Efficiency Saves: Cutting Energy Waste Can Save $31,000 per Household

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Research Report

ACEEE

About ACEEE

The **American Council for an Energy-Efficient Economy** (ACEEE), a nonprofit research organization, develops policies to reduce energy waste and combat climate change. Its independent analysis advances investments, programs, and behaviors that use energy more effectively and help build an equitable clean energy future.

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Data and licensing information

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Executive summary

Key findings

We model eight broad opportunities to reduce energy waste by deploying energy efficiency and demand flexibility throughout the economy. Using Energy Innovation's Energy Policy Simulator (EPS), we find that between now and 2050 these could significantly lower energy bills, help manage rising peak electricity demand, and strengthen the economy and the environment:

- Families and businesses avoid about $4.8 trillion in wasted energy and related costs cumulatively—almost **$31,000 per household**.
- Energy costs savings average **$215 billion** a year.
- Electric efficiency measures reduce growing peak demand by **20%** on average; the 208-GW average reduction is equivalent to the output of more than 400 large power plants.
- The U.S. economy nets an additional **1 million jobs** per year on average.
- The U.S. avoids **22 billion metric tons** of climate pollution cumulatively.
- Thousands of tons of small particulates and other air pollution are eliminated, resulting in approximately **278,000 fewer premature deaths** cumulatively.

Energy efficiency is the fastest, cheapest, and cleanest way to meet our energy needs while addressing the three major, interlocking energy challenges of rising home energy bills and gasoline prices, new demand for electricity from data centers and other loads, and high greenhouse gas emissions from burning fossil fuels. Cutting energy waste reduces bills, frees up electric system capacity, and slashes pollution. Efficiency can also improve health, comfort, and resilience, especially for limited-income and rural communities that are struggling economically. Demand flexibility—shifting electricity demand to times when the electric system has more capacity to meet it—provides similar benefits.

Achieving these energy savings requires a number of strategies, including reducing energy waste (e.g., through more insulation in buildings); newer efficient technologies (e.g., industrial heat pumps); using sensors, controls, and communications to make systems work better (e.g., digital freight networks); and shifting electricity demand to reduce strain on the grid (e.g., preheating water). Among the most important public policies to drive these changes are

- Efficiency standards: vehicle standards, appliance efficiency standards, energy codes for new buildings, and performance standards for existing buildings
- Consumer information: ENERGY STAR, home energy ratings, and vehicle labels
- Financial incentives: programs to help limited-income and other utility customers purchase more efficient products

- Research, development, and demonstration funds to invent and commercialize new technologies

In this report, we combine many technologies, programs, and policies into eight broad energy efficiency and demand flexibility opportunities for residential and commercial buildings, industry, and transportation: (1) buildings equipment efficiency, (2) zero-emissions new buildings, (3) existing building improvements, (4) industrial energy efficiency and electric heat, (5) reduced industrial materials, (6) efficient and electric vehicles, (7) transportation system efficiency and access, and (8) electricity demand flexibility. We then use the EPS to model the impacts on energy bills, electricity demand, climate pollution, and other metrics through 2050. We assume widespread implementation of the measures, which would require concerted, long-term public and private action and yield large benefits. We include measures that shift from fuels to electricity in all three economic sectors when they are the best way to achieve large energy savings.

The analysis shows that the package of efficiency measures would reduce energy bills and associated operating costs in homes, commercial buildings, industry, and transportation; they require only modest net capital investments. Total net savings rise to about $550 billion a year by 2050 (figure ES1). Cumulative net savings are $4.8 trillion (discounted present value), which is almost $31,000 for each American household. For comparison, that is more than the $3.6 trillion that Americans spent on housing in 2024.

