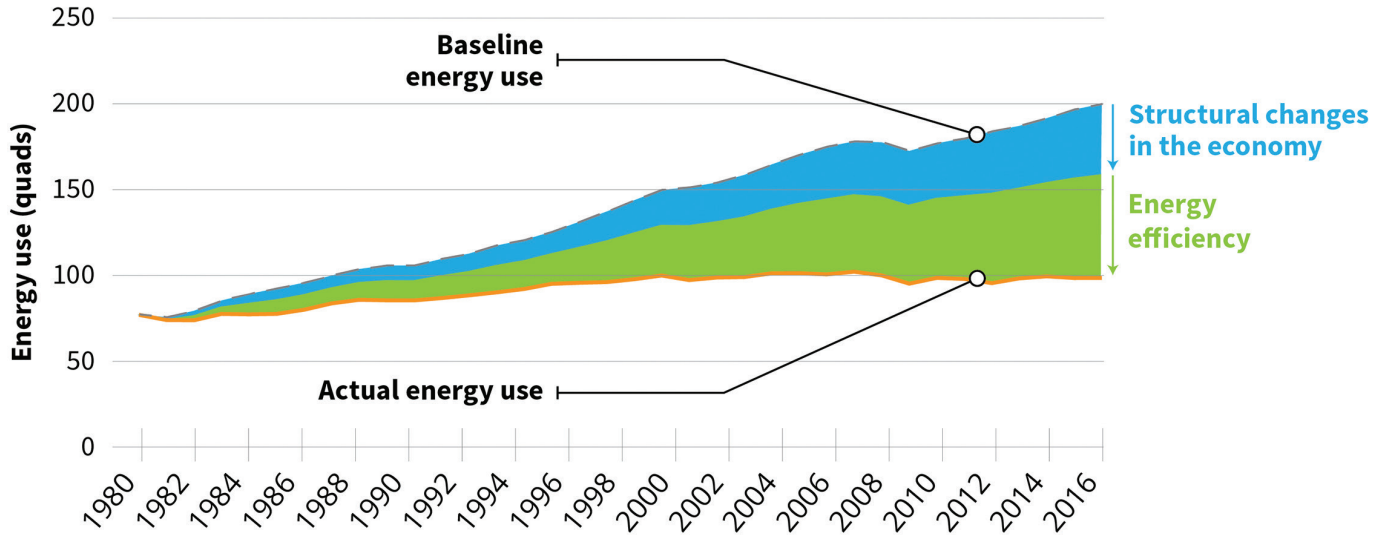
ACEEE
American Council for an Energy-Efficient Economy

The Road to Cutting US Energy Use and Emissions in Half While Strengthening the Economy



The United States can put itself on a path to halving energy use by 2050 by implementing 13 packages of energy efficiency measures. These efforts will save the nation billions of dollars in lower energy bills, create domestic jobs, improve health by reducing pollution, and make homes and businesses more comfortable.

