encourage a shift to electric vehicles.

- Local governments can install electric vehicle charging stations in public places and facilitate—through changes in codes and regulations—the installation of charging stations in residential and commercial areas.

- State governments can adopt the zero-emission vehicle program, part of the larger Clean Cars Program pioneered by California and adopted by a number of other states, which sets specific targets for deployment of zero-emission and ultra-clean vehicles in the fleet. States can also encourage the development of electric vehicle charging infrastructure.

- The federal government can continue to provide incentives for the purchase of plug-in cars, helping those vehicles along on their way to commercial acceptance. In addition, the federal government can provide resources to assist in the installation of electric vehicle charging infrastructure. One approach, reflected in legislation introduced in Congress during 2010, would focus federal resources in a series of "deployment communities," which would ensure the development of high-density charging networks in a few cities, setting an example for future efforts in other places. The federal government can also encourage electric vehicle deployment by setting and properly enforcing global warming pollution standards for the vehicle fleet.

Electric vehicles are likely to be an important compliance option for meeting the 62 mpg-equivalent fleet fuel economy target by 2025. Moreover, we assumed that, beyond 2025, the momentum toward cleaner vehicles continues through policies designed specifically to aid the deployment of plug-in vehicles. The oil savings numbers reported here reflect the benefits of using electric vehicles to comply with a 62 mpg standard and deploying additional electric vehicles after 2025.

What might this look like in terms of the number of vehicles on America's roads?

- The U.S. Environmental Protection Agency, the National Highway Traffic Safety Administration (NHTSA), and the California Air Resources Board have studied various compliance scenarios for a 62 mpg-equivalent fuel economy and emissions standard. They estimate that plug-in vehicles will make up anywhere between 4 and 14 percent of the light duty fleet by 2025 under a 62 mpg-equivalent target.[96]

- We assume in our analysis that the progress toward plug-in vehicles continues and accelerates beyond 2025, such that by 2030, an additional 15 percent of all new vehicles sold are electric vehicles.

As a result, by 2030, roughly 22 percent of new light-duty vehicles sold each year would be electric vehicles, with 20 million such vehicles already on the road.

Energy Efficient Replacement Tires

The policy: Require the use of energy-efficient, low rolling resistance replacement tires.

The savings (compared with business as usual case)**:**
- 7.4 million barrels per year by 2020
- 6.5 million barrels per year by 2030*

* *Savings decline after 2020 due to improved fuel economy of the vehicle fleet.*

The use of energy-saving low rolling resistance tires is a relatively quick and low-cost way to improve vehicle fuel economy. Many vehicle manufacturers already equip their new cars with energy efficient tires to meet federal fuel economy standards, but the availability of energy-efficient replacement tires is limited. Requiring replacement tires to meet strong energy efficiency standards can curb energy use with no impact on vehicle safety.

Current federal law specifies how tire manufacturers must test and report the fuel efficiency of the tires they produce.[97] This information must be provided to consumers at the time of sale, so that they can consider energy efficiency when selecting replacement tires. But the federal government has not yet established mandatory efficiency standards for tires.

Requiring the sale of energy-efficient replacement tires that are 5 percent more efficient than current replacement tires—starting in 2013—would deliver significant oil savings. Moreover, because tires wear out faster than cars, it would do so quickly—by 2020, all tires on the road would be of the energy-saving variety.

Compact and Transit-Oriented Development

The policy: Through local, state and federal policies, ensure that 75 percent of new metropolitan development takes place in communities where walking, biking and transit are viable transportation options.

The savings (compared with business as usual case)**:**
- 23 million barrels of oil per year by 2020
- 41 million barrels of oil per year by 2030

America's transportation system requires most of us to use a car for most of the basic tasks of daily life—working, shopping, going to school or church, or visiting friends. However, a growing number of Americans are looking for alternatives to long commutes and big bills at the gas pump by seeking out communities with a wide variety of amenities that can be accessed on foot, by bike, or via transit.

Research shows that residents of these compact and transit-oriented communities drive significantly less than their counterparts in traditional suburban developments.[98] Demographic trends—including the aging of the population—and changing consumer preferences suggest that compact communities with multiple transportation options are likely to be in increasing demand in the coming decades.[99]

Unfortunately, local and state planning and zoning policies often make it easier for developers to build traditional "sprawl-style" suburban developments than to build the vibrant, walkable communities that are increasingly in demand. Planning and zoning changes that encourage compact development, along with policies that allow for compact development in the areas immediately surrounding transit stations, can help to achieve these goals. State and federal policy can encourage these changes by requiring local land-use plans to be consistent with overall plans for oil savings or global warming emission reductions (as is the case in California) and by providing financial assistance, financing tools and technical assistance to help developers and communities move forward with compact development projects.

An aggressive yet reasonable target would be to ensure that 75 percent of all new development in metropolitan areas takes place in compact or transit-oriented communities.[100] According to a groundbreaking study by the Urban Land Institute, residents of these communities can be expected to drive, on average, 23 percent fewer miles than they would have under business-as-usual trends in development.[101]

It is very likely that these figures underestimate the oil savings that are possible from compact and transit-oriented development, since they only count oil savings from *residents* of those new developments. By creating new centers of activity, many of them reachable by transit, these new developments may also lead to reductions in vehicle travel by residents of existing developments.

Pay-as-You-Drive Automobile Insurance

The policy: Transition to an automobile insurance system in which most insurance premiums are charged based on the number of miles driven, rather than a flat, annual rate.

The savings (compared with business as usual case):

- 58 million barrels per year by 2020
- 51 million barrels per year by 2030*

** Savings decline after 2020 due to improved fuel economy of the vehicle fleet.*

Automobile insurance premiums are commonly charged to drivers at a flat, annual rate—discounting the significant effect of the number of miles driven each year on accident risk.[102] Pay-as-you-drive insurance shifts the bulk of insurance charges from a flat rate to a per-mile rate. Increasing the per-mile cost of driving acts as an economic disincentive to driving, thereby reducing vehicle-miles traveled. Pay-as-you-drive insurance pilot programs have been launched in several states and by insurance companies, and pay-as-you-drive can be implemented either through the use of on-board transponders or regular odometer readings.

Widespread adoption of pay-as-you-drive insurance would reduce global warming pollution from light-duty vehicles by approximately 2.3 percent nationwide, based on an estimate from the U.S. Department of Transportation, with oil savings of a similar proportion.[103] States with higher auto insurance rates would likely experience greater savings, while those with lower rates would experience fewer benefits.

The savings listed above are based on phased-in requirement that auto insurance premiums be charged based on the number of miles driven, in which pay-as-you drive insurance would become mandatory in 2015.

Commute-trip reduction programs use a variety of strategies—including preferential parking for car pools—to reduce the number of single-passenger commutes to workplaces. Credit: istockphoto.com/Adam Nollmeyer

Commute-Trip Reduction Strategies

The policy: Adopt state-level programs (potentially supplemented by local or federal efforts) to require employers to reduce the number of single passenger commutes to and from workplaces.

The savings (compared with business as usual case)**:**

- 28 million barrels per year by 2020
- 24 million barrels per year by 2030*

** Savings decline after 2020 due to improved fuel economy of the vehicle fleet.*

Commute-trip reduction policies set targets for employers to reduce the number of single-passenger commutes to their worksites. Washington state has long implemented a successful commute-trip reduction program that reduced commuting vehicle-miles traveled (VMT) by 62 million miles in 2009, or roughly one-quarter of one percent of the state's total vehicle travel.[104] Washington state has achieved these results with little public expenditure, delivering $35 in congestion reduction benefits for every state dollar spent.[105] Greater emission reduction benefits could likely be achieved by expanding the scope of the program to cover more employers and devoting additional resources to the effort.

Employers have many tools with which they can achieve commute-trip reduction goals, including employee rideshare matching, vanpool programs, discounted transit passes, preferential parking for carpools and vanpools, provision of bicycling facilities, "cashing out" of free parking, telecommuting and compressed work weeks. Many of these changes have benefits for businesses—reducing the need to invest in parking and creating work environments that enhance productivity and improve employee morale.

A strong, national push to reduce single-passenger commute trips, implemented at a wide range of businesses, could deliver significant reductions in vehicle travel, with the U.S. Department of Transportation estimating that such programs could reduce total light-duty vehicle travel by approximately 1.1 percent.[106]

Public Transportation Expansion, Improvement and Efficiency

The policy: Expand public transportation service to achieve a doubling of transit ridership in 20 years, while achieving further ridership gains by improving the comfort, reliability and efficiency of transit service, and reducing per-mile consumption of oil in transit vehicles.

The savings (compared with business as usual case)**:**

- 9 million barrels per year by 2020
- 19 million barrels per year by 2030

Public transportation plays a critical role in reducing oil consumption in many parts of the country. Cities with electric rail systems—including New York, Chicago, Boston, Denver, Los Angeles, Seattle, Dallas and Salt Lake City—move tens of thousands of passengers each day without burning a single drop of oil. In addition, cities with diesel bus fleets are increasingly adopting energy-saving technologies such as hybridization, or are switching to alternative fuels such as compressed natural gas, providing new opportunities to reduce oil consumption.

In recent years, many fast-growing metropolitan areas have experienced rapid growth in transit ridership. For example, the number of passenger-miles traveled on Phoenix's Valley Metro system more than doubled between 2004 and 2009. Portland, Oregon, has experienced a doubling of transit ridership over the period from 1991 to 2009, and Salt Lake City has experienced similar growth.[107] All three cities have made significant investments in transit infrastructure, particularly light rail.

Light rail transit systems—such as this one in Sacramento—transport large numbers of people efficiently without burning a single drop of oil. Credit: istockphoto.com/Nancy Johnson

But America's public transportation networks have much room for improvement. Lack of investment has left many cities that could sustain robust rail transit systems with either a small number of transit lines or no rail transit system at all. Meanwhile, budget cuts driven by the recession have forced transit agencies to cut service and put off expansion plans.

Among the tools that can be used to take advantage of transit's potential to deliver oil savings are the following:

1) Expand public transportation service to double ridership in the next 20 years.[108]

2) Further boost public transportation ridership by another 15 percent over 20 years through improvements to existing services—including tools that can make transit rides more comfortable (e.g., improved bus shelters), more reliable (e.g., traffic signal priority for buses), and less expensive (e.g., discounted weekly or monthly passes and lower pricing for off-peak periods). In addition, transit agencies can adopt tools that help transit riders better integrate transit into their lives (e.g., real-time arrival and departure information provided via smart phone, and the addition of bicycle racks to transit buses).

3) Take full advantage of transit's oil-saving potential through a transition to more fuel efficient transit vehicles operating on alternative fuels.

Clean Fuel Standard

The policy: Require a 10 percent reduction in the life cycle global warming impact of transportation fuels by 2020 and (at least) a 15 percent reduction by 2030.

(No savings estimate provided: see below.)

Making our vehicles more energy-efficient and providing more and better transportation alternatives through smarter community design and better public transportation can go a long way toward reducing our dependence on oil. But we also need to take action to replace the oil we use in our cars and light trucks with cleaner fuels.

Clean fuel standards are key policies that can help drive the transition away from oil as a transportation fuel. Clean fuel standards set limits on the "life cycle" global warming emissions of various transportation fuels. By looking at emissions over the entire life cycle of a fuel—from extraction through refining, transportation, delivery and combustion—clean fuel standards ensure that we do not replace our dependence on oil with dependence on fuels with an outsized impact on the climate and our environment.

California's clean fuel standard (called the Low-Carbon Fuel Standard), for example, requires fuel suppliers to reduce the carbon intensity of transportation fuels by 10 percent by 2020.[109] Fuel suppliers can meet the standard by blending low-carbon biofuels with gasoline, improving the efficiency of their refining processes, or purchasing credits from suppliers of electricity for use in electric vehicles. A group of states in the Northeast are working to develop a similar standard in that region.