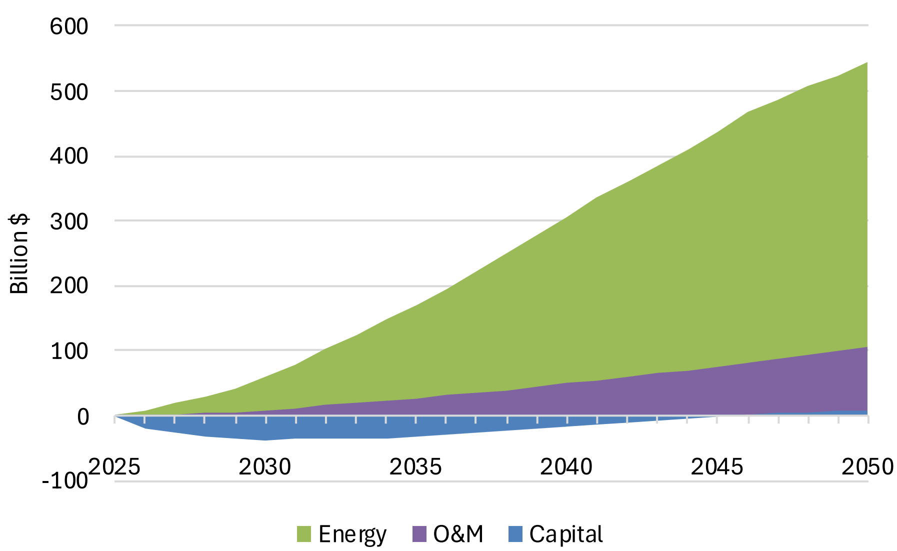

Figure ES1. Total costs and savings (energy, capital, and operations) by year in real 2025 dollars from the set of energy efficiency and demand flexibility measures modeled. Negative numbers are added investment.

Energy cost savings alone are $215 billion a year on average and steadily rise to $439 billion in 2050. Almost half of these savings go directly to families—$636 annually per household on average—in the form of lower home energy bills and vehicle fuel costs.

Efficiency yields major savings in gas and oil costs.[1] While electricity costs would at first rise modestly, due to a shift to electric equipment and vehicles, by 2043 the full set of measures also lowers overall

[1] Throughout this report "gas" is used to refer to natural gas, which is mostly methane, and liquefied petroleum gas (LPG) or propane.

electricity costs. Remarkably, the efficiency measures modeled in EPS save more than their initial upfront investment *even apart from the energy savings*. This is because industrial material and transportation system efficiency reduce operations and maintenance costs, such as fewer vehicle repairs, as well as the need for capital investment.

The more efficient use of electricity also relieves pressure on the electric system. Electric efficiency measures (i.e., other than measures that shift use from fuels to electricity) reduce peak demand by 20% on average through 2050 or 208 GW. The reduction would leave capacity for new loads from data centers, heat pumps, and electric vehicles. By 2050 those efficiency measures reduce electricity use and peak demand by even more: 1,788 TWh (32%) and 440 GW (37%), respectively. In the EPS model, demand flexibility reduces the peak use of the most expensive power plants, like those fueled by gas and oil, rather than total peak demand; it reduces peak fossil generation by 14%, and the 67-GW reduction in 2050 is equivalent to the output of more than 130 large power plants.

When families and businesses save money on energy bills, they also create new jobs throughout the economy as they spend the money saved. This is in addition to the jobs directly created by efficiency investments. The EPS model estimates an average of 1 million net additional jobs per year, rising to 1.8 million jobs in 2050, from the suite of measures.

The reduced energy waste delivers significant environmental and health benefits. It reduces climate pollution by 1.6 billion metric tons of carbon dioxide equivalent (CO_2e) in 2050, a 34% reduction from baseline emissions in that year. Cumulative emissions reductions through 2050 are 22 billion tons of CO_2e. The reduced burning of fossil fuels also results in 24% less energy-related small particulates, 22% less sulfur dioxide, and 33% less nitrogen oxides. The environmental benefits bring health benefits, including an estimated 278,000 fewer premature deaths due to particulates between now and 2050.

Unfortunately, the current attacks on federal, state, and local energy efficiency policies threaten more waste, higher energy bills, less ability to power new data centers, and more pollution and health problems. We urgently need to reverse course and use the power of energy efficiency to reduce energy costs, free up electric grid capacity, cut pollution, and meet our energy needs.

Introduction

Home energy bills are rising sharply. In parts of the United States, notably the central Midwest and Mid-Atlantic, electricity rates have risen 15% or more in just the last year (EIA 2026a). Gasoline prices have risen even faster, as of this writing, due to the war with Iran. Energy bills are a major political issue for the first time in decades. At the same time, data centers and other new loads are poised to increase demand on some electric systems, with forecasts that data center electricity use could double or even triple in just five years (Nadel 2025a). After decades of flat electricity demand, some estimate a 20% increase in peak load by 2030 (Specian and Aquino 2026; Energy Systems Integration Group 2025). And climate change continues to be an enormous threat, increasing costs on families and businesses, with almost no reduction in U.S. greenhouse gas emissions in the last few years (EIA 2025c).

Supply-side measures are very constrained in addressing these three urgent, interconnected challenges. There are years-long backlogs of orders for gas turbines and delays in facility permitting, construction, and interconnection of major generators. Even when new generation makes it online, the cost is likely to increase electricity prices, especially with the end of some federal tax credits, and, burning gas and other fossil fuels in the plants will worsen climate change. The delays are so long that some large new data centers are providing their own generation, thus competing with utilities for equipment and labor.