US ENERGY EFFICIENCY HAS IMPROVED SUBSTANTIALLY

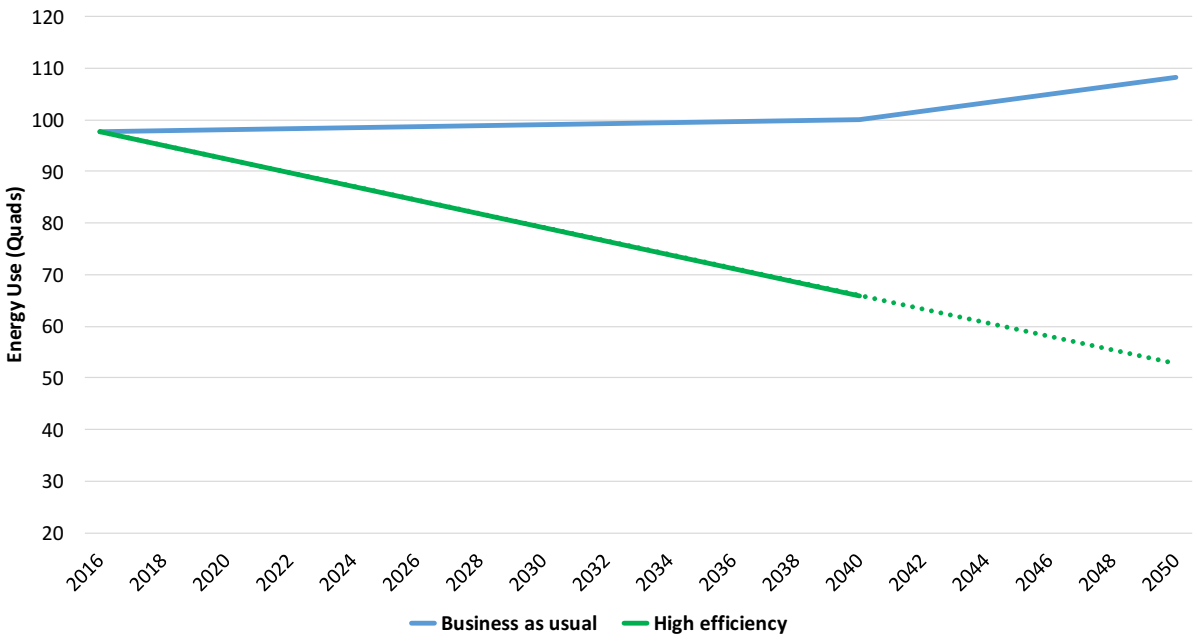
Since 2000, energy use in the United States has been approximately level, even as our economy has grown by 32%. Since 1980, energy use per dollar of gross domestic product (GDP) has fallen by more than half, with the majority of this change attributable to energy efficiency. The rest of the change is mostly due to structural changes in our economy. The figure above illustrates these trends. Energy efficiency has reduced US energy use about 50% relative to what it would have been if 1980 patterns had continued. These reductions in energy use are saving every American $2,500 per year in energy bills and reduced prices for products and services.

SUSTAINING AND RAMPING UP EFFICIENCY IMPROVEMENTS

ACEEE recently conducted an analysis to see if this rate of efficiency improvement could be sustained or even accelerated. We looked at projected 2050 energy use and greenhouse gas (GHG) emissions and considered whether these could be cut in half while continuing to grow our economy. We examined 13 sets of efficiency measures, modeling their impact through 2040 and seeing if they could put us on a trajectory to halve energy use by 2050. As shown in the figure on the next page, we conclude that efficiency can put us on that path of dramatically lower energy use. We also modeled emissions and the decline is similar.

Many measures contribute to these efficiency improvements. Of the energy savings, nearly half are in the commercial and residential building sectors, 25% in transportation, 21% in industry, and 7% in the power sector.

Zero energy buildings and homes. Thousands of new homes and hundreds of new commercial buildings today

