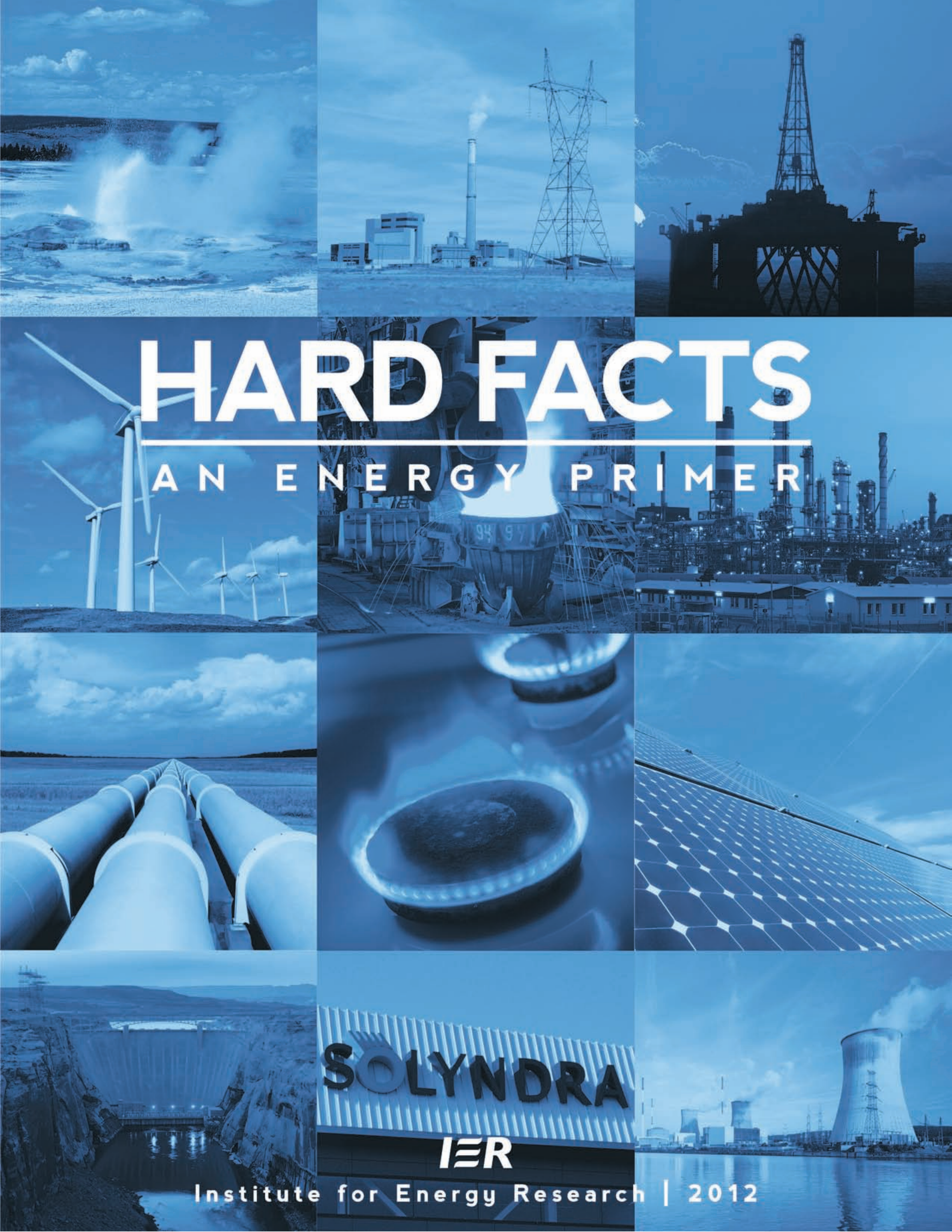

HARD FACTS

AN ENERGY PRIMER

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Institute for Energy Research | 2012

TABLE OF CONTENTS

AFFORDABLE, RELIABLE ENERGY IS ESSENTIAL TO THE ECONOMY

Affordable, reliable energy is essential to the economy because energy powers everything that makes modern life possible. It heats our homes, lights the night, fuels our transportation, and powers our machines. Put simply, energy makes our lives better.

Affordable energy makes the economy more efficient, lowers the cost of goods, and saves us money. More importantly, affordable energy allows us to spend more time with our families and friends and less time merely working to survive. Moreover, by making transportation less costly, affordable energy gives us greater freedom to live, work, and play how and where we want.

Affordable and abundant energy is a crucial component of a strong economy. Low domestic energy prices help keep jobs at home by lowering the cost of producing goods and services in the United States.

There are, however, a number of challenges to maintaining a sufficient supply of affordable energy. Seemingly every year there is a new energy bill in Congress that alleges to fix our energy problems. The premise of these bills is often fatally flawed resulting in the cry for a new national energy policy practically every year.

Energy policy would be greatly improved if policymakers took into account the actual energy landscape. Far too often, energy bills are based on incorrect assumptions, such as the notion that new, revolutionary technologies, such as affordable cellulosic ethanol, are just around the corner if only the federal government provides the energy industry sufficient mandates and subsidies. Time after time, experience has shown that the government cannot force new technologies to market.

Policymakers should take time to understand the facts about energy and the obstacles to making it affordable and reliable given its critical role in our lives and our economy. America is home to vast natural resources, but many of our energy policies are built on the notion that energy is scarce and becoming more scarce. The reality is that we have more combined oil, coal, and natural gas resources than any other country on the planet. We have enough energy resources to provide reliable and affordable energy for decades, even centuries to come. The only real question is whether we will have access to our abundant energy resources, not whether sufficient resources exist.

BASIC ENERGY FACTS

Fossil Fuel Facts

- In 2011, the United States produced 23.0 trillion cubic feet of natural gas,[1] making it the world's largest natural gas producer.[2]
- In 2011, the United States produced 5.67 million barrels of oil, making it the world's third largest oil producer.[3]
- Proved conventional oil reserves worldwide more than doubled from 642 billion barrels in 1980 to more than 1.3 trillion barrels in 2009.[4]
- The United States is home to the richest oil shale deposits in the world—estimates are there are about 1 trillion barrels of recoverable oil in U.S. oil shale deposits, nearly four times that of Saudi Arabia's proved oil reserves.[5]
- The United States has 261 billion tons of coal in its proved coal reserves. These are the world's largest coal reserves and over 27 percent of the world's proved coal reserves.[6]
- The United States produces nearly 1.1 billion short tons of coal a year, making it the world's second largest coal producer.[7] China produces over 3.5 billion short tons a year.
- The United States has 486 billion tons of coal in its demonstrated reserve base, enough domestic coal to use for the next 485 years at current rates of consumption. These estimates do not include Alaska's coal resources, which according to government estimates, are larger than those in the lower 48 states.[8]
- The federal government leases less than 3 percent of federal lands for oil and natural gas production—2.2 percent of federal offshore areas[9] and less than 5.4 percent of federal onshore lands.[10]
- The world could hold more than 700 quadrillion (700,000 trillion) cubic feet of methane hydrates—more energy than all other fossil fuels combined.[11]

Renewables and Nuclear

- In 2011, wind power produced 1.2 percent of the energy used in the United States.[12]
- In 2011, solar power produced 0.1 percent of the energy used in the United States.[13]
- Total federal subsidies in fiscal year 2007 were $24.34 per megawatt hour for solar-generated electricity and $23.37 per megawatt hour for wind, compared with $1.59 for nuclear, $0.67 for hydroelectric power, $0.44 for conventional coal, and $0.25 for natural gas and petroleum liquids.[14] In fiscal year 2010, the subsidies were even higher. For solar power, they were $775.64 per megawatt hour, for wind $56.29, for nuclear $3.14, for hydroelectric power $0.82, for coal $0.64 and for natural gas and petroleum liquids $0.64.[15]
- In 2011, hydroelectric power contributed 3.3 percent of the energy used in the United States and 7.9 percent of the electricity.[16]
- Today, there are 104 nuclear reactors in the United States and construction began for all of these reactors prior to 1974.[17]

Energy Efficiency and Environmental Indicators

- Since 1970, the six so-called "criteria pollutants" have declined by 63 percent, even though the generation of electricity from coal-fired plants has increased by over 180 percent, gross domestic product has increased by 204 percent, energy consumption has increased by 40 percent, and vehicle miles traveled have increased by 168 percent.[18]

- Energy use per person in the United States fell 12 percent between 1979 and 2010 from 359 million BTUs to 317 million BTUs per person.[19]

- Energy intensity—energy consumption per dollar of GDP—fell by 52 percent between 1973 and 2011.[20]

- In 2010, China was responsible for 24 percent of global carbon dioxide (CO2) emissions. In comparison, the United States, the second largest emitter of carbon dioxide, emitted 17 percent of the global total.

- China's CO2 emissions increased by 167 percent between 1999 and 2009, while CO2 emissions from the United States decreased by 4.4 percent over the same 10-year period.[21]

1 *Energy Information Administration, Monthly Energy Review, Table 4.1, http://www.eia.gov/totalenergy/data/monthly/pdf/sec4_3.pdf*

2 *BP, Statistical Review of Energy 2011, p. 22, http://www.bp.com/assets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/statistical_review_of_world_energy_full_report_2011.pdf.*

3 *Energy Information Administration, Monthly Energy Review, Table 3.1, http://www.eia.gov/totalenergy/data/monthly/pdf/sec3_3.pdf*

4 *Energy Information Administration, International Energy Statistics: Crude Oil Proved Reserves, http://tonto.eia.doe.gov/cfapps/ipdbproject/iedindex3.cfm?tid=5&pid=57&aid=6&cid=regions&syid=1980&eyid=2010&unit=BB.*

5 *Task Force on Strategic Unconventional Fuels, Development of America's Strategic Unconventional Fuels Resources—Initial Report to the President and the Congress of the United States (Sept. 2006), p. 5, http://www.fossil.energy.gov/programs/reserves/npr/publications/sec369h_report_epact.pdf; US Geological Survey, Oil Shale and Nahcolite Resources of the Piceance Basin, Colorado p. 1, Oct. 2010, http://pubs.usgs.gov/dds/dds-069/dds-069-y/. The Task Force on Strategic Unconventional Fuels estimated that U.S. oil shale resources were 2.1 trillion barrels. In 2010, the USGS estimated that in-place resources in the Piceance Basin were 50 percent larger than previously estimated (1.5 trillion barrels versus 1.0 trillion barrels). The addition of these 0.5 trillion barrels makes U.S. in-place oil shale resources a total of 2.6 trillion barrels. Previous estimates put the total economically recoverable oil shale resources at 800 billion barrels. Assuming the same rate of recovery for these additional 0.5 trillion barrels brings the total recoverable resources to 982 billion barrels of oil resources.*

6 *Energy Information Administration, International Energy Statistics, http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=1&pid=7&aid=6*

7 *Energy Information Administration, International Energy Statistics-Coal-Production, http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=1&pid=7&aid=1&cid=regions&syid=2000&eyid=2010&unit=TST.*

8 *Energy Information Administration, Annual Energy Review 2010, Table 4.11, http://www.eia.gov/totalenergy/data/annual/pdf/sec4_23.pdf a U.S. Geological Survey, Alaska Coal Geology, Resources, and Coalbed Methane Potential, Nov. 2005, http://pubs.usgs.gov/dds/dds-077/.*

9 *See Bureau of Ocean Energy Management, Regulation and Enforcement, Offshore Energy and Minerals Management, http://www.boemre.gov/offshore/. According to the administration's website, the outer continental shelf is 1.76 billion acres (http://www.boemre.gov/ld/PDFs/GreenBook-LeasingDocument.pdf page 1) and only 38 million acres are leased (Department of Interior, Oil and Gas Lease Utilization – Onshore and Offshore, http://www.doi.gov/news/pressreleases/loader.cfm?csModule=security/getfile&pageid=239255 page 4). That is a mere 2.16% of the entire Outer Continental Shelf.*

10 *According to the Department of Interior, 38 million acres of onshore lands are leased for oil and natural gas production. See Table*

3 in Department of Interior, Oil and Gas Lease Utilization – Onshore and Offshore, http://www.doi.gov/news/pressreleases/loader.cfm?csModule=security/getfile&pageid=239255 According to the Congressional Research Service, the federal government owns just over 650 million acres of land. See Appendix A. Congressional Research Service, Major Federal Land Management Agencies: Management of Our Nation's Lands and Resources, May 15, 1995, http://www.ncseonline.org/nle/crsreports/natural/nrgen-3.cfm. The federal government also controls an additional 58 million acres of federal mineral estate below privately owned surface estate. See Bureau of Land Management, Split Estate, http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS__REALTY__AND_RESOURCE_PROTECTION_/bmps.Par.98100.File.dat/SplitEstate08finalWeb.pdf.

11 *U.S. Geological Survey, Natural Gas Hydrates-Vast Resource, Uncertain Future, http://pubs.usgs.gov/fs/fs021-01/fs021-01.pdf and Department of Interior, Gas Hydrates on Alaska's North Slope Hold One of Nation's Largest Deposits of Technically Recoverable Natural Gas , Nov.12, 2008, http://www.doi.gov/archive/news/08_News_Releases/111208.html.*

12 *Energy Information Administration, Monthly Energy Review, http://www.eia.gov/mer/pdf/pages/sec1_7.pdf*

13 *Id.*

14 *Energy Information Administration, Federal Financial Interventions and Subsidies in Energy Markets 2007- Chapter 5: Electricity Subsidies Per Unit of Production (April 2008), p. 106, http://www.eia.doe.gov/oiaf/servicerpt/subsidy2/pdf/chap5.pdf. See also Institute for Energy Research, Subsidizing American Energy: A Breakdown By Source, July 30, 2008, http://www.instituteforenergyresearch.org/2008/07/30/energy-subsidies-study/.*

15 *Energy Information Administration, Direct Federal Financial Interventions and Subsidies in Energy in Fiscal Year 2010, July 2011, http://www.eia.gov/analysis/requests/subsidy/pdf/subsidy.pdf and http://www.instituteforenergyresearch.org/2011/08/03/eia-releases-new-subsidy-report-subsidies-for-renewables-increase-186-percent/*

16 *Energy Information Administration, Monthly Energy Review, http://www.eia.gov/mer/pdf/pages/sec1_7.pdf and http://www.eia.gov/totalenergy/data/monthly/pdf/sec7_5.pdf*

17 *Matthew L. Wald, Nuclear 'Renaissance' Is Short on Largess, NEW YORK TIMES, Dec. 7, 2010, http://green.blogs.nytimes.com/2010/12/07/nuclear-renaissance-is-short-on-largess/.*

18 *Environmental Protection Agency, Air Quality Trends, http://www.epa.gov/airtrends/aqtrends.html.*

19 *Energy Information Administration, Annual Energy Review p. 13, Table 1.5, http://www.eia.gov/totalenergy/data/annual/pdf/sec1_13.pdf*

20 *Energy Information Administration, Monthly Energy Review, http://www.eia.gov/totalenergy/data/monthly/pdf/sec1_16.pdf*

21 *Energy Information Administration, International Energy Statistics, http://tonto.eia.doe.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=90&pid=44&aid=8.*

A BRIEF HISTORY OF ENERGY USE IN THE UNITED STATES

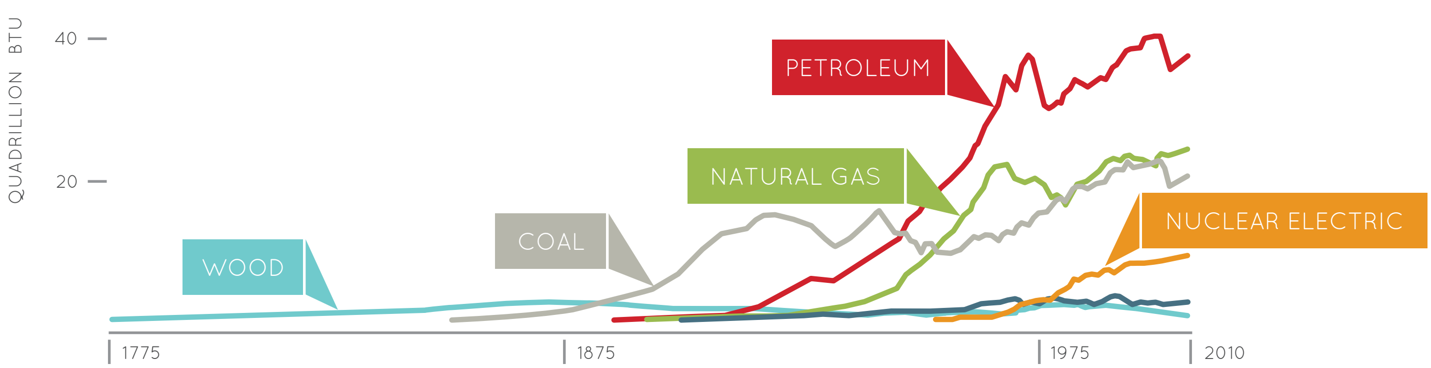
We use energy because it makes our lives better. Our prehistoric ancestors used fire for cooking, light, and warmth. During colonial times, people used renewable energy almost exclusively, harnessing energy from animal labor, watermills, windmills, and wood. In fact, wood energy was the dominant source of energy in the United States until the late 1800s when energy from coal entered the picture.[1]

Energy from wood, wind, and water power started the Industrial Revolution, but by 1885, coal took over as the dominant fuel. The energy demands of the late Industrial Revolution were prodigious—America's energy use quadrupled between 1880 and 1918, fueled largely by coal.[2]

Among its many uses, coal fueled blast furnaces, generated steam in steam engines, heated homes, and (after being turned into gas) illuminated streets and homes. By the end of World War I, coal produced 75 percent of the energy used in the United States.

With the advent of the automobile, coal use began to decline as America's dominant source of energy. Petroleum was first used for lighting and as an ingredient in medicines, but as automobile use greatly increased, petroleum use grew along with it. By 1950, petroleum surpassed coal, and became the largest source of energy in the United States.[3]

PRIMARY ENERGY CONSUMPTION BY SOURCE 1775-2010



SOURCE: ENERGY INFORMATION ADMINISTRATION, UNITED STATES ENERGY HISTORY, AUG. 19, 2010, HTTP://WWW.EIA.GOV/TOTALENERGY/DATA/ANNUAL/PDF/SEC1_8.PDF

As petroleum use grew, so too grew the use of natural gas. As with petroleum, the first major use of natural gas was for lighting. But when electricity became a safer source of illumination than coal-gas, petroleum, or natural gas, the natural gas industry was forced to look for other markets. As a result, natural gas started to be used for household heating, industrial heating, cooking, and making electricity. In the late 1950s, natural gas use surpassed coal use.[4] Coal use continues to remain strong, however, because it is the dominant fuel source for electricity production.

