



Residential Buildings

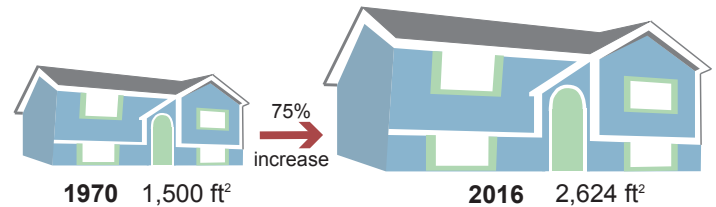
Patterns of Use

Although climate-specific, resource-efficient house design strategies exist, per capita material use and energy consumption in the residential sector continue to increase. From 2000 to 2010, the U.S. population increased by 9.7%, while the number of housing units increased by 13.6% and urban land area increased by 15%.¹ The following trends demonstrate usage patterns in the residential building sector.

Size and Occupancy

- Increased average area of a new U.S. single-family house:^{2,3,4}
1950 **983 ft²**; 1970 **1,500 ft²**; 2000 **2,265 ft²**
2016 **2,624 ft²**, a 167% increase from 1950.
- Increased average area *per person* in a new U.S. single-family house:^{2,3,5}
1950 **292 ft²**; 1970 **478 ft²**; 2000 **840 ft²**
2016 **1,037 ft²**, a 256% increase from 1950.
- Decreased average number of occupants *per U.S. household*:^{2,5}
1950 **3.37**; 1970 **3.14**; 2015 **2.62**
2016 **2.53**, a 25% decrease from 1950.
- A majority of Americans live in single-family houses. In 2013, 64% of the 116 million U.S. households were single family.⁶
- In 1950, 9% of housing units were occupied by only one person.⁷ By 2016, this value had increased to 28%.⁵

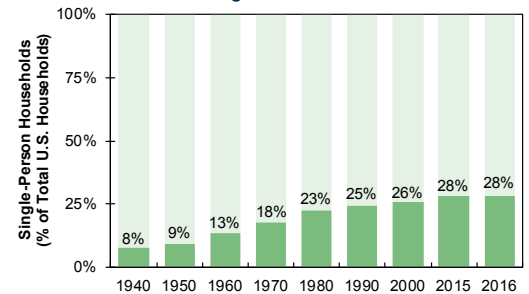
Average Size of a New U.S. Single-Family House^{3,4}



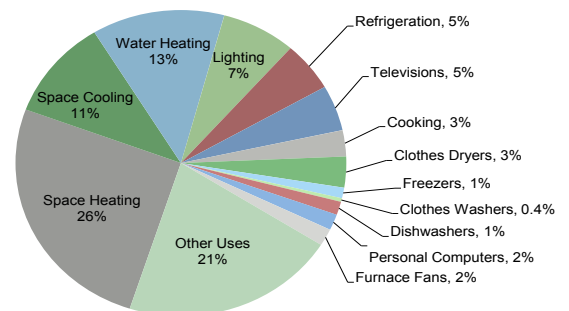
Energy Use

- A 1998 study by the Center for Sustainable Systems of a single-family house in Michigan showed an annual energy consumption of 1.3 GJ/m².⁹
- A study of 3 houses in Sweden built in the 1990s estimated annual energy consumption from 0.49–0.56 GJ/m², less than half the energy consumed by the Michigan house.¹⁰
- Residential electricity consumption increased 13-fold from 1950 to 2015. In 2015, the residential sector consumed 1.47 trillion kWh of electricity, 38% of U.S. electricity consumption.¹¹
- In 2016, the U.S. residential sector consumed 20 quadrillion Btu of primary energy, 21% of U.S. primary energy consumption.¹²
- Between 1990 and 2014, total residential GHG emissions increased by 20%, accounting for 17% of total U.S. GHG emissions in 2014.¹³
- Miscellaneous load per household doubled from 1976 to 2006. Miscellaneous loads consume more electricity than any other residential end use (lighting, HVAC, water heating, and refrigeration), accounting for 2.4% of a household's electricity and 16% of primary energy consumption.¹⁴
- Wasteful energy uses include heating and cooling of unoccupied homes and rooms, inefficient appliances, thermostat oversetting, and standby power loss. Together, these uses represent about 39% of residential primary energy use.¹⁵
- Home energy management systems display energy use via in-home monitor or mobile application and enable remote control of devices. Home energy management systems can reduce a house's energy use by an estimated 4-7%.¹⁶

U.S. Single-Person Households^{5,7}



Average U.S. Residential Energy Consumption by End Use, 2016⁸



Material Use

- The average U.S. single-family house built in 2000 required 19 tons of concrete, 13,837 board-feet of lumber, and 3,061 ft² of insulation.¹⁷
- From 1975 to 2000, the consumption of clay for housing and construction more than tripled, due to its use in tiles and bathroom fixtures.¹⁸
- In 2012, around 2.4% of all wood products consumed in the U.S. were used for residential construction.¹⁹
- Approximately 10 million tons of waste was generated in the construction of new residential buildings in 2003—4.4 lbs per ft².²⁰
- U.S. average recycling rate of waste from construction and demolition (C&D) is 20-30%.²¹ Seattle recycled 57% of its C&D waste in 2015.²²

Codes and Standards

- DOE Pacific Northwest National Laboratory estimated cumulative savings from the International Energy Conservation Code (IECC) for 42 states. From 2010-2016, the IECC saved 0.27 quadrillion Btu of primary energy, 1% of residential primary energy consumption in 2016.¹² Cumulative energy savings generated \$3.2 billion (2016 dollars) in cost savings and avoided 17.6 million metric tons of CO₂.²³
- For most building types, conventional energy efficiency technologies can achieve a 20% reduction in energy use relative to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 90.1-2004 standard.²⁴
- Florida's 2007 energy code saved 13% relative to pre-2007 energy consumption through the reduction in heating, cooling and hot water demand. Efficiency gains were offset by increasing house sizes and plug loads.²⁵