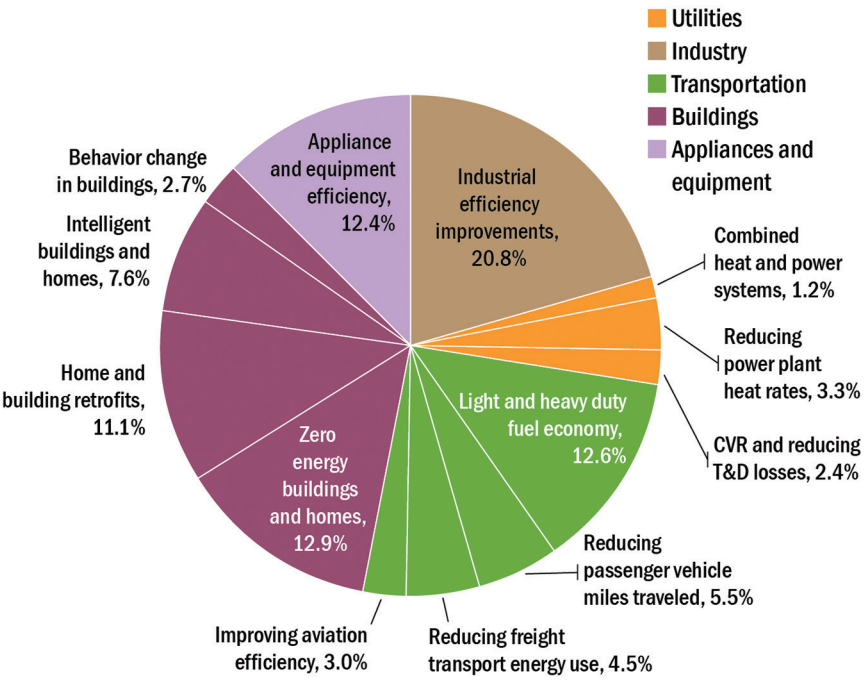


Energy use in a business-as-usual and high-efficiency scenario

produce at least as much energy as they use on an annual basis. Commonly labeled zero energy buildings (ZEB), they combine high levels of energy efficiency with solar or other renewable energy systems to meet building loads. Related to ZEB are ultra-low energy (ULE) buildings, sometimes labeled ZEB ready. By reducing energy use, ULE construction makes ZEB much more feasible. ZEB and ULE can sometimes lower costs by allowing simpler heating and cooling systems. Multiple organizations and states are working to make ZEB common practice in new construction by 2030 through a combination of R&D, implementation, and building code strategies.

Home and building retrofits. A substantial share of the homes and commercial buildings that will be standing in 2050 have already been built. This reality makes the retrofit of existing buildings critically important. Programs such as Home Performance with ENERGY STAR® can reduce energy use by 20% or more, and retrofits saving 50% or more have been documented. Similar savings are possible in commercial buildings. For example, a retrofit of the Empire State Building in New York is projected to reduce energy use by 38%, while a deep energy retrofit of a large federal office building in Maryland is projected to save 60%. To achieve these savings, we need our building retrofit efforts to go wider (involve more buildings) and deeper (achieve more savings per building). Multiple strategies can achieve these savings, including building energy use transparency (e.g., benchmarking, rating, access to energy use data), contractor training and certification, home and building owner education and technical assistance, incentives and financing for energy efficiency improvements, and improved program designs to increase participation rates and savings per building.

Intelligent buildings and homes. One type of system improvement has been labeled intelligent efficiency, that is, optimizing energy-using systems through information and communications technologies (ICT), real-time information, and smart algorithms. A simple example of an intelligent efficiency measure is a learning thermostat (e.g., Nest or Ecobee) that monitors system parameters and finds ways to improve operation after learning a household's patterns (e.g., when people are home and which temperatures they like). More sophisticated systems used in commercial and industrial buildings offer even greater reductions in energy use. Steps to realize these savings include adopting common communication protocols so that



Distribution of savings by measure and sector. CVR is conservation voltage reduction, as explained below.

systems from different vendors can talk to each other, using ICT to document savings, educating home and building owners on intelligent efficiency capabilities and benefits, documenting best practices from early projects, and conducting demonstration projects in promising market niches that lack documented results.

Behavior change in buildings. Influencing the decisions people make when using energy can also achieve savings of up to 23%. One approach is home energy reports, which are regular mailings that inform residents of their energy use relative to neighbors and how they can reduce their consumption. Other programs include real-time feedback (for example, via in-home displays or workplace dashboards), competitions and games at work or home, community-based efforts (in buildings, neighborhoods, businesses, or cities), and school education programs.

Appliance and equipment efficiency. Federal minimum energy efficiency standards currently apply to more than 50 types of appliances and equipment ranging from residential refrigerators to industrial pumps. Standards already established will reduce energy bills by nearly $2 trillion on a cumulative basis. Under federal law, these standards are periodically reviewed and updated to reflect technological developments, increasing energy savings. In addition, voluntary equipment specifications such as ENERGY STAR produce additional energy savings by going beyond federal standards or covering products not subject to them.