Energy efficiency is the fastest, cheapest, and cleanest way to meet our energy needs—from the demand side by reducing energy waste—while addressing all three challenges: reducing energy bills, accommodating new electric loads, and addressing climate change (e.g., Nadel and Ungar 2019; Specian and Aquino 2026). Cutting energy waste lowers costs, electricity demand, and emissions. It can also improve health, comfort, and resilience. These benefits are especially important for limited-income and underserved communities. Demand flexibility—shifting electricity demand to times when the electric system has more capacity to meet it—provides similar benefits in meeting the challenges.

Underused technologies like heat pumps, advanced LED lights, electric vehicles, and smart manufacturing provide better services using less energy throughout the economy. Effective policies, from vehicle and appliance efficiency standards to utility programs that help their customers save energy, overcome market barriers to help capture the savings. For example, without appliance standards a typical family would have spent $6,000 more on utility bills over the past decade, and businesses collectively would have spent $330 billion more (Mauer and Margolis 2026). Utility ratepayers spend about $9 billion a year on efficiency programs that help customers save far more on electricity and gas bills, with program costs averaging 2.3 cents per kilowatt-hour saved (Kresowik et al. 2025; Specian and Aquino 2026).

ACEEE has issued a series of reports on the broad benefits of energy efficiency, most recently the *Halfway There* report in 2019 (Nadel and Ungar 2019). Other work has focused on energy efficiency in large segments of the economy, including the national labs' careful work on buildings (Langevin et al. 2021), the Electric Power Research Institute's estimates of utility program potential (EPRI n.d.), and ACEEE's recent review of demand-side solutions for load growth (Specian and Aquino 2026). Energy efficiency is also included, often in a cursory way, in various studies of pathways to decarbonization (reviewed in Specian and Bell-Pasht 2023).

This report considers the combined effects of eight broad energy efficiency and demand flexibility opportunities on energy bills, electricity demand, greenhouse gas emissions, and other key metrics through 2050. The measures include the largest opportunities we see, spanning the buildings, industry, and transportation sectors. We consider widespread implementation of measures that are technically feasible and would have large benefits but would require concerted government and private action. Some of the measures in all three economic sectors require shifting from fuels to electricity; we include these when they are the best way to achieve large energy savings. Current political feasibility is not analyzed at the federal or state level.

The eight opportunities, described more fully in the next section, are

Buildings

1. Buildings equipment efficiency: Reduce energy waste from new appliances, equipment, and lighting, including through a shift from inefficient electric heating to heat pumps.
2. Zero-emission new buildings: Make new homes and commercial buildings more efficient so that remaining energy needs can be met with clean electricity.
3. Existing building improvements: Reduce waste from existing buildings, including by improving insulation and air sealing and switching from fuels to heat pumps and other efficient electric equipment.

Industry

4. Industrial energy efficiency and electric heat: Reduce energy waste from industrial processes and use efficient electrical equipment to provide low- and medium-temperature heat.
5. Reduced industrial materials: Reduce the need for industrial materials and products through lower waste, efficient utilization, and longer lifetimes.

Transportation

6. Efficient and electric vehicles: Improve the efficiency of new cars, SUVs, trucks, and buses, including by running more of them on electric batteries.
7. Transportation system efficiency: Reduce the need for driving cars and trucks by improving the availability of and access to other transportation options.

Power Sector/Crosscutting

8. Demand flexibility: Shift electricity demand away from times when there is high demand on power plants and the grid and toward times when abundant sun and wind power are available.

To understand the grid impacts and other interactive effects, we use Energy Innovation's Energy Policy Simulator (Energy Innovation 2025a). This economic model includes energy use in multiple buildings, industry, and transportation sectors; an electric system buildout and dispatch model that can capture large long-term effects; and an input-output model of macroeconomic impacts including jobs. With this approach, we can see on a broad scale the kinds of demand-side measures that would have a large impact and estimate the benefits of energy efficiency for cutting energy costs, freeing up electric system capacity, and helping to mitigate climate change.

Efficiency opportunities

This section describes each of the eight savings opportunities and gives a sense of their scale and key policies that can spur their implementation.

Buildings equipment efficiency

Since their inception four decades ago, appliance and equipment efficiency standards have driven large reductions in energy and water use. Voluntary ENERGY STAR and incentive programs have helped push markets to efficient technologies. Products such as refrigerators, clothes washers, and light bulbs use a fraction of the energy they once did even as they are bigger, work better, and have more features. At the same time, large, additional savings are possible as technologies improve and the programs and policies expand (Margolis and Mauer 2025). Preserving recently finalized standards for residential water heaters and residential furnaces is especially important, as are future potential standards for electric motors and air-conditioning equipment, especially with the savings gained from use of variable speed drives.