America has a long history of harnessing power from water. In Colonial America, water was used to power mills that ground grain, wove fabric, and made paper. In the late 1800s, water was used as one of the first important sources of electricity production, and hydroelectric power was born.[5]

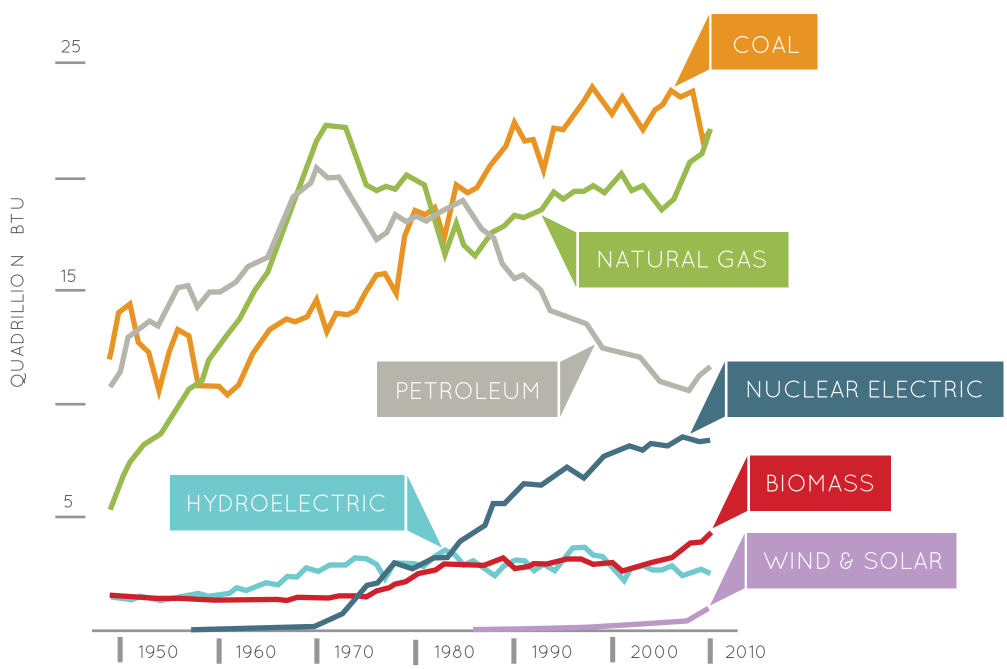
Nuclear electric power is the newest source of electricity generation and was first produced in 1957. The amount of nuclear electric power has grown steadily over time, but the rate of growth has leveled off in recent years. Today there are 104 nuclear reactors in the United States, and ground was broken for all of them before 1974.[6] The recent growth in nuclear electric power is the result of capacity upgrades at existing nuclear plants.

In the past few decades, there has been a strong political push to return to renewable energy. Solar and wind have proved to be expensive sources of energy and so far have not lived up to the economic promises of their proponents. Since at least the 1980s, wind and solar advocates have claimed that these technologies would be affordable in just a few years if they continued to receive subsidies.[7] Despite decades of subsidies and special treatment, wind and solar continue to be far more expensive than other sources of energy.[8] Even with these subsidies and mandates, wind and solar still provide very little of our energy needs. In 2011, for example, wind and solar combined to produce a mere 1.3 percent of the energy used in the United States.

The American taxpayer does not get much of a bang for its subsidy buck with renewable energy subsidies. Renewable energy subsidies were 49 times greater than fossil fuel subsidies when comparing the amount of energy produced per dollar of subsidy.[9] In 2009, renewables received a 77 percent share of total federal energy incentives, while fossil fuels received a 13 percent share but produced more than 7 times the energy. This is not to say that oil, coal, or natural gas should receive subsidies, but they do produce much more energy per dollar of subsidy received.

Since 1950, Americans have consumed energy from a wide variety of sources. The following chart shows how the pattern of U.S. energy consumption has changed over the past 60 years:[10]

PRIMARY U.S. ENERGY PRODUCTION BY MAJOR SOURCE 1949—2010



SOURCE: ENERGY INFORMATION ADMINISTRATION, UNITED STATES ENERGY HISTORY, AUG. 19, 2010, HTTP://WWW.EIA.GOV/TOTALENERGY/DATA/ANNUAL/PDF/SEC1_8.PDF.

1 *Energy Information Administration, United States Energy History, Aug. 19, 2010, http://www.eia.doe.gov/emeu/aer/eh/eh.html.*

2 *Id.*

3 *Id.*

4 *Id.*

5 *Id.*

6 *Matthew L. Wald, Nuclear 'Renaissance' Is Short on Largess, NEW YORK TIMES, Dec. 7, 2010, http://green.blogs.nytimes.com/2010/12/07/nuclear-renaissance-is-short-on-largess/.*

7 *Energy Information Administration, Annual Energy Review 2009, p. 8, http://www.eia.doe.gov/aer/pdf/aer.pdf.*

8 *Robert L. Bradley, Jr., Will renewable become cost-competitive anytime soon?, Apr. 1, 2009, http://www.instituteforenergyresearch.org/2009/04/01/will-renewables-become-cost-competitive-anytime-soon-the-siren-song-of-wind-and-solar-energy/.*

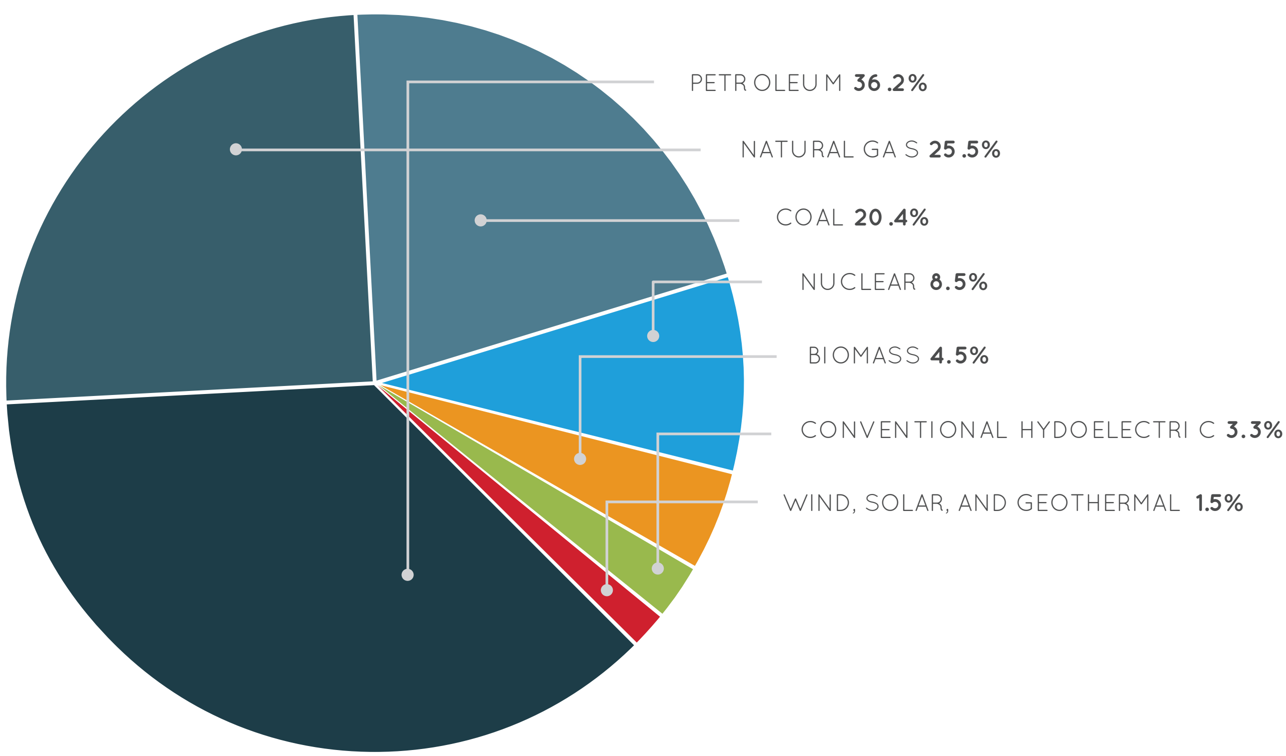
9 *See Institute for Energy Research, Levelized Cost of New Electricity Generating Technologies, Feb. 2, 2010, http://www.instituteforenergyresearch.org/pdf/Levelized%20Cost%20of%20New%20Electricity%20Generating%20Technologies.pdf.*

10 *Institute for Energy Research, On a Btu Basis, Renewable Subsidies are 49 Times Greater than Fossil Fuel Subsidies, Jun. 10, 2011, http://www.instituteforenergyresearch.org/2011/06/10/on-a-btu-basis-renewable-subsidies-are-49-times-greater-than-fossil-fuel-subsidies/.*

WHAT POWERS THE UNITED STATES

The United States uses energy from an array of sources. Petroleum, the vast majority of which is used as a transportation fuel, is our largest source of energy, followed by natural gas, coal, nuclear, biomass, hydroelectric, and the other sources (wind, solar, geothermal).

U.S. ENERGY CONSUMPTION
BY SOURCE 2011

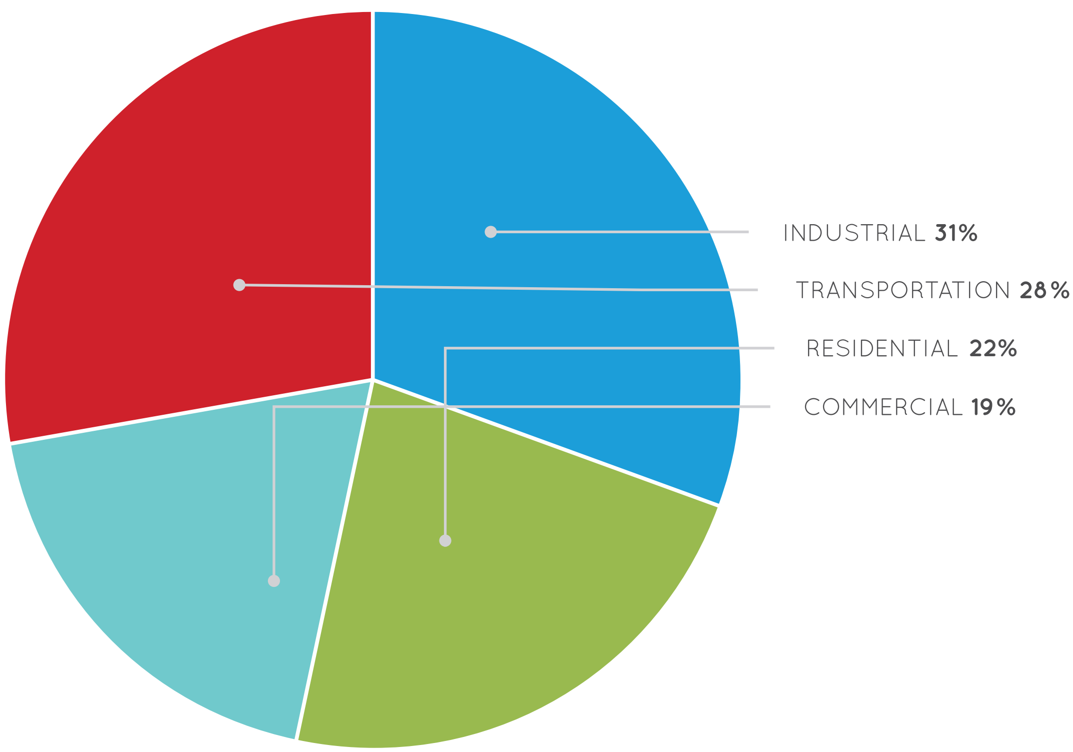


SOURCE: EIA, MONTHLY ENERGY REVIEW, MARCH 2012, TABLE 1.3
PRIMARY ENERGY CONSUMPTION BY SOURCE (QUADRILLION BTU), 7
HTTP://WWW.EIA.GOV/TOTALENERGY/DATA/MONTHLY/PDF/MER.PDF

Energy Consumption

Energy is generally used in four sectors—residential, transportation, industrial, and commercial. Policies that affect the price and use of energy affect all four sectors.

END-USE SECTOR SHARES
OF TOTAL CONSUMPTION 2011

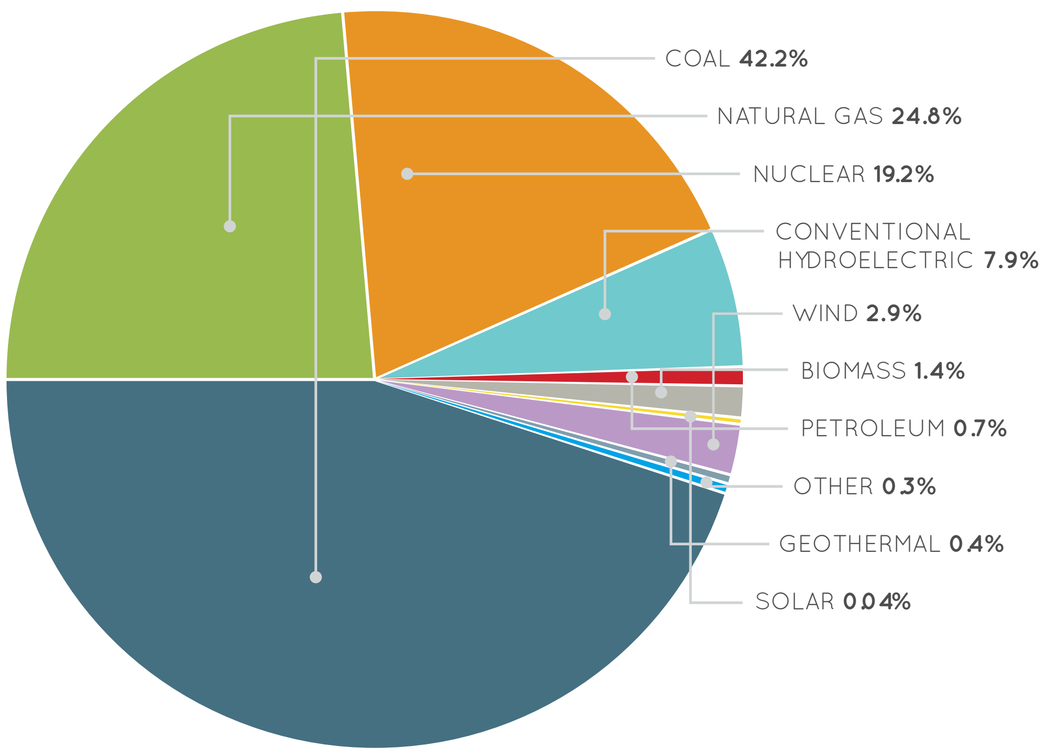


SOURCE: EIA, MONTHLY ENERGY REVIEW, MARCH 2012
HTTP://WWW.EIA.GOV/TOTALENERGY/DATA/MONTHLY/PDF/SEC2_3.PDF

Sources of Electricity Generation

Electricity in the United States is generated from a wide variety of sources, shown in the graph below. Coal produces 42 percent of our electricity, natural gas produces 25 percent, nuclear 19 percent, and hydroelectric another 8 percent. The remaining 6 percent comes from a variety of smaller sources such as biomass, geothermal, wind, petroleum and solar power.

U.S. ELECTRIC POWER INDUSTRY
NET GENERATION 2011



SOURCE: EIA, MONTHLY ENERGY REVIEW, MARCH 2012, TABLE 7.2A ELECTRICITY NET GENERATION. HTTP://WWW.EIA.DOE.GOV/TOTALENERGY/DATA/MONTHLY/PDF/MER.PDF

OVERVIEW OF ENERGY SOURCES

Rational energy policy should be based on energy facts, not on wishes or hopes. Too often, debates about energy are steeped in misinformation and misdirection instead of hard facts. Americans have been told for decades that we are running out of energy and that we are energy poor, but the reality is that we are an energy rich country.

For example, how many people know that the United States has the largest combined reserves of coal, oil, and natural gas of any country on earth?[1]

How many people know that the United States is the world's third largest oil producer?

How many people know that increasing nuclear power would not reduce our oil imports? Less than one percent of our electricity is generated from petroleum.

How many people know that the United States leads the world in natural gas production?

How many people know that the United States leads the world in consumption of non-hydro renewables (wind, solar, biomass)?[2]

Sound energy policy should reflect reality. The only way policies can reflect reality is if we understand where our energy comes from, how much it costs, and how reliable its sources are. The following describes the most important facts about our energy sources in order of their market share.

1 *Gene Whitney et. al, U.S. Fossil Fuel Resources: Terminology, Reporting, and Summary, Congressional Research Service, Nov. 30, 2010, http://www.instituteforenergyresearch.org/wp-content/uploads/2011/07/CRS-US-Fossil-Fuel-Resources.pdf.*

2 *Institute for Energy Research, BP Statistical Report Shows U.S. Largest Non-Hydro Renewable User in the World, Jun. 13, 2011, http://www.instituteforenergyresearch.org/2011/06/13/bp-statistical-report-shows-u-s-largest-non-hydro-renewable-user-in-the-world/.*

PETROLEUM

- Petroleum provides more than 35 percent of our total energy.[1]
- However, petroleum generates less than 1 percent of our electricity.
- In 2011, the United States produced 5.67 million barrels per day of oil (7.86 million barrels per day including natural gas plant liquids), making it the world's third largest oil producer.
- The U.S. has 1.44 trillion barrels of technically recoverable oil resources, enough to power America for the next 210 years at current rates of consumption.[2]
- The United States has almost 1 trillion barrels of recoverable oil in oil shale deposits. This is almost four times greater than Saudi Arabia's proved oil reserves.
- The federal government leases less than 2.2 percent of federal offshore areas and less than 6 percent of federal onshore lands for oil and natural gas production.

Oil is the most-used energy source in the United States because it is our primary transportation fuel. Petroleum is used to make both gasoline and diesel, which combine to supply 93 percent of our transportation fuels.[3] The use of petroleum is ubiquitous because it is energy-dense, easily transportable, and thus available nearly everywhere.

One hundred years ago, it was not obvious that petroleum would be our most-used energy source. At the time, there were a number of competing sources of energy for horseless carriages, including electricity, steam, ethanol, kerosene, coal oil, and gasoline. In 1910, for example, the New York Times declared that the electric car "has long been recognized as the ideal solution" because it "is cleaner and quieter" and "much more economical."[4] In 1925, Henry Ford told a New York Times reporter that ethanol was "the fuel of the future."[5] But over time, both the New York Times and Henry Ford were proven wrong, and petroleum emerged because it was more efficient and easily transported than ethanol.

Although petroleum is the most-used source of energy for transportation, it is seldom-used for electricity generation. Less than one percent of American electricity is generated from petroleum power plants because other sources of electricity are more cost-effective.

World and U.S. Oil Production

America's largest source of oil is America itself—52.5 percent of the petroleum we consumed in 2011 came from U.S. domestic sources.[6] The United States is the third largest oil-producing nation in the world, behind only Saudi Arabia and Russia.[7]

The top oil-producing states, in order of their volume, are Texas, Alaska, California, North Dakota, Louisiana, and Oklahoma.[8] In 2011, the United States domestically produced over 50 percent of the crude oil and refined petroleum products that it used.[9] The United States imported (on a net basis: imports minus exports) 8.4 million barrels of oil per day, about 45 percent of consumption.[10]

TOP TEN WORLD OIL PRODUCERS 2010

COUNTRY	THOUSAND BARRELS PER DAY
SAUDI ARABIA	10,521
RUSSIA	10,146
UNITED STATES	**5,673**
CHINA	4,273
IRAN	4,252
CANADA	3,483
MEXICO	2,983
UNITEDARAB EMIRATES	2,813
BRAZIL	2,719
NIGERIA	2,458

SOURCE: ENERGY INFORMATION ADMINISTRATION, WWW.EIA.DOE.GOV/IPM/SUPPLY.HTML

America's Oil Imports

Oil import statistics can be cited on a net basis (because the United States both imports and exports oil) or on a gross basis. For example, in 2011 the United States imported 11.36 million barrels a day of crude oil and petroleum products, and exported 2.92 million barrels a day, for net oil imports of 8.44 million barrels a day. On a net basis, we imported 45 percent of the oil we use. In 2011, on a gross basis, we imported 60 percent of the petroleum products we consumed.

