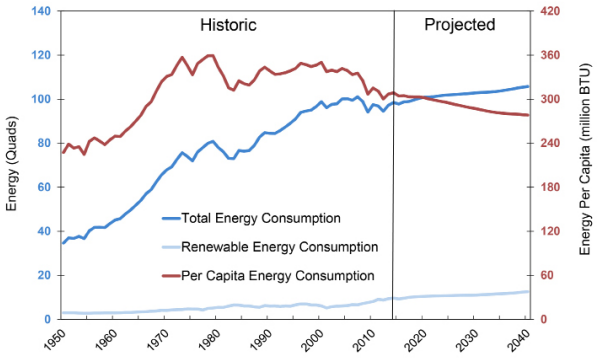
U.S. Energy System

Energy plays a vital role in modern society, enabling systems that meet human needs such as sustenance, shelter, employment, and transportation. In 2015, the U.S. spent $1.1 trillion on energy, or 6.2% of Gross Domestic Product (GDP).[1,2] When spread over the population, annual costs were $3,512 per person.[1,3] Environmental impacts associated with the production and consumption of energy include global climate change, acid rain, hazardous air pollution, smog, radioactive waste, and habitat destruction.[4] The nation's heavy reliance on fossil fuels (primarily imported petroleum) poses major concerns for energy security. Potential gains in energy efficiency in all sectors may be offset by increases in consumption, leading to overall increases in energy use.[5] The unsustainable nature of the current U.S. energy system is described below.

U.S. Energy Consumption: Historic and Projected Values[6,7]

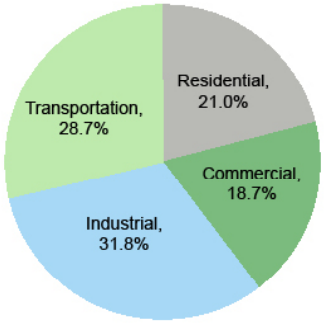


Patterns of Use

Demand

- With less than 5% of the world's population, the U.S. consumes 18% of the world's energy and accounts for 16% of world GDP. To compare, the European Union has 7% of the world's population, uses 12% of its energy, and accounts for 16% of its GDP, while China has 19% of the world's population, consumes 23% of its energy, and accounts for 18% of its GDP.[9,10]
- Each day, U.S. per capita energy consumption includes 2.5 gallons of oil, 12.3 pounds of coal, and 233 cubic feet of natural gas.[8,9]
- Residential daily consumption of electricity is 11.9 kilowatt-hours (kWh) per person.[8,9]
- In 2016, total U.S. energy consumption was 4% below 2007 peak levels, similar to total energy consumption in 2002.[8]

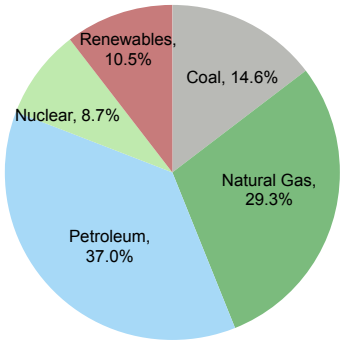
U.S. Energy Consumption by Sector, 2016[8]



Supply

- By current estimates, 78% of U.S. energy will come from fossil fuels in 2050.[6]
- Renewable energy consumption is projected to increase annually at an average rate of 1.7% between 2016 and 2050, compared to 0.3% growth in total energy use. Photovoltaics are projected to grow the fastest. At these rates, renewables would only provide 14% of U.S. energy consumption in 2050, which is more than today's 10.14% renewable energy consumption.[6,8]
- U.S. net imports met 24% of domestic oil demand in 2016.[8] This figure is projected to drop to 17% in 2050.[6] Canada, Saudi Arabia, and Venezuela are the three largest foreign suppliers of U.S. oil.[11]
- The Persian Gulf region accounted for 18% of U.S. petroleum imports in 2016 and contains 48% of the world's oil reserves.[11,12] Roughly 16% of all reserves lie in Saudi Arabia alone.[12] OPEC controlled 34% of the oil imported by the U.S. in 2016.[8]
- There is disagreement as to when oil production will peak. Assuming reserves of 3.3 trillion barrels and a production growth rate of 2%, the U.S. Department of Energy (DOE) projects global oil production to peak in 2044.[13]

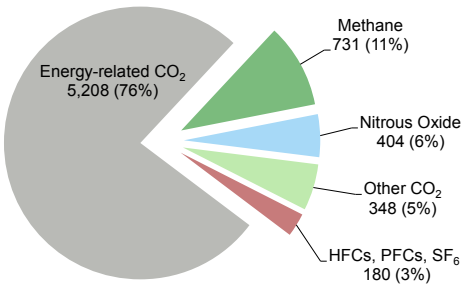
U.S. Energy Consumption by Source, 2016[8]



Life Cycle Impacts

- Air emissions from the combustion of fossil fuels are the primary environmental concern of the U.S. energy system. Such emissions include carbon dioxide (CO_2), nitrogen oxides, sulfur dioxide, volatile organic compounds, particulate matter, and mercury.
- U.S. total GHG emissions increased by 4% from 1990 to 2015. 77% of total U.S. GHG emissions were energy-related CO_2 emissions in 2015.[14]
- Other energy sources also have environmental implications. For example, issues associated with nuclear power generation include radioactive waste and a high energy requirement to build the plants and mine the uranium; large hydroelectric power plants cause habitat degradation and fish kills; and wind turbines alter landscapes in ways some find unappealing and can increase bird and bat mortality.[15]

U.S. GHG Emissions, 2015[14]
(Million Metric Tons CO_2 Equivalent)



Solutions and Sustainable Alternatives

Consume Less

- Reducing energy consumption not only brings environmental benefits, but also can result in cost savings for individuals, businesses and government agencies.
- Living in smaller dwellings, living closer to work, and utilizing public transportation are examples of ways to reduce energy usage. See the Center for Sustainable Systems' factsheets on personal transportation and residential buildings for additional ways to trim energy consumption.