The largest potential future savings are from policies that would shift the market from wasteful electric resistance and gas furnace heating to highly efficient heat pumps. Today, about 25 million households use inefficient electric resistance heating equipment, often baseboard heating, as their primary space heating (EIA 2023); each inefficient unit represents a large opportunity for energy and bill savings and to reduce winter peak electricity demand. Residential gas furnaces, which burn gas directly to heat homes, also are limited in efficiency and lose some heat as hot flue gas—even from “condensing” furnaces. Heat pumps use compressors and refrigerant to extract heat from outside air and move it inside, somewhat like an air conditioner in reverse. Thus, they can provide far more heat than the energy they use. Most are electric, but they can also burn gas (NAGHPC 2024).

Scale

A recent analysis by the Appliance Standards Awareness Project estimated that without existing appliance standards, a typical family would have spent $6,000 more on utility bills over the past decade, and businesses collectively would have spent $330 billion more. Absent the standards, total U.S. electricity consumption in 2025 would have been 14% higher and 115 GW would have been added to summer peak demand (Mauer and Margolis 2026). The Environmental Protection Agency (EPA) estimates that the voluntary ENERGY STAR program has helped Americans save an additional $500 billion in energy costs since 1992, and helped reduce electricity consumption by 520 billion kilowatt hours (kWh) in 2020 (EPA 2024a). An earlier study found that the next round of standards could save an additional average of $150 a year on household energy bills over two decades, and reduce U.S. electricity use by an added 5% and peak demand by 32 GW (Margolis and Mauer 2025).

Key policies

The Department of Energy (DOE) oversees the appliance standards program, which now covers approximately 60 types of appliances, equipment, and lighting. As of this writing, DOE is working to weaken the standards despite a law prohibiting rollbacks. To realize the major savings described above, DOE must act on its legal obligation to update existing standards to the maximum level that is “technologically feasible and economically justified” rather than searching for ways to weaken standards. For some products, like residential air conditioners and heat pumps, DOE’s review is overdue.

ENERGY STAR is an essential complement to standards, helping consumers know what products go beyond standards—and new homes beyond building codes—to reduce energy waste and costs. Although EPA recently considered eliminating this vital program for reducing energy bills, Congress fully funded it for 2026, and the administration announced it would shift the program to DOE.

Emission requirements control not the energy use but the pollutant emissions of appliances and equipment, and are set by air quality management districts, responsible for clean air in regions around the United States. Two districts in California have set zero-NOx requirements for residential space and water heating appliances, and the statewide Air Resources Board has proposed a framework. Only electric equipment meets this requirement. If implemented with heat pumps, this policy should also cut the site energy consumption of homes by around a quarter, roughly a 50% reduction from 50% of home energy use.

State and utility programs

Energy efficiency rebate and incentive programs funded by electric and gas ratepayers and run by utilities and states (and their contractors) have been a key spur for shifting markets to more efficient lighting, equipment, and appliances. They also have been important support for most of the buildings and industry measures discussed below. These programs currently spend about $9 billion each year in about half the states to help utility customers waste less energy because it is cheaper than building new plants and pipelines (Kresowik et al. 2025).

Energy efficiency resource standards (EERS) require programs to achieve a specified level of savings, an important driver in most of the states. But some programs are targeting specific locations where they can avoid the need for a new power line, transformer, or power plant. Or they can target times of peak demand or maximize abatement of greenhouse gas emissions.

Zero-emission new buildings

Two-fifths of energy use and three-fourths of electricity use in the United States occurs in residential and commercial buildings (EIA 2026b). Almost half of that energy (47%) heats and cools the buildings (EIA 2023, 2022). Energy consumption is a major part of household bills, with the average family spending approximately $2,500 on electricity, gas, and other heating fuels in 2024, around 3% of household income, growing to 8% for lower-income households (U.S. Bureau of Labor Statistics 2025; Ayala and Dewey 2024). Residential use also is a driver of electricity peak load, with home cooling driving summer peaks and home heating driving winter peaks.

Significantly reducing the energy consumption of new buildings and powering remaining energy needs with on-site solar cells or other renewable sources (especially if backed up by batteries) can slash utility bills and peak demand, while also improving the comfort, safety, and health of buildings. In combination with the efficient appliances and equipment discussed above, air sealing, insulation, multipane windows, and other envelope improvements allow buildings to consume a fraction of the energy they would otherwise. Furthermore, using electric heat pumps to provide heat and hot water eliminates burning of most fossil fuels on-site and often the need for expensive gas hookups. Heat pumps for space and water heating are 2–4 times more efficient than legacy fossil fuel appliances such as furnaces and boilers. Efficient and all-electric buildings often can be powered entirely through renewable energy provided by on-site solar panels.