The United States imports oil from a variety of countries. By far the largest foreign oil source is Canada, followed by Mexico, Saudi Arabia, Venezuela, and Nigeria.

Approximately 24 percent of our oil product supply in 2011 was imported from the Organization of Petroleum Exporting Countries (OPEC).[11] OPEC is comprised of twelve oil-exporting countries: Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, and Venezuela.

Non-OPEC countries supplied the other 36 percent of U.S. petroleum imports. These non-OPEC countries include Brazil, Canada, Colombia, Mexico, Netherlands, Norway, Russia, the United Kingdom, U.S. Virgin Islands, and others.[12]

TOP 5 SOURCES OF U.S. PETROLEUM IMPORTS

COUNTRY	BARRELS PER DAY
CANADA	2,706,000
MEXICO	1,205,000
SAUDI ARABIA	1,195,000
VENEZUELA	944,000
NIGERIA	817,000

SOURCE: EIA, MONTHLY ENERGY REVIEW, MARCH 2012
HTTP://WWW.EIA.DOE.GOV/TOTALENERGY/DATA/MONTHLY/#PETROLEUM

A Very Limited Leasing of Federal Lands for Oil & Natural Gas Production

One reason we import more than half of our oil (on a gross basis) is because of federal policies. The United States is an energy-rich country, but large quantities of U.S. energy resources are on federal lands. The federal government owns 28 percent of the land in the United States, and a majority of the land in the energy-rich western states.[13] The federal government also controls oil and natural gas leasing on the Outer Continental Shelf (OCS)—the submerged area between land and the deep ocean.

Developing oil and natural gas production on federal lands is becoming more difficult and time consuming. As a result, oil production is decreasing in the federally-controlled offshore areas and Alaska, but increasing on state and privately-controlled onshore areas.[14]

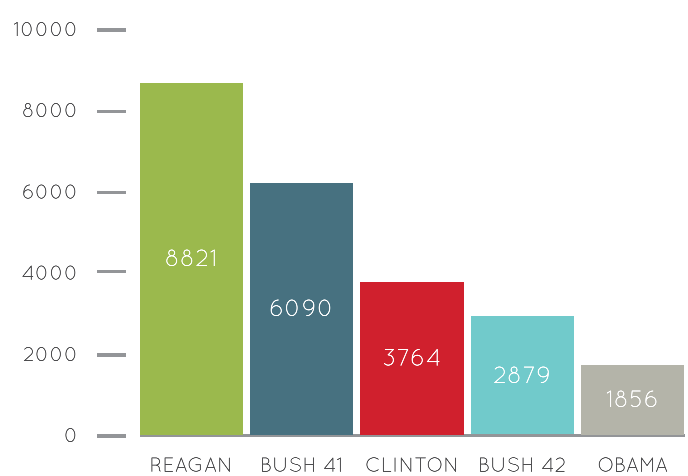
Furthermore, the federal government offers very little of that land for energy production. In fact, the federal government leases less than 2.2 percent of federal offshore areas[15] and less than 6 percent of federal onshore lands for oil and gas production.[16] If additional lands were leased, more domestic energy production could be pursued.

In 2009, the Obama administration leased fewer onshore acres for energy development than in any other year on record.[17] But the declining trend did not begin with the Obama administration. For example, President Bush leased less land than President Clinton.[18] The next graph shows the decline in federal lands leased by the Bureau of Land Management since the 1980s.[19]

Part of the reduction in area offered for lease occurred because in 1982, Congress banned the development of oil and natural gas resources on most of the Outer Continental Shelf. America's OCS encompasses 1.76 billion acres of submerged, taxpayer-owned lands, with over 97 percent of these offshore lands not leased for energy exploration and development.[20]

The Bureau of Ocean Energy Management (BOEM), an agency of the U.S. Department of Interior,

AVERAGE NUMBER OF ONSHORE LEASES ISSUED DURING EACH ADMINISTRATION



SOURCE: HTTP://WWW.BLM.GOV/PGDATA/ETC/MEDIALIB/BLM/WO/MINERALS_REALTY_AND_RESOURCE_PROTECTION_/ENERGY/OIL__GAS_STATISTICS/FY_2011.PAR.19679.FILE.DAT/CHART_2011_03.PDF
THE AVERAGE FOR EACH ADMINISTRATION INCLUDES THE FISCAL YEARS WHERE THERE IS OVERLAP. FOR EXAMPLE, FY 2009 IS USED IN THE CALCULATION FOR BOTH BUSH 42 AND OBAMA

estimates that the OCS contains 86 billion barrels of technically recoverable oil (over 12 years of supply at current consumption rates) and 420 trillion cubic feet of technically recoverable natural gas (over 18 years of supply at current consumption rates).[21] The Congressional prohibition was reinforced by a presidential moratorium instituted in 1990 by President George H.W. Bush. These moratoria made the United States the only developed country in the world that banned access to its own offshore energy sources.

The moratoria remained in place until the price of oil rose to more than $145 a barrel in 2008. Only then did President George W. Bush finally lift the presidential offshore ban. Because of a strong public outcry, Congress allowed its moratorium to expire on September 30, 2008. With the expiration of the congressional moratorium, it was finally permissible for the United States to move forward with developing its offshore energy resources.

Near the end of President George W. Bush's term in 2009, the Department of the Interior issued a plan to lease new offshore areas, but this plan was quickly rescinded by the Obama administration. President Obama proposed opening a few additional offshore areas in March of 2010,[22] but he canceled those plans less than a month later, citing safety reasons following the Deepwater Horizon accident in the Gulf of Mexico. Instead of offering more areas for energy production, the Obama administration halted all drilling in the Gulf, initially as a six-month moratorium.

Later, the administration claimed to have relaxed the moratorium, but a de facto moratorium, or aptly named permitorium, has remained in place because the administration has granted only a handful of the necessary government permits needed for drilling on federal land (including offshore areas). Through the rest of 2010 and into 2011, the Obama administration failed to issue a single permit to drill a new deepwater well, and a federal judge held the administration in contempt for their "determined disregard" to take action on drilling permits.[23]

After a disaster like the Deepwater Horizon, some introspection is understandable, but the Obama administration's response was considered by many experts as overblown. For example, the drilling moratorium and the subsequent permitorium not only affected deepwater drilling, but also shallow-water drilling in the Gulf of Mexico. Yet shallow-water operators have a very impressive safety record. Over the last 15 years, 11,070 wells were drilled in shallow water and less than 15 barrels of oil were spilled.[24]

Since March 2011, the Obama administration has been slowly issuing deep-water offshore permits for the Gulf of Mexico.[25] The administration has also approved a few supplemental plans to applications for deepwater drilling that were originally submitted in the 1980s. But these moves were made too late for the ten deepwater drilling rigs that had already moved to Brazil, French Guiana, Egypt, and other parts of Africa.[26]

Data from the Energy Information Administration (EIA) show that production in the Gulf of Mexico slowed significantly following the moratorium. In 2010, 1.55 million barrels of oil a day were produced in the federal offshore Gulf of Mexico and only 1.32 million barrels a day in 2011. Thus after the moratorium and permitting difficulties, oil companies produced 15 percent less oil a day in 2011.[27]

Oil production projects frequently have long lead times. Multi-billion dollar projects, such as many of the large offshore projects, take years to plan and build the necessary infrastructure to bring oil to market. For example, the Thunder Horse field was discovered in the Gulf of Mexico in 1999, but the first barrel of oil was produced in 2008.

This long lead time means that decisions made today affect oil production for years in the future. One frequent criticism of the development of ANWR, for instance, is that it may take years to start producing oil. This may be true, but it is also true that if energy development in ANWR had been approved in the past, ANWR would be producing oil today. In 1995, President Clinton vetoed a bill to permit oil exploration and development in ANWR. If he had signed that bill, oil most certainly would be being produced in ANWR today.

Decisions made today about access to energy resources affect energy production for years and decades into the future. The more areas that are accessible to energy production today increases the likelihood of more domestic energy production in the future.

Offshore Drilling and the Price of Oil

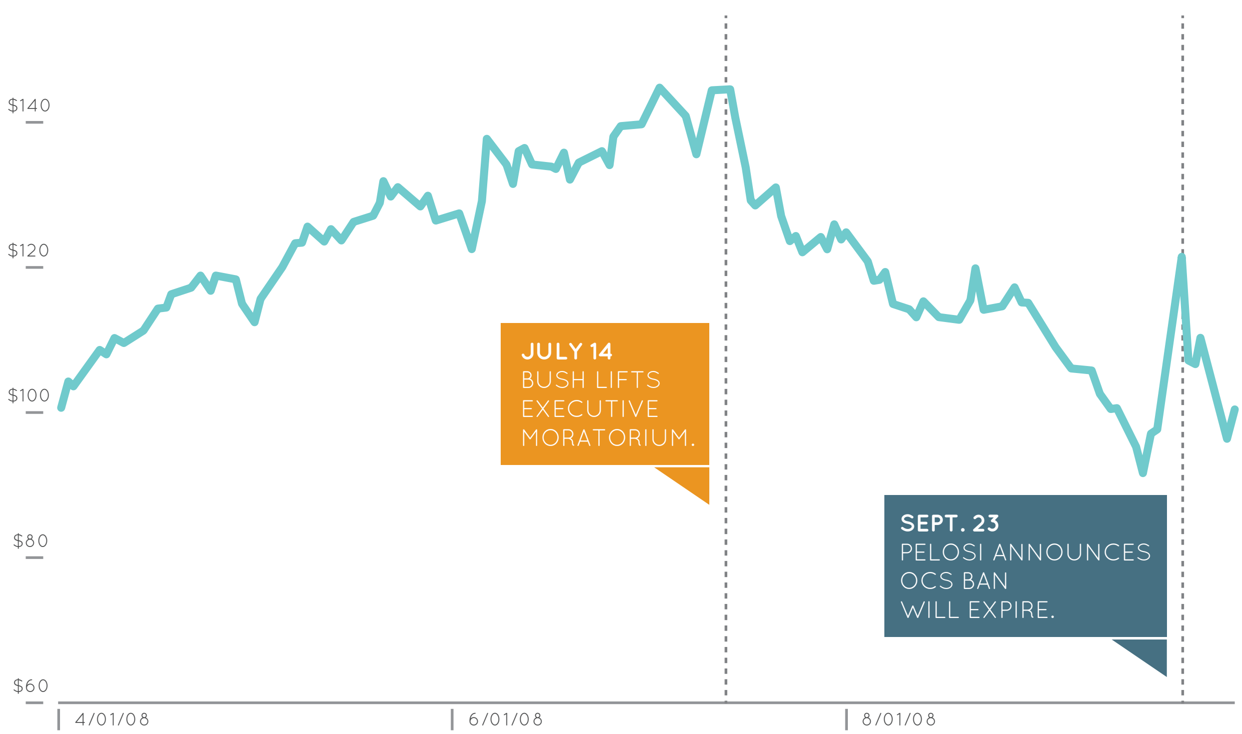
Some advocates have argued that allowing more domestic offshore drilling would have little impact on oil prices. While it is true that oil is a global commodity, it is also true that presidential and congressional actions can have an impact on oil prices. In 2008, when President George W. Bush ended the executive branch moratorium on oil and gas drilling on the Outer Continental Shelf, oil futures dropped by $9.26, or 6.3 percent, just after the announcement was made.[27]

Economic theory predicts that the potential for greater future oil production should lead to price relief. It is true that lifting the moratorium will not immediately increase oil production from the affected areas, but other oil producers with excess capacity (such as OPEC nations) would have an incentive to produce more in the present once they realize that future U.S. output would be higher, as illustrated in 2008.

The oil price drop continued after then House Speaker Nancy Pelosi announced on September 23, 2008 that Congress would allow the congressional moratorium to expire.[28] These price changes are illustrated by the chart below.

OIL PRICES AND THE
OFFSHORE MORATORIUM

WEST TEXAS INTERMEDIATE SPOT CRUDE PRICES



U.S. and World Oil Reserves in Perspective

People frequently confuse the crucial differences between proven reserves and the total amount of resources in the ground. For example, in March 2011 President Obama said:

> America holds about 2 percent of the world's proven oil reserves. What that means is that even if we drilled every drop of oil out of every single one of the reserves that we possess—offshore and onshore—it still wouldn't be enough to meet our long-term needs.[30]

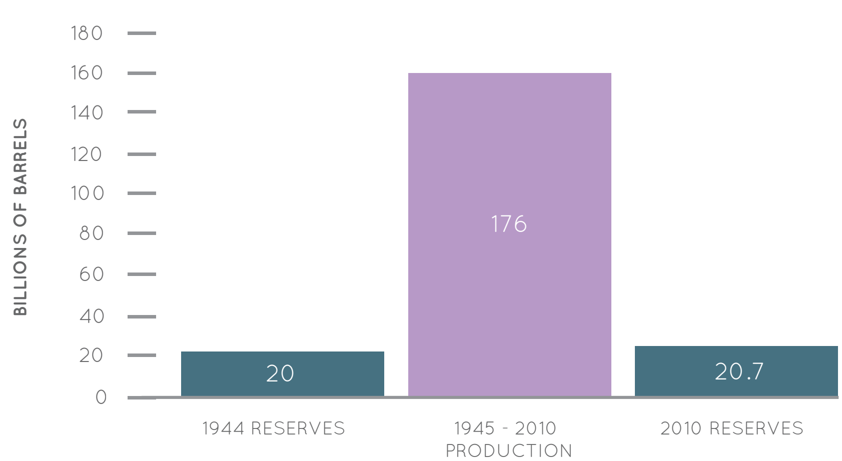
The President is confusing proven oil reserves with recoverable oil or the total amount of oil actually in the ground. His comment is similar to looking at all of the food in a grocery store and saying that when the food currently in the store is gone, there is no more food.

Proven reserves are similar to the food currently in the grocery store. They are the estimated reserves that are easily accessible and recoverable with today's technology and today's oil prices.[31] But proven reserves are a small fraction of the amount of oil that is in the ground. History has shown us that as today's proven reserves are used, people find more reserves.

Consider the history of proven oil reserves in the United States. In 1980, the U.S. had 29.8 billion barrels of proven oil reserves.[32] From 1980 through 2010, however, we produced 77.4 billion barrels of oil.[33] In other words, over the last 30 years, we produced more than double our total proved oil reserves in 1980.

This is true over a longer timeframe as well. The chart below shows U.S. proved oil reserves in 1944, total U.S. oil production from 1944 through 2010, and proved reserves in 2010.[34]

U.S. PROVED OIL RESERVES VERSUS PRODUCTION
1944—2010

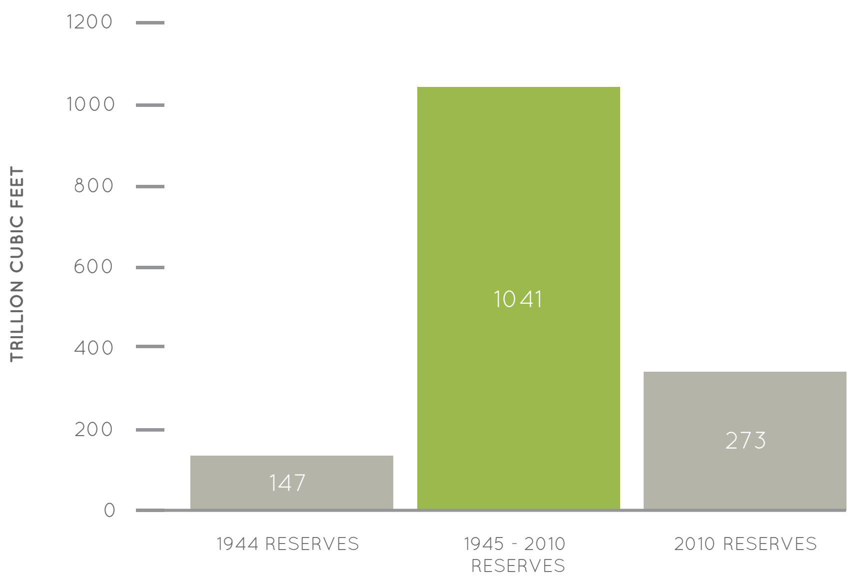


SOURCE: ENERGY INFORMATION ADMINISTRATION, ANNUAL ENERGY REVIEW, HTTP://WWW.EIA.GOV/TOTALENERGY/DATA/ANNUAL/PDF/SEC5_7.PDF; ENERGY INFORMATION ADMINISTRATION, INTERNATIONAL ENERGY OUTLOOK 2011, HTTP://WWW.EIA.GOV/FORECASTS/IEO/TABLE5.CFM; ROBERT L. BRADLEY JR. & RICHARD W. FULMER, ENERGY: THE MASTER RESOURCE, P. 88 (2004).

Over time, not only have we produced many times the amount of proved oil reserves as we had just a few decades ago, but the same is true of natural gas reserves and production, as the following chart shows.[35]

This same story of producing far more resources than our proven reserves is also true on a global scale. In 1980, global proven oil reserves stood at 642 billion barrels.[36] But from 1980 through 2007, the world consumed 720 billion barrels of oil.[37] In other words, globally from 1980 through 2007 we consumed 112 percent of the proven oil reserves we had in 1980. While we were producing these reserves, oil companies discovered more reserves and new technologies unlocked even more oil resources. Today the world has more proven oil reserves than ever before.[38] In fact, from 1980–2007 proven reserves doubled.[39]

U.S. NATURAL GAS RESERVES VERSUS PRODUCTION 1944—2010

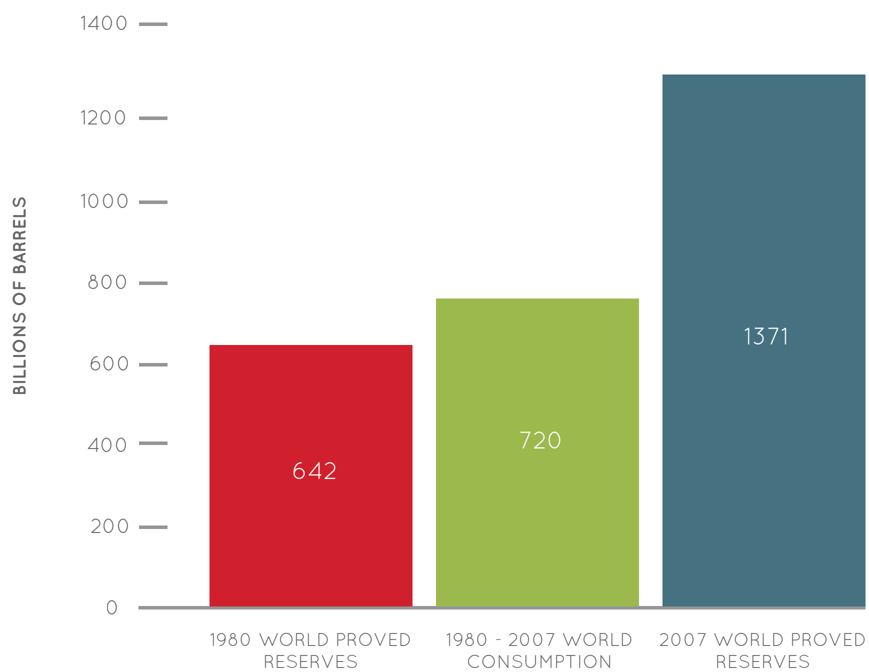


SOURCE: ENERGY INFORMATION ADMINISTRATION, ANNUAL ENERGY REVIEW, HTTP://WWW.EIA.GOV/TOTALENERGY/DATA/ANNUAL/PDF/SEC6_5.PDF; ENERGY INFORMATION ADMINISTRATION, INTERNATIONAL ENERGY OUTLOOK 2011, HTTP://WWW.EIA.GOV/FORECASTS/IEO/TABLE7.CFM; ROBERT L. BRADLEY JR. & RICHARD W. FULMER, ENERGY: THE MASTER RESOURCE, P. 88 (2004).