Increase Efficiency

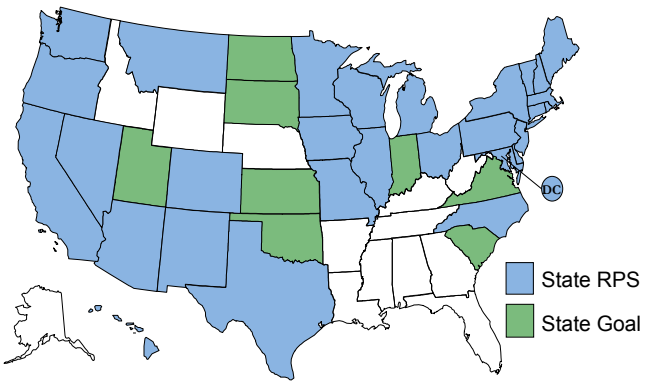
- An aggressive commitment to total cost-effective energy efficiency could reduce U.S. carbon emissions by 500 million metric tons per year.[16]
- Additional information on energy efficiency can be found at the following organizations' websites:
  - General: U.S. DOE Energy Efficiency and Renewable Energy, http://energy.gov/eere/office-energy-efficiency-renewable-energy
  - Residential & Commercial: U.S. EPA Energy Star, https://www.energystar.gov
  - Transportation: U.S. DOE and EPA Fuel Economy Guide, https://www.fueleconomy.gov
  - Industrial: U.S. DOE Industrial Technologies Program, http://energy.gov/diversity/downloads/eere-industrial-technologies-program

Increase Renewables

- U.S. installed wind capacity grew 11% in 2016, expanding to 82 GW.[17] If 224 GW of wind capacity were installed by 2030, an amount determined feasible by one U.S. DOE study, wind would satisfy 20% of projected electricity demand.[18]
- Solar photovoltaic modules covering 0.6% of the land in the U.S. could supply all of the nation's electricity.[19]

Encourage Supportive Public Policy

States with Renewable Energy Portfolio Standards[28]



- The U.S. currently produces 16% of the world's energy-related CO_2 emissions, which are expected to increase by 1.4% between 2016 and 2050.[6,20] The Clean Energy and Security Act, passed by the House in June 2009, would have required emissions reductions of 3% below 2005 levels in 2012, 20% below 2005 levels in 2020, 42% below 2005 levels in 2030, and 83% below 2005 levels in 2050.[21] The Act was not brought to a vote in the Senate and did not become law.[22] In comparison, the United Kingdom established a goal of reducing CO_2 emissions 80% below their 1990 level by 2050.[23]
- A joint rule issued by the U.S. EPA and National Highway Traffic Safety Administration (NHTSA) in 2012 set new auto manufacturing standards for model years 2017-2025, raising corporate average fuel economy (CAFE) standards to 54.5 miles per gallon for new light-duty vehicles in 2025. This rule is projected to save 4 billion gallons of fuel, between $326 and $451 billion, and cut CO2 emissions by 2 billion metric tons.[24]
- An additional rule, issued by the U.S. EPA and NHTSA in 2012, raises CAFE standards to 49.7 miles per gallon in 2025, which is projected to save 4 billion gallons of fuel, $300-400 billion, and cut CO_2 emissions by 2 billion metric tons.[25] In comparison, if the Arctic National Wildlife Refuge (ANWR) were opened to oil drilling, production would peak at 284.7 million barrels of oil per year in 2027.[26]
- The growth of wind and biomass was spurred by the 2.3¢/kWh Federal Production Tax Credit (PTC), as well as state Renewable Energy Portfolio Standards (RPS) that require a certain percentage of electricity be derived from renewable sources. The PTC for wind will expire December 31, 2019.[27] Thirty-seven states, the District of Columbia, and four U.S. territories had renewable portfolio standards or goals in place as of February 2017.[28]
- A $2,500-$7,500 federal tax credit is available for electric and plug-in hybrid electric vehicles purchased after January 1, 2010.[29]
- Residential consumers can receive tax credits for up to 30% of purchase and installation costs for renewable energy additions to new and existing houses until 2019. Eligible renewable technologies include geothermal heat pumps, solar water heaters, solar panels, small wind turbines, and residential fuel cells.[30]

kWh = kilowatt hour. One kWh is the amount of energy required to light a 100 watt light bulb for 10 hours.
Btu = British Thermal Unit. One Btu is the amount of energy required to raise the temperature of a pound of water by 1° Fahrenheit.
Quad = quadrillion (10^{15}) Btu. One Quad is equivalent to the annual energy consumption of ten million U.S. households.

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