Further benefits of efficient construction include the safety and resilience of the occupants and structure. For example, building to Passive House standards reduces deaths up to 93% from power outages during extreme heat and cold, and lowers property damage risks such as foundation damage, mold growth, and burst pipes (Franconi et al. 2023). As U.S. buildings emit more nitrogen oxides (NOx) than gas power plants, using electric heat also can have a significant impact on local pollution and health (Gruenwald et al. 2021).

All these improvements are much cheaper to implement in new construction, as the incremental cost of more efficient components is often low and can be negative. For example, thicker insulation will cost slightly more, but the labor to install it will not change much. Meanwhile, being able to install a smaller heating and/or cooling system due to a tight envelope can save money and make electric heat more cost effective.

Scale

Current model codes reduce building energy use by 38% (residential) or 45% (commercial) compared with model codes of 20 years ago (BECP 2025b), and some codes are much stronger. ENERGY STAR New Construction and DOE's Efficient New Homes (formerly Zero Energy Ready Homes) program further reduce energy use, with 3.3 million and 140,000 certified homes, respectively (EPA 2026; DOE 2026).

Key policies

- Building energy codes have been the most important policy driving efficient new buildings, adopted by state, local, and federal agencies, usually based on national models. They should adopt current model codes, or preferably stretch codes, that require cost-effective efficiency improvements. Notably, the federal government should set requirements that all federally backed new homes meet modern codes to protect residents with Fannie Mae, Freddie Mac, FHA, VA, and USDA mortgages, as well as setting a strong code for manufactured homes. Codes also should further advance to near-zero net energy use after on-site generation, which is already required in some European countries, and is the near-term goal of ASHRAE (which sets a key model commercial standard) and of a multistate effort (Nadel and Janssen 2024).
- The federal 45L tax credit, which offers builders a $2,500 or $5,000 tax credit for meeting ENERGY STAR or DOE's Efficient New Homes program, respectively, is spurring much more efficient construction. Congress terminated the credit as of June 2026. The federal 179D tax deduction included a modest incentive for efficient new commercial and multifamily buildings, but is now also expiring in June 2026.
- The code-setting agencies should require similar overall efficiency in electric and gas-fueled buildings: Since heat pumps are so much more efficient, a building with a gas furnace or boiler would need much more insulation and air sealing to achieve the same level of energy use.

Existing building improvements

While the energy and peak demand reduction opportunity in new buildings is significant, most buildings that will exist by 2050 have already been built. The U.S. Energy Information Administration (EIA) estimates that 79% of homes and 42% of commercial buildings that will exist in 2050 are already standing today (EIA 2025a). Therefore, improving existing buildings is necessary to deliver affordability and peak demand benefits today, without waiting for new construction. Buying or renting existing buildings tends to be cheaper than building new, so older buildings especially serve limited-income owners and tenants who have the greatest need for energy bill savings.

The types of measures that are possible in existing buildings are mostly similar to those in new buildings, discussed above, but are often costlier to implement, and the degree of improvement may be constrained by the existing building design and systems. For example, attic insulation is easier and cheaper to add to an existing building than wall insulation, which usually requires opening wall cavities. Similarly, rather than replacing windows, window attachments or commercial secondary windows may be more cost effective for existing buildings.

Another opportunity available to existing commercial and large multifamily buildings is operations and maintenance (O&M) improvements. These include reviews of the building equipment and its energy usage, fixing equipment and operating settings, other low-capital-cost improvements (e.g., upgrading control systems), and operator training—collectively called "retrocommissioning" or "continuous commissioning." These O&M improvements can inform and bring down the cost of larger retrofit projects. Reduced heating load can allow a smaller, right-sized heating system with lower up-front cost and lower peak demand when the heating system is electric.

Scale

This opportunity applies to all current commercial and residential buildings, as well as many to be built that may be 10–25 years old by 2050. One recent ACEEE analysis found that replacing air conditioners with high-efficiency (24 SEER) heat pumps and light-touch envelope measures would reduce peak demand by 8% and outage hours by 63% (Srivastava et al. 2025); the further strategies described above would result in even greater impact. A recent study in California found that commercial building control system upgrades can achieve gas use reductions of 50–60%, while updating control software without any capital investment achieved 4–18% (Cheng et al. 2024).

Key policies

As building codes do not apply to existing buildings except in the case of additions or major renovations, different sets of policies are needed.

