

Halfway There:

Energy Efficiency Can Cut Energy Use and Greenhouse Gas Emissions in Half by 2050

Energy efficiency is vital for mitigating climate change. Our new report shows it can slash US energy use and greenhouse gas emissions by 50% by 2050, getting us halfway to US climate goals. While prior studies have also documented such massive savings, we provide a road map with 11 opportunities.

We cannot wait. Across the United States, we already see the effects of intensifying climate change and the resulting increase in extreme weather events – from respiratory and other health problems to flooding, drought, heat waves, and wildfires. To avert a climate catastrophe, reports by the US government and the United Nations call for swift, robust action.

Energy efficiency – using energy smarter to reduce waste – can deliver transformative results.

The good news: We can start right now. The United States can achieve immense carbon savings by dramatically scaling up efficiency measures that are ambitious but cost-effective and technically possible. We don't need pie-in-the-sky ideas. We need public and private investment in energy-efficient appliances, buildings, vehicles, and industrial plants.

The payoff will be impressive. We can reduce emissions and deliver energy savings worth more than \$700 billion by 2050. Plus, we'll create jobs, boost grid resilience, reduce air pollution, and improve people's health. Energy efficiency is a win-win solution with a proven track record.

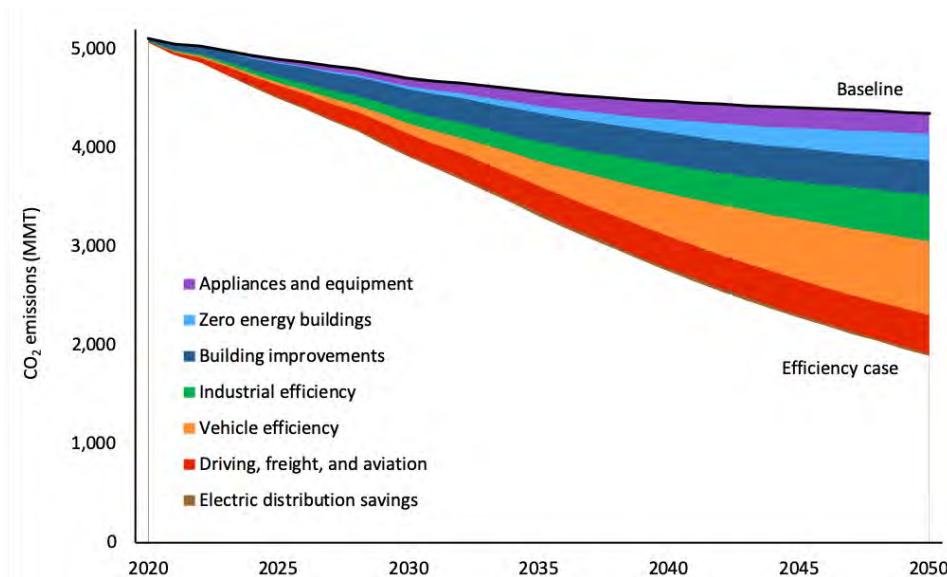


Figure 1. Carbon dioxide emissions reductions relative to baseline energy-related emissions.

Note: The 2050 CO₂ emissions cut of 57% is higher than the 49% cut for all greenhouse gas emissions, which include other gasses such as methane.



Our pathway to 2050 climate savings: 11 opportunities and related policies

Energy Savings
(quadrillion
Btus):

CO₂ emission
cuts
(million
metric
tons):



Industrial efficiency. The industrial sector has steadily improved its energy intensity for decades. Still, it can do a lot more. It can boost savings by adopting energy efficiency technologies and practices, such as strategic energy management and smart manufacturing, and making fundamental changes in processes and products. To tap its full potential, we will need expanded R&D efforts, technical assistance, incentives, financing, and sector commitments. We estimate total savings of about 30%.

12.0 467

Policies: Research, demonstration, deployment, and sector commitments



Light- and heavy-duty vehicle fuel economy. US vehicles have substantially increased in energy efficiency in recent years, driven largely by stricter federal fuel economy standards. More electric vehicles (EVs) are entering the market — a trend we expect to accelerate. We can further boost vehicle efficiency with continual improvements in the federal fuel economy standards, greater promotion of EVs and other high-efficiency vehicles such as hybrid trucks, and R&D efforts. We estimate CO₂ emissions savings of about 50%.

8.4 754

Policies: Fuel economy standards and electric vehicle promotion



Zero energy buildings and homes (ZEBs). Organizations and states are working to make ZEBs common practice in new construction by 2030. Already, thousands of new homes and hundreds of new commercial buildings produce at least as much energy as they use annually. We estimate that the energy use of almost all new homes and commercial buildings could be cut by 70%, with the balance supplied by electricity and renewables. Aggressive building energy codes could deliver four-fifths of these savings.

5.7 265

Policies: Building Energy Codes



Appliance and equipment efficiency. Current federal minimum energy efficiency standards, which apply to more than 50 types of appliances and equipment ranging from refrigerators to industrial pumps, will reduce energy bills by nearly \$2 trillion cumulatively. Updates can boost savings. The voluntary ENERGY STAR® labeling program produces additional savings by going beyond federal standards and covering products not subject to them. We estimate 13% energy savings for buildings.

5.6 210

Policies: Appliance efficiency standards and ENERGY STAR® labeling



Home and building retrofits. Most homes and commercial buildings that will be standing in 2050 have already been built, making efficiency retrofits critically important. Retrofits typically save 10-40%, but to tap their full potential, they will need to cover more buildings and deliver more savings per building. Ultimately, we may need performance standards. Retrofits can save 30% on average for most homes and buildings.

3.8 148

Policies: Commercial building energy use benchmarking, home energy labeling, and existing building performance standards



Energy Savings (quadrillion Btus):

CO₂ emission cuts (million metric tons):



Smart buildings and homes. Sensors, automated controls, and other smart software can optimize energy use and reduce it 15% or more. Examples include learning thermostats (like Nest or ecobee) in homes that automatically adjust heating and cooling based on residents' patterns, as well as more sophisticated systems used in commercial buildings. We estimate 15% savings in most homes and 20% in most commercial buildings.

3.2 125

Policies: Commercial building energy use benchmarking, home energy labeling, and existing building performance standards



Passenger vehicle miles traveled. Improved mobility options such as ridesharing, bike sharing, and expanded public transit, combined with compact and walkable communities, can reduce car use and save energy. So, too, can the continued revitalization of transit-friendly US cities and inner suburbs. Fees based on miles driven and roadway congestion could reduce driving and help fund alternative modes of travel. We estimate light-duty vehicle savings of 30%.

2.5 129

Policies: Road use and congestion fees, mobility planning



Aviation efficiency. Improved engines, operational efficiency, and reductions in the amount of travel can cut aviation energy use and emissions by about 50%.

2.4 157

Policies: Airplane efficiency standards



Freight transport. The freight sector can save energy through digitization of logistics, using collaborative shipping arrangements to optimize vehicle loads, and providing seamless transitions among highway, rail, water, and air modes. We estimate savings of 25%.

1.8 107

Policies: Road use and congestion fees, infrastructure investments, and energy and emissions targets



Electrification of space and water heating. As the electric grid gets cleaner, high-efficiency heat pumps can reduce both energy use and emissions. Their economics are best for new homes, existing homes without air conditioning but where it is desired, homes and buildings using fuel oil and propane, and homes with central air conditioning in the South. We estimate equipment energy savings of 26% in homes and 13% in commercial buildings, and even larger emission cuts.

0.9* 76

Policies: Consumer incentives, building codes, and limiting expansion of gas distribution systems

**(these savings are after loads are dramatically reduced by prior measures)*



Electric distribution system. Electric distribution system. New electric grid technologies, such as conservation voltage reduction and amorphous core transformers, can reduce power losses in the grid and in consumer appliances. We estimate 5% savings for most electric use.

0.7 22

Policies: Regulatory policies to encourage or require utilities to use these technologies

Total: 47.1 2,461



Methodology:

We modeled 11 energy efficiency opportunities and related government policies. We used the Annual Energy Outlook 2019 as our baseline and adjusted it to show continued growth in renewable electricity and shrinkage in coal after 2022. We also included upstream savings in refineries and some rebound in energy consumption due to increased use of efficient equipment and vehicles.

Key results:

- ◇ Efficiency measures could halve 2050 energy use and greenhouse gas emissions, getting the United States halfway to its climate goals.
- ◇ The United States can achieve almost all these savings, worth more than \$700 billion in 2050, by dramatically scaling up government policies and programs.
- ◇ Buildings deliver 40% of the total energy savings, transportation delivers 32%, and the industrial sector delivers 27%. For emissions reductions, they deliver 33%, 46%, and 20%, respectively.

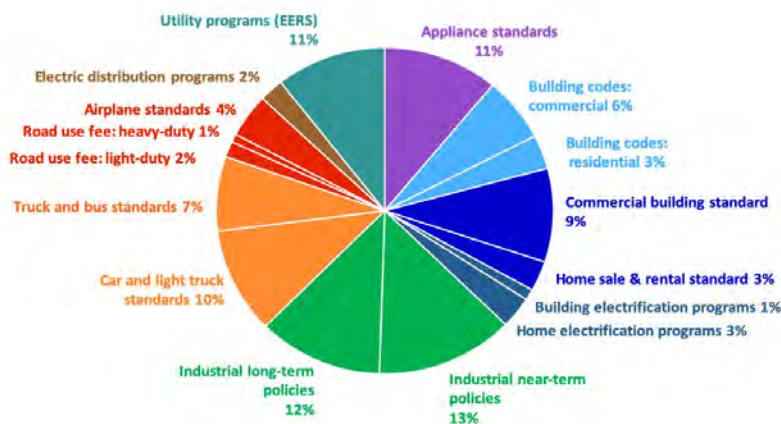


Figure ES2. Allocation of energy savings by policy

What's needed:

- ◇ Rapid upgrades to vehicle standards, building energy codes, equipment efficiency standards, and ENERGY STAR® specifications.
- ◇ Substantial improvements to existing factories, homes, commercial buildings, and the electric grid, and better management of energy use in all of them.
- ◇ More mobility options and better management of freight and aviation energy use, including user fees.
- ◇ A switch to electric vehicles, equipment, and industrial processes (along with a more-efficient and cleaner power sector).
- ◇ Greater investment in research and development in new efficiency options in every sector.

With bold but achievable measures, energy efficiency can deliver half the greenhouse gas emission reductions needed to meet US climate goals. It will also save money, create jobs, and clean the air. Efficiency, the heart of a clean energy future, is an urgently needed climate solution.

For further detail and citations, see our full report at [aceee.org/halfway-there](https://www.aceee.org/halfway-there)