The oil savings benefits of a clean fuel standard, while potentially substantial, are difficult to quantify. First, fuel distributors have many options for how to comply—each with very different implications for oil consumption. In addition, the clean fuel standard exists within the context of other policies—such as vehicle global warming pollution standards and incentives for alternative fuel vehicles—that make it difficult to isolate its effects. Third, to the extent that a clean fuel standard encourages the use of advanced, low-emission biofuels in existing vehicles, the targets would likely not exceed the already ambitious targets for biofuel deployment in the existing federal Renewable Fuel Standard—in other words, a national clean fuel standard would do more to change the *type* of biofuels used than the amount of oil they would displace. Finally, because the clean fuel standard is a "life cycle" standard, some of the benefits of the standard will accrue in other countries or in other sectors of the economy.

As a result, we did not quantify the impact of a clean fuel standard on oil savings, though it remains an important policy to encourage a transition away from oil and toward transportation fuels with less impact on the global climate.

Bicycle Commuting Strategies

The policy: Invest in bike lanes and other forms of bicycle infrastructure to facilitate a five-fold increase in bicycle commuting over the next two decades.

(No savings estimate provided: see below.)

American cities have made tremendous progress in just the last few years in encouraging travel via bicycle. The addition of new bicycle lanes and trails, along with the launch in a few cities of bike-sharing programs, has helped spur increases in bicycle commuting. Nationally, bicycle commuting's share of overall commuting increased by 44 percent between 2000 and 2009. Several cities—including Portland, Oregon, Atlanta and Pittsburgh—have seen the share of bicycle commuting triple

The past decade has seen a dramatic increase in bicycle commuting in many cities, driven in part by efforts to expand and improve bike lanes. Credit: Sandy Ridlington

in the last decade.[110] In Portland, Oregon, which has a long-time policy of substantial investment in bicycle infrastructure, bicycling now accounts for nearly 6 percent of all commute trips.[111]

Increasing bicycle use is not rocket science. Improving safety—whether by creating dedicated bicycle paths or bicycle boulevards, designating bike lanes on existing streets, or creating special painted turning lanes for bicyclists—is a key, often low-cost step. In addition, the launch of bike-share programs, the addition of bike racks to transit vehicles, and the installation of safe structures for bicycle storage in urban areas can help reduce barriers that keep people from taking their bicycles to work.

The Urban Land Institute's *Moving Cooler* report evaluates a scenario in which bicycle commuting increases by 449 percent—a figure based on the creation of bicycle lanes, boulevards or paths at half-mile spacing in American cities.[112] This increase may seem dramatic at first blush, but given the rapid increase in bicycle commuting in some cities in recent decades, as well as the high levels of bicycle commuting in some bike-friendly European cities (37 percent of all suburban commuters and 55 percent of urban residents commuting to jobs in Copenhagen, Denmark, travel via bicycle, for example)[113], there is clearly room for dramatic improvement.

Oil savings from an increase in bicycle commuting are not quantified separately in this report, but are incorporated in the total oil savings from the policy case, as discussed on page 38.

High-Speed Rail

The policy: Build high-speed rail lines in 11 high-priority corridors by 2030.

The savings (compared with business as usual case)**:**

- 6 million barrels per year by 2020
- 15 million barrels per year by 2030

Nations around the world have operated high-speed rail lines for more than 50 years, dating back to the launch of Japan's *Shinkansen* bullet train in 1964. True high-speed rail lines are operated on electricity, potentially substituting for the use of two transportation modes that are highly dependent on oil—cars and airplanes. In addition, high-speed rail lines that operate at high capacity can be significantly more energy efficient than airplane or car travel.[114] Finally, high-speed rail can be designed to encourage more compact forms of development, providing an incentive for the location of businesses in densely developed districts near train stations and serving as a focal point for expanded and improved transit service.

The U.S. Department of Transportation has designated 11 corridors for high-speed rail nationwide. Completing construction of high-speed rail lines in those corridors—while simultaneously making investments in improved conventional passenger rail service and intercity bus service—can deliver significant oil savings while laying the groundwork for a less oil-intensive intercity transportation network for the future.

Figure 6. Federally Designated High-Speed Rail Corridors

Heavy-Duty Vehicle Fuel Economy

The policy: Set strong fuel economy standards for heavy-duty trucks.

The savings (compared with business as usual case)**:**

- 59 million barrels per year by 2020
- 260 million barrels per year by 2030

Heavy-duty trucks consume approximately 4.5 quadrillion Btu of energy per year—about 5 percent of total U.S. energy consumption, almost all of it in the form of oil.[115] There are many opportunities to reduce energy consumption and global warming pollution from heavy-duty trucks—both in the short-term, using measures such as improvements to the aerodynamics of existing tractor trailers, and in the long run, through efforts to improve the efficiency of diesel engines. Unlike light-duty vehicles, heavy-duty trucks are not currently subject to fuel economy regulations and limits on global warming pollution. This scenario assumes that standards will be applied to trucks in such a way as to take advantage of technologically feasible improvements in fuel economy.

Adoption of standards recently proposed by the National Highway Traffic Safety Administration (NHTSA) and the Environmental Protection Agency (EPA) for model years 2014 to 2018 would take the first steps toward tapping the potential for oil savings in heavy-duty vehicles, yielding up to 20 percent reductions in fuel use from some trucks. But there is potential to go much further; the American Council for an Energy-Efficient Economy (ACEEE) estimates that fuel economy improvements of 39 percent for long-haul trucks and as much as 70 percent for some short-haul trucks are possible.[116]

Airplane and Rail Fuel Economy Improvements

The policy: Provide incentives to encourage the rapid introduction of more fuel-efficient airplanes and rail equipment.

The savings (compared with business as usual case)**:**
- 43 million barrels per year by 2020
- 122 million barrels per year by 2030

Air travel and freight rail are significant users of oil—indeed, jet fuel consumption accounts for 10 percent of America's transportation oil use.[117] Rail is a significantly more energy-efficient option for freight transport than trucking, but there are still many opportunities to reduce oil consumption in rail transport. The use of more energy-efficient engines, improved aerodynamics, and improved lubrication—along with electrification of rail lines—all have the potential to reduce global warming pollution from rail operations.[118]

Commercial airlines have made large strides in improving the energy efficiency of their operations, both through improvements to airplane technology and increasing the number of passengers occupying each plane. Indeed, on a passenger-mile basis, today's aircraft are approximately 70 percent more energy efficient than those in use 40 years ago.[119] Again, however, there are opportunities for additional oil savings, through improvements in the energy efficiency of engines, changes to aircraft bodies that incorporate the use of lighter-weight materials, and the use of technologies to reduce aerodynamic drag.

Neither rail vehicles nor airplanes are subject to federal vehicle fuel economy standards. The challenge in reducing emissions from these modes is only partially technological—the bigger issue is the high capital investment required for the purchase of new locomotives and aircraft and, consequently, the long time they remain in service once built. State and federal policies can create financial and other incentives for freight railroads and airlines to retrofit existing vehicles with technologies that reduce emissions, while hastening the introduction of a new generation of cleaner technologies. State-level incentives and support for development have already encouraged the introduction of more efficient locomotives, mainly in California and Texas.[120]

Other Opportunities for Oil Savings in Transportation

There are many other opportunities to reduce oil consumption in transportation beyond those evaluated in detail in this report.

One opportunity is the potential for the policies discussed here to deliver greater oil savings in combination than they would separately. Consider, for example, the situation of a person living in a new transit-oriented community, with expanded access to efficient and reliable public transportation, and better facilities for bicycling. He or she might also work for an employer with a strong program to reduce the number of single-passenger vehicle commutes, and have access to a new high-speed rail line or improved regional passenger rail service for trips out of town. The total effect of these changes might be to convince that person to go from two family cars to one—or from one to none—thereby reducing the number of miles driven for all trips, and curbing oil consumption in ways that are nearly impossible to predict.

Another set of opportunities is presented by additional policy strategies that could deliver further reductions in oil consumption. Among those potential strategies are the following:

- Increasing the per-mile cost of driving, including congestion pricing and higher gasoline taxes.

- Encouraging a shift of freight transport from trucking to less oil-intensive modes such as rail and water transportation.

- Public education efforts to help drivers maximize their fuel economy through speed reduction, proper tire inflation and other means.

- Efforts to reduce truck idling, including truck stop electrification.

- Conversion of existing rail lines, where possible, from diesel to electric power.

- Programs to reduce oil consumption in water-borne transportation.

The transportation policies described here deliver large reductions in oil consumption—putting the nation on track to a more sustainable future. But there is far more that can be done to further curb America's dependence on oil for transportation.

Curbing Oil Use in Homes, Business and Industry

Homes, businesses and industry (along with electric power producers) consume the remaining one-third of the nation's oil that is not consumed in the transportation sector. Industrial uses—which include manufacturing, agriculture, construction and mining—account for 22 percent of the nation's oil consumption.

Unlike transportation, in which oil is an important fuel nationwide, oil use in homes, businesses and industry varies a great deal geographically and by type of economic activity. Oil is primarily used for home heating only in the Northeast, while it is primarily used for electricity generation in Hawaii. Industries use oil for a vast array of purposes, including as an ingredient in the production of plastics, chemicals, lubricants and asphalt. These "non-energy" uses of petroleum are not included in this report (which focuses on energy consumption), though there are strategies—such as increased recycling and shifting from petroleum-based to non-petroleum-based ingredients—that can reduce consumption of oil for these purposes as well.

Improving the energy efficiency of homes, businesses and industries and substituting cleaner fuels (such as solar energy and sustainably harvested biomass) for oil are among the steps we can take to curb energy use.

Residential and Commercial Energy Retrofits

The policy: Provide incentives and other support for the installation of energy efficiency improvements in existing homes and commercial buildings, sufficient to achieve a 30-50 percent energy savings per building at 75 percent of American homes and commercial buildings.

The savings (compared with business as usual case)**:**

Residential
- 6 million barrels per year in 2020
- 19 million barrels per year in 2030

Commercial
- 17 million barrels per year in 2020
- 31 million barrels per year in 2030

A whole-home energy retrofit—sealing air leaks, adding insulation, repairing ductwork, improving heating and cooling systems, and upgrading lighting and appliances—can reduce a home's energy consumption by up to 40 percent.[121] The U.S. Environmental Protection Agency's Home Performance with Energy Star program is a good example of a home energy retrofit program. Trained contractors visit the home to identify opportunities for energy savings, and design and implement a plan for energy efficiency improvements, the cost of which is often defrayed by financial incentives from utilities or local, state or federal governments. Home energy retrofits benefit homeowners by cutting utility bills, and often benefit consumers at large by reducing the need for expensive investments in energy infrastructure, as well as by reducing pollution.

There are a variety of policy avenues for delivering on the promise of home energy retrofits, including:

- **Federal:** Tax credits and cash grants for home energy efficiency improvements, direct provision of energy efficiency services through national service programs, energy efficiency measures in low-income housing, creation of new financing tools for home energy efficiency improvements, and stronger energy efficiency standards for appliances.

- **State and local:** Stronger building energy codes (applying to renovations of existing buildings), energy efficiency resource standards, utility-based energy efficiency programs, and community-based energy efficiency programs, among others.

Similar energy savings are possible for retrofits of existing commercial buildings that use oil for space heating and water heating. As with homes, there is tremendous potential to improve the energy efficiency of America's commercial buildings—including its hotels, big-box stores, and office buildings. A 2010 report by the consulting firm Pike Research estimated that an aggressive integrated design retrofit for commercial space can yield energy savings of 20 to 60 percent using strategies that are "relatively straightforward and low risk," with a simple payback of 7 to 12 years.[122] More aggressive energy savings are possible in a "zero net energy" retrofit approach. In this analysis, we target energy savings of 50 percent in existing commercial structures.

The vast bulk of the oil savings delivered by building retrofits are in the Northeast and Mid-Atlantic regions, which are more dependent than other regions on oil as a fuel for heating.

Residential Building Energy Codes

The policy: Establish strong building energy codes for new residential construction (as well as major renovations).