- Building performance standards (BPSs) require existing buildings to meet progressively lower energy use or emissions levels, prompting improvements in operations and retrofits. BPSs typically apply to larger (>20,000 sq. ft.) commercial and multifamily residential buildings; they can yield energy use reductions of around 30–40%, with some long-term targets set at net-zero (Nadel and Hinge 2023; Webb and McConnell 2023).

  Four states and 13 localities so far have adopted BPSs, some responsible for a notable share of commercial buildings (for example, New York City, which has a BPS, has roughly the same commercial square footage as all of New England (Day et al. 2020; EIA 2022)), with many other jurisdictions considering BPSs (BECP 2025a). President Biden established in 2022, and President Trump revoked in 2025, a BPS for federal buildings based on direct greenhouse gas emissions (Council on Environmental Quality 2022).
- Requirements for home energy ratings or renovations at time of sale or rental apply to single-family and small multifamily residential buildings, which are typically excluded from BPSs. Home energy ratings inform buyers of building energy efficiency at time of sale, which tends to result in an increase in retrofits (Nadel 2025b). Similar requirements can also apply to rentals.
- Some utility efficiency programs, discussed above, as well as the DOE-funded state-run Home Energy Rebate program, facilitate and provide incentives for building retrofits. Programs also support large commercial building savings from strategic energy management and continuous commissioning. Strengthened federal tax incentives to replace the expired 25C tax credit for homes as well as the 179D deduction for commercial buildings could spur similar improvements.

Industrial energy efficiency and electric heat

The U.S. industrial sector accounts for a third of the country's overall energy use, either as fuel that powers industrial processes or as a feedstock to turn into higher value products (EIA 2026b). Major industrial subsectors include refining, chemicals, cement, pulp and paper, iron and steel, aluminum, manufacturing, and food and beverage. In each of these subsectors, energy efficiency and electrification can provide industrial firms with a pathway to reduce costs, improve performance, and eliminate emissions.

Traditional efficiency improvements are typically the lowest cost, highest reward approach to reducing industrial emissions. Although industry has made significant progress in capturing many low-hanging opportunities, significant savings are still possible through technologies like advanced controls, optimized systems, insulation, efficient lighting, and high-efficiency drives for motors. Smart manufacturing tools and practices, including sensors and real-time monitoring, can further reduce energy waste.

Process heat accounts for half of on-site industrial energy use, and electrifying low- to medium-temperature process heat with efficient alternatives like industrial heat pumps (IHPs) can cut associated source energy use by roughly one-third (Rightor et al. 2022). Certain subsectors, like food and beverage, are especially strong candidates for electrification given their almost exclusively low-temperature process heat needs.

High-efficiency electric technologies are already available, including IHPs, electric boilers, and thermal batteries. IHPs often achieve two to four times higher—and sometimes even better—efficiencies compared to combustion-based systems (Rightor et al. 2022). Further development of technologies to reach higher industrial temperatures could enable even greater savings. Electrified processes can also offer flexible load potential and allow facilities to shift demand where feasible in response to grid conditions.

Scale

Industrial energy efficiency measures can still reduce energy use and emissions in five energy-intensive U.S. industrial sectors by more than 25%, even after decades of incremental improvement (DOE 2022). Two-thirds of low- and medium-temperature heat in three key sectors, chemicals, pulp and paper, and food and beverage, can be supplied by electric heat pumps along with electric ovens and dryers in the near term (The 2035 Initiative 2025); replacing heat from combined heat and power (CHP) units and burning by-products would be longer term and may require other decarbonization approaches, including low-carbon fuels and material efficiency.

Key policies

Key policies to ensure progress in efficiency and electrification include

- Expanded industrial energy efficiency programs, including
    - DOE’s Industrial Training and Assessment Centers (ITACs), the Better Plants Program, and the ENERGY STAR for Industry program, which provide technical assistance and resources to industrial facilities to improve efficiency and reduce energy costs
    - State-based energy programs such as New York’s FlexTech program to provide energy assessments and guidance for industry
    - Smart manufacturing programs to increase uptake of advanced technologies, like artificial intelligence and automation, to increase manufacturing efficiency
    - Industrial subsector pilot programs for new, highly efficient industrial technologies such as new processes to produce low-carbon steel, aluminum, and cement

- Targeted transition funding such as
  - A federal clean heat tax credit to drive deployment of low-emission industrial heat technologies like thermal batteries and industrial heat pumps
  - A low-carbon contracts for difference (CfD) program, which would provide price certainty and mitigate risk for industry investing in low-carbon production (Look et al. 2025)
  - "Buy Clean" government procurement programs that increase demand for steel, cement, and other construction materials that were produced with low emissions (Masanet et al. 2026)
- Performance-based efficiency standards for industrial plants or sectoral commitments like Denmark's Energy Efficiency Obligation scheme (Hoffmeister et al. 2024)
- Clean electricity policies that improve the economics and energy savings potential of powering industrial processes with clean electricity