One reason proven reserves doubled over the last 30 years is that oil exploration and production technologies improved. One of the most important recent technological advancements is precision horizontal and directional drilling. Coupling horizontal and directional drilling with hydraulic fracturing has enabled oil production in new areas where oil was known to exist, but was not considered part of our proven reserves.

In the United States, oil production increased 14 percent from 2008 through 2011[40] as a result of drilling investment made during the time of high oil prices in 2008[41] as well as improved technology. Oil production increased from 4.95 million barrels per day in 2008 to 5.67 million barrels per day in 2011.[42]

WORLD PROVED OIL RESERVES VERSUS PRODUCTION 1980—2007



SOURCE: ENERGY INFORMATION ADMINISTRATION, INTERNATIONAL ENERGY STATISTICS: CRUDE OIL PROVED RESERVES, HTTP://TONTO.EIA.DOE.GOV/CFAPPS/IPDBPROJECT/IEDINDEXX3.CFM?TID=5&PID=57&AID=6&CID-REGIONS&SYID=1980&EYID=2010&UNIT=BB

Oil Potential in the 1002 Area of the Arctic National Wildlife Refuge

As previously noted, the federal government only allows energy production on a small fraction of taxpayer-owned lands. The 1002 Area of the Arctic National Wildlife Refuge (ANWR) is one area that contains large amounts of oil and remains off limits to production. In 1980, Congress and President Jimmy Carter set aside 1.5 million acres of ANWR's 19 million acres for future study of its energy resource potential.[43] These 1.5 million acres, known as the 1002 Area, have no trees, deepwater lakes, or mountain peaks, but contain immense energy resources.[44]

The U.S. Geological Survey has estimated that the 1002 Area has an average expected value of 10.4 billion barrels of recoverable oil that could be produced at a rate of about one million barrels of oil per day.[44] This potential resource could make ANWR the largest oil-producing field in the United States. The area's oil and natural gas resources could be developed using merely 2,000 acres of the surface area, or less than 0.01 percent of ANWR's total area.[46]

Despite ANWR's great energy potential, Congress has prohibited the development of these resources for almost 30 years. One reason given by the opponents of energy production in ANWR is that it might adversely impact caribou populations. The good news about the caribou is that since energy development began in nearby Prudhoe Bay in 1977, the size of the Central Arctic Herd has grown more than 1,015 percent, from about 6,000 animals in 1978 to record levels of an estimated 67,000 caribou in 2009.[47]

1 *Energy Information Administration, Annual Energy Review 2010, Table 5.1b, http://www.eia.gov/totalenergy/data/annual/pdf/sec5_7.pdf*

2 *Energy Information Administration, Annual Energy Review 2010, Table 4.1, http://www.eia.gov/totalenergy/data/annual/pdf/sec4_3.pdf and http://www.eia.gov/totalenergy/data/annual/pdf/sec5_6.pdf .*

3 *Energy Information Administration, Table 2.5 Transportation Sector Energy Consumption, March 2011, http://www.eia.gov/emeu/mer/pdf/pages/sec2_11.pdf.*

4 *NEW YORK TIMES, Nov. 12, 1911, cited in Robert Bryce, The Electric Car Boondoggle, The Daily Beast, July 29, 2010, http://www.thedailybeast.com/blogs-and-stories/2010-07-29/electric-cars-subsidized-by-harry-reid-and-the-senate/.*

5 *Ford Predicts Fuel from Vegetation, NEW YORK TIMES, Sept. 20, 1925, p. 24, cited in Bill Kovarik, Henry Ford, Charles Kettering and the "Fuel of the Future", Automotive History Review, Spring 1998, p. 7, available at http://www.radford.edu/wkovarik/papers/fuel.html.*

6 *See Energy Information Administration, Monthly Energy Review, Table 3.1, http://www.eia.gov/totalenergy/data/monthly/pdf/sec3_3.pdf.*

7 *Energy Information Administration, Country Energy Profiles, http://www.eia.doe.gov/country/index.cfm.*

8 *Energy Information Administration, Petroleum Supply Monthly (Oct. 2011), http://www.eia.gov/pub/oil_gas/petroleum/data_publications/petroleum_supply_monthly/current/pdf/table26.pdf.*

9 *Energy Information Administration, Monthly Energy Review (March 2012) http://www.eia.doe.gov/totalenergy/data/monthly/#petroleum*

10 *Id.*

11 *Energy Information Administration, Monthly Energy Review, Table 3.3a, http://www.eia.gov/mer/pdf/pages/sec3_7.pdf.*

12 *Energy Information Administration, Monthly Energy Review (March 2012) http://www.eia.gov/totalenergy/data/monthly/pdf/sec3_11.pdf.*

13 *See Bureau of Land Management, BLM Public Land Statistics 1999, Table 1.3, Mar. 2000, http://www.blm.gov/public_land_statistics/pls99/index.html.*

14 *Energy Information Administration, Short Term Energy Outlook, Table 4a. U.S. Crude Oil and Liquid Fuels Supply, Consumption, and Inventories, July 2011.*

15 *See Bureau of Ocean Energy Management, Regulation and Enforcement, Offshore Energy and Minerals Management, http://www.boemre.gov/offshore/. According to the administration's website, the outer continental shelf is 1.76 billion acres (http://www.boemre.gov/ld/PDFs/GreenBook-LeasingDocument.pdf page 1) and only 38 million acres are leased (Department of Interior, Oil and Gas Lease Utilization – Onshore and Offshore, http://www.doi.gov/news/pressreleases/loader.cfm?csModule=security/getfile&pageid=239255 page 4). That is a mere 2.16% of the entire Outer Continental Shelf.*

16 *According to the Department of Interior, 38 million acres of onshore lands are leased for oil and natural gas production. See Table 3 in Department of Interior, Oil and Gas Lease Utilization – Onshore and Offshore, http://www.doi.gov/news/pressreleases/loader.cfm?csModule=security/getfile&pageid=239255 According to the Congressional Research Service, the federal government owns just over 650 million acres of land. See Appendix A. Congressional Research Service, Major Federal Land Management Agencies: Management of Our Nation's Lands and Resources, May 15, 1995, http://www.ncseonline.org/nle/crsreports/natural/nrgen-3.cfm. The federal government also controls an additional 58 million acres of federal mineral estate below privately owned surface estate. See Bureau of Land Management, Split Estate, http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS__REALTY__AND_RESOURCE_PROTECTION_/bmps.Par.98100.File.dat/SplitEstate08finalWeb.pdf.*

17 *Institute for Energy Research, Obama Administration Breaks (non) Leasing Records, Presents a Clear and Present Danger to U.S. Energy Security, Nov. 24, 2009, http://www.instituteforenergyresearch.org/2009/11/24/actions-speak-louder-than-words/.*

18 *Congressional Research Service, Federal Lands Offered for Lease Since 1969 by Administration, Jan. 14, 2009, http://www.instituteforenergyresearch.org/pdf/CRS_Acreage_Offered_for_Lease_by_Administrations.pdf.*

19 *Bureau of Land Management, Number of New Leases Issued During the Year, Nov. 9, 2011, http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS__REALTY__AND_RESOURCE_PROTECTION_/energy/oil___gas_statistics/fy_2011.Par.19679.File.dat/chart_2011_03.pdf. In the chart, the average for each administration includes the fiscal years where there is overall between two administrations. For example, FY2008 is used in the average for both Bush 42 and Obama.*

20 *Institute for Energy Research, Who Benefits from Federal Lease Hoarding, July 16, 2008, http://www.instituteforenergyresearch.org/2008/07/16/who-benefits-from-federal-lease-hoarding/.*

21 *Bureau of Ocean Energy Management, Regulation and Enforcement, Outer Continental Shelf Oil & Gas Assessment 2006, http://www.boemre.gov/revaldiv/RedNatAssessment.htm.*

22 *John M. Broder, Obama to Open Offshore Areas to Oil Drilling for First Time, NEW YORK TIMES, Mar. 31, 2010, http://www.nytimes.com/2010/03/31/science/earth/31energy.html.*

23 *Laurel Brubaker Calkins, U.S. in Contempt Over Gulf Drill Ban, Judge Rules, BLOOMBERG, Feb. 3, 2011, http://www.bloomberg.com/news/2011-02-03/u-s-administration-in-contempt-over-gulf-drill-ban-judge-rules.html.*

24 *Brett Clanton, Drillers fear sinking in shallow waters: They saw federal delays in permit process threaten companies' existence, HOUSTON CHRONICLE, Aug, 18, 2010, http://www.chron.com/disp/story.mpl/business/energy/7159334.html.*

25 *Institute for Energy Research, The Obama Administration is Slowing Reissuing Offshore Drilling Permits, Mar. 23, 2011, http://www.instituteforenergyresearch.org/2011/03/23/the-obama-administration-is-slowly-reissuing-offshore-drilling-permits/.*

26 *Forbes, Why U.S. Oil rigs left Gulf of Mexico for Brazil, Mar. 23, 2011, http://blogs.forbes.com/kenrapoza/2011/03/23/as-us-oil-rigs-leave-for-brazil-permits-and-prices-only-factor.*

27 *See Energy Information Administration, http://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbblpd_a.htm*

28 *Larry Kudlow, Bush Says Drill, Drill, Drill—and Oil Drops $9, July 15, 2008, http://www.nationalreview.com/kudlows-money-politics/2249/bush-says-drill-drill-drill-151-and-oil-drops-9.*

29 *Institute for Energy Research, Lifting the Offshore Ban Gave Immediate Price Relief, Oct. 2, 2008, http://www.instituteforenergyresearch.org/2008/10/02/lifting-the-offshore-ban-gave-immediate-price-relief/.*

30 *Remarks by the President on America's Energy Security, Mar. 30, 2011, http://www.whitehouse.gov/the-press-office/2011/03/30/remarks-president-americas-energy-security.*

31 *Energy Information Administration, Glossary, http://www.eia.gov/emeu/iea/glossary.html#ProvedEnergyReserves.*

32 *Energy Information Administration, International Energy Statistics: Petroleum—Reserves, http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=5&pid=57&aid=6&cid=regions&syid=1980&eyid=2011&unit=BB.*

33 *See Energy Information Administration, U.S. Field Production of Crude Oil, http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=mcrfpus1&f=a*

34 *See Energy Information Administration, Annual Energy Review, http://www.eia.gov/totalenergy/data/annual/pdf/sec5_7.pdf; Energy Information Administration, International Energy Outlook 2011, http://www.eia.gov/forecasts/ieo/table5.cfm; Robert L. Bradley Jr. & Richard W. Fulmer, Energy: The Master Resource, p. 88 (2004).*

35 *See Energy Information Administration, Annual Energy Review, http://www.eia.gov/totalenergy/data/annual/pdf/sec6_5.pdf; Energy Information Administration, International Energy Outlook 2011, http://www.eia.gov/forecasts/ieo/table7.cfm; Robert L. Bradley Jr. & Richard W. Fulmer, Energy: The Master Resource, p. 88 (2004).*

36 *Energy Information Administration, International Energy Statistics: Petroleum—Reserves, http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=5&pid=57&aid=6&cid=regions&syid=1980&eyid=2011&unit=BB.*

37 *Energy Information Administration, International Energy Statistics: Petroleum—Consumption, http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=5&pid=5&aid=2&cid=regions&syid=1980&eyid=2010&unit=TBPD.*

38 *Energy Information Administration, International Energy Statistics: Crude Oil Proved Reserves, http://tonto.eia.doe.gov/cfapps/ipdbproject/iedindex3.cfm?tid=5&pid=57&aid=6&cid=regions&syid=1980&eyid=2010&unit=BB.*

39 *Id.*

40 *Energy Information Administration, Crude Oil Production, http://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbblpd_a.htm.*

41 *Mead Gruver, Govt. says US oil production increased in 2009, ASSOCIATED PRESS, Mar. 25, 2010, http://www.businessweek.com/ap/financialnews/D9EL8MI00.htm.*

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43 *U.S. Department of Interior, Facts: Environmentally Responsible Energy Production in Alaska's ANWR, http://www.doi.gov/initiatives/ANWRmediafactsheet.pdf.*

44 *Id.*

45 *U.S. Geological Survey, Arctic National Wildlife Refuge, 1002 Area, Petroleum Assessment, 1998, Including Economic Analysis (April 2001), http://pubs.usgs.gov/fs/fs-0028-01/.*

46 *Energy Information Administration, Potential Oil Production from the Coastal Plain of the Arctic National Wildlife Refuge: Updated Assessment, 3. Summary, http://www.eia.doe.gov/pub/oil_gas/petroleum/analysis_publications/arctic_national_wildlife_refuge/html/summary.html. See also, Arctic Power, Top 10 Reasons to Support Development in ANWR, http://www.anwr.org/topten.htm.*

47 *Cameron et al, Central Arctic Caribou and Petroleum Development: Distributional, Nutritional, and Reproductive Implications, 58 ARCTIC 1, Mar. 2005, http://pubs.aina.ucalgary.ca/arctic/Arctic58-1-1.pdf and Alaska Department of Fish and Game, Press Release: ADF&G Reports Increase in Teshekpuk and Central Arctic Caribou Herds, http://outdoornewsdaily.com/index.php/archives/6821.*

UNCONVENTIONAL OIL PRODUCTION

Shale Oil versus Oil Shale

In addition to conventional oil deposits, the United States has large shale oil resources and the richest oil shale deposits in the world.[1] The United States also has oil sands resources. In the past, these energy resources have been too expensive to produce, but new advancements in technology have created a shale oil and shale gas revolution.

Despite having similar names, shale oil and oil shale are very different oil resources. Shale oil is conventional oil trapped in shale rock. These shale rock formations can also hold natural gas. The natural gas produced from these formations is called shale gas. Unlike oil shale, the oil produced from shale oil formations is conventional oil and does not require special processing.

Oil shale, however, is neither oil nor is it necessarily found in shale rock. Oil shale is sedimentary rock that contains kerogen, a solid organic material. When the kerogen is heated to high temperatures, it releases petroleum-like liquids that can be processed into liquid fuels.

Another difference between oil shale and shale oil is the location of the resources. Shale oil (and shale gas) resources are spread over much of North America,[2] but oil shale is concentrated in the western United States in Utah, Wyoming, and Colorado.

The Shale Oil Revolution

According to the chairman of Cambridge Energy Research Associates, Daniel Yergin, the biggest energy breakthroughs over the past decade were not new solar cells or better wind turbines but the unlocking of oil and gas in shale rock formations. Ten years ago, shale oil formations[3] produced about 200,000 barrels of oil a day. Today, these formations produce over one million barrels and production could reach three million barrels a day by 2020.[4]

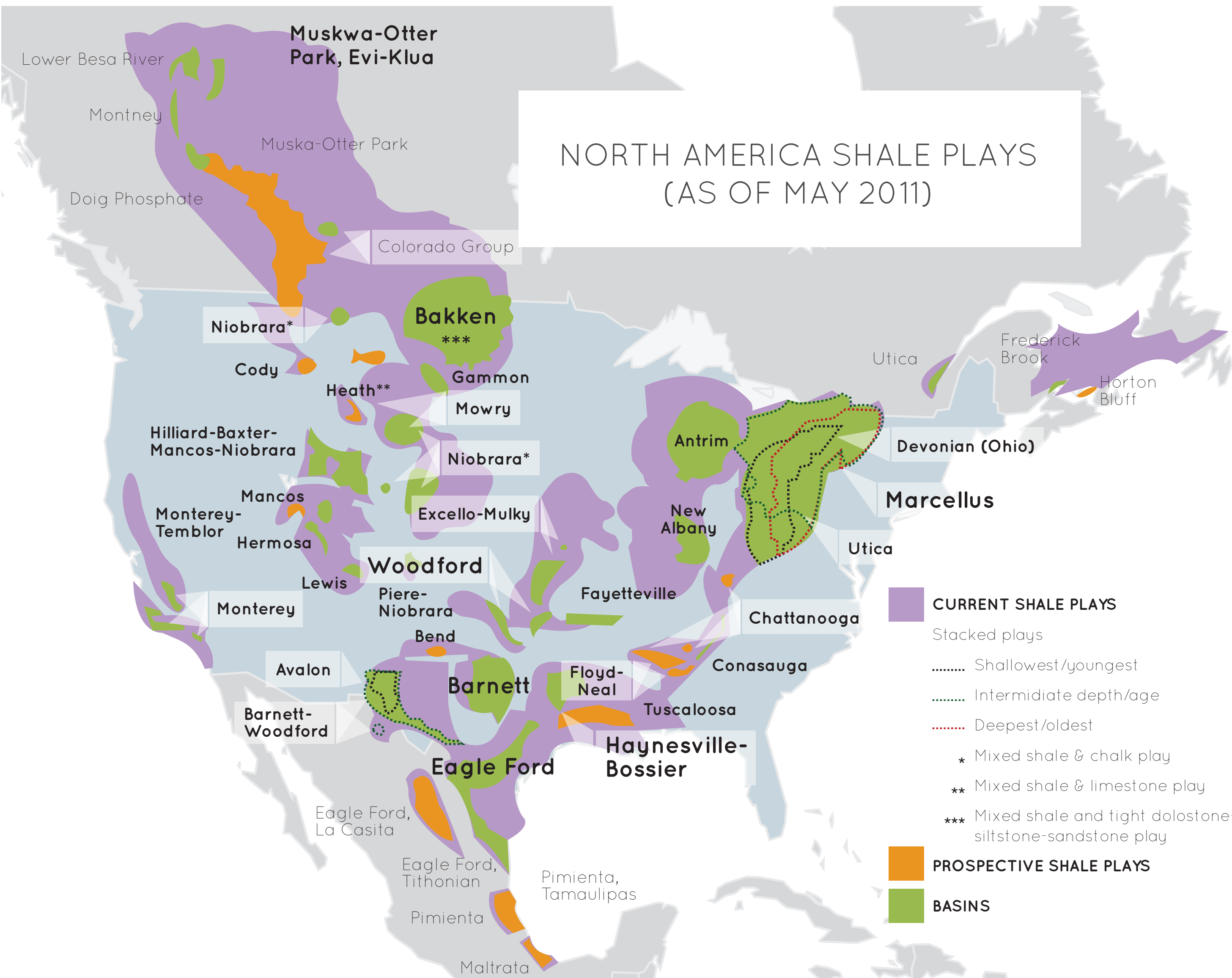
This new oil production is occurring in a number of places around the country, including the Bakken formation in North Dakota, the Eagle Ford formation in Texas, and the Niobrara formation in Colorado. Unlike the large oil fields of the past few decades such as the fields in the Gulf of Mexico or Prudhoe Bay, Alaska, these new shale fields are mostly on private and state lands. As a result, total U.S. oil production has increased on private and state lands, even as the federal government has leased fewer and fewer acres for energy production.[5]

The development that makes it possible to produce large amounts of oil and natural gas from shale formations was the combination of directional drilling with hydraulic fracturing, also known as “fracking.” Hydraulic fracturing has been in use since the 1940s, but combining fracturing with directional drilling allows much more of the oil and natural gas to be extracted than if the hydraulic fracturing was only done in vertical wells.