Industrial efficiency improvements. The energy intensity of the industrial sector has been steadily improving. Industrial energy use per dollar of shipment value declined 38% from 1980 to 2013. This rate of improvement can be sustained or even increased by optimizing industrial processes and motor, fan, pump, and compressed air systems; implementing smart manufacturing (applying intelligent efficiency strategies in the industrial sector); shifting to less energy-intense materials; and promoting continuous improvement processes—often referred to as strategic energy management.

Light- and heavy-duty vehicle fuel economy improvements. The fuel economy of US light-duty vehicles—cars and light trucks such as many SUVs and pickup trucks—has increased substantially in recent years, driven by increases in federal fuel economy standards. This rate of improvement can be sustained, leading to an average

70 mpg by 2040 as measured in the test lab. Likewise, fuel economy standards that have already been adopted for heavy-duty vehicles (which range from heavy pickup trucks to 18-wheelers) are projected to decrease fuel use by 37% by 2027 relative to 2010 vehicles. We estimate an additional 29% reduction is possible for new vehicles by 2040. Achieving these car and truck savings will require progressive improvements in federal fuel economy standards, continued R&D efforts like the DOE SuperTruck Program, and expanded efforts to promote and incentivize high-efficiency vehicles including hybrid, plug-in hybrid, and all-electric vehicles.

Other transportation measures. Many people's need to drive or own personal vehicles can be reduced by **new mobility options**, especially in urban areas. These options include ridesharing, car sharing, and real-time transit information. Continued revitalization of US urban cores and inner suburbs both supports and benefits from these developments. With the increase in compact growth patterns and pedestrian- and bike-friendly streets, residents can rely on non-motorized modes to meet more of their work and non-work mobility needs. On-demand vehicle access that is reliable and affordable can allow many households to forego vehicle ownership altogether. Likewise, **freight energy use** can be lowered by reducing empty backhauls, increasing truck loads via collaborative shipping arrangements, and providing seamless transitions among highway, rail, water, and air modes. ICT applications can help shippers use the least costly and energy-intensive mode to meet each load's needs. Finally, **aviation energy use** can also be reduced by more than 50% through improved engines and airframes, operational efficiency, and reductions in the amount of travel.

Power system measures. Electric power systems can save energy by **improving the efficiency of generating stations**, **using more combined heat and power systems** (which produce both heat and power for buildings and industrial processes), and **reducing transmission and distribution energy losses**. Improved voltage control on utility circuits, called conservation voltage reduction, is one strategy to reduce these losses.

CONCLUSIONS

Our analysis finds that the efficiency measures we examine, if pursued aggressively, would reduce 2040 energy use by 34%, putting the United States on a path to halve energy use by 2050 relative to currently predicted levels. These energy savings will achieve similar percentage reductions in GHG emissions. The reductions in energy bills will increase spending on goods and services and enable increased business investment, helping to grow our economy.

To achieve these savings, we will need to expand energy efficiency efforts beyond business as usual through:

- New building codes, vehicle and equipment efficiency standards, and ENERGY STAR specifications
- Improving the efficiency of existing factories, homes, commercial buildings, electric transmission and distribution systems, and power plants
- Efforts to better manage freight and aviation energy use, use new mobility options, and spur changes in how individuals use energy at home, at work, and in transport

We have described savings through 2040. To halve energy use by 2050, we will need to continue efficiency efforts, including those profiled here, for another decade and refine these efforts based on lessons learned over the 2017–2040 period. We must also continue to invest in R&D to identify new energy-saving opportunities we can only imagine today. Together, these steps will reduce energy use, cut emissions, and strengthen our economy.

For citations and additional details, see our full report at aceee.org/white-paper/pathways-cutting-energy-use.