Reduced industrial materials

Reducing the need for industrial materials such as cement and steel (material efficiency) is a significant but typically underestimated strategy for advancing industrial efficiency and decarbonization. It helps reduce energy use and resulting emissions by lowering the need for primary material production. Product reuse and circularity through longer product lifetimes, increased repair instead of replacement, and lower waste of materials can reduce the need to produce energy-intensive materials. Improved packaging design (right-sizing) and recyclability can further mitigate energy use and emissions. Behavioral and operational changes are also critical to reducing waste, which will require not only advanced technologies and systems but a trained workforce.

The industrial sectors that can benefit the most from material efficiency include construction supplies such as steel and cement. However, all industrial sectors can use material efficiency to reduce waste, improve product throughput, and mitigate indirect (scope 3) emissions across the economy.

Scale

International Energy Agency analyses have found that material efficiency strategies can reduce industrial energy use and emissions by 20–30% in key subsectors including steel, cement, and aluminum manufacturing (International Energy Agency 2019).

Key policies

Reducing materials use requires coordinated action across the life-cycle of industrial goods—from designing, to building, using, and eventually disposing of the products that are made in industrial facilities. Architects, engineers, procurement officers, consumers, policymakers, and industry itself need to shift long-standing practices and align on goals to use industrial materials efficiently (IPCC 2023). Technical assistance programs like ITACs and support for energy management, both described in the last section, as well as USDA's Natural Resources Conservation Service, can play a key role in helping implement these strategies. In addition, federal and state policies could spur broader adoption of material efficiency practices in the industrial sector, including building codes and standards that allow less construction materials, public procurement standards that support low-waste and recycled content products, and waste reduction and recycling mandates.

Efficient and electric vehicles

Gasoline costs exceed home energy bills for the typical family. In the United States, about 30% of energy use and greenhouse gas emissions are from transportation, and the vast majority of those, over 80%, are from light-, medium-, and heavy-duty road vehicles (EPA 2024d; EIA 2026b). Due in part to federal standards, the fuel efficiency of vehicles has increased by more than a third in the past two decades (EPA 2025).

Electric vehicles (EVs) are able to deliver superior efficiency compared to internal combustion engine (ICE) vehicles, and sales have grown rapidly in recent years. Electric cars and SUVs in particular can have efficiencies of well over 100 miles per gallon-equivalent, compared to an average of around 25 miles per gallon for ICE vehicles (EPA 2025). EVs convert a significantly higher percentage of the total energy contained in their batteries to forward motion, reaching over 90%, compared to ICE vehicles that may only reach 25% because they lose so much energy to wasted heat. Hybrid ICE vehicles fare better because they need less power from the engine and they can capture some energy through regenerative braking; they may be able to capture upwards of 40% of the energy in their fuel (EPA and DOE n.d.a, n.d.b).

While the shift to electric trucks and buses is progressing more slowly than for light-duty, private and public entities are making significant investments to deploy electric trucks due to their superior efficiency and reduced total cost of ownership (EDF 2026). There is also significant savings potential to improve the efficiency of ICE heavy-duty trucks including weight reduction, aerodynamic improvements, and reduced tire rolling resistance (Ghosh et al. 2025).

Scale

EPA estimated that its vehicle emission standards for 2027–2032 will help consumers save thousands of dollars over the lifetime of a vehicle with a net benefit to society of almost $100 billion per year. Consumers will save 780 billion gallons of gasoline through 2055 (EPA 2024e). EPA estimated the standard for trucks and buses will yield additional net benefits of $13 billion each year and save 135 billion gallons of diesel and gasoline through 2055 (EPA 2024c).

Key policies

Improving fuel efficiency has been the goal of the Department of Transportation Corporate Average Fuel Economy (CAFE) standards since the Energy Policy and Conservation Act of 1975, amended with the Energy Independence and Security Act of 2007 (H.R.6 2007). More recently, EPA and state tailpipe greenhouse gas emissions standards have driven greater efficiency, including through EVs. Standards that set decreasing emissions levels for vehicles along with zero-emission vehicle (ZEV) sales targets will significantly increase overall efficiency and lower energy use and emissions from all classes of vehicles. California's Advanced Clean Cars and Advanced Clean Trucks standards set goals of 100% light-duty ZEV sales and 40–75% medium- and heavy-duty ZEV sales in 2035, respectively, in California and other states that adopted the standards (CARB, n.d.a, n.d.b)

Yet the federal government has blocked state standards and proposed rolling back the federal ones. Keeping and restoring federal and state standards and developing new standards on efficiency for ZEVs is vital to advance efficiency and climate goals further into 2050.