The savings (compared with business as usual case)**:**
- 1 million barrels per year by 2020
- 6 million barrels per year by 2030

There are tremendous opportunities to improve the energy efficiency of newly constructed residential and commercial buildings. In 2010, the International Code Council established new residential model energy codes for 2012 that will improve energy efficiency by 30 percent relative to the 2006 version of the codes (emission reductions will be greater when compared to homes in existence today).[123]

These new codes, while representing the largest single improvement in energy efficiency codes in history, do not begin to tap the full potential for energy efficiency improvements in residential structures. The U.S. Department of Energy has established a goal of achieving a 50 percent energy savings in new construction relative to the 2006 baseline by 2015.[124]

Strong building energy codes can provide economic savings to home buyers while reducing the need for investments in energy infrastructure and protecting the environment. Modeling of the new residential codes suggests that energy savings from the new codes will pay off the additional cost of complying with the code in less than seven years, depending on the region and building type.[125]

The United States should establish strong residential energy codes capable of reducing energy consumption in new homes by 50 percent by 2020 and by 75 percent by 2030, while coupling those codes with stronger enforcement efforts to ensure that these energy efficiency improvements are realized in practice.

Similar strong building energy codes should also be adopted for new commercial construction. However, because federal energy projections suggest that the use of heating oil in new commercial structures is likely to be small in future years, the impacts of commercial building codes are not included in this analysis.

Energy Efficiency Improvements in Industry

The policy: Set strong standards for the energy efficiency of industrial boilers and process heat systems and create incentives to encourage the replacement of existing systems with energy efficient models.

The savings (compared with business as usual case)**:**

- 10 million barrels per year by 2020
- 16 million barrels per year by 2030

Industry is responsible for more than one-fifth of America's oil consumption. Much of that oil is used in the production of heat, hot water and steam to power industrial processes. Energy consumption for industrial process heat and boiler fuel accounts for more than half of total energy use in manufacturing and is a potential high-yield area for energy efficiency improvements that also boost the competitiveness of American industry.[126]

The American Council for an Energy-Efficient Economy (ACEEE) has identified numerous opportunities to improve the energy efficiency of equipment that produces heat and hot water for industry, estimating that it is technically achievable to reduce industrial boiler fuel usage and process heat usage by 10 percent by 2020, and by 15 percent (for process heat) and 19 percent (for boilers) by 2030.[127] The ACEEE analysis recommended a series of policy changes to tap the potential for improved efficiency in process heat production and boiler fuel use, including financial incentives for the replacement of outmoded equipment, streamlined permitting, and the adoption of output-based emission standards for boilers.

Maximizing the energy efficiency of

Residential Appliance Efficiency Standards

Energy efficiency standards for residential appliances have proven to be an effective way to cut energy consumption in the home. Strengthening efficiency standards for oil-fired boilers, furnaces and water heaters can reduce petroleum consumption in areas of the country where fuel oil is commonly used for space heating and water heating.

Based on estimated savings from a 2009 report by the American Council for an Energy-Efficient Economy and Appliance Standards Awareness Project titled *Ka-BOOM: The Power of Appliance Standards*, the United States could save approximately 8 million gallons of oil in 2020 and 18 million gallons in 2030 through aggressive efficiency standards for oil-saving appliances. These savings overlap with savings from energy efficient building retrofits and building codes. A state-by-state breakdown of oil savings from residential efficiency standards appears in the Appendix.

industrial equipment that consumes oil can not only reduce America's petroleum dependence, but also improve the competitiveness of American industry.

Reduced Energy Consumption in Oil Refineries

The policy: Achieve the oil savings described elsewhere in this report, reducing the demand for energy use in oil refineries.

The savings (compared with business as usual case)**:**

- 20 million barrels per year by 2020
- 50 million barrels per year by 2030

One of the most oil-intensive industrial activities is the production of petroleum products itself. Oil refineries consume massive amounts of energy—accounting for approximately one-third of industrial energy use.[128] A significant share of the energy in any barrel of crude oil is used to power the refining process.

There are many ways to improve the energy efficiency of the refining process through equipment upgrades and better energy management.[129] But perhaps the greatest opportunity to reduce oil consumption in refineries is to reduce our demand for oil in the first place.

The oil savings produced by the policies discussed in this report will yield additional savings by reducing the demand for energy use in petroleum refineries. These savings will likely occur even without efforts by the oil industry to make their refineries more energy efficient. By combining reduced petroleum consumption with improved refinery efficiency, the nation can achieve even greater reductions in oil consumption.

Curbing Oil Use in Government Operations

The policy: Compliance with President Obama's Executive Order 13514, which requires federal agencies to reduce their emissions of global warming pollution.

The savings (compared with business as usual case)**:**

- 4 million barrels per year by 2020
- 4 million barrels per year by 2030

The federal government is the nation's largest consumer of energy.[130] In October 2009, President Obama signed Executive Order 13514, directing federal agencies to develop plans to reduce global warming pollution, to improve the energy efficiency of government buildings, vehicles and equipment, and to take other steps to reduce their impact on the environment.

Responding to the executive order on federal sustainability, federal agencies filed plans by January 2010 setting specific targets for global warming pollution reductions from their operations. In total, those plans would put the federal government on a path to reduce global warming pollution by 28 percent below 2008 levels by 2020.[131] Those efforts are projected to save the federal government between $8 billion and $11 billion on energy costs by 2020.[132]

Many of the savings generated by Executive Order 13514 will be in the form of oil savings, particularly through the use of energy-efficient or alternative fuel vehicles in the federal fleet.

Additional Oil Saving Opportunities in Homes, Business and Industry

In addition to the policies discussed here, there are many other opportunities to reduce oil consumption in the nation's homes, businesses and industry. Among the policy tools that can be used are the following:

- Energy efficiency measures in agriculture, mining and construction.

- Incentives and policy support for renewable heating—including water heating, space heating, and industrial process heat. Solar and geothermal energy sources are among those with promise to substitute for oil for these uses.

- Policies to encourage the redesign of industrial processes to maximize energy efficiency.

In addition, while non-energy uses of oil are not addressed in this report, finding alternatives to the use of oil in plastics, chemicals and other products is a critical part of curbing America's dependence on oil. Steps to achieve this goal include:

- Expanded recycling of plastics.

- Substitution of non-petroleum based substances for chemicals, plastics and other oil-based materials, where possible.

The Results

Oil Savings Resulting from the Policy Strategies

By implementing the policy strategies discussed in this report, the United States could cut its consumption of oil for energy by 31 percent compared with 2008 consumption levels, and by 26 percent compared with business-as-usual levels, by 2030.

This level of oil savings is sufficient to achieve President Obama's goal of cutting oil imports by one-third by 2025.[133]

Oil savings occur in all parts of the economy and in each of the 50 states. In the key transportation sector, the policies will result in a 35 percent reduction in oil consumption relative to 2008 consumption levels. The smallest relative savings are in the industrial sector, where oil consumption is distributed across a wide variety of activities.

Figure 7. Oil Savings Resulting from Policy Strategies

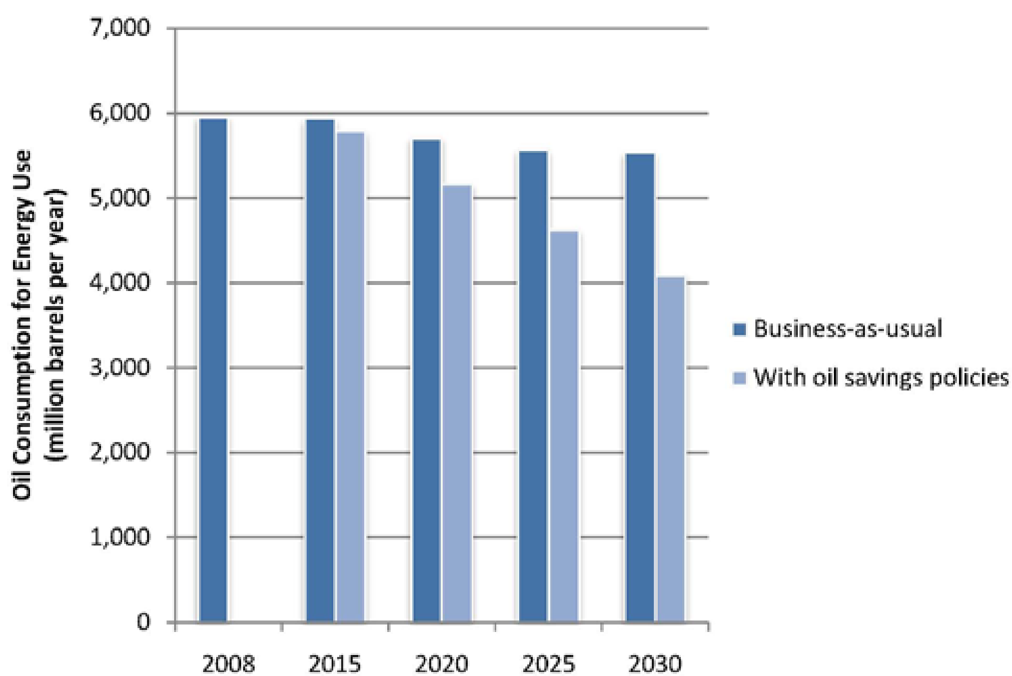


Table 1. Percentage Reduction in Oil Consumption for Energy Use from 2008 Levels by 2030 with Oil Savings Policies

Sector	% Reduction from 2008 Consumption in 2030
Transportation	35%
Residential	31%
Commercial	39%
Industrial	9%

Oil savings are also broadly distributed across the United States. Relative to 2008 consumption levels, oil savings range from 4 percent in fast-growing Nevada to nearly 46 percent in Michigan. See the Appendix for state-by-state and policy-by-policy estimates of oil savings from these strategies.

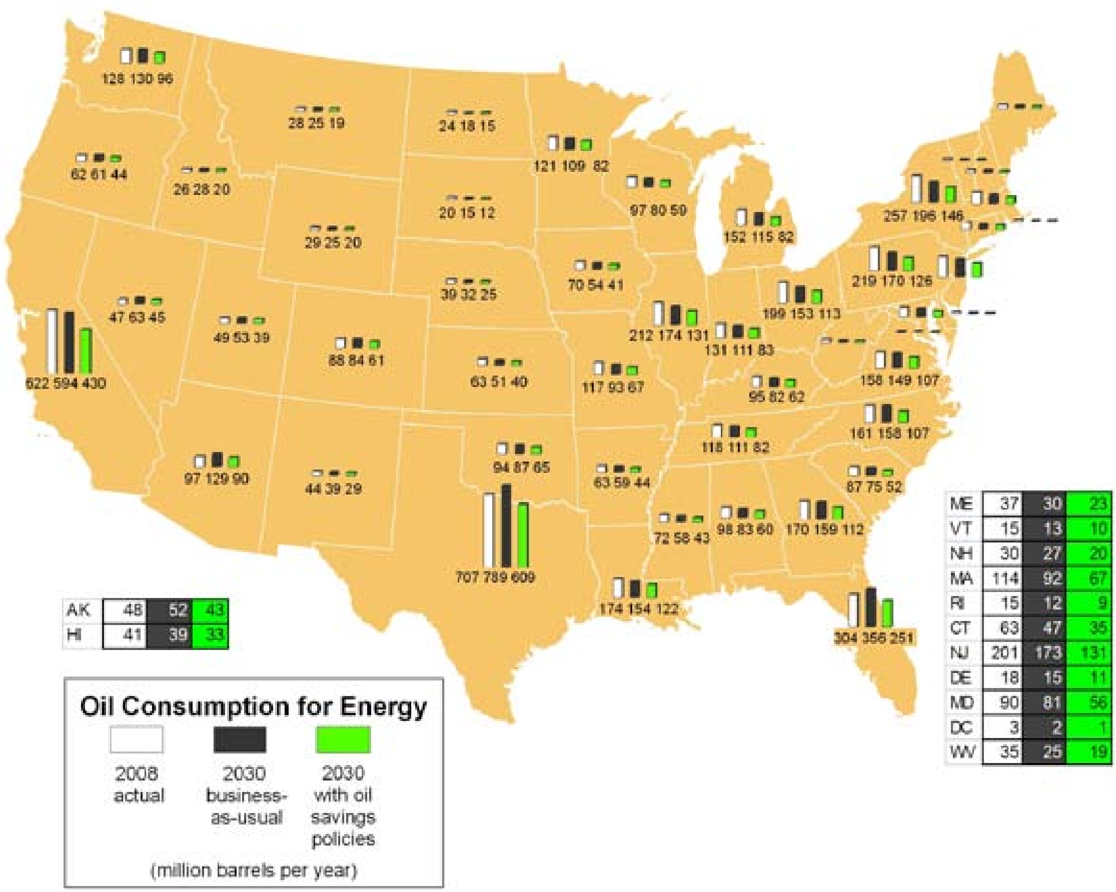
Making it Happen: The Potential for Oil-Saving Policies at All Levels of Government

There are countless opportunities to pursue public policy changes that reduce America's dependence on oil and its environmental impacts.

At the **federal** level, Congress and the President can:

- Adopt national oil savings goals and develop a comprehensive national plan for achieving them.
- Maximize improvements in the fuel economy of passenger vehicles and heavy-duty vehicles through federal rule-makings.

Figure 8. Oil Consumption by State under Business-as-Usual and Oil Savings Policy Case



- Develop effective incentive programs to encourage improvements in fuel economy in air, rail and water transportation.

- Revamp America's system of transportation funding to evaluate potential projects based on the degree to which they reduce America's dependence on oil.

- Focus federal highway funding on the repair and maintenance of existing roads and create adequate, ongoing funding sources for transportation alternatives such as high-speed rail.

- Require metropolitan planning organizations (MPOs) to incorporate oil savings as a metric for planning and prioritization of transportation projects and provide technical support to MPOs to help them achieve that goal.

- Reward state and local governments that have adopted and are moving to implement oil savings plans.

- Adopt strong energy efficiency requirements for replacement tires.

- Set strong energy efficiency standards for appliances and equipment, and promote the adoption of strong national building energy codes.

- Provide funding for an ambitious program of home and commercial retrofits.

- Repeal all subsidies for oil companies and redirect the funds toward clean technologies that reduce our dependence on oil.

Policy-makers at the **state level** can:

- Set statewide oil savings goals and develop comprehensive plans to achieve them.

- Adopt the Clean Cars Program, pioneered by the state of California and since adopted by 13 other states, which sets ambitious standards for reducing global warming pollution from light-duty vehicles and encourages the sale of advanced, zero-emission vehicles such as electric cars.

- Create strong clean fuel standards that reduce the carbon intensity of transportation fuels, largely through the use of clean alternative fuels.

- Create commute-trip reduction programs that reward employers who effectively encourage carpooling, telecommuting, teleconferencing, and other commute reduction strategies.

- Provide permitting and financial assistance to encourage the development of walkable communities in proximity to public transportation.

- Require municipalities to adopt land-use plans consistent with the goal of reducing oil consumption.

- Require the adoption of strong model building energy codes, and implement energy efficiency standards for appliances and equipment.

- Revamp state transportation planning funding policies to encourage the development of public transportation, passenger rail, demand reduction, bicycling, and pedestrian infrastructure as solutions to transportation challenges.

- Require auto insurers to offer pay-as-you-drive insurance.

Local governments can:

- Revamp their planning and zoning policies to encourage the development of walkable communities in close proximity to public transportation.
- Eliminate regulations that effectively subsidize driving and oil use, such as arbitrary limitations on building size, regulations that require stores and businesses to provide parking facilities, publicly subsidized parking, and practices that prevent mixed-use zoning.
- Maintain quality public transportation service, purchase energy efficient and alternative fuel transit vehicles, and plan for expanded facilities and service, with assistance from state and federal governments.
- Provide safe facilities for pedestrians and bicyclists—including sidewalks and bike lanes, bike racks, and, where feasible, access to bike-sharing programs.
- Adopt and properly enforce strong building energy codes and encourage the use of green building techniques.

Conclusion

America's dependence on oil is more than a century in the making, and ending it won't be easy. But the technologies and policy tools exist to take the first, important steps. By improving the energy efficiency of our economy, moving people and goods more efficiently, and finding sustainable substitutes for petroleum, the nation can achieve significant reductions in our oil consumption and do so within the next two decades.

The benefits of breaking our dependence on oil are great, including greater economic stability and improved national security. But the most profound benefits are to our environment. By taking action now to curb our use of oil, we can protect our climate, our oceans, our forests and rivers—and our own health—from the rampant pollution caused by the extraction, transportation and combustion of oil. With the world's easy-to-find sources of oil running out—and oil companies poised to tap riskier and more difficult-to-produce sources of oil in more environmentally sensitive places—there is no better time than the present to act.

Methodology

The following sections of this report describe our assumptions—and the sources of those assumptions—for how specific changes in policy would affect oil consumption in the United States. In general, we began by constructing a set of baseline conditions—or a "business-as-usual case"—that reflects one vision for how the nation might consume energy in the absence of any changes in existing public policy. Our business-as-usual case was based primarily on energy use projections produced by the U.S. Energy Information Administration (EIA) and published in its *Annual Energy Outlook 2011* report, though we did make several adjustments to those projections.

We split projected energy consumption in the reference case among the 50 states, assuming (in most cases) that the EIA's regional projections of growth in energy consumption were applied to each of the states in that region, adjusted for projected growth in population.

Then, for each policy, we conducted a literature review to develop estimates for how each set of policies would affect energy consumption in each of the states. These estimates were fed into a simple spreadsheet model that projected energy savings from each of the policies (calculated either as percentage reductions in energy use or specific numerical reductions). In addition to estimating the impact of each policy in isolation, we also constructed separate scenarios that modeled the impact of the policies in combination, taking into account the potential overlap among policies.

Limitations

Assembling an overall picture of how local, state and federal clean energy policies could affect oil consumption across the country required us to make many simplifying assumptions about how the various policies would be implemented and would interact with other policies.

Among the key simplifying assumptions are the following:

- The state-by-state oil consumption projections in our reference case are based on regional projections of the growth of energy consumption from the U.S. Department of Energy (DOE). The DOE does not publish state-by-state energy use projections. Our attempt to distribute future growth in energy consumption and emissions among states in a given region may fail to account for some state-specific factors that affect changes in energy use over time.

- States have developed, and likely will continue to develop, slightly different methods for implementing particular public policies. While every effort has been taken to account for these variations in existing state policies, we developed uniform definitions of future policies that are applied to all states, regardless of their historic or likely future choices for how to implement clean energy policies.

The best way to interpret this analysis, therefore, is as an outline of how various policy actions can affect oil consumption in the U.S. economy and how those policies might affect different states differently. We hope that future analysts will build off the work of this report to produce more detailed and accurate emission forecasts in the years to come.

A final—and significant—limitation of this analysis is that it only addresses consumption of petroleum products for energy in the United States. We do not address consumption of petroleum for other uses—for example, for the production of chemicals, plastics, lubricants, asphalt or other durable products. It is imperative that the United States also find ways to reduce the consumption of petroleum for these purposes, but these changes require a different set of policy steps and are therefore excluded from this analysis.

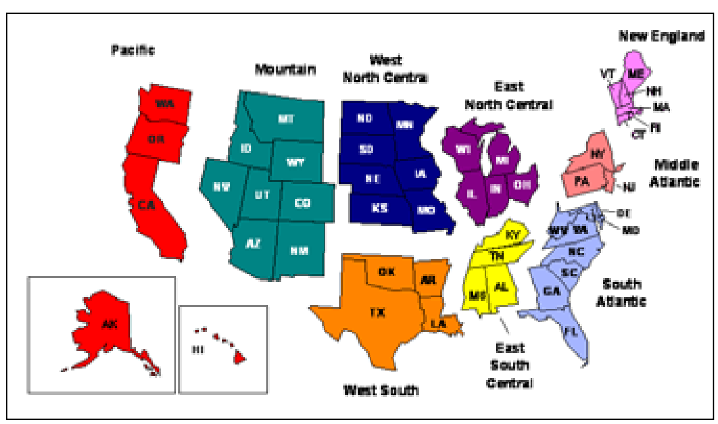
Building the Business-as-Usual Scenario (Reference Case)

General Approach and Assumptions

The business-as-usual scenario in this report was based on two sources of data from the Energy Information Administration. First, it uses the *Annual Energy Outlook* (*AEO*), which provides forward-looking data at the national and regional level. Second, it utilizes the State Energy Data System (*SEDS*), which provides historical data (with 2008 being the most recent year) at the state level.[134] These sources are, respectively, the official U.S. government forecasts of future energy use and the only comprehensive database of state energy consumption available in the public domain. Thus, they represent a generally accepted, if imperfect, starting point for evaluating the impact of policies that shift America's patterns of energy consumption.

We made one important alteration to the reference case scenario presented in the *AEO 2011*. We altered the EIA's reference case scenario to reduce the projected growth in vehicle-miles traveled (VMT) in future years. The *AEO 2011* projects a 0.7 percent annual growth rate in per capita vehicle travel between 2008 and 2030—a rate that far exceeds the 0.2 percent annual growth rate from 2000 to 2009 (and the negative average annual growth rate since 2005). Instead, we assumed that per-capita VMT will remain steady between now and 2030, which may prove to be a conservative assumption, given changes in demographics, consumer preferences and other factors.

Figure 9. Map of Census Divisions[135]



Estimating Future Energy Consumption

We combined the *SEDS* data and *AEO 2011* to obtain state-level estimates of future energy use in Btu. We projected the state-level *SEDS* data for energy consumption in 2008 forwards by pairing up fuel use categories in the *SEDS* with corresponding categories in the *AEO*. In cases where categories did not directly correspond, we paired the *SEDS* category with the larger *AEO* category that contained it.

For each category of energy use in the *SEDS*, we obtained a "regional multiplier" for each census division for each of the years 2015, 2020, 2025 and 2030, representing the amount by which usage of energy in that category is projected to increase between 2008 and that year. This multiplier was obtained using the projections for the corresponding category of energy in the *AEO*, as described in Formula 1, top, right column.

Formula 1.

$$Multiplier_{FY} = Usage_{FY} / Usage_{2008}$$

Where:

$Multiplier_{FY}$ is the regional multiplier for a given future year,

$Usage_{2008}$ is the amount of energy used in 2008,

And $Usage_{FY}$ is the amount of energy projected to be used in the future year.

To make this regional multiplier specific to individual states, we adjusted it for the change in the balance of population within each region over time. We reallocated future energy consumption within the states of the region by giving a higher share of projected energy consumption to states that are projected to grow faster than the region as a whole, and a lower share to states that are projected to grow more slowly than the region as a whole. Our specific formula is described in Formula 2, below.

Formula 2.

$$StateEnergy_{FY} = \frac{\left(\frac{StateEnergy_{2008}}{StatePop_{2008}}\right) * \left(\frac{RegionPop_{2008}}{RegionEnergy_{2008}}\right) * RegionEnergy_{FY}}{\sum_{i=1}^{NumStates}\left(State(i)Pop_{FY} * \left(\frac{State(i)Energy_{2008}}{State(i)Pop_{2008}}\right) * \left(\frac{RegionPop_{2008}}{RegionEnergy_{2008}}\right)\right)}$$

Where:

NumStates is the number of states in the region,

All variables subscripted "FY" refer to that quantity in the future year, while all variables subscripted "2008" refer to the quanity in 2008,

StateEnergy refers to the amount of a particular fuel, in Btu, consumed in the state in a given year,

RegionEnergy refers to the amount of a particular fuel, in Btu, consumed in the census division in a given year,

StatePop refers to the projected or estimated population of the state in a given year,

And *RegionPop* refers to the projected or estimated population of the census division in a given year.

State and regional energy consumption figures in 2008 were drawn from the EIA's State Energy Data System.[136] State and regional population figures (estimated for 2008, projected for future years) were drawn from the U.S. Census Bureau.[137]

To adjust for the reduced growth in vehicle travel in our reference case versus the *AEO 2011*, we first extracted the component of transportation fuel usage attributable to light-duty vehicles; we did this by combining the total amount of motor gasoline consumed for transportation purposes with the total amount of ethanol consumed for the same purpose, and then multiplying this total by the share of transportation gasoline consumed by light-duty vehicles from *AEO2011*.

We derived a baseline figure for vehicle-miles traveled per capita by dividing the *AEO*'s projection of total national VMT (from "Transportation Sector Key Indicators and Delivered Energy, Reference Case" in *AEO2011*) by the U.S. Census Bureau's projection of national population in each year. We assumed that changes in VMT per capita would be distributed equally across all states, and that changes in fleet fuel economy would also be distributed equally across states. Based on these assumptions, we calculated light-duty vehicle fuel consumption for each state as described in Formula 3, below.

and non-energy fuel consumption would remain constant over time and excluded the amount of fossil fuels used for non-energy purposes from our reference case.

Some fuels required special treatment. One of these was ethanol, which is incorporated in various blends into motor gasoline. The *Annual Energy Outlook* provides several fuel categories that relate to ethanol: one for standard motor gasoline, which contains an unspecified amount of ethanol, one for the blend known as E85, which contains 85 percent or more ethanol, and one separate category, which tallies up all the pure ethanol used in fuel of any blend. The *SEDS* data, meanwhile, list the amount of unblended ethanol consumed, and the amount of motor gasoline (all blends of petroleum gas and ethanol included) consumed. We combined the two *AEO* categories covering motor gasoline blends to obtain a multiplier for all motor gasoline. For emissions tracking purposes, we then subtracted the amount of ethanol consumed (in Btu) from the amount of blended gasoline consumed (in Btu) in each year to obtain separate figures for pure ethanol and pure petroleum gasoline.

A Note on Units and Conversions

The raw analysis of the data for this report was conducted in Btu. To present our savings in terms of gallons, we converted

Formula 3.

$$Consumption_{reference\ case} = Consumption_{AEO\ 2011} * \left(\frac{National\ VMT\ per\ capita_{2008}}{National\ projected\ VMT\ per\ capita_{target\ year}}\right)$$

We also needed to determine what share of fossil fuel consumption was for non-energy purposes, which are excluded from this analysis. We obtained our figures for the amount of each fuel that was consumed for non-energy purposes from the EPA's inventory of U.S. greenhouse gas emissions.[138] We assumed that the relationship between total fuel consumption

our data on fuel consumption from Btus to physical units using the methodology presented by EIA in *State Energy Data 2008: Consumption*, *Appendix B*, *Thermal Conversion Factor Source Documentation*, 30 June 2010.

Oil savings are communicated in terms of barrels, calculated by dividing the total amount of oil products saved by 42 gallons per barrel. The savings presented here, therefore, may not convert directly into savings in terms of barrels of crude oil.

Evaluating the Policy Scenarios

Light-Duty Vehicle Fuel Economy and Global Warming Pollution Standards

Our reference scenario, per EIA's projections, assumes that corporate average fuel economy (CAFE) standards increase to 34 mpg by model year (MY) 2016 and to 35 mpg by 2020. Fuel economy and emission standards in the reference case remain stable after that time.

We modeled a scenario in which combined federal global warming emission/fuel economy standards rise rapidly from 2017 to 2025, reaching the equivalent of a 62 mpg standard. Fuel savings continue to accrue from 2025 to 2030 as older vehicles are replaced with more efficient models.

To calculate savings from this new policy, we relied upon modeling done by the Union of Concerned Scientists (UCS). UCS estimates that achieving a 62 mpg standard by 2025 will reduce fuel consumption by 29 billion gallons by 2025 and 43.7 billion gallons by 2030, compared to a situation in which no further improvements occur after MY2016.[139] We estimated 2020 savings by interpolating from 2016 to 2025.

We applied these savings to motor gasoline consumption in the transportation sector.

The impact of these fuel savings is split between two scenarios in this analysis—this one, and the "Deployment of Electric Vehicles" scenario described in the next section. We assigned responsibility for half of the estimated oil savings—calculated as described below—to improvements in the fuel economy of light-duty gasoline powered vehicles and the other half to increased penetration of electric vehicles. We split the savings equally on the assumption that automakers follow a variation of Path D in U.S. Environmental Protection Agency, National Highway Traffic Safety Administration and California Air Resources Board, *Interim Joint Technical Assessment Report: Light-Duty Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2017-2025*, September 2010. Path D assumes that automakers make no improvements in the performance of gasoline and diesel-powered vehicles and that all savings are achieved through widespread use of electric vehicles, reaching 14 percent of the new vehicle fleet in 2025. Our modified version of Path D reduced electric vehicles to 7 percent of the new vehicle fleet and assumed the rest of the savings came from gasoline and diesel vehicles.

We assumed that the relative savings in this scenario were the same in every state, an assumption that may overstate savings in states with more pickups and SUVs than the national average, and understate savings in states with more cars than average.

Deployment of Electric Vehicles

As discussed in the methodology for fuel economy improvements from light-duty vehicle fuel economy and global warming pollution standards, we assume that, by 2025, 7 percent of new light-duty vehicles will be electric vehicles. Beyond 2025, we assume electric vehicle sales will continue at that level in order for manufacturers to comply with the light-duty vehicle fuel economy standards, and that the progress toward plug-in vehicles continues and accelerates.

By 2030, we assume an additional 15 percent of all new vehicles sold are electric vehicles. As a result, by 2030, roughly 22 percent of new light-duty vehicles sold each year would be electric vehicles, for a total of 20 million such vehicles on the road.

Reduced motor gasoline consumption from electric vehicles put into service to comply with the light-duty vehicle fuel economy and global warming pollution standards was calculated as explained in the "Light-Duty Vehicle Fuel Economy and Global Warming Pollution Standards" scenario above. Reduced motor gasoline use from the additional 15 percent of new vehicle sales in 2030 was calculated by multiplying the number of electric vehicles on the road by gasoline consumed per gasoline-powered vehicle. We estimated the number of electric vehicles by assuming a linear ramp-up in sales between 2025 and 2030, and multiplying annual sales of new vehicles by the car survival rate.[140] Gasoline consumption in new gasoline-powered vehicles was calculated by dividing light-duty vehicle gasoline consumption by the number of vehicles in the light-duty vehicle fleet, per the EIA.

We assume that electricity consumption in electric vehicles has no impact on oil consumption in the electric sector because oil is an infrequently used fuel for electricity generation.

Energy-Saving Tires

In preparing its rule specifying how tire manufacturers must test and report the fuel efficiency of the tires they produce, the National Highway Traffic Safety Administration modeled the fuel savings that would occur if 1 percent of the light-duty vehicle replacement tires sold in the nation each year were 5 percent more efficient than current replacement tires.[141] Setting aside the 20 percent of replacement tires purchased each year that are already higher efficiency tires, the NHTSA calculated fuel savings from efficient tires after incorporating the frequency with which tires are replaced, the number of miles driven by vehicles of different ages, the differences in mileage in cars and light trucks, and an 8-year phase-in of the program.

We chose to model a scenario in which the use of energy-efficient replacement tires is required beginning in 2013. By 2020, wear and tear will have led to the replacement of all low-efficiency tires in light-duty vehicles. To estimate the savings from this approach, we multiplied the NHTSA's estimate by 100 to create a scenario in which 100 percent of replacement tires are 5 percent more efficient. We compared the fuel savings from this to the total amount of gasoline consumed in the transportation sector in 2008 to develop an estimate of how much gasoline consumption would change.[142]

Compact and Transit-Oriented Development

We assumed that a suite of planning, zoning and other policies could result in 75 percent of all new development in the nation's urbanized areas being in the form of compact or transit-oriented development. This is in between the mid-range and aggressive scenarios in the Urban Land Institute's report, *Moving Cooler*.[143] Based on the *Moving Cooler* report, we assumed that residents of these communities would drive 23 percent less on average than they would have in the absence of policy action.

We applied this 23 percent reduction to 75 percent of the vehicle-miles traveled (VMT) by new residents of urbanized areas in each of the states. To estimate the VMT of new residents, we first calculated urban per-capita VMT estimates for each of the states from the Federal Highway Administration's *Highway Statistics 2008* report. We estimated future urban per-capita VMT by multiplying the 2008 figures by the annual rate of change in VMT per driver from *AEO 2010*. We then multiplied this figure by the number of new urban residents of each state, which was estimated by multiplying the number of residents of urbanized areas in each state from *Highway Statistics* by the projected annual rate of growth of each state's population, as obtained from the U.S. Census Bureau. This estimate of VMT from new urban residents was then multiplied by the compact development multiplier (23 percent reduction in VMT on 75 percent of VMT for new urban residents) and added to estimates of VMT not subject to smart growth (VMT from pre-existing residents). This figure was then divided by projected total VMT by state to arrive at a percentage reduction in VMT resulting from compact development. All energy savings were assumed to come in the form of motor gasoline.

For states in which population is projected to rise and then decline, we held the new urban VMT constant at its peak year, thereby assuming that population declines will occur in pre-existing rather than newly built neighborhoods.

Public Transportation Improvement, Expansion and Energy Efficiency

Emission reductions from transit are based on three proposed sets of improvements in transit service—a 3.5 percent annual increase in ridership from new service; a 0.6 percent annual increase in ridership on existing services, driven by service improvements and changes in fare policies; and improvements in the energy efficiency of transit vehicles. The 3.5 percent annual ridership increase represents a doubling of transit ridership over the course of 20 years—this estimate is at the midrange of potential annual growth estimates from the Urban Land Institute's *Moving Cooler* report, although in this study we assume that all of the doubling of ridership is provided by new service.[144] The 0.6 percent annual increase is based on a target increase in ridership through service improvements of 15 percent over 20 years, based on the assumed growth in bus load factors from the *Moving Cooler* report.[145] The combined ridership increase of 4.1 percent per year is between the mid-range and most aggressive scenarios in *Moving Cooler.*

To estimate the net increase in transit ridership over and above that in the reference case, we subtracted the percentage increase in VMT from *AEO 2010* from the percentage increase in transit ridership in the policy scenario. (*AEO 2010* assumes that transit use increases at the same rate as overall VMT, see U.S. Department of Energy, Energy Information Administration, *Transportation Sector Module of the National Energy Modeling System: Model Documentation 2010*, June 2010).

While this scenario is based on a 4.1 percent annual growth rate in transit ridership, we did not assume that every transit service sees the same increase in ridership, since a doubling of ridership in transit-heavy cities such as New York is unreasonable to expect, as is a major increase in ridership in cities experiencing slow population growth. To estimate the VMT reductions that would result from this increase in ridership, we calculated the national increase in transit ridership that would result by multiplying the percentage change in ridership by urbanized area passenger-miles traveled data from the Federal Transit Administration's *National Transit Database* (NTD) (we excluded passenger-miles traveled in demand response vehicles.) We then split the increase in passenger-miles traveled among the nation's urbanized areas based on their projected share of U.S. urban population, estimated as described in "VMT Reductions from Compact and Transit Oriented Development" above.

To estimate the impact on energy consumption, we assumed, as a starting point, that increased ridership from new service would consume the same amount of fuel per passenger mile as existing transit services (with some important adjustments, see below), and that increased ridership from system improvements would consume no additional fuel. To calculate the increased energy consumption from new transit service, we calculated annual fuel use from transit per passenger mile from the NTD for 2009 by urbanized area (again excluding demand response), and assumed that this level of energy consumption per passenger mile would apply to new transit use as well.

We then applied several adjustments to this figure:

- First, we adjusted to account for the presumed acceleration of fuel-switching in transit vehicles away from diesel fuel and toward compressed natural gas. The EIA, in its *AEO 2010* forecast[146], projected that compressed natural gas will become the primary fuel used in transit buses by 2027. To account for this shift, we estimated the total amount of diesel fuel in new transit service that would be replaced by natural gas if the diesel/natural gas split in new service were to mimic the EIA forecast over the next two decades nationwide. We then allocated the reductions in diesel fuel use to states based on their share of projected consumption of diesel fuel for new transit services in our scenario and reallocated that energy consumption (on a Btu basis) to natural gas. Because our model does not differentiate between diesel fuel used in new bus service versus new train service, this method will tend to over-allocate natural gas usage to states with existing diesel-fueled commuter rail systems. However, these commuter rail fleets are also likely to experience oil savings as a result of improved energy efficiency of diesel locomotives (see "Airplane and Rail Fuel Economy Improvements," page 33), and the oil savings projected here can be seen as broadly representative of those that would result from rail energy efficiency improvements.

- Second, we incorporated the projected increased energy efficiency of transit buses in the *AEO 2010*, which was calculated by dividing the projected percentage increase in energy consumption from transit buses by the percentage increase in VMT, which *AEO 2010* uses as a proxy for transit ridership.) No increase in energy efficiency was assumed for transit systems using electricity.

- Third, for new diesel transit energy use, we applied the reductions in heavy-duty vehicle fuel consumption in the "Heavy-Duty Vehicle Fuel Economy" scenario (see page 32).

Note that this scenario does not account for potential future increases in the fuel economy of existing transit services, which are covered in the Heavy-Duty Vehicle Fuel Economy scenario.

To calculate the amount of automobile emissions reduced as a result of increased transit use, we assumed that each new mile of passenger travel via new transit service would offset 1.23 miles of vehicle travel, and that each new passenger-mile via ridership improvements on existing services would offset 0.65 miles of vehicle travel using the following assumptions:

- First, for all transit service, we assumed that 88.2 percent of transit trips would replace car trips, based on assumptions from the *Moving Cooler* report.[147]

- Second, we assumed that the car trips that would be replaced would have an average occupancy of 1.36 people per vehicle, per the 2009 National Household Travel Survey.[148]

- Finally, we assumed that new transit service would "leverage" additional reductions in vehicle travel beyond the direct replacement of vehicle travel with transit travel. This leveraging effect is well documented in transportation literature and stems from the fact that the existence of transit service spurs more compact

> land-use patterns, leads to reductions in vehicle ownership, and shifts patterns of trip-chaining, all of which reduce vehicle-miles traveled, even for trips not made by transit. We assumed a vehicle-miles traveled reduction multiplier of 1.9, based on the standard national default figure used by the American Public Transportation Association.[149] It is important to note that this leveraging effect is likely to be greater than average in areas with new rail service and less than average in areas with new bus service.

We assumed that the VMT reductions would reduce motor gasoline consumption at the same proportion as light-duty vehicle motor gasoline consumption to total motor gasoline consumption in the transportation sector.

Bicycle Commuting Strategies

Estimated VMT reductions from increased bicycle commuting were based on a presumed increase in bicycle commuting of roughly 10 percent per year beginning in 2012, achieving a 449 percent increase by 2030. The number of bicycle commuters in each state was obtained from the U.S. Census Bureau's 2009 American Community Survey. We assumed the average length of a bicycle commute to be four miles (eight miles round-trip) based on studies in Portland, Oregon, as described in Columbia River Crossing Transportation Planning Team, *Memorandum Regarding Pedestrian and Bicycle Demand Forecasts for I-5 Bridge*, 27 August 2008. We assumed that bicycle commuters would commute via bicycle on half of all workdays each year and that their trips would replace single-occupancy vehicle commutes proportionate with the share of single-occupancy vehicle commuting in each state in 2009. All 2009 commuting data were obtained from the U.S. Census Bureau's 2009 American Community Survey.

The authors judge the oil savings estimated here to be *extremely* conservative, as those emission reductions only apply to commuting trips. Improved bicycling infrastructure would likely enable replacement of other vehicle trips as well, while reducing vehicle ownership and encouraging shifts in land-use patterns, creating a similar "leveraging" effect as new transit infrastructure. The literature on these secondary impacts of bicycle infrastructure is less well developed, however, and these impacts are therefore excluded from our analysis.

High-Speed Rail

We modeled a scenario presented by the U.S. Department of Transportation (DOT) in which high-speed rail (HSR) is constructed in 11 federally designated HSR corridors (see Figure 6, page 32). The DOT envisioned a scenario in which the HSR network is supported by a strengthened intercity rail network, on which ridership increases by 20 percent, and a stronger intercity bus network, where ridership increases 3 percent annually. DOT estimates that such an improved network could produce a net reduction in light-duty vehicle motor gasoline emissions of up to 0.6 percent in 2030.[150]

The bulk of these savings come from HSR (63 percent), while intercity rail and intercity bus each account for 19 percent of the savings. We assumed that intercity bus and rail savings occur at the same rate in every state. In contrast, we assumed that HSR savings accrue to states serviced by one of the federally designated HSR corridors, and that states with larger populations will reap greater benefits. Using a map of HSR corridors, we identified the major cities that would be served.[151] We used 2009 population data for metropolitan areas from the Census Bureau, and calculated the total major metropolitan populations to be served by HSR in each state.[152] This enabled us to calculate the share of the

HSR-related savings that should be attributed to each state.

We phased in these savings beginning in 2020, with just one-third of the savings projected for 2030. Savings in 2025 were assumed to equal two-thirds of the projected 2030 savings.

Heavy-Duty Truck Fuel Economy Standards

We estimated the impact of stronger fuel economy standards for medium- and heavy-duty trucks, those that are 8,500 pounds or more. We assumed that the standards recently proposed by the National Highway Traffic Safety Administration (NHTSA) and the Environmental Protection Agency (EPA) for model years 2014 to 2018 are adopted as proposed, yielding up to 20 percent reductions in fuel use from some trucks. After model year 2018, we assumed that fuel economy standards continue to improve, using many of the technologies and approaches evaluated by the American Council for an Energy-Efficient Economy (ACEEE). [153]

The NHTSA and the EPA have proposed fuel economy and greenhouse gas emission standards for medium-duty and heavy-duty trucks for model years 2014 to 2018. The standards would reduce fuel consumption by up to 20 percent in heavy-duty combination tractors, up to 15 percent for heavy-duty pickup trucks and vans, and up to 10 percent for vocational vehicles such as garbage trucks, buses, and tow trucks.[154] The NHTSA estimates that these standards would reduce fuel use by 1.93 billion gallons by 2018, equal to cutting fuel use in medium- and heavy-duty trucks by 3.7 percent.[155]

As a fleet, medium- and heavy-duty trucks consume both motor gasoline and diesel for fuel, as well as small amounts of compressed natural gas (CNG) and liquefied petroleum gases (LPG, or propane). We assumed that the NHTSA's projected savings result in reduced motor gasoline and diesel consumption and do not affect CNG and LPG use. We divided total fuel savings between motor gasoline and diesel in proportion to their use by the medium- and heavy-duty truck fleet as projected in *AEO 2010's* Supplemental Table 46: Transportation Sector Energy Use by Fuel Type Within a Mode. This produced a percentage reduction in transportation sector motor gasoline and diesel use for 2015 and 2018.

To calculate potential fuel use after 2018, we drew upon an analysis by ACEEE.[156] We selected ACEEE's "aggressive" scenario of fuel economy improvements, which for new long-haul trucks means fuel economy standards for engines and vehicles, aerodynamic improvements, and auxiliary power units to reduce idling. Together, these changes would reduce fuel use in new long-haul trucks by 39 percent. In addition, existing long-haul trucks that travel more than 500 miles from home are also assumed to be retrofitted with auxiliary power units, and half of short-haul trucks are assumed to use hybrid-electric engines that reduce fuel use by up to 70 percent. ACEEE assumed that these improvements are introduced rapidly into the truck market, and estimated the resulting savings at 0.46 million barrels of oil per day in 2015 and 0.8 million barrels per day in 2020.

To find out what this means in terms of a percentage reduction in fuel use, we compared these savings to projected 2015 and 2020 transportation sector fuel use presented in *AEO 2005's* Supplemental Table 34: Transportation Sector Energy Use by Fuel Type Within a Mode. Because it is apparent that these standards will not be adopted on the timeline envisioned by ACEEE in its analysis and because it is likely that these same technologies have the potential to produce similar savings even if introduced at a later date, we applied ACEEE's percentage reduction in fuel use to fuel consumption in 2025 and 2030. To estimate 2020 savings, we interpolated between the NHTSA 2018 savings and ACEEE's 2025 savings.

Note that though the MY2014 to MY2018 fuel economy standards are being developed by NHTSA in conjunction with EPA's development of greenhouse gas emission standards, we focus here just on the fuel economy standards. We do not account for the possibility of fuel switching (for example, from diesel to natural gas) in heavy-duty vehicles, which is one possible means of complying with EPA emission standards.

Residential and Commercial Building Retrofits

Residential Retrofits

We calculated the impact of a residential unit energy retrofit program by estimating the total energy use that would take place in residential units built during or before 2008, assuming that the average home retrofit achieves 30 percent energy savings, applying a market penetration projection, and calculating the resulting reduction in oil consumption.

Forecast of Housing Units out to 2030

We first estimated the number of housing units in each state through 2030 using data from the U.S. Census Bureau. Using 2008 estimates of population and housing units, we calculated a ratio of residents per household by state.[157] Holding this ratio constant, we then applied population projections by state to obtain an estimate of total housing units in each state and each census division for 2015, 2020, 2025 and 2030.[158]

We assumed that residential units built during or before 2008 would be retired at a rate of 0.4 percent per year, per EIA, *Assumptions to AEO 2010*, obtaining a forecast of the number of housing units dating to 2008 or earlier by state out to 2030. Further, we assumed that all housing units built to accommodate new population or housing retirements would be newly built.

Assigning Residential Energy Use to Existing Residential Units

We assigned a portion of total residential energy use to residential units built during or before 2008 across the forecast period, assuming some improvement in energy efficiency of existing homes, using the following steps.

1) Using the EIA *Residential Energy Consumption Survey 2005*, we broke down energy use by end use for each fuel and census division.[159]

2) We combined these data with relative improvements in building envelope efficiency for existing buildings and improvements in efficiency for appliances and equipment, per *AEO 2010*, to estimate the relative improvement in energy use for an average existing home by census division.[160]

3) We then multiplied the average energy use of an existing home in each census division by the number of existing housing units by state within that census division to estimate the total energy use of existing homes by state and fuel.

4) On average, based on this methodology, existing homes in each state increase in efficiency by 9 to 13 percent between 2008 and 2030 in the absence of additional retrofit policy.

Applying the Impact of Residential Energy Retrofit Policy

To estimate the additional impact of an enhanced residential energy retrofit policy, we assumed that an average home in existence as of 2008 would see an average energy use reduction of 30 percent vs. 2008 average energy use following a retrofit. We also assumed that energy retrofits affect all energy end uses across all fuels equally. Further, we assumed that retrofit policies

Table 2: Energy Efficiency Improvement Relative to Average 2008 Housing Unit due to Residential Energy Retrofits

Year	Energy Efficiency Improvement
2015	5.6%
2020	11.3%
2025	16.9%
2030	22.5%

would be sufficient to reach 75 percent of all homes in America by 2030, with progress building evenly over time. It is likely that this assumption understates the prospect for short-term emission reductions from home retrofits, since it is likely that the least-efficient homes will be the first to be addressed by such a program.

This translates into an energy efficiency improvement across all existing homes according to the schedule in Table 2.

In each year, we calculated the difference between baseline efficiency improvement in an average home and the efficiency improvement that could be achieved with an enhanced retrofit program. We then applied this additional improvement to estimate the total energy savings that could be achieved by the policy in each year.

Commercial Retrofits

We calculated the impact of a commercial building energy retrofit program by estimating the energy use that would take place in commercial buildings built in 2008 or earlier, applying a percentage improvement in average energy use per square foot, including a market penetration trajectory, and then calculating the resulting reduction in oil consumption.

Estimating Area of Commercial Building Space by State Through 2030

To estimate the growth in commercial building space by state through 2030, we began with a 2004 Brookings Institution Metropolitan Policy Program report called *Toward a New Metropolis: The Opportunity to Rebuild America*. This report estimates of the number of commercial workers by state in 2000 and 2030, and the building space that they require. To interpolate those figures for intervening years, we assumed that the percentage of the population engaged in commercial work (determined using the Brookings Institution commercial workers data and U.S. Census Bureau population projections) would change at a steady rate between 2000 and 2030. Then, we calculated the total square footage of building space that those commercial workers would require using the Brookings Institution estimates of space requirements per worker.