To understand the difference that hydraulic fracturing makes, in 1995 the U.S. Geological Survey (USGS) estimated that the Bakken formation held 151 million barrels of technically recoverable oil. But in 2008, after the impact of hydraulic fracturing and direction drilling were included in the USGS's assessment, the estimate of recoverable oil in the Bakken jumped 25 fold.[6]

Some interest groups have expressed concern about hydraulic fracturing's environmental impact, but to date those concerns are unfounded. Hydraulic fracturing has been used more than one million times over the past 60 years and despite this widespread use, there is not a single confirmed case of groundwater contamination. The Environmental Protection Agency (EPA) recently released a preliminary report that claims that shallow hydraulic fracturing has contaminated some ground water in Wyoming. One early report indicates that EPA may have used lax testing methods which could have contaminated EPA's samples,[7] but only time will tell if EPA's report will withstand scientific scrutiny.

Nevertheless, the hydraulic fracturing track record is clear—it has been in use for over 60 years in more than one million wells and there has never been a scientifically substantiated claim of groundwater contamination due to the technology. Any way you look at it, that is an impressive safety record.



SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION BASED ON DATA FROM VARIOUS PUBLISHED STUDIES. CANADA AND MEXICO PLAYS FROM ARI. UPDATED: MAY 9, 2011.

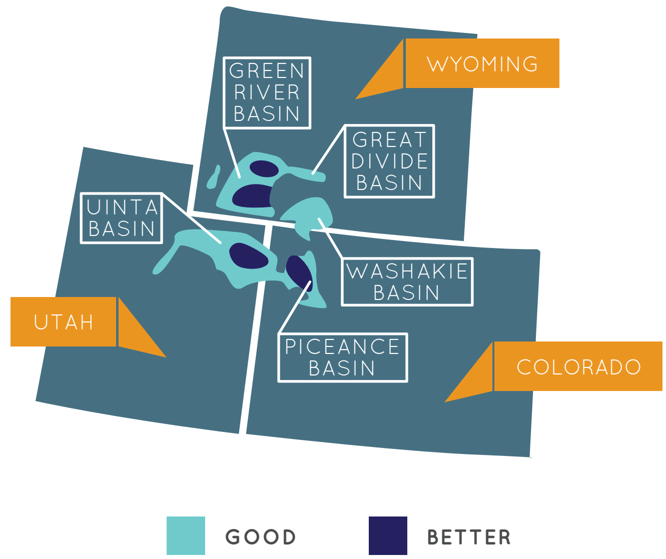
Oil Shale

The United States Geological Survey estimates that U.S. oil shale resources hold 2.6 trillion barrels of oil, with about 1 trillion barrels that are considered recoverable under current economic and technological conditions.[8] These 1 trillion barrels are nearly four times the amount of Saudi Arabia's proven oil reserves—a large enough supply for over 140 years at America's 2010 rate of oil use.

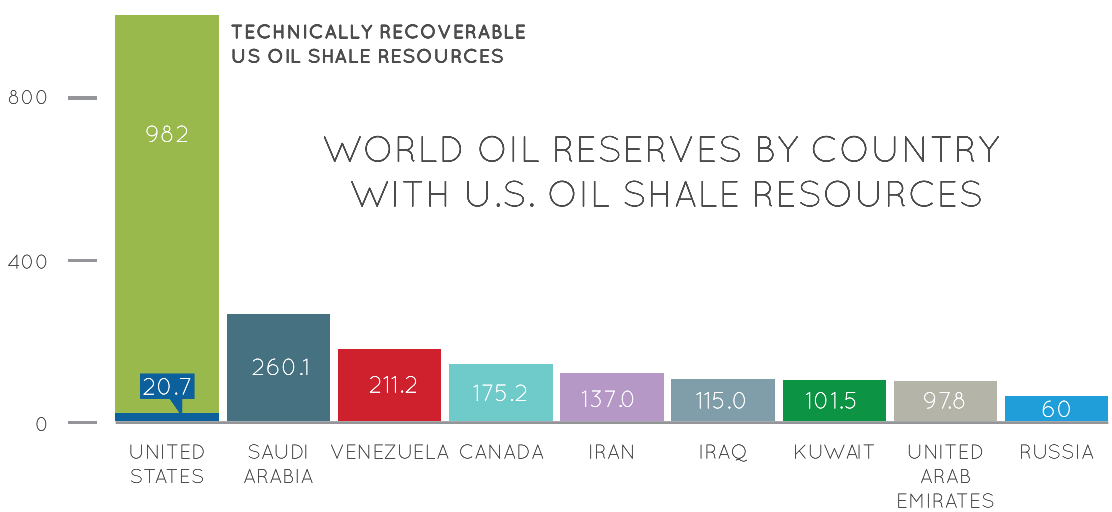
Despite the great promise these resources hold, one of the first acts of the Obama administration was to withdraw the research and development oil shale leases that the Bush administration had offered.[9] Private sector research and development is necessary to bring these resources to market. Without these leases, companies will not invest the hundreds of millions of dollars required to develop the necessary technology. In Jordan, for example, Shell pledged to spend $500 million in exploration of the country's vast oil shale resources.[10] But this large expenditure was only possible because Shell would be able to develop the resources if the exploration proves successful.

It is important for people to be able to secure the rights to explore and then produce oil shale resources because of the potential these resources hold. Oil shale could radically shift the center of world oil production. The following graph shows how the production of U.S. oil shale could change the world oil market.

UNITED STATES OIL SHALE RESOURCES



SOURCE: NATIONAL ENERGY TECHNOLOGY LABORATORY



SOURCE: EIA, INTERNATIONAL OIL OUTLOOK 2011, HTTP://WWW.EIA.GOV/FORECASTS/IEO/TABLE5.CFM

Oil Sands

Oil sands are another source of petroleum. Oil sands are a heavier form of oil that is mixed with sand, water, and clay. Because of its thickness, this oil (also called bitumen) does not flow like conventional oil, so extraction requires heating or the addition of other fluids to break apart the constituent materials.

Deposits of oil sands are found in more than 70 countries, but the largest deposits in the world are located in Canada. The inclusion of oil sands nearly quadrupled Canada's proved oil resources in 2003 alone.[11] Oil sands resources in the United States are not as great as Canada's, but the Department of Energy estimates that U.S. oil sands hold 10 billion barrels of recoverable oil.[12]

1 *U.S. Department of Interior, U.S. Geological Survey, Technical Announcement: U.S. Oil Shale Assessment Updated, Apr. 2, 2009, http://www.usgs.gov/newsroom/article.asp?ID=2182.*

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12 *Advanced Resources International, Undeveloped Domestic Oil Resources: The Foundation for Increasing Oil Production and a Viable Domestic Oil Industry, Feb. 2006, p. 20, http://www.fossil.energy.gov/programs/oilgas/publications/eor_co2/Undeveloped_Oil_Document.pdf.*

COAL

- Coal is the world's most plentiful fossil fuel currently in use (only methane hydrate resources are estimated to be greater). The United States has 261 billion tons of coal in its proved coal reserves. These are the world's largest coal reserves and over 27 percent of the world's proved coal reserves.
- The United States produces nearly 1.1 billion short tons of coal a year, making it the world's second largest coal producer. China produces over 3.5 billion short tons a year.
- Coal generates nearly 42 percent of the electricity in the United States.
- The United States (in the lower 48 states) has 486 billion tons of coal in the demonstrated reserve base, enough to power America for the next 485 years at current rates of consumption.[1]
- Alaska coal reserves are larger than those in the lower 48 states and they have not been tapped.

Coal is the world's most plentiful fossil fuel currently in use[2] and the United States has the world's largest coal reserves. In fact, there is enough mineable coal in the lower 48 states alone to supply the U.S. for the next 485 years at current rates of coal consumption. Besides being plentiful, coal is also energy dense, which means that a lot of energy is concentrated in a small space. These factors help make coal one of the most cost-effective, affordable fuels for electricity generation.

Coal helped create the modern era by powering the latter part of the Industrial Revolution. Today, coal is the backbone of U.S. electricity generation, accounting for 42.2 percent of the nation's electricity.[3] Overall, coal provides 20.4 percent of energy used in the United States.[4] While coal use has slightly decreased over the last few years in the United States, its share of world energy consumption has increased to 29.6 percent in 2010, the highest since 1970.[5]

The United States Has Vast Coal Reserves—Energy for Hundreds or Even Thousands of Years

The Energy Information Administration categorizes coal resources in three categories:

Total Coal Resources: The most inclusive category of coal resources is called in-place coal resources. EIA estimates that there are approximately 4 trillion short tons of coal in the lower 48 United States.[6] Four trillion tons of coal would last nearly 4,000 years at current domestic rates of coal use.[7]

EIA's estimate of 4 trillion short tons of coal does not include an estimated 6 trillion short tons in Alaska.[8] In other words, the United States contains an estimated 10 trillion short tons of coal.

Demonstrated Reserve Base: Given that it is not feasible to mine all 4 trillion tons of coal that makes up EIA's total coal resources, EIA defines the total coal resources that may be mined commercially as the demonstrated reserve base.

EIA estimates that the demonstrated reserve base is 486 billion short tons of coal.[9] This is enough coal to supply America for the next 485 years at current rates of coal consumption. This does not include coal resources in Alaska, which are larger than those in the lower 48 states, and which have not even been tapped.[10]

Estimated Recoverable Resources: Not all 486 billion short tons of coal can be mined with current mining technology, after accessibility constraints and recovery factors are estimated.[11] EIA defines this more restrictive category of coal resources as the "estimated recoverable resources." This is essentially the proved coal reserves.

EIA estimates that the estimated recoverable coal resources total about 261 billion short tons.[12] At current rates of domestic coal consumption, these reserves would last the country for roughly 250 years.[13]

As has happened with oil and natural gas production, technology can improve the recoverable amount of reserves, increasing the number of years that the U.S. coal reserve base could meet demand.

Coal Generates Inexpensive Electricity

There are several ways to look at the cost of producing electricity. One way is to look at the cost of building and operating new electricity-generation facilities. EIA forecasts energy supply and demand, and their forecast includes estimates of:

- The cost of electricity that includes the capital cost.
- The cost of operating and maintaining the facilities (including fuel).
- The cost of the transmission to get the electricity to market.

REAL LEVELIZED COSTS OF ELECTRICITY

GENERATING TECHNOLOGIES	PRICE (CENTS PER kWh)
CONVENTIONAL COAL	3.79
"CLEAN COAL" (IGCC)	4.37
NATURAL GAS	5.61
NUCLEAR	5.94
BIOMASS	5.95
WIND	6.64
SOLAR THERMAL	18.82
SOLAR PHOTOVOLTAIC	37.39

SOURCE: GILBERT METCALF, FEDERAL TAX POLICY TOWARD ENERGY, P. 22 (OCT. 2007) HTTP://WEB.MIT.EDU/GLOBALCHANGE/WWW/MITJPSPGC_RPT142.PDF

LEVELIZED COST OF NEW GENERATING TECHNOLOGIES IN 2016

GENERATING TECHNOLOGIES	PRICE (CENTS PER kWh)
NATURAL GAS	6.6
HYDRO	8.6
CONVENTIONAL COAL	9.5
WIND (ONSHORE)	9.7
GEOTHERMAL	10.2
BIOMASS	11.2
ADVANCED NUCLEAR	11.4
SOLAR PHOTOVOLATIC	21.1
WIND (OFFSHORE)	24.3
SOLAR THERMAL	31.2

SOURCE: EIA, LEVELIZED COST OF NEW GENERATION RESOURCES IN THE ANNUAL ENERGY OUTLOOK 2011, HTTP://WWW.EIA.DOE.GOVE/OIAF/AEO/ELECTRICITY_GENERATION.HTML

EIA estimates these data for 2016, the most recent year that technologies can be compared due to the lead time for construction. The least expensive form of new electricity generation is expected to be natural gas, followed by hydro, followed by conventional coal.[14]

Besides EIA's estimates, there are other estimates of the cost of various sources of electricity generation. Economist Gilbert Metcalf of Tufts University compiled the data below comparing the cost of electricity from various sources.[15] Because the different sources of electricity generation are treated differently by the tax code, Metcalf calculated a "level playing field," which shows the cost of electricity assuming all of the sources were treated equally by the tax code.

Metcalf explains that the costs of wind and solar shown here are actually too low because they do not reflect the fact that solar and wind are intermittent—the sun doesn't always shine on a locale and the wind doesn't always blow. Metcalf notes that the Royal Academy of Engineering calculates that the stand-by reserves required by wind power increases its real cost by nearly 50 percent.[16]

According to Metcalf, wind power costs 75 percent more than conventional coal, but because wind power necessitates back-up generation, its "true cost" would be 142 percent greater than the cost of coal. And if there were a "level playing field" with respect to tax treatment between different forms of electricity production, the true cost of wind would be 163 percent greater than the cost of coal.[17]

Another way to compare the relative price of electricity generation sources is to look at actual electricity prices in the states. The source of electricity generation is not the only factor, but it is the largest factor in determining electricity prices. What is clear is that states that generate the largest share of their electricity from coal or hydropower have the lowest electricity prices.

In fact, of the 15 states with the lowest electricity prices only two, Oklahoma and Louisiana, do not generate the largest share of their electricity from coal or hydropower.[18]

By these measures—projections of future cost, estimates of current costs, and actual electricity prices in the states—coal is one of the most inexpensive sources of electricity generation.

STATES WITH THE LOWEST RESIDENTIAL ELECTRICITY PRICES

STATES	PRICE (CENTS PER kWh)	LARGEST SOURCE	PERCENTAGE OF SOURCE
US AVERAGE	**8.73**	**COAL**	**71.5%**
IDAHO	7.99	HYDRO	76%
WASHINGTON	8.04	HYDRO	66%
NORTH DAKOTA	8.13	COAL	82%
KENTUCKY	8.57	COAL	93%
UTAH	8.71	COAL	81%
WYOMING	8.77	COAL	89%
WEST VIRGINIA	8.79	COAL	97%
ARKANSAS	8.86	COAL	46%
OREGON	8.87	HYDRO	55%
NEBRASKA	8.94	COAL	64%
SOUTH DAKOTA	8.97	HYDRO	52%
LOUISIANA	8.98	NATURAL GAS	50%
MISSOURI	9.08	COAL	81%
OKLAHOMA	9.14	NATURAL GAS	47%
MONTANA	9.16	HYDRO	93%

SOURCE: EIA, AVERAGE PRICE BY STATE BY PROVIDER BACK TO 1990 (FORM EIA-861), HTTP://WWW.EIA.GOV/CNEAF/ELECTRICITY/EPA/AVERAGE_PRICE_STATE.XLS;
EIA, ELECTRICITY GENERATION 2010, HTTP://EIA.GOV/CNEAF/ELECTRICITY/EPA/GENERATION_STATE_MON.XLS
HTTP://WWW.EIA.DOE.GOV/CNEAF/ELECTRICITY/EPA/GENERATION_STATE_MON.XLS

Air Pollution and Coal

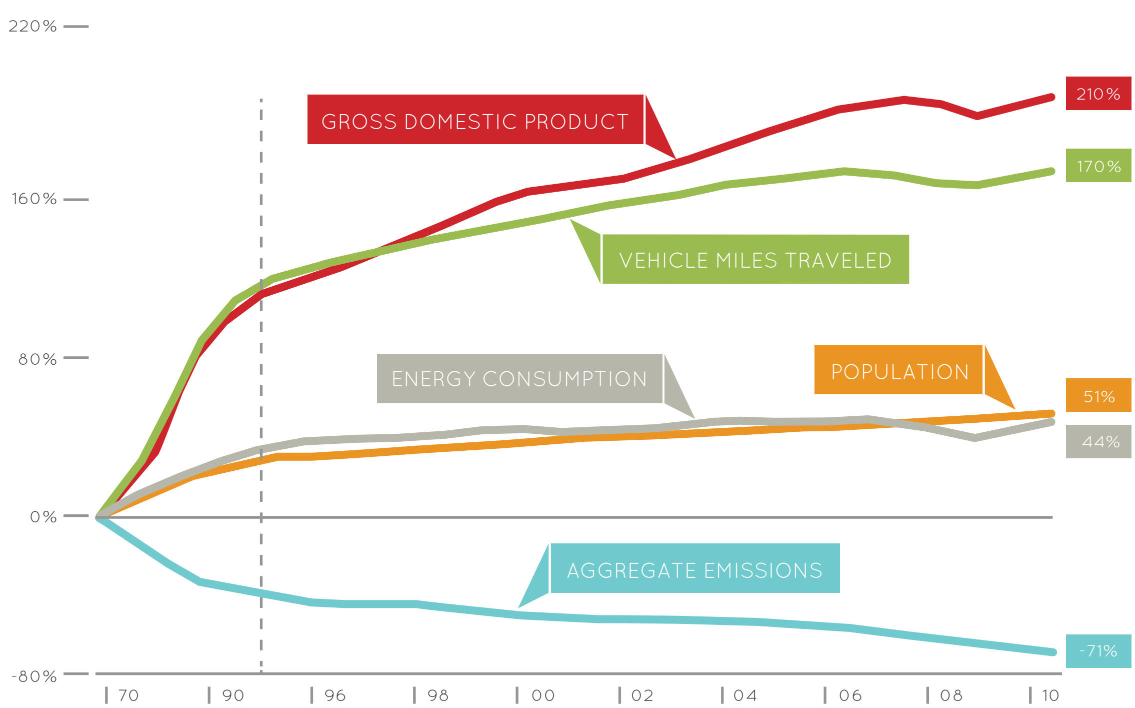
One of the biggest concerns about coal is air pollution. Coal is an inexpensive source of electricity, but it emits more pollution than natural gas when burned. But there is good news—our air quality is improving and new coal plants are cleaner than ever before.