It also is important to restore federal tax incentives for EV purchases, EV battery manufacturing, and EV charging installations. These incentives make EVs more affordable to purchase and operate, increase uptake, lessen concerns over switching, provide more EV options, and create a stronger domestic EV market.

Transportation system efficiency

Walking, biking, transit, freight rail, and other ways to move people and goods more efficiently reduce overall energy use in the transportation sector by taking cars and trucks off the road. These modes use less energy to move the same person or ton of freight as vehicles and result in greater efficiency overall. Short personal vehicle trips can be replaced with walking and biking, and longer trips with transit. Trips can also be reduced altogether with greater use of videoconferencing for work or accessing certain services. Freight can be moved from trucks to rail, and we also can reduce trips made by empty trucks through improved logistics.

More compact and mixed-use neighborhoods with good walking and biking infrastructure allow residents to make shorter trips by foot or by bike, essentially eliminating the energy use and emissions from those trips, while improving accessibility and affordability. Greater transit investments and more housing development around transit also encourage more trips to be made by transit, reducing energy use and emissions especially when that transit is electrified rail, although bus services can also lead to improvements. Focusing investments on corridors with significant transportation demand and investing in electric rail (light, heavy, or regional rail) where demand is particularly high can significantly reduce overall energy use and emissions.

Reducing miles driven by empty freight trucks is key to reducing energy consumption in the freight sector while moving the same amount of cargo. Using digital freight networks, which better match freight shipments to trucks, can improve overall efficiency, with one estimate that perfect optimization could reduce empty miles by up to 64%. Digital freight networks can also reduce freight miles by improving load factor, that is, the percentage of the theoretical maximum a truck can haul. On average trucks only carry about 57% of their maximum capacity, leaving significant room for improvement (Nakajima 2024).

Scale

Compact neighborhoods can reduce household vehicle energy use by 10% to 60% compared to sprawling neighborhoods (Litman 2025). Efficiency of transit, measured in per passenger-mile energy use, can be anywhere from 2 to 10 times greater than that of passenger vehicles depending on mode and the transit load factor (Litman 2021).

Key policies

Transit investments depend on the federal transportation bill, due to be reauthorized in 2026, along with local and state contributions. Development patterns depend significantly on local zoning and planning, as well as on federal housing taxes and policies. Driving fees based on road congestion and parking fees discourage vehicle use in certain areas and incentivize alternative forms of transportation while decreasing congestion (Litman 2025). Congestion pricing in New York City, the first in the United States, has already reduced vehicle miles traveled by 7.1% in its first year while speeding up buses in the congestion area, increasing bus and subway ridership, and reducing vehicle greenhouse gas emissions by 6.1% (Metropolitan Transit Authority 2026).

Demand flexibility

A major challenge of the electricity system is that electric supply must exactly meet electricity demand every second of every day at all locations. Thus, power plants and transmission and distribution infrastructure are built to meet the peak demand on the hottest summer afternoon or coldest winter morning. In addition, solar cells and wind turbines, now often the cheapest sources of electricity, are highly variable, dependent on the sun and wind at a given moment. Utilities run expensive gas plants constantly to adjust to changing generation and demand (spinning reserves) or only a few days a year to meet peak demand (peaker plants), and peak demand is rising due to large new loads.

Many of the measures above reduce electricity use and thus reduce peak demand.[2] But demand-side measures in each of the economic sectors also can shift electricity use away from times of peak demand and toward times when extra renewable electricity is available, adjusting demand to meet supply. Some examples are

- With properly designed equipment, much of residential and commercial electric loads can be moved up or back by a few hours without affecting occupants. Electric storage water heaters can preheat water, and heating and air-conditioning systems can preheat or pre-cool the air, especially when controlled by smart thermostats and in a well-sealed and insulated building. Refrigerators can run defrost cycles and make ice at any time of day.
- Many industrial plants can curtail electricity use at peak times either by turning off nonessential functions or by halting production at times when high electricity rates make it uneconomical (Gerke et al. 2024). Some data centers also can scale back electricity use, for example, for training artificial intelligence models, or shift load to other data centers (Norris et al. 2025).
- Electric vehicle charging can be done at night or when demand is lower. In addition, the batteries in EVs could potentially supply electricity to the grid when needed (leaving enough power for daily use of the vehicle).

Grid-scale batteries and smaller batteries on-site at buildings (sometimