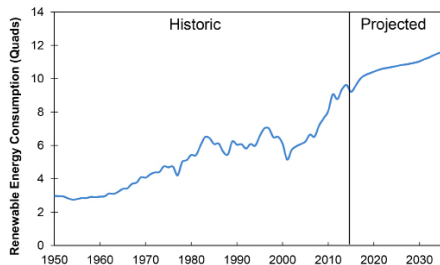


U.S. Renewable Energy

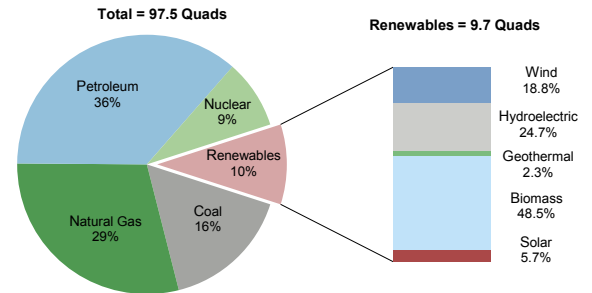
Patterns of Use

While energy is essential to modern society, most primary sources are unsustainable. The current fuel mix is associated with a multitude of environmental impacts, including global climate change, acid rain, freshwater consumption, hazardous air pollution, and radioactive waste. Renewable energy has the potential to meet demand with a much smaller environmental footprint and can help to alleviate other pressing problems, such as energy security, by contributing to a distributed and diversified energy infrastructure. About 81% of the nation's energy comes from fossil fuels, 8.5% from nuclear, and 10% from renewable sources.³ Wind is the fastest growing renewable source but contributes only 1.8% of total energy used in the United States.³ The examples below illustrate the progress and potential of U.S. renewable energy.

U.S. Renewable Energy Consumption: Historic and Projected^{1,2}



U.S. Total and Renewable Energy Consumption by Source, 2015³

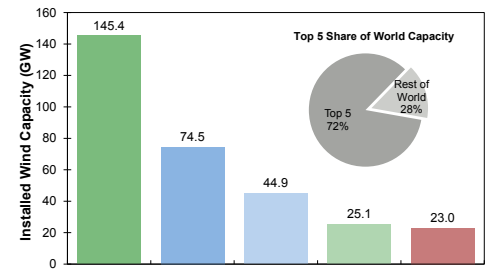


Major Renewable Sources

Wind

- U.S. onshore wind resources have the potential to generate almost 11,000 GW of electricity, 148 times more than the current installed capacity of 74.5 GW.^{5,6}
- In 2013, the U.S. installed 1.1 GW of wind capacity, a 92% decrease from 2012.⁷ This significant drop resulted from the expiration of the federal production tax credit (PTC) in 2013.⁸ Since 2013, the PTC has been retroactively reinstated with an expiration date of December 31, 2019.⁹ 8,598 GW of wind capacity were installed in the U.S. in 2015, a 12% increase in cumulative wind power capacity from 2014.⁶ Future estimates range from 80 GW to almost 400 GW by 2050.¹⁰
- Based on the average U.S. electricity fuel mix, a 1 MW wind turbine can displace 1,800 tons of CO₂ emissions per year.¹¹ With a wind power capacity of 400 GW, wind could account for 35% of U.S. electricity demand and 12.3 gigatonnes of CO₂ emissions could be avoided annually, resulting in a 14% reduction in CO₂ emissions when compared to 2013.¹²
- Wind turbines generate no emissions and use no water when producing electricity, but concerns include bat and bird mortality, land use, noise, and aesthetics.¹³

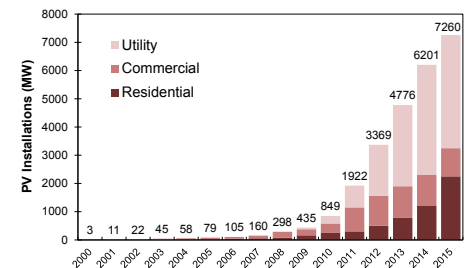
Installed Wind Capacity, Top 5 Countries, 2015⁴



Solar

- Assuming intermediate efficiency, solar photovoltaic (PV) modules covering 0.6% of U.S. land area could meet national electricity demand.¹⁵
- PV module prices have significantly declined, costing ≈ \$.83/Watt in residential systems.¹⁶ U.S. market share of PV production dropped from 30% to 7% between 2000 and 2010.¹⁷
- Solar PV installations reached an all-time high of 7,260 MW in 2015, increasing by 16% compared to 2014 installations and raising total installed capacity to 25.6 GW. Solar accounted for almost one-third of new generating capacity in 2015.¹⁴
- The U.S. Department of Energy's SunShot Initiative aims to reduce the price of solar energy 75% from 2010 to 2020, which is projected to lead to 27% of U.S. electricity demand met by solar technology and a 28% decrease in electricity sector greenhouse gas emissions by 2050.¹⁵
- While solar PV modules produce no emissions during operation, toxic substances (e.g., cadmium and selenium) are used in them.¹⁵

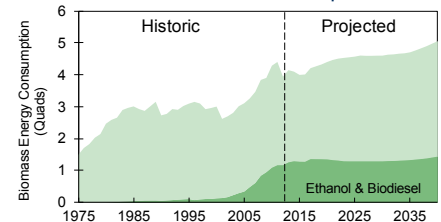
U.S. Photovoltaic Installations, 2000-2015¹⁴



Biomass

- Wood—mostly as pulp, paper, and paperboard industry waste products—accounts for 43% of total biomass energy consumption. Waste—municipal solid waste, landfill gas, sludge, tires, and agricultural by-products—accounts for an additional 11%.³
- Biomass has low net CO₂ emissions compared to fossil fuels. At combustion, it releases only CO₂ previously removed from the atmosphere. Additional emissions are associated with processing and 124 acres of land are required to generate one GWh of electricity per year.¹⁸
- U.S. ethanol production is projected to reach 39 million gallons per day in 2040.²

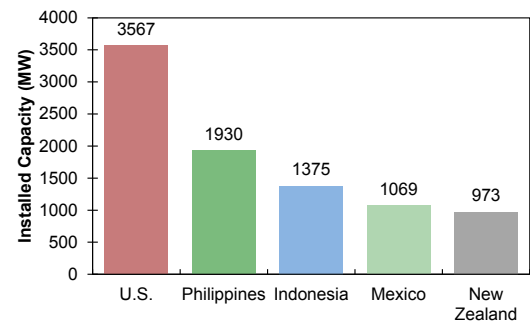
U.S. Biomass Consumption^{2,19}



Geothermal

- Hydrothermal resources, i.e., steam and hot water, are available primarily in the western U.S., Alaska, and Hawaii, yet geothermal heat pumps can be used almost anywhere to extract heat from shallow ground, which stays at relatively constant temperatures year-round.²¹
- U.S. geothermal power offsets 22 million metric tons of CO₂ emissions, 200,000 metric tons of nitrogen oxides, and 110,000 metrics tons of particulate matter from coal-powered plants each year.²² Some geothermal facilities produce solid waste such as salts and minerals that must be disposed of in approved sites, but some by-products can be recovered and recycled.²¹
- Electricity generated from geothermal power plants is projected to increase from 17 billion kWh in 2013 to 70 billion kWh in 2040 and has the potential to exceed 500 billion kWh, which is half of the current U.S. capacity.^{2,23}

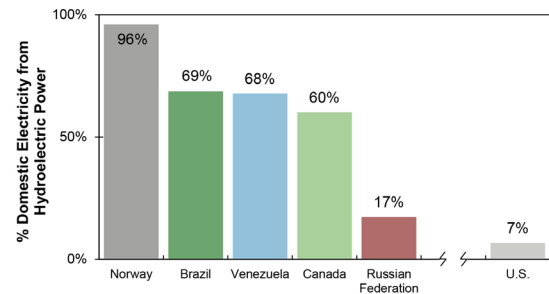
Geothermal Installed Capacity, Top 5 Countries, 2016²⁰



Hydroelectric

- In the U.S., net electricity generation from conventional hydropower peaked in 1997 at 356 TWh/yr. Currently, the U.S. gets about 251 TWh/yr of electricity from hydropower.^{3,19}
- While electricity generated from hydropower is virtually emission free, significant levels of methane and CO₂ may be emitted through the decomposition of vegetation in the reservoir.²⁵ Other environmental concerns include fish injury and mortality, habitat degradation, and water quality impairment. “Fish-friendly” turbines and smaller dams help mitigate some of these problems.²⁶

Hydropower Electricity Generation, 2013²⁴



Advancing Renewable Energy

Encourage Supportive Public Policy

- Renewable Portfolio Standards (RPS) that mandate certain levels of renewable generation are proving successful. For example, Texas installed 10,000 MW of renewable energy generating capacity in 2010, meeting its 2025 mandate 15 years early.²⁷ Thirty-seven states, the District of Columbia, and four U.S. territories had renewable portfolio standards or goals in place as of April 2016.²⁸ State standards are projected to support 103,000 MW of renewable electricity by 2050.²⁹
- Renewable energy growth is driven by important federal incentives such as the Investment Tax Credit, which offset upfront costs by 10-30%.³⁰ Tax credits, grants, and other incentives are also offered to the residential, commercial, and industrial sectors for renewable energy installations, some defraying up to 30% of the cost.³¹
- Eliminating subsidies for fossil and nuclear energy would encourage renewable energy. Congress allocated over \$15.1 billion in tax relief to the oil and gas industries for fiscal years 2015-2019.³² Studies estimate that the Price-Anderson Act, which limits the liability of U.S. nuclear power plants in the case of an accident, amounts to a subsidy of \$366 million to \$3.5 billion annually.³³
- Net metering enables customers to sell excess electricity to the grid, eliminates the need for on-site storage, and provides an incentive for installing renewable energy devices. Forty-one states, the District of Columbia, and three U.S. territories have some form of net metering program.³⁴

Engage the Industrial, Residential, and Commercial Sectors

- Renewable Energy Certificates (RECs) are sold by renewable energy producers in addition to the electricity they produce; for a few cents per kilowatt hour, customers can purchase RECs to “offset” their electricity usage and help renewable energy become more cost competitive. More than 850 utilities in the U.S. offer consumers the option to purchase renewable energy, or “green power.”³⁵
- Many companies purchase renewable energy as part of their environmental programs. Intel, Microsoft, Kohl’s, Cisco, and Google were the top five users of renewable energy as of April 2016.³⁶

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 (10¹⁵) Btu. One Quad is equivalent to the annual energy consumption of ten million U.S. households.

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