Today's coal-fired electricity-generating plants produce more power, with less emission of pollutants, than ever before. The reason is because of pollution control technologies such as flue gas desulfurization, selective catalytic reducers, fabric filters, and dry sorbent injection, all of which have greatly reduced coal plant emissions. Coal plants can be built today with much lower emissions than in the past. For example, according to the National Energy Technology Laboratory (NETL), a new pulverized-coal plant (operating at lower, "subcritical" temperatures and pressures) reduces the emission of NOx (nitrogen oxides) by 86 percent, SO2 (sulfur dioxide) by 98 percent, and particulate matter by 99.8 percent, as compared with a similar plant having no pollution controls.[19]

These advances in technology have enabled large improvements in air quality. Since 1970, the total emissions of the six criteria pollutants have declined by 71 percent, even though energy consumption has increased by 44 percent, vehicle miles traveled have increased by 170 percent, and the economy has grown by 210 percent.[20] (The "criteria pollutants" are carbon monoxide, lead, sulfur dioxide, nitrogen oxides, ground-level ozone, and particulate matter.) The following chart from EPA shows the increase in economic measures compared to the decrease in pollution emissions.[21]

As technology continues to advance, coal-fired power plants will become even cleaner and air quality will continue to improve.

ENERGY USE VERSUS POLLUTION
1970—2010



SOURCE: HTTP://WWW.EPA.ORG/AIRTRENDS/IMAGES/COMPARISON70.JPG

Opposition to Coal

Although coal produces inexpensive energy (or maybe because it produces inexpensive energy), many activist groups adamantly oppose coal mining and coal-fired power plants. There are a number of different tactics these groups are exploiting to limit coal use in the United States.

The Sierra Club, for example, has worked particularly hard to stop coal-fired power plants. They claim that they have prevented 150 coal-fired power plants from being built.[22] Coal mines, especially in Appalachia, are coming under increasing fire from environmental interest groups and the Obama administration. Recently, EPA revoked a clean water permit that the Army Corps of Engineers had previously awarded, despite the fact that, according to the Army Corps, the permit complies with West Virginia state water law and the federal Clean Water Act.[23] The problem, according to EPA, is that granting the permit would lead to changes in the conductivity (or salinity) of the water that would be detrimental to mayflies, stoneflies, and caddis flies.[24] In other words, EPA denied the permit, not because of impacts on human health, but impacts on mayflies.

There are a number of other threats to coal production and use, including:

- **Greenhouse gas regulations.** In 2009, the EPA determined that carbon dioxide and other greenhouse gases harm public health and welfare and subsequently promulgated regulations to limit carbon dioxide emissions from coal-fired power plants and other large emitters.

- **Ozone national ambient air quality regulations.** In 2008, the Bush administration tightened the ozone regulations. The Obama administration wants to tighten them further. If EPA tightens the regulations as much as some special interest groups want, it could cost 7.3 million jobs[25] and $90 billion a year by 2020.[26]

- **Boiler MACT (Maximum Achievable Control Technology).** EPA is also in the process of imposing new regulations on industrial boilers to tighten limits on hazardous air pollutants. These proposals would impose maximum available control technology on boilers for sources which emit as few as 10 or more tons per year.

- **"Conductivity" guidance.** As discussed above, the EPA used new conductivity standards to stop a new coal mine in West Virginia. But EPA is applying these standards across Appalachia. To get a Clean Water Act permit, mining companies must show that their project will not cause salt levels to increase to five times what EPA considers the "normal" level. But EPA Administrator Lisa Jackson admitted that there are "no or very few valley fills that are going to meet this standard."[27] Thus, by its own standard, EPA will not permit any mining that results in valley fills. In an unprecedented move, EPA is applying this guidance only to Appalachia.

- **Possible regulation of coal ash as a hazardous waste.** EPA is considering whether to regulate coal ash—used in cinder blocks and a number of other applications—as a hazardous waste.

- **Environmental interest group campaigns.** Environmental interest groups are waging a well-funded campaign to stop the production and use of coal. Such a campaign received a boost last year when New York Mayor Michael Bloomberg pledged $50 million to the Sierra Club to help eliminate coal-fired power plants.

- **Anti-coal industry interest group campaigns.** Chesapeake Energy, the second largest producer of natural gas in the United States, has spent millions of dollars opposing coal use. In 2007, they ran a campaign attacking coal as "filthy." Aubrey McClendon, Chesapeake's CEO, gave millions to the Sierra Club to oppose coal, and Chesapeake has funded a campaign to attack coal through the American Lung Association.[28]

This is a partial list of threats to coal use and production in the United States. It is particularly noteworthy that while activist antipathy toward coal has grown in the United States, China's coal consumption has increased dramatically. China already uses nearly four times as much coal as the United States, even though its coal reserves are much smaller than our own. In 2010, China consumed more than 3.7 billion short tons of coal while the United States consumed 1 billion short tons.[29] Because it is growing more difficult to use in the United States, some U.S. mining companies have started to export coal to China and elsewhere.

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2 There are more methane hydrate resources around the world than even coal resources.

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4 Energy Information Administration, Monthly Energy Review, March 2012, Table 1.3 Primary Energy Consumption by Source (Quadrillion Btu), p. 7, http://www.eia.doe.gov/emeu/mer/pdf/mer.pdf.

5 BP, Statistical Review of Energy 2011, p. 5, http://www.bp.com/assets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/statistical_review_of_world_energy_full_report_2011.pdf.

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10 Energy Information Administration, Annual Energy Review 2010, Table 4.11, http://www.eia.gov/totalenergy/data/annual/pdf/sec4_23.pdf

11 See Energy Information Administration, Coal Explained: How Much Coal is Left, http://tonto.eia.doe.gov/energyexplained/index.cfm?page=coal_reserves.

12 Id.

13 Energy Information Administration, Monthly Energy Review March 2012- Table 6.2: Coal Consumption by Sector (Thousand Short Tons), http://www.eia.doe.gov/emeu/mer/pdf/pages/sec6_4.pdf.

14 For more information, see this explanation of EIA's calculations, see Institute for Energy Research, Levelized Cost of new Electricity Generating Technologies, Feb. 1, 2011, http://www.instituteforenergyresearch.org/2009/05/12/levelized-cost-of-new-generating-technologies/. For example, EIA's annualized cost figure for generating electricity from new coal includes a penalty of three percentage points on the cost of capital to represent the difficulty of obtaining financing for new coal units.

15 See Gilbert Metcalf, Federal Tax Policy Toward Energy p. 22, Oct. 2007, http://web.mit.edu/globalchange/www/MITJPSPGC_Rpt142.pdf.

16 Id.

17 Id.

18 See Energy Information Administration, Electric Power Monthly, Table 5.6.B., Average Retail Price of Electricity, Oct. 2010, Released Dec. 27, 2010, http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_b.html.

19 Email from J. Kukielka, NETL to Mary Hutzler, Institute for Energy Research, Jan. 9, 2009. See also Institute for Energy Research, The Facts About Air Quality and Coal-Fired Power Plants, http://www.instituteforenergyresearch.org/2009/06/01/the-facts-about-air-quality-and-coal-fired-power-plants/.

20 Environmental Protection Agency, Air Quality Trends, Jan. 5, 2012, http://www.epa.gov/airtrends/aqtrends.html.

21 Environmental Protection Agency, Air Quality Trends, http://www.epa.gov/airtrends/aqtrends.html. The specific graphic is available here: http://www.epa.gov/airtrends/images/comparison70.jpg

22 Sierra Club, 150 Coal Plants Unplugged, http://www.sierraclub.org/coal/150plants/. Also, many other environmental groups have fought coal-fired power plants. See e.g. U.S. Chamber of Commerce, Project, No Project, http://www.projectnoproject.com/category/project/coal.

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27 Patrick Reis, EPA sets water standards in bid to curb mountain-top mining pollution, E&E News PM, April 1, 2010.

28 Anna Palmer & Robin Bravender, Gas company, lung association team up, POLITICO, Dec. 14, 2011, http://www.politico.com/news/stories/1211/70470.html.

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COAL-TO-LIQUIDS

Because the United States has the world's largest coal reserves, there is interest in creating liquid fuel from coal through coal-to-liquids technology. Worldwide coal-to-liquids production is estimated to increase 9 percent per year between 2015 and 2035, with worldwide production totaling around 1.7 million barrels per day in 2035 (from 200,000 barrels per day in 2010).[1] The Energy Information Administration predicts that with a rise in petroleum prices, the United States could produce almost 280,000 barrels a day of coal-to-liquids fuel by 2035.[2]

There are two main processes used to make liquid fuel from coal: indirect and direct liquefaction. In indirect liquefaction, coal is gasified and the resultant gases are recombined to make liquid fuel.[3] This process is similar to the process used to create fuel from biomass gasification. In direct liquefaction, coal is heated to high temperatures at high pressure in order to liquefy it.[4] Direct liquefaction is more efficient than indirect liquefaction at creating liquid fuel, but it requires additional refining to make fuel of an acceptable quality.[5]

Is coal liquefaction economical? It depends on the price of liquid fuels compared to coal input costs, and only the market can properly make those comparisons. The Chinese, however, claim that they are making large profits from their first commercial-scale coal-to-liquids project.[6]

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NATURAL GAS

- Natural gas provides 25.5 percent of our total energy.
- Natural gas produces 24.8 percent of our electricity.
- In 2011, the United States produced 23.0 trillion cubic feet of natural gas, making it the world's largest natural gas producer.
- The United States has 2,744 trillion cubic feet of technically recoverable natural gas resources,[1] enough to power America for the next 109 years at current rates of consumption.
- The federal government leases less than 2.2 percent of federal offshore areas and less than 5.4 percent of federal onshore lands for oil and natural gas production.

Natural gas is a mixture of methane, ethane, and propane gases. Methane makes up 70 to 90 percent of raw natural gas before it is refined. Natural gas is a plentiful and versatile fossil fuel, providing 25.5 percent of U.S. energy needs.[2] It fuels electricity generation, manufacturing, vehicles, home heating, and appliances. Natural gas provides about 24.8 percent of U.S. electricity and heats more than half of American homes.[3]

Natural gas is also used in a large number of industrial applications including the manufacturing of fertilizer, plastics, pharmaceuticals, and methanol. It is the cleanest-burning hydrocarbon-based fuel, emitting less carbon dioxide, nitrogen oxides, and sulfur dioxide than coal or oil on a per unit of output basis.[4]

Historically, the United States has had some of the highest natural gas prices in the world. In the past, these high natural gas prices, coupled with high U.S. labor costs, have led to an outsourcing of U.S. manufacturing jobs, particularly in Asia.[5] Thanks to hydraulic fracturing,[6] however, U.S. natural gas prices are declining as domestic natural gas production rises. U.S. natural gas reserves grew by 46 percent over the last decade and the United States is now the largest natural gas producer in the world.[7]

Natural Gas Reserves

The United States had 272 trillion cubic feet (Tcf) of proven natural gas reserves at the beginning of 2010 (about four percent of the world's total).[8] While substantial, this amount pales in comparison to Russia with 1,680 Tcf (25 percent of world reserves) and Iran with 1046 Tcf (16 percent of world reserves).[9]

Proved reserves are not the total natural gas endowment, but the natural gas that is recoverable under existing economic and technological conditions. As technology improves and currently-used sources of natural gas become more expensive, additional natural gas resources will become viable reserves. In total, the United States has 2,744 Tcf of technically recoverable natural gas—enough to satisfy current U.S. natural gas demand for 110 years at the present rate of use. So-called technically recoverable resources are resources that are recoverable with current technology, regardless of cost or other economic factors.[10] These 2,744 Tcf of natural gas resources include unconventional natural gas (shale gas, tight sands, and coalbed methane).[11]

Even though the United States has produced natural gas for decades, our proved reserves have actually grown. At the end of 1989, the United States had 167 Tcf of proved natural gas reserves. A decade later, despite 10 years of production, the U.S. still had 167 Tcf of natural gas reserves. By the end of 2009, however, U.S. natural gas reserves had grown by 63 percent to 273 Tcf because of improved technology such as hydraulic fracturing and horizontal drilling.[12]

The Obama administration could easily expand U.S. natural gas reserves by allowing access to the Outer Continental Shelf, the Arctic National Wildlife Refuge, and other federal lands. The Bureau of Ocean Energy Management estimates that the OCS contains 420 trillion cubic feet of natural gas.[13] The U.S. Geological Survey estimates that ANWR contains 3.6 trillion cubic feet of natural gas, but the federal restrictions on these resources are symptomatic of much broader restrictions on resource development in the United States.[14] Overall, 97 percent of government-owned lands are not leased for energy exploration and development.[15] In fact, the Obama administration leased fewer onshore acres for energy development in 2009 than in any other year on record.[16] Similarly, 97 percent of offshore government-owned lands are not leased for energy exploration and development.[17] More than one-third of all undiscovered natural gas resources in the United States are estimated to be in federal offshore areas.[18]

Hydraulic Fracturing and Other Technological Improvements in Natural Gas Production

Technological progress is unlocking new natural gas resources. Access to traditional natural gas resources has been significantly improved by horizontal drilling and hydraulic fracturing, which is also greatly increasing output from existing wells, particularly from shale gas. Hydraulic fracturing, also known as "hydrofracking" or just "fracking," refers to the injection of water (usually mixed with high-viscosity additives) at high pressures into either oil or natural gas wells. This results in the fracturing of rock in the wells, yielding continued or higher oil and gas production.[19]

Hydraulic fracturing has led to an increase in both U.S. natural gas reserves and an increase in natural gas production. As noted earlier, because of hydraulic fracturing, U.S. natural gas reserves grew by 63 percent over the last decade and the United States is now the largest natural gas producer in the world.[20]

In addition to the United States' conventional natural gas resources, unconventional resources such as coalbed methane and shale gas can also be utilized for natural gas. Coalbed methane is natural gas produced from coal deposits. These natural gas resources can store six or seven times as much gas as a conventional natural gas reservoir of equal volume, and are accessible at shallow depths. They are also especially affordable to locate.[21] In 2008, proven reserves of coalbed methane totaled 20.8 Tcf while about 1.9 Tcf of natural gas was produced from coalbed methane.[22]

Shale gas is natural gas found in sedimentary rock.[23] These resources have completely revolutionized natural gas production in the United States, greatly increasing the nation's supply of natural gas. In particular, the Marcellus and Barnett formation offer the promise of vast new natural gas reserves. With the increased use of technologies such as hydraulic fracturing, U.S. proven reserves of shale gas increased from 21.7 Tcf in 2007 to 32.8 Tcf in 2008.[24] In 2008, 2.1 Tcf of shale gas was produced in the United States; that increased by almost 50 percent to 3.1 Tcf in 2009.[25]

Almost all of the natural gas consumed in the United States is produced domestically. The largest natural gas producing areas, in descending order of production, are Texas, Alaska, Wyoming, federal offshore areas, Louisiana, and Oklahoma.[26] Of the 24.4 Tcf of natural gas that Americans consumed in 2011, just 1.95 Tcf, or 8 percent, was provided from net imports.[27] Natural gas imported into the United States comes primarily from Canada through pipelines, although it can also be imported from other countries as liquefied natural gas (LNG). LNG is cooled to approximately -260 degrees Fahrenheit to be transported in ships.[28] Natural gas is compressed and transported across the country through a massive network of pipelines. The nation's total natural gas pipelines are so long they could stretch to the moon and back, twice.[29]

Threats to Natural Gas Production

The outlook of natural gas production in the United States has dramatically changed over the last decade. Just a few years ago, there was a push to build more liquefied natural gas terminals in the United States to allow greater importation of natural gas. At the time, the U.S. had relatively high natural gas prices. Now, energy companies are considering building liquefied natural gas terminals to export natural gas.[30] The boom in natural gas production, brought about by hydraulic fracturing, has completely changed the natural gas landscape and has greatly lowered prices for consumers and industrial users.

The increase in hydraulic fracturing has led to new attacks on natural gas production. Many special interest groups have launched anti-hydraulic fracturing campaigns, claiming that it is a new, dangerous technology that contaminates groundwater. But the reality is far different. Hydraulic fracturing has been used for over 60 years in over one million wells. Despite this widespread use, there are no confirmed cases of groundwater contamination. This is not to say that we should not study the possible environmental impacts of hydraulic fracturing, but so far it has an enviable safety record.

Despite its safety record, the anti-hydraulic fracturing campaign has been met with some success. New York State imposed a ban on permitting high-volume hydraulic fracturing (ie. hydraulic fracturing coupled with directional drilling) and the New Jersey legislature has also passed a ban.[31] The federal government would like to regulate hydraulic fracturing. Even though it is regulated at the state level, the federal government has multiple panels studying hydraulic fracturing.

Methane Hydrates: a Vast Potential Natural Gas Resource

The world's supply of natural gas can be significantly prolonged by the use of methane hydrates. Methane hydrates, also called methane clathrate or methane ice, is methane trapped in ice. This occurs under conditions of high pressure and low temperature, in places such as an outer continental shelf or under permafrost.

Methane hydrates are the most extensive fossil fuel energy resource in the world. Conservative estimates place the reserves of methane hydrates at double the amount of all other hydrocarbon fuels.[32] Nations like Japan and Canada are vigorously pursuing the commercial development of methane hydrates because they would represent a quantum shift in the world's energy picture if commercially developed.[33]

In the United States, methane hydrates are found on the Outer Continental Shelf and under the Alaskan permafrost. Methane hydrates have not yet been studied extensively, but the best current estimates suggest that the United States has enough methane hydrate resources to supply natural gas at current consumption levels for between 350 and 3,500 years.[34] The U.S. Geological Survey estimates that the United States has about 320,000 Tcf of methane hydrate resources.[35] To put that number in perspective, in 2010 the entire world consumed 3,169 Tcf of natural gas.[36] In other words, there are enough methane hydrate resources in the United States alone to meet the world's current natural gas demand for 100 years.

The Alaskan North Slope is estimated to hold 85.4 Tcf of technically recoverable methane hydrates.[37] If these were counted as proven natural gas reserves, it would cause U.S. proven natural gas reserves to increase by 31 percent.

The estimates of recoverable methane hydrates will certainly increase as further research is conducted and extraction technology is improved. As energy expert Vaclav Smil explains:

> Needless to say, the world's natural gas industry would be radically transformed even if we were to recover just a very small share of all of the hydrates in shallow sediments. Tapping just 1% of the resource would yield more methane than is currently stored in the known reserves of natural gas.[38]

Though there is still much to learn about methane hydrates, they offer an incredible future energy potential.

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NUCLEAR

- The United States is the world's largest producer of nuclear power.
- Today there are 104 nuclear reactors in the United States and construction began for all of these reactors prior to 1974.
- Because of regulatory hurdles, it costs 200–250 percent more to build a nuclear power plant in the United States than in China.
- Nuclear power provides 19 percent of the electricity in the United States.

The United States was the world's first, and remains the world's largest, producer of nuclear power. Today nuclear electric power provides 19 percent of the nation's electricity.[1] Although the United States produces more nuclear power than any other country, other countries generate a larger percentage of their electricity from nuclear power. France, for example, generates nearly 80 percent of its electricity from nuclear energy.[2]

The first commercial power generation from a nuclear plant in the United States occurred in 1957, in Santa Susana, California.[3] The United States now has 104 nuclear power reactors, located in 31 states.[4] The construction of new plants has been halted, however, as the Department of Energy has not ordered a new plant since 1978.[5] The last new nuclear reactor in the U.S. was brought online in 1996.[6] Between 1973 and 2010, electricity generated from nuclear power rose from about 80 billion kilowatt hours to more than 800 billion kilowatt hours.[7]

Uranium is the most commonly used fuel in nuclear power plants. In a nuclear reactor, subatomic particles called neutrons strike atoms of Uranium-235 (U-235),[8] breaking them apart. This split, known as nuclear fission, releases an incredible amount of energy in the form of heat and radiation. One ton of natural uranium can produce as much electricity as burning 16,000 tons of coal or 80,000 barrels of oil.[9] In a nuclear power plant, this heat is used to boil water, produce steam, and turn the turbines that generate electricity.

Nuclear Challenges in the United States

The main obstacles to nuclear power are its relatively high cost, disposal of the spent nuclear fuel, and activist opposition to the construction of new plants.

New nuclear power plants are expensive. The EIA estimates that the cost of generating electricity from a new nuclear plant in 2016 will be 11.9 cents per kilowatt hour (in 2009 dollars), 80 percent higher than a natural gas combined cycle plant, and 20 percent higher than a conventional coal plant.[10]

The United States has also placed numerous regulatory obstacles in the way of new nuclear power plants. For example, China can build a Western-designed nuclear reactor in 46 months, or less than 4 years. That is quite a feat considering that it takes France almost 6 years to build a new reactor and it costs the Chinese 40 percent less, around $4 billion, compared to almost $7 billion for France.

In the United States, environmental and regulatory approvals lengthen the time from initiation of the project until operations begin, increasing financing costs and making capital more difficult to obtain.

The EIA estimates the overnight capital cost (the estimate of capital costs if the plant could be constructed in one day)[11] for an advanced nuclear reactor, at $5,335 per kilowatt.[12] The construction costs of nuclear units undergoing the permit process that include these other charges (financing and contingencies) are estimated at around $8,000 to $10,000 per kilowatt.[13] This means that the fully-loaded capital costs for domestic nuclear plants could potentially be 200 to 250 percent more expensive than a new Chinese nuclear plant.

Nuclear power does not emit greenhouse gases, making nuclear a viable alternative to coal or natural gas for electricity generation in the view of some governments. Many environmentalists, however, have vigorously opposed nuclear power because of concerns about nuclear reactor safety and the storage of used nuclear fuel, thus creating another impediment to new nuclear plant construction in addition to cost. Thirteen projects to expand the generation of electricity at already existing nuclear plants are facing either prolonged delays or indeterminate completion dates owing to opposition from environmental activist groups.[14]

Nuclear Accidents

Nuclear power plants have an impressive safety record, but their safety record is not perfect. In the United States, the worst nuclear accident occurred at the Three Mile Island nuclear power plant in 1979.

At Three Mile Island, human and mechanical failures led to a core meltdown in one of the reactors. This led to a release of radioactive gas and radioactive water as the reactor was brought under control. Even though this was the worst nuclear accident in the United States, no deaths occurred and no adverse effects from the radiation release could be found on human, animals, or plant life in the area.[15]

The largest nuclear accident was the Chernobyl disaster in the Soviet Union in 1986. At Chernobyl, a strong explosion caused the reactor vessel to rupture allowing the melting reactor core to spew large amounts of radioactive materials directly into the atmosphere for ten days.

The World Health Organization estimates that as of 2005, the official death toll from the Chernobyl disaster is less than 50 people.[16] Eventually, a total of 4,000 radiation-related deaths of emergency workers and residents from the area may be linked to the accident.[17]

Unlike nuclear reactors in the United States and other industrialized countries, the Chernobyl reactor did not have a strong containment building around the reactor vessel. This design flaw allowed a large amount of radiation to escape containment when the explosion occurred.

In 2011, problems at the Fukushima Daiichi nuclear plant in Japan were caused by a huge earthquake and subsequent large tsunami. The 9.0 earthquake that hit the plant was the largest known earthquake to hit Japan and was one of the five largest earthquakes since 1900.[18] After the earthquake, a tsunami of 45 feet hit the plant. Because the plant was designed to withstand an 18-foot tsunami, it was overwhelmed and critical cooling equipment was flooded.[19] The earthquake and tsunami disabled the cooling pumps, as well as the emergency backups for the reactors. This led to a partial meltdown in three of the reactors.

The Fukushima reactors are boiling water reactors. This type of reactor requires active cooling after a shutdown. At Fukushima the damage from the earthquake and tsunami knocked out the pumps that cool the reactor core and possibly damaged the primary containment vessel.

The damage to the plant led to a release of radioactive material from the plant, but unlike Chernobyl, no one died at Fukushima as a result of the radiation. To date, two people have suffered tsunami related deaths at Fukushima.[20]

The Japanese authorities established a 20 kilometer exclusion zone around the beleaguered plant because radiation had spread. But at this point, it is too early to know what the long-term health effects will be on the people around the plant.

How likely is a Fukushima-like accident in the United States? The United States has 35 nuclear reactors of the same design as those at Fukushima.[21] It is possible to have a chain of events, such as huge earthquake, followed by a tsunami that wipes out cooling backups, but such an event is exceptionally unlikely.[22]

Newer nuclear power plants are safer than boiling water reactors because new plants do not require active cooling to keep the reactor core cool after shutdown. Boiling water reactors were designed more than 50 years ago and nuclear technologies have greatly advanced since then.

Reprocessing of Spent Nuclear Fuel

While reprocessing of used nuclear fuel occurs in most countries, in the United States it does not. Reprocessing consists of separating and conditioning the components of spent nuclear fuel for recycling. When nuclear fuel leaves the reactor, approximately 97 percent of it can be recycled—96 percent as uranium and 1 percent as plutonium, leaving 3 percent as non-reusable waste material.[23] Thus, reprocessing allows for the conservation of natural uranium resources and reduces both the volume and toxicity of the final waste materials.

The United States had a few private reprocessing facilities in the 1960s and 1970s, but they were terminated for a number of reasons—the cost of regulation compliance, equipment problems, technical failures, and concern about nuclear proliferation. Since the 1970s, the federal government has not allowed nuclear reprocessing.[24]

Rather than reprocess, the United States opted to store the spent nuclear fuel at a disposal site, with the last attempt being Yucca Mountain in Nevada. The Obama administration, however, has withdrawn the majority of funding for that project, which leaves the United States in limbo regarding the treatment of spent nuclear fuel.

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BIOMASS

- Biomass, including ethanol, produces 4.5 percent of the total energy consumed in the United States.
- Replacing U.S. gasoline consumption with corn ethanol would require planting 500 million acres with only corn—more than the current total U.S. cropland.
- Biomass represents 1.4 percent of U.S. electricity generation.
- Congress mandated the production of 100 million gallons of cellulosic ethanol in 2010, but not a drop of cellulosic ethanol was commercially blended with gasoline in 2010.

Biomass, especially wood, was the world's primary energy source until the widespread use of coal during the latter part of the Industrial Revolution. In fact, in many poorer countries, biomass remains the most important source of heat. Biomass provides 80 percent of the energy in about 20 of the world's poorest countries.[1]

Biomass is a broad renewable energy category encompassing energy derived from a variety of biological materials, such as wood and corn (made into ethanol), as well as energy derived from such waste sources as municipal solid waste, manufacturing waste, and landfill gas.[2]

In the United States, biomass accounts for 1.4 percent of the nation's electricity.[3] In 2011, 65 percent of biomass-generated electricity was derived from wood and wood-derived fuels.[4] All told, biomass produced 4.5 percent of energy in the United States in 2011. This is about 50 percent of the total renewable energy consumed across the country.[5]

Even solar, hydro, and wind power produce ten times the amount of energy per acre than biomass can produce from the world's most productive ecosystems.[6] And solar, hydro, and wind power take much more land to produce the same amount of energy as oil, coal, or natural gas.

Consider that for biomass to replace the amount of energy produced by the use of coal in the year 2000 it would take cultivating the total forested land area of both the United States (including Alaska) and the European Union.[7] But even this would not be enough land today as global coal use has increased by 50 percent since 2000.[8] Replacing U.S. gasoline consumption with ethanol would require cultivating corn on all of the cropland in the United States, plus an additional 20 percent.[9] In 2002, the U.S. Department of Agriculture reported that U.S. cropland totaled 442 million acres.[10] This means that replacing U.S. gasoline consumption with corn ethanol would require growing corn on more than 500 million acres.

Ethanol and Other Biofuels

Biofuels consist of a wide range of fuels derived from biomass. The most widely used biofuel is ethanol (another name for alcohol) made from corn. Besides corn, biofuels are made from fermenting sugar-rich crops such as sugar cane and sugar beets.

Just a few years ago, ethanol was hailed by some as a savior.[11] Allegedly, ethanol production would reduce the carbon dioxide emissions from transportation fuels and reduce dependence on imported oil. As Congresswoman Nancy Pelosi put it, "Our plan will send our energy dollars to the Midwest, not the Middle East."[12] In 2007, at the behest of President George W. Bush, Congress passed the Energy Independence and Security Act which included a renewable fuels mandate. The mandate required the production of 20.5 billion gallons of renewable fuel in 2015 increasing to 36 billion gallons in 2022. The mandate also required 16 billion gallons of cellulosic biofuel to be produced by 2022.[13]

Biofuel Production May Increase Greenhouse Gas Emissions

While one justification for the renewable fuel mandate was to decrease carbon dioxide emissions, some scientific research suggests otherwise. In fact, some corn-based ethanol production and other forms of ethanol production may actually increase carbon dioxide emissions rather than reduce them. According to a study published in Science by the Nature Conservancy and the University of Minnesota, many biofuels emit more greenhouse gases than gasoline. According to the researchers, these biofuels may produce "17 to 420 times more carbon dioxide than the fossil fuels they replace."[14] Other research has come to similar conclusions. The Energy and Resources Group of the University of California, Berkeley found that "if indirect emissions [resulting from the production of ethanol] are applied to the ethanol that is already in California's gasoline, the carbon intensity of California's gasoline increases by 3% to 33%."[15] Not only does ethanol production appear to produce more greenhouse gas emissions than petroleum production, but ethanol production and combustion may lead to worse air quality than petroleum production.[16]

But even if biofuel production reduces greenhouse gas emissions, producing ethanol is, nevertheless, a very expensive way to achieve this goal. According to the Congressional Budget Office (CBO), the production of corn ethanol costs $750 per metric ton of carbon dioxide emissions avoided.[17]

Ethanol Production and Mandates

In 2011, almost 14 billion gallons of corn-based ethanol were sold in the United States—about 10 percent of the total motor fuel sold.[18] While corn-based ethanol has rapidly growth, cost-effective cellulosic ethanol remains a dream. In 2010, E&E News reported that, instead of producing 100 million gallons as mandated by Congress, "not a drop" of cellulosic ethanol was "commercially blended with gasoline."[19] In late 2011, the EIA was still unsure as to whether any cellulosic ethanol had been sold commercially despite Congress' mandate to produced 500 million gallons in 2011.[20]

Besides a federal mandate to produce billions of gallons of ethanol a year, ethanol received other favorable treatment designed to increase domestic ethanol production. From 1980 through 2011, U.S. ethanol producers were protected by a 54-cent per gallon tariff on imported ethanol. In recent years, ethanol blenders were eligible for a 45-cent tax subsidy for every gallon of corn ethanol blended with gasoline. At the end of 2011, both the ethanol tariff and the blenders' tax credit expired.[21]

These programs have been costly. The CBO reports that it cost taxpayers $1.78 per gallon for ethanol made from corn and $3.00 for cellulosic ethanol.[22]

E10, E15, E85, and Ethanol Availability

Most U.S. ethanol has been used in E10, a blended fuel that is 10 percent ethanol and 90 percent gasoline. This fuel has been certified by the Environmental Protection Agency as suitable for use in typical gasoline-powered engines.[23] EPA recently certified E15 as safe for cars manufactured in 2001 or later. Some ethanol has been used in E85, a blended fuel that is 85 percent ethanol and 15 percent gasoline. In contrast to E10, E85 can be used only in specially designed Flexible Fuel Vehicles (FFVs). But EIA estimates that, of the 260 million registered vehicles in the United States in 2008, including the more than 8 million E85-compatible vehicles that have been sold,[24] just 450,327 vehicles, or 0.2 percent of all U.S. vehicles, are actually used as FFVs.[25] In addition to the limited use of E85, there is also limited distribution of it. Of the 162,000 retail gasoline stations in the U.S., only 2,357 stations, or 1.4 percent, offer E85.[26]

Other Challenges for Ethanol

Ethanol is not as energy dense as gasoline. A gallon of ethanol contains about 34 percent less energy than a gallon of gasoline, which means that cars get fewer miles per gallon with ethanol than with gasoline.

The creation of ethanol also turns corn, a vital food stock, into motor fuel. This increases the price of a staple food and disproportionately affects the global poor. Because of this detrimental effect on the poor, Jean Zieglier, the former United Nations special rapporteur on the right to food, described ethanol as a “crime against humanity.”[27]

Even though ethanol can be used as a motor fuel, it cannot be transported in the same pipelines as petroleum products. Instead, ethanol must be transported in specially-designed trucks or trains and mixed with gasoline at the distribution center. This increases the cost of using ethanol over petroleum-based fuel and contributes to the argument that ethanol actually increases, not decreases, greenhouse gas emissions.

Biofuel Failure

Despite the federal government’s renewable fuel mandate and government loans, some renewable fuel producers have struggled. One such firm was the Colorado-based Range Fuels. The company received generous government assistance, including $76 million in federal grants, and $80 million in loan guarantees from the Department of Agriculture,[28] but the company failed, leaving taxpayers holding the bag.[29]

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HYDROELECTRIC

- Hydroelectric power provides 3.3 percent of total U.S. energy production.
- Hydroelectric power produced 7.9 percent of U.S. electricity in 2011.
- The United States is the world's fourth largest hydroelectric producer behind China, Canada, and Brazil.[1]

Hydroelectric power is the second most significant source of renewable energy in the United States, providing 3.3 percent of total energy and roughly 35 percent of all renewable energy.[2] This energy is wholly dedicated to generating electricity, providing 7.9 percent of U.S electricity.[3] Hydroelectricity generates over 50 percent more electricity than all the other renewable energy sources combined.[4]

At first blush, hydroelectric power plants seem very attractive. Hydroelectric power can be used to cover peak loads in electrical grids, unlike other renewable energy, coal, nuclear, or combined cycle natural gas. Hydroelectric power plants do not create greenhouse gases and are environmentally friendly. Also hydroelectric dams serve multiple purposes: flood control, irrigation, the provision of drinking water, and recreation. Lastly, the states that generate a large percentage of their electricity from hydroelectric power have some of the lowest electricity prices in the country.

Hydroelectric dams, however, have an environmental impact. The reservoirs submerge large areas, migrating fish have a difficult time bypassing the dams, native fish populations frequently struggle to survive in reservoirs, and decaying vegetation in the reservoirs releases greenhouse gases.

Hydroelectric development has also been limited because hydroelectric power plants must be located on suitable waterways, and many locations have already been used. The Alaska Energy Authority, however, is currently working on the first large dam to be built in the United States since 1979.[5] The dam is currently scheduled to be completed in 2025.

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WIND

- Wind power provides 1.2 percent of our total energy.
- Wind power produces 2.9 percent of our electricity.
- The United States has the second largest wind capacity in the world.
- Wind producers receive $56.29 per megawatt hour of electricity produced.
- Wind is highly dependent on subsidies for new construction.

During the last decade, energy production from wind has dramatically increased. Today, wind produces about 18 times as much electricity in the United States as it did 10 years ago.[1] But even after this dramatic increase, wind produces only 1.2 percent of our energy[2] and 2.9 percent of our electricity.[3]

Wind Generation

In 2010, China surpassed the United States as the country with the largest installed wind capacity. China has 11 percent more wind capacity than the United States,[4] but because not all of China's wind capacity is connected to the grid, the United States has more useable wind capacity.

While the United States has a large amount of wind capacity, other countries produce a larger share of their electricity from wind. One of these countries is Denmark. Denmark produces nearly 20 percent of its total electricity generation from wind, but frequently uses only half of this wind-produced electricity.[5] It turns out that west Denmark cannot use, and therefore exports, an average of 57 percent of the wind power it generates.[6] Most of those exports are transmitted to Norway and Sweden, whose electricity is composed mainly of hydroelectric power, a zero-emitting greenhouse gas technology. In order to generate such a large percentage of its electricity from wind, Denmark provides large subsidies for wind. As a result, residents pay more for their electricity than any other country in the European Union.[7]

Subsidies, Mandates, and Preferential Tax Treatment

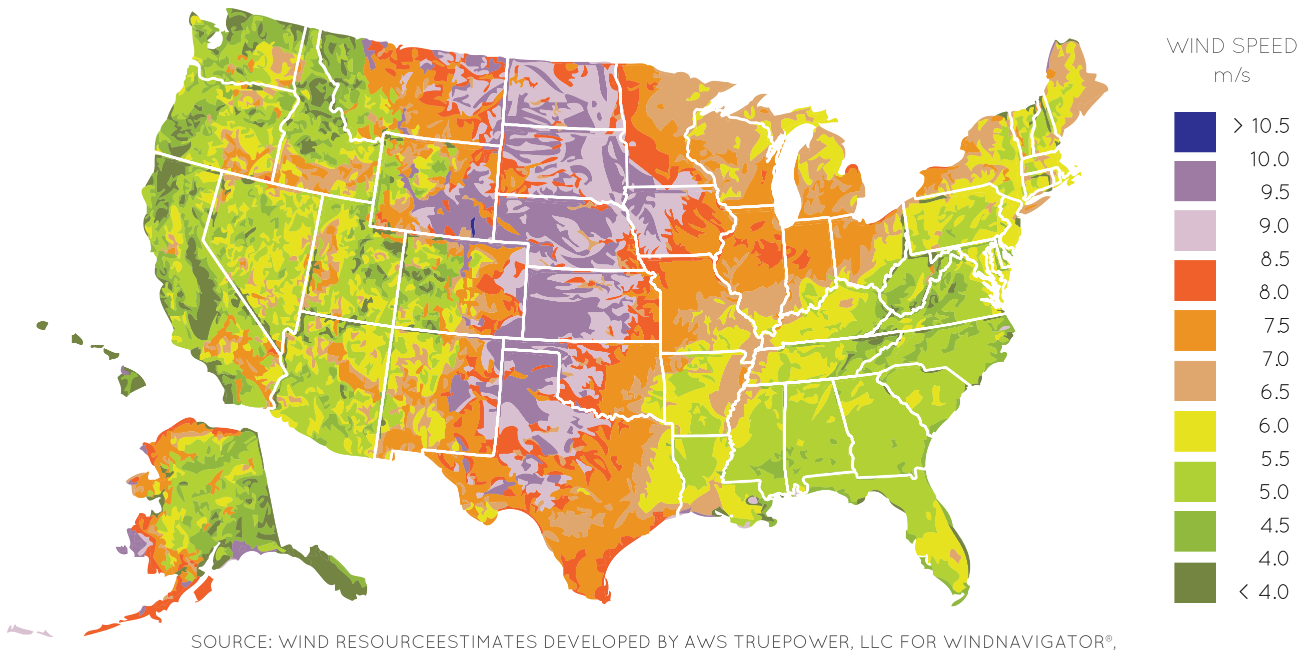
In an effort to boost wind generation in the United States, the federal government provides wind energy producers with substantial tax subsidies. Although fossil fuels receive larger total subsidies than wind power, when one compares the subsidies per unit of energy output, wind subsidies dwarf those of more conventional resources. According to EIA, total federal subsidies for wind-generated electricity for fiscal year 2007 were $23.37 per megawatt hour, compared to $1.59 for nuclear, $0.67 for hydroelectric power, $0.44 for conventional coal, and $0.25 for natural gas and petroleum liquids.[8]

In fiscal year 2010, the subsidies for renewables were even higher. For solar power, the subsidies totaled $775.64 per megawatt hour, for wind $56.29, for nuclear $3.14, for hydroelectric power $0.82, for coal $0.64, and for natural gas and petroleum liquids $0.64.[9]

Wind power receives a production tax credit of 2.1 cents per kilowatt-hour.[10] Or, wind producers can opt instead for the section 1603 grant program. This program provides a grant for 30 percent of the basis of the property. This federal subsidy was originally set to expire in 2010, but legislation during the lame duck session of 2010 extended the program for another year.[11] Because wind energy is more expensive than fossil fuel technologies, companies rely on these government subsidies and mandates to construct their units and to sell electricity generated from wind. These subsidies, however, have kept wind energy prices artificially lower than their true costs.[12]

Offshore wind costs 2.5 times as much as onshore wind, but is being promoted by some politicians in the United States. The Cape Wind project, off the coast of Cape Cod in Massachusetts, is expected to be the first offshore wind farm in the United States. The 130-turbine wind farm is estimated to cost at least $2 billion and was approved in 2010 by Interior Secretary Ken Salazar after more than eight years of federal review. National Grid, the state's largest utility, is to buy half of Cape Wind's power, starting at 18.7 cents per kilowatt hour,[13] less than EIA's estimate of 24.32 cents per kilowatt hour, but increasing annually at 3.5 percent in a 15 year deal. But 18.7 cents per kilowatt hour is still about twice what the utility pays for power from conventional sources, and almost twice the average U.S. cost of electricity—9.99 cents per kilowatt in 2011.[14] Not surprisingly, the project is having trouble finding buyers for the other half of its output because of its high cost.[15]

UNITED STATES—ANNUAL AVERAGE WIND SPEED AT 80M



SOURCE: WIND RESOURCEESTIMATES DEVELOPED BY AWS TRUEPOWER, LLC FOR WINDNAVIGATOR®,
WEB: HTTP://WWW.WINDNAVIGATOR.COM | HTTP://WWW.AWSTRUEPOWER.COM
SPATIAL RESOLUTION OF WIND RESOURCE DATA: 2.5 KM
PROJECTION: ALBERTS EQUAL AREA WGS84

Wind Challenges

One of the biggest challenges for wind is that the best wind resources are far from major population centers. Many states have areas of good wind potential, but the best area for wind in the United States is a corridor that extends from Texas to North Dakota.[16]

But while this corridor has good wind resources, it is far from population centers where electricity is needed. Long transmission lines would be needed to bring the power to market and it is often difficult to secure permits to site new transmission lines.[17] For example, the Public Utility Commission of Texas estimates that it will cost $5 billion just to run a transmission line from the areas of good wind resources in west Texas to the population centers of east Texas.[18]

Wind turbines do not emit pollution as they produce electricity, but wind turbines nevertheless have negative environmental impacts. Wind turbines harm birds, bats, and other animal populations.[19] Many environmentalists are particularly concerned with the health of endangered raptor populations. There is also evidence that the vibrations and noise from wind turbines can cause negative health effects.[20] Lastly, many consider wind turbines to be unsightly and even unsettling in pastoral settings.

Because wind is a diffuse energy source, especially compared to fossil fuels, wind generation requires far more surface area to produce as much energy as coal, oil, or natural gas. For example, it would take 7,700 3.6-megawatt wind turbines to produce as much energy per year as a high quality natural gas well.[21] That many wind turbines would cover an area of 1,475 square miles, or 65 times the size of Manhattan.[22]

Lastly, we like electricity to be always on and always on-demand. But the wind doesn't always blow. Weather forecasts are improving and these improved forecasts are helping better predict when and how much the wind will blow, but that does not help balance the ups and downs of electricity demand.[23] As a result, wind power must have redundant backup such as natural gas turbines or hydropower to produce electricity when demand is high and wind power production is low.

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GEOTHERMAL

- Geothermal power provides 0.2 percent of our total energy.
- Geothermal power produces 0.4 percent of our electricity.
- The United States is the largest geothermal producer in the world.

Geothermal energy is derived from the natural heat of the earth's core. Hot water or steam is extracted from underground to heat buildings or generate electricity. The United States generates more geothermal energy than any other country, but geothermal power provides only 0.2 percent of total U.S. energy[1] and 0.4 percent of U.S. electricity production.[2]

Most U.S. geothermal reservoirs are located in Alaska, Hawaii, and the western states. With current technology, reservoirs with temperatures of 300 to 700 degrees Fahrenheit are necessary for commercial power plants.[3] Hot water or steam is extracted from these reservoirs and piped to steam turbines that drive electricity generators.[4] Five states have geothermal power plants: California (34 plants), Nevada (16 plants), Hawaii, Idaho, and Utah (one plant each).[5]

Reservoirs with low or moderate temperatures can be used for direct-use applications such as space heating or for "district" heating (whereby a sole source of geothermal energy is used to heat multiple buildings or a wider community). Lower-temperature, shallow-ground geothermal resources can also be used by heat pumps to heat and cool individual buildings. This approach is becoming increasingly popular in new home construction.

Geothermal is Renewable

Geothermal power is a renewable resource. The earth naturally produces heat and whatever water is lost during the power generation process is replenished by rainfall.[6] Geothermal power has a negligible impact on the environment, as power plants do not burn fuel and therefore have very low emission levels. Steam from geothermal reservoirs naturally contains hydrogen sulfide, a hazardous air pollutant. This pollutant is removed from the hot water and steam through the use of scrubber systems.[7]

Geothermal Challenges

Geography limits geothermal capacity. With current technology, there is a very limited number of high-grade locations where geothermal power can be affordably used. If geothermal technology improves, however, there is great potential. One study found that geothermal power could provide 10 percent of the electricity in the United States by 2050.[8] Currently, though, the technology to provide cost-effective geothermal outside of high-grade areas is not affordable.

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SOLAR

- Solar power provides 0.1 percent of our total energy.
- Solar power is expensive—photovoltaic solar is more than twice as expensive as coal, and thermal solar is more than three times as expensive.
- Solar power produces 0.04 percent of our electricity.
- Solar power producers receive subsidies of $775.64 per megawatt hour of electricity produced.

Solar power has a longer history than some might imagine. The first solar cells were made in 1883 by American inventor Charles Fritts.[1] The first photovoltaic cells powerful enough to run everyday electrical equipment were created in 1954.[2] The first utility-scale solar plants were built in the 1980s both by the Department of Energy and by private companies.[3] But because solar is the most expensive way to create electricity, solar market penetration has been very low.

Solar production has increased 78 percent during the past 10 years.[4] But even with this dramatic increase, solar provides only 0.1 percent of U.S. energy[5] and 0.04 percent of U.S. electricity.[6]

Solar Technologies

There are a variety of solar energy technologies, including reflector mirrors for industrial electricity production, small water-heating panels, and photovoltaic cells. Photovoltaic cells, also called solar cells, are probably the most important solar technology. Today, the most efficient solar film panels are only about 12.8 percent efficient.[7] In real world conditions, however, this rate deteriorates over time.[8] Such low conversion rates explain part of the cost premium of solar over other sources of electricity generation.

Subsidies, Mandates, and Preferential Tax Treatment

While solar power is older than many realize, it provides a very small percentage of energy today because it is very expensive compared to other sources of energy, even after generous taxpayer subsidies.

The Energy Information Administration estimates that the levelized costs per kilowatt hour is 21.1 cents for a photovoltaic solar (solar PV) plant and 31.2 cents for a thermal solar plant.[9] That is far more expensive than the 6.6 cents per kilowatt hour for conventional combined cycle natural gas and the 9.5 cents per kilowatt hour for conventional coal. Also, EIA inflates the cost of coal by the equivalent of $15 per metric ton of carbon dioxide emitted, to represent the difficulty of obtaining financing for coal plants.

Solar receives substantial subsidies from the federal government. Total federal subsidies for electric production from solar power in fiscal year 2007 were $24.34 per megawatt hour, compared to $1.59 for nuclear, $0.67 for hydroelectric power, $0.44 for conventional coal, and $0.25 for natural gas and petroleum liquids.[10] In fiscal year 2010, they were even higher. For solar power, they were $775.64 per megawatt hour, for wind $56.29, for nuclear $3.14, for hydroelectric power $0.82, for coal $0.64 and for natural gas and petroleum liquids $0.64.[11] These subsidies include the federal investment tax credit, but do not include accelerated depreciation (a five-year tax write-off) and applicable state subsidies.

Foreign Governments are Cutting Back on Unsustainable Solar Subsidies

Some U.S. politicians and renewable industry groups have pointed to the European governments' promotion of solar and other renewables through lavish subsidies as a model the United States should emulate.[12] Many European governments provide substantial subsidies for solar. For example, Germany pays $0.38 per kilowatt hour for electricity from solar.[13] In comparison, the average retail price of electricity in the United States is just $0.099 a kilowatt hour.[14]

Spain's lavish solar subsidies pay up to 575 percent above the average electricity price for solar photovoltaic plants.[15] These high subsidies caused 40 percent of the world's total solar installation to occur in Spain in 2008.[16] As a result, the Spanish government's payout of subsidies for solar energy increased from $331 million in 2007 to $1.5 billion in 2008.[17]

The financial burden created by these subsidies has forced the German and Spanish governments to pull back and reduce their subsidies considerably. Germany has approved cuts to its solar subsides in an effort to bring solar construction back to sustainable levels[18] and Spain's solar growth has also become unsustainable. Spain now has a $21 billion electricity rate fund deficit because it has kept electricity rates too high while paying large solar subsidies.[19] In 2008, the Spanish government reduced its subsidies for solar, and it slashed subsidies by 30 percent in late 2010.[20]

Subsidizing Solar is an Expensive Way to Create Jobs

Although solar and other renewables are expensive, some argue we should subsidize renewables to create "green jobs." This has proven to be a very expensive proposition in places where it has been tried. In Spain, for every green job financed by Spanish taxpayers, 2.2 jobs were lost as an opportunity cost.[21] Since 2000, Spain committed $750,000 for every green job created.[22] The situation is similar in Germany. Financial aid to Germany's solar industry is as high as $240,000 per job created.[23] Over the last decade, Germany has provided $73 billion for solar and $28 billion for wind. A similar expenditure in the United States would equal half a trillion dollars.[24]

Other Solar Challenges

Solar energy suffers from some of the same problems that plague wind energy, namely inconsistency, non-reliability, and the large land area required. The sun does not always shine on a given locale, and the strength of sunshine is not always sufficient during periods of peak energy demand. New photovoltaic plants produce their full capacity only 25 percent of the time and new thermal solar plants produce their nameplate capacity only 18 percent of the time.[25] This unreliability means that solar energy is not commercially viable in many areas.

Solar energy is also land-intensive. Solar power production of the large amounts of electricity necessary to satisfy demand would require massive fields of reflectors or solar cells. These large fields are usually located in areas that are sunnier and drier than the rest of the country, such as the Southwest. Yet the reflectors or solar cells must be cleaned regularly, which pushes the limits of water resources in already water-scarce regions.

As with wind, the areas best suited for solar power are located far from population centers. The power lines to bring the electricity to market are expensive and it is frequently difficult to procure the necessary regulatory approvals. One example is the 120-mile Sunrise Powerlink in southern California. This power line will take years to secure the necessary permits and is estimated to cost $1.88 billion for construction.[26]

Solar Company Failures

For years, the government has provided subsidies for solar firms as well as mandates that require the use of electricity from solar sources. But even with substantial subsidies and a guaranteed market, a number of solar companies have failed. The most high-profile of the solar failures was the Fremont, California-based company named Solyndra. The company received $530 million in loans from the federal government, as well as a visit from President Obama to tout the company's products. But in the end, the money and goodwill was not enough to keep the company afloat.

Solyndra wasn't the only solar company to fail in 2011. At least seven solar-panel manufactures went bankrupt or filed for insolvency in 2011.[27] These failures included the German firms Solar Millennium AG and Solon SE. The German firms failed despite feed-in tariffs which provide solar electricity providers with revenue in excess of market rates.

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CONCLUSION

America is an energy rich nation. We are the world's largest natural gas producer, the second largest coal producer, and the third largest oil producer. According to the Congressional Research Service, we have the most fossil fuel resources of any country on Earth, but most of these resources are off-limits due to federal policies. Sadly, many policymakers either do not understand these facts, or they try to reduce our ability to use America's vast energy sources.

The problem with making energy resources off limits is that energy is the lifeblood of the economy. Energy is an input into almost all economic activity. The use of energy makes our life better by magnifying our abilities and allowing us to do more with the one resource for which there is no substitute—time.

Americans should have more access to our domestic energy resources and the market should enable energy consumers to pick winners and losers, not politicians and unelected bureaucrats. Energy subsidies and preferential treatment are forms of discrimination that harm energy producers, consumers, and taxpayers alike through higher prices and higher taxes.

Because much of America's massive energy resources lie on federal land, production of these resources depends on the federal government. For too long, in both Republican and Democratic administrations, the federal government has denied access to many of these resources and created byzantine regulatory processes. The federal government needs to simplify and promote certainty in the permitting process instead of maintaining the current opaque regulatory framework. Today's rules simply discourage people who want to do business and produce energy in the United States.

Given the increasing demand for energy around the world, now is the time to seize America's great energy potential and unleash our creative abilities to solve today's and tomorrow's energy challenges. There is no shortage of energy in this country, but up to this point we have been hampered by governmental policies that restrict our ability to prosper. Allowing access to our own energy resources will grow the economy, lower energy prices, and create the necessary jobs to thrive during good and bad economic times.

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Thank you all,

Daniel Simmons

GLOSSARY

Barrel of Oil: A unit of volume equal to 42 U.S. gallons (of oil)

BOEM (Bureau of Ocean Energy Management): Formerly the Minerals Management Service. BOEM is an agency of the Department of the Interior that manages natural gas, oil, and other mineral resources on the Outer Continental Shelf.

Capacity factor: The ratio of the electrical energy produced by a generating unit for the period of time considered to the electrical energy that could have been produced at continuous full power operation during the same period.

Coalbed methane: Unconventional natural gas found in underground coal seams. It can be extracted in existing coal mines or through the use of hydraulic fracturing.

Conventional oil: Crude oil that is produced by a well drilled into a geologic formation in which the reservoir and fluid characteristics permit the oil to readily flow to the wellbore.

Criteria pollutants: The Clean Air Act requires EPA to regulate six common air pollutants—ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead. These are known as the criteria pollutants.

Greenhouse gas: A gas absorbs and emits radiation within the thermal infrared range. Greenhouse gases include carbon dioxide, methane, nitrous oxide, fluorinated gases. These gases are sometimes erroneously called "carbon" emissions. Nitrous oxides and fluorinated gases, however, are greenhouse gases, but do not contain carbon.

Heavy Oil: Unconventional oil source that is thicker and heavier than conventional oil. Heavy oil is a biodegraded form of traditional oil, where the lighter parts of the oil are gone, often by being consumed by bacteria in the reservoir.

Hydraulic Fracturing: Procedure for stimulating and enhancing oil and natural gas wells. A mixture of mostly water and sand is injected under high pressure to wells thousands of feet below the surface to break apart, or "fracture," the surrounding shale rock, which releases trapped oil or natural gas and is then pumped to the surface. Sometimes referred to as "fracking" or "hydrofracturing."

Levelized Cost: The present value of the total cost of building and operating a generating plant over its economic life, converted to equal annual payments. Costs are levelized in real dollars (i.e., adjusted to remove the impact of inflation).

Methane hydrates: Methane hydrates, also known as natural gas hydrates are solid, crystalline, ice-like substances composed of water, methane, and usually a small amount of other gases, with the gases frozen in ice. They form under high pressure and at low temperatures and are located in ocean-bottom sediments and permafrost regions. It has been estimated that 270 million trillion cubic feet of natural gas could theoretical exist in hydrate deposits.

Natural gas: A gaseous mixture of hydrocarbon compounds, the primary one being methane.

OCS (Outer Continental Shelf): The submerged lands, subsoil, and seabed, lying between the seaward extent of the States' jurisdiction and the seaward extent of Federal jurisdiction. Generally, the OCS begins 3–9 nautical miles from shore (depending on the state) and extends 200 nautical miles outward, or farther if the continental shelf extends beyond 200 nautical miles.

Oil Sands: Naturally occurring thick heavy oil (bitumen) impregnated sands that yield mixtures of liquid hydrocarbon and that require further processing other than mechanical blending before becoming finished petroleum products.

Oil Shale: A sedimentary rock containing kerogen, a solid organic material.

Photovoltaic cells: An electronic device consisting of layers of semiconductor materials fabricated to form a junction (adjacent layers of materials with different electronic characteristics) and electrical contacts and being capable of converting light directly into electricity (direct current).

Plutonium: A heavy, fissionable, radioactive, metallic element (atomic number 94) that occurs naturally in trace amounts. It can also result as a byproduct of the fission reaction in a uranium-fuel nuclear reactor and can be recovered for future use.

Reserves (oil, natural gas, and coal):

In-Place Resources: All oil, natural gas, or coal in a given formation, regardless of economic or technical recoverability.

Coal Resources:

Demonstrated Reserve Base (DRB): Coal resources that are known to exist (to a certain degree of accuracy) and could likely be recovered economically with current technologies.

Technically Recoverable Reserves (Coal): Portion of the demonstrated reserve base that can be recovered using existing technologies.

Economically Recoverable Reserves (Coal): Portion of the technically recoverable reserves that can be recovered under current economic conditions.

Oil and Natural Gas Quantity Definitions

Undiscovered Resources: Undiscovered oil and natural gas in currently unexplored areas that is estimated to exist based upon geologic characteristics.

Undiscovered Technically Recoverable Resources (UTRR): Portion of undiscovered resources that is recoverable with existing drilling and production technologies.

Undiscovered Economically Recoverable Resources (UERR): Portion of undiscovered technically recoverable resources that is recoverable under imposed economic or technical conditions.

Proved Reserves: Oil and natural gas that have already been discovered, typically through actual exploration or drilling, and which can be recovered economically.

Shale Oil and Gas: Unconventional oil and natural gas source that is trapped in sedimentary rock formations known as shale. Production typically requires the use of hydraulic fracturing.

Unconventional Oil or Natural Gas Deposit: When natural gas or oil is distributed throughout a geologic formation instead of confined to a single reservoir. Extraction typically requires technologies and procedures in addition to—or markedly different from—what is required to obtain conventional deposits. Key examples: shale gas, oil sands, coalbed methane, and heavy oil.

Uranium: A heavy, naturally radioactive, metallic element (atomic number 92). Its two principally occurring isotopes are uranium-235 and uranium-238. Uranium-235 is indispensable to the nuclear industry because it is the only isotope existing in nature, to any appreciable extent, that is fissionable by thermal neutrons. Uranium-238 is also important because it absorbs neutrons to produce a radioactive isotope that subsequently decays to the isotope plutonium-239, which also is fissionable by thermal neutrons.

West Texas Intermediate: A crude stream produced in Texas and southern Oklahoma which serves as a reference or "marker" for pricing a number of other crude streams and which is traded in the domestic spot market at Cushing, Oklahoma.

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