We divided commercial building space into space in buildings built in 2008 or earlier and space in new buildings, assuming that buildings in existence as of 2008 would be retired at a rate of 1.37 percent per year, per the Brookings Institution report cited above. All square footage in between the total estimated building space and existing building space was assumed to be new construction.

Estimating Energy Use by Existing Commercial Buildings

We assigned a fraction of total commercial energy use to commercial buildings in existence as of 2008 across the forecast period using the following steps.

1) We assumed that the rate of energy usage per square foot in existing buildings (by state and fuel) would remain constant in the reference case over the forecast period. (Unlike in the residential sector, where EIA assumes improvements in building envelope efficiency over time, the EIA does not provide data for assessing trends in the efficiency of existing commercial structures.) Applying this rate to the amount of existing building

space in each year gave an estimated energy consumption level in existing buildings.

2) In cases where this estimate exceeded the total forecast commercial energy usage for that fuel, we capped existing building energy usage at 100 percent of the sector total. (This only occurred for fuels in relatively large flux, including distillate fuel.)

3) All additional energy use was assigned to new commercial buildings.

Estimating the Impact of Commercial Building Energy Retrofit Policy

We assume that 75 percent of commercial buildings built in 2008 or earlier receive retrofits by 2030, with an average energy efficiency improvement per square foot of 50 percent. We assume an even rate of market penetration, achieving an overall improvement in energy use per square foot according to the schedule in Table 3.

Table 3: Average Commercial Sector Building Energy Efficiency Improvement due to Energy Retrofits, Relative to Average 2008 Building

Year	Energy Efficiency Improvement
2015	9%
2020	19%
2025	28%
2030	38%

We then multiplied the new, post-policy energy use rate per square foot by the projected total area of existing commercial building space by state to obtain an estimate of the overall impact of the policy. We assumed that energy retrofits affect all energy end uses across all fuels equally.

Residential Building Energy Codes

To estimate the impact of new home building energy codes, we first determined the fraction of energy use attributable to newly built homes by subtracting energy use from homes built in 2008 or earlier (as described in the "Residential Retrofits" case above) from total reference case residential energy use. We then calculated the total energy use by fuel and by state for housing units built in the periods between 2008 and 2015, 2016 and 2020, 2021 and 2025, and 2026 and 2030.

Further, we assumed that enforcement efforts would achieve 90 percent compliance with the building code, with builders delivering business-as-usual performance 10 percent of the time. This compliance assumption follows the target set as part of the American Recovery and Reinvestment Act of 2009.[161]

Table 4 breaks down the resulting efficiency improvement by year of home construction.

In other words, all homes built between 2009 and 2015 would be 14 percent more efficient, on average, than a typical home in existence in 2008, due to building energy code policy. All homes built between 2016 and 2020 would be 36 percent more efficient, on average, and so on.

We assumed that new homes would increase in efficiency in the range of 10 to 17 percent (with results varying by census

Table 4: Average New Residential Unit Energy Efficiency Improvement by Year of Construction due to Residential Building Energy Codes, Relative to Average 2008 Unit

Year of Construction	Average Efficiency Improvement
2009-2015	14%
2016-2020	36%
2021-2025	52%
2026-2030	63%

division) from 2008 to 2030 in the absence of strengthened building energy codes, per assumptions in the *AEO 2010*.[162] Accordingly, we reduced the energy savings percentages in Table 4 by this percentage, calculated by time period and census division, to yield the additional impact of the policy.

To estimate the overall impact of the strengthened building code policy, we reduced forecast energy consumption for homes built within each of the four time periods by the percentage savings we attributed to the policy as described above. We assumed that retrofits would affect all fuel uses equally.

Energy Efficiency Improvements for Industrial Process Heat and Boiler Fuel

We estimated the savings these policies would produce by first determining, from the EIA's 2006 *Manufacturing Energy Consumption Survey (MECS)*, how much fuel was used for boiler and process heat purposes in each state.[163] We obtained this figure by calculating from the *AEO* the percentage of each industrial sector fuel that is projected to be used by the manufacturing facilities (as opposed to other activities designated by the EIA as "industrial," such as agriculture) in each year, and then calculating from the *MECS* what percentage of the manufacturing sector's usage of each fuel went towards boiler and process heating in 2005.[164] Assuming that these figures were constant within census regions, we derived a projection for how much of each major fuel would be used for these purposes in each state. In each year, we reduced the fuel's use by the targeted amount, with 15 percent savings for process heat achieved by 2025 and 19 percent reduction in boiler energy consumption by 2030.

Oil Savings from Reduced Refinery Use

Refineries—in order to break crude oil down into its fractions and fuel the cracking and recombining processes through which lower value hydrocarbons are converted into high value gasoline and diesel—consume a large amount of petroleum themselves. Fuel consumed within refineries is identified as "still gas" by the EIA and recorded as such in the *SEDS* and *AEO*. Our model assumes that, as petroleum consumption rises and falls, refinery use (and thus still gas consumption) will follow it.

We accounted for the impact of changing demand for petroleum on refinery use by reducing still gas usage in our model by the same percentage that overall petroleum products consumption (measured in Btu) fell in each given policy scenario. Emissions reductions from refinery savings were calculated only in the combined scenario, were assigned to states in proportion to the amount of refinery fuel usage in that state, and were not attributed to any particular policy.

Federal Government Energy Savings

Executive Order 13514 requires federal agencies to complete inventories of their emissions of global warming pollution. As of this writing, those inventories are not yet complete. As a result, the energy savings estimated to result from Executive Order 13514 in this analysis are based on projected changes in energy consumption based on historical energy consumption data.

This analysis omits two potential sources of emission reductions (and corresponding energy savings) resulting from Executive Order 13514:

- First, it omits savings from so-called "Scope 3" emission sources, such as vendor supply chains, employee commuting and travel. The executive order requires federal agencies to plan for reductions in Scope 3 emissions, but a baseline estimate of these emissions has not yet been developed, so estimating emission reductions from these sources is not possible.

- Second, it omits savings from improved energy efficiency of vehicles in the Department of Defense. The Defense Department's Strategic Sustainability Performance Plan calls for a 30 percent reduction in the use of petroleum products in non-tactical vehicle fleets by 2020.[165] However, it is difficult to differentiate energy use in non-tactical vehicles from use in tactical vehicles in inventories of Defense Department energy use, so these potential savings are omitted.

To estimate the emission reduction impact of the executive order, we assumed that the 28 percent reduction in global warming pollution would apply equally to all fuels used by federal agencies, that those savings would be phased in annually beginning in 2012, and that all facilities-related energy savings would be applied to the commercial sector. Baseline energy consumption figures for federal agencies were based on the most recent available data (for fiscal year 2007) from the U.S. Department of Energy.[166] Energy consumption estimates for vehicles used by the Department of Defense were subtracted from the total federal government energy consumption in vehicles, based on data from the Department of Defense.[167]

To calculate the energy savings that would be expected in the commercial sector, federal energy use was apportioned among the states based on their share of federal civilian employment.[168] We then calculated the share of overall energy use in the commercial sector that resulted from energy consumption in federal buildings. This share of commercial energy use was held constant for every year through 2030. We then applied the estimated percentage energy savings resulting from the executive order to the share of commercial energy use from federal facilities in each state. For distillate oil, whose use in the commercial sector is highly concentrated in certain states, we apportioned federal energy use among the states based on their share of overall coal and distillate fuel use in the commercial sector.

For transportation fuel savings, we used a similar method as with buildings, except that federal transportation energy use was distributed among the states based on their share of national vehicle-miles traveled.[169] (This assumption is justified by the fact that a large share of federal transportation energy use is accounted for by the U.S. Postal Service.) The only exception was with regard to transportation use of residual fuel, which is highly concentrated in a few states, and which was apportioned among the states based on their overall consumption of residual fuel for transportation.

Constructing the Combined Policy Case

The main sources of policy overlap in the policy case are in the transportation sector, where there are multiple policies that potentially affect oil consumption in light-duty vehicles. In general, the impact of policies in the light-duty vehicle sector was assumed to be multiplicative, rather than additive: for example, a simultaneous 10 percent reduction in vehicle travel and 10 percent improvement in fuel economy would yield a 19 percent reduction in emissions, not 20 percent. This principle also applies to multiple policies that reduce vehicle travel. For example, if the construction of transit-oriented development reduces overall vehicle travel by 2 percent, the remaining vehicle-travel reduction strategies (transit expansion, commute-trip reduction, pay-as-you-drive insurance, etc.) are anticipated to affect the 98 percent of vehicle travel that remains.

The transportation sector emission reductions described here also include the impacts of reduced energy use in government vehicles as part of the "Federal Government Energy Savings" case.

Notes

1 “2 percent”: BP, *BP Statistical Review of World Energy*, June 2010.

2 U.S. Department of Energy, Energy Information Administration, *Emissions of Greenhouse Gases in the United States,* downloaded from www.eia.doe.gov, 17 January 2010.

3 International emissions of carbon dioxide based on U.S. Department of Energy, Energy Information Administration, *International Energy Statistics*, downloaded from tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=90&pid=44&aid=8, 1 February 2011.

4 See note 2.

5 Thomas R. Karl, Jerry M. Melillo and Thomas C. Peterson (eds.), U.S. Global Change Research Program, *Global Climate Change Impacts in the United States,* 2009.

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Appendix:
State-by-State Oil Savings Estimates

Table A-1. Transportation Policies (million gallons saved in 2030)

	Transportation Policies										
State	Light-Duty Vehicle Fuel Economy	Electric Vehicles	Energy-Efficient Tires	Compact/ Transit-Oriented Develpment	Pay-as-You-Drive Insurance	Commute Trip Reduction	Transit Expansion & Improvement	High-Speed Rail	Heavy-Duty Vehicle Fuel Economy	Rail and Airplane Efficiency	Combined Transportation Scenario
AK	35	39	1	3	4	2	0	0	69	195	347
AL	296	327	5	8	38	18	8	9	207	31	921
AR	184	203	3	8	24	11	1	4	169	20	613
AZ	501	553	8	124	64	31	27	7	291	92	1,611
CA	1,966	2,172	32	267	252	121	156	80	870	871	6,516
CO	291	321	5	30	37	18	14	4	150	108	946
CT	157	173	3	4	20	10	11	4	72	22	460
DC	8	9	0	0	1	0	1	5	3	0	27
DE	53	58	1	4	7	3	2	1	17	2	141
FL	1,344	1,485	22	335	172	82	65	44	585	390	4,302
GA	622	687	10	74	80	38	25	25	371	73	1,929
HI	49	55	1	3	6	3	2	1	27	79	222
IA	145	160	2	0	19	9	0	2	143	15	486
ID	96	106	2	8	12	6	1	1	72	12	307
IL	448	495	7	11	57	27	37	23	351	248	1,658
IN	286	316	5	9	37	18	6	9	311	75	1,049
KS	121	134	2	3	16	7	3	2	128	19	425
KY	216	239	4	5	28	13	4	7	230	72	801
LA	266	294	4	5	34	16	9	7	201	128	943
MA	303	335	5	13	39	19	27	14	115	106	941

	Transportation Policies										
State	Light-Duty Vehicle Fuel Economy	Electric Vehicles	Energy-Efficient Tires	Compact/ Transit-Oriented Develpment	Pay-as-You-Drive Insurance	Commute Trip Reduction	Transit Expansion & Improvement	High-Speed Rail	Heavy-Duty Vehicle Fuel Economy	Rail and Airplane Efficiency	Combined Transportation Scenario
MD	352	389	6	38	45	22	21	16	151	38	1,034
ME	70	78	1	1	9	4	-2	2	45	16	222
MI	444	491	7	7	57	27	20	14	211	53	1,294
MN	272	301	4	19	35	17	12	10	314	86	1,040
MO	318	351	5	13	41	19	11	15	238	48	1,030
MS	175	194	3	2	22	11	0	3	158	34	591
MT	59	66	1	1	8	4	1	1	59	10	205
NC	659	728	11	91	85	40	21	90	295	61	1,996
ND	30	33	0	0	4	2	-5	0	50	7	124
NE	79	87	1	1	10	5	-3	1	91	12	283
NH	92	102	2	7	12	6	3	2	31	4	251
NJ	483	533	8	32	62	30	41	15	242	273	1,659
NM	115	127	2	2	15	7	1	2	106	20	390
NV	211	233	3	55	27	13	12	8	122	88	734
NY	561	619	9	2	72	34	60	38	270	158	1,762
OH	452	499	7	1	58	28	19	16	357	164	1,568
OK	205	227	3	8	26	13	4	9	294	55	828
OR	192	212	3	21	25	12	9	8	164	57	682
PA	509	563	8	5	65	31	28	23	330	119	1,639
RI	42	46	1	1	5	3	4	1	20	4	122
SC	310	343	5	20	40	19	7	8	173	24	920
SD	36	40	1	0	5	2	1	0	43	7	132
TN	339	374	6	29	43	21	8	4	290	125	1,206
TX	1,780	1,967	29	299	228	109	65	71	1,426	640	6,380
UT	156	173	3	26	20	10	3	2	128	62	563
VA	523	578	9	56	67	32	29	15	300	143	1,686
VT	39	43	1	1	5	2	-4	1	17	4	109
WA	347	383	6	55	44	21	20	12	256	186	1,286
WI	239	264	4	8	31	15	11	8	189	36	781
WV	77	85	1	0	10	5	-3	1	61	6	241
WY	37	41	1	0	5	2	0	0	93	10	187
ALL	**16,590**	**18,329**	**272**	**1,717**	**2,127**	**1,017**	**792**	**644**	**10,907**	**5,109**	**55,588**

Table A-2. Residential, Commercial, Industrial and Cross-Cutting Policies (million gallons saved in 2030)

State	Residential, Commercial and Industrial Policies							Cross-Cutting Policies	
	Residential Retrofits	Res. Bldg. Codes	Res. Appliance Stds.	Comm. Retrofits	Ind. Boiler Fuel Efficiency	Ind. Process Heat	Combined Res., Comm., and Ind. Scenario	Federal Agencies	Combined Policy Scenario
AK	4	0	0	16	0	0	20	1	409
AL	7	0	0	19	5	3	34	3	968
AR	9	2	0	7	1	1	21	1	643
AZ	5	7	0	18	1	1	32	4	1,643
CA	35	0	0	60	3	5	102	15	6,878
CO	13	2	0	11	2	3	31	2	987
CT	33	6	2	35	1	1	75	3	535
DC	0	0	0	2	0	0	2	0	29
DE	5	0	0	5	2	1	12	0	172
FL	9	9	0	59	9	3	90	12	4,391
GA	13	4	0	18	4	2	42	5	1,971
HI	1	0	0	7	0	0	8	1	247
IA	14	0	0	27	2	3	46	1	533
ID	4	2	0	7	0	0	13	1	321
IL	23	18	0	26	3	4	74	4	1,823
IN	18	15	0	27	1	1	62	3	1,155
KS	7	0	0	8	4	5	24	1	484
KY	9	0	0	11	2	3	25	2	849
LA	3	0	0	8	20	34	66	2	1,350
MA	41	8	2	42	2	1	94	3	1,035
MD	16	2	0	22	2	1	43	3	1,077
ME	19	6	1	48	11	3	87	2	309

State	Residential, Commercial and Industrial Policies							Cross-Cutting Policies	
	Residential Retrofits	Res. Bldg. Codes	Res. Appliance Stds.	Comm. Retrofits	Ind. Boiler Fuel Efficiency	Ind. Process Heat	Combined Res., Comm., and Ind. Scenario	Federal Agencies	Combined Policy Scenario
MI	35	24	0	23	2	1	85	4	1,390
MN	17	0	0	30	3	2	52	3	1,134
MO	16	0	0	24	1	1	41	3	1,071
MS	6	0	0	11	0	0	18	2	646
MT	8	0	0	6	1	0	15	1	239
NC	34	15	0	55	13	5	123	5	2,119
ND	4	0	0	7	0	0	12	0	141
NE	6	0	0	6	0	0	12	1	296
NH	19	15	1	27	2	1	64	1	315
NJ	24	4	1	35	2	1	65	5	1,778
NM	6	0	0	10	2	5	23	1	426
NV	2	3	0	6	1	1	13	1	748
NY	85	9	5	222	6	3	323	12	2,085
OH	22	11	0	36	2	2	72	5	1,689
OK	11	1	0	12	2	1	27	2	913
OR	4	0	0	11	1	1	16	2	698
PA	54	8	3	74	7	8	150	7	1,860
RI	7	1	0	9	0	0	17	1	139
SC	7	0	0	16	4	2	29	2	949
SD	4	0	0	5	0	0	10	0	141
TN	8	1	0	14	1	1	25	3	1,252
TX	32	29	0	52	124	280	516	13	7,581
UT	2	1	0	9	1	1	15	1	598
VA	25	4	1	33	9	3	74	5	1,767
VT	9	6	0	16	1	0	32	1	141
WA	12	0	0	24	1	1	38	3	1,409
WI	28	21	0	24	2	1	75	3	860
WV	4	0	0	4	2	1	11	1	254
WY	3	0	0	8	1	0	13	0	214
ALL	**783**	**236**	**18**	**1,294**	**267**	**401**	**2,970**	**157**	**60,662**

Table A-3. Oil Savings from Combined Policy Scenario

State	Reduction vs. 2008				Reduction vs. Business-as-Usual				Oil Consumption for Energy Use Total (million barrels)		
	2015	2020	2025	2030	2015	2020	2025	2030	2008	2030 Business-as-Usual	2030 with Policies
AK	0.1%	4.3%	7.3%	12.0%	1.1%	6.6%	12.2%	18.6%	48	52	43
AL	5.9%	16.5%	27.5%	39.0%	2.5%	9.9%	17.8%	27.8%	98	83	60
AR	3.6%	11.7%	19.4%	30.3%	2.2%	8.8%	16.0%	25.8%	63	59	44
AZ	-7.9%	-2.0%	1.0%	7.3%	3.1%	11.0%	19.6%	30.2%	97	129	90
CA	1.2%	15.6%	22.0%	30.9%	2.5%	9.9%	18.1%	27.6%	622	594	430
CO	3.6%	13.1%	21.2%	30.4%	2.4%	9.8%	18.0%	27.8%	88	84	61
CT	8.6%	20.7%	34.8%	45.1%	2.5%	9.8%	17.5%	26.8%	63	47	35
DC	24.8%	43.2%	57.3%	68.9%	3.0%	14.0%	25.7%	39.3%	3	2	1
DE	6.2%	19.0%	29.9%	40.2%	2.7%	9.9%	17.8%	27.1%	18	15	11
FL	-5.2%	3.3%	10.1%	17.5%	2.9%	10.9%	19.3%	29.4%	304	356	251
GA	4.0%	14.8%	24.0%	33.8%	2.8%	10.5%	18.8%	29.5%	170	159	112
HI	5.0%	12.1%	16.0%	20.3%	1.2%	5.6%	10.2%	15.1%	41	39	33
IA	6.9%	17.8%	31.5%	41.2%	2.3%	8.6%	14.8%	23.5%	70	54	41
ID	-0.5%	6.9%	13.4%	22.3%	2.4%	9.4%	17.1%	27.2%	26	28	20
IL	4.1%	16.2%	30.2%	38.4%	2.2%	9.3%	16.1%	25.0%	212	174	131
IN	4.4%	15.2%	28.2%	36.3%	2.3%	9.0%	15.5%	24.8%	131	111	83
KS	5.7%	15.7%	28.3%	36.5%	2.2%	8.3%	14.2%	22.4%	63	51	40
KY	2.7%	14.9%	24.0%	34.2%	2.2%	8.6%	15.5%	24.5%	95	82	62
LA	3.7%	13.0%	20.0%	29.8%	2.0%	7.6%	13.7%	20.8%	174	154	122
MA	6.5%	18.1%	31.7%	41.4%	2.4%	9.9%	17.7%	26.9%	114	92	67
MD	1.2%	15.3%	27.1%	38.4%	3.0%	11.3%	20.5%	31.6%	90	81	56

State	Reduction vs. 2008				Reduction vs. Business-as-Usual				Oil Consumption for Energy Use Total (million barrels)		
	2015	2020	2025	2030	2015	2020	2025	2030	2008	2030 Business-as-Usual	2030 with Policies
ME	6.7%	17.2%	29.3%	38.8%	2.7%	9.2%	16.1%	24.3%	37	30	23
MI	3.2%	18.0%	35.7%	45.6%	2.6%	10.5%	18.5%	28.6%	152	115	82
MN	2.7%	11.7%	23.7%	31.6%	2.4%	9.1%	15.6%	24.7%	121	109	82
MO	7.3%	18.8%	33.5%	42.7%	2.5%	10.0%	17.5%	27.5%	117	93	67
MS	6.2%	16.5%	30.6%	39.8%	2.3%	9.4%	16.5%	26.3%	72	58	43
MT	3.8%	13.0%	21.8%	31.7%	2.0%	7.8%	14.3%	23.0%	28	25	19
NC	1.9%	13.4%	23.3%	33.2%	3.0%	11.5%	20.8%	32.0%	161	158	107
ND	9.6%	18.4%	28.8%	37.2%	1.7%	6.6%	11.2%	18.3%	24	18	15
NE	7.3%	16.9%	28.9%	37.3%	2.0%	8.0%	13.8%	22.3%	39	32	25
NH	2.8%	12.6%	25.1%	33.9%	2.8%	10.4%	18.3%	27.6%	30	27	20
NJ	4.2%	14.5%	24.4%	34.9%	2.2%	9.1%	16.3%	24.4%	201	173	131
NM	2.4%	12.2%	21.8%	33.4%	2.4%	9.0%	16.2%	25.9%	44	39	29
NV	-10.1%	-6.0%	-3.0%	3.7%	2.7%	10.4%	18.5%	28.4%	47	63	45
NY	9.0%	21.1%	32.1%	43.0%	2.5%	9.5%	16.9%	25.3%	257	196	146
OH	6.1%	19.2%	34.2%	43.3%	2.3%	9.6%	16.7%	26.3%	199	153	113
OK	5.1%	14.4%	21.0%	31.1%	2.2%	8.5%	15.4%	25.1%	94	87	65
OR	4.3%	16.5%	20.9%	29.0%	2.5%	9.5%	17.3%	27.3%	62	61	44
PA	8.4%	20.1%	31.1%	42.6%	2.4%	9.5%	17.0%	26.1%	219	170	126
RI	4.9%	18.0%	33.7%	45.1%	2.8%	10.4%	18.3%	28.1%	15	12	9
SC	5.9%	18.7%	29.4%	40.0%	2.8%	10.6%	19.2%	30.2%	87	75	52
SD	9.5%	19.6%	31.8%	40.3%	2.0%	8.0%	13.8%	22.3%	20	15	12
TN	0.5%	12.5%	21.0%	30.7%	2.4%	9.6%	17.2%	26.8%	118	111	82
TX	-1.6%	3.6%	7.0%	13.9%	2.4%	8.5%	15.1%	22.9%	707	789	609
UT	3.8%	9.6%	14.5%	21.3%	2.4%	9.4%	17.0%	26.8%	49	53	39
VA	1.4%	12.8%	22.3%	32.1%	2.6%	10.0%	18.1%	28.2%	158	149	107
VT	3.2%	13.7%	26.5%	35.9%	2.6%	9.6%	17.0%	25.8%	15	13	10
WA	3.6%	14.3%	18.3%	24.8%	2.4%	9.2%	16.8%	25.9%	128	130	96
WI	3.7%	15.7%	30.2%	39.0%	2.4%	9.4%	16.3%	25.7%	97	80	59
WV	9.1%	22.3%	33.8%	45.1%	2.1%	8.1%	14.8%	23.9%	35	25	19
WY	5.7%	12.9%	20.6%	30.6%	1.8%	6.5%	11.8%	20.2%	29	25	20
ALL	**2.8%**	**13.2%**	**22.3%**	**31.3%**	**2.5%**	**9.5%**	**16.9%**	**26.1%**	**5,954**	**5,534**	**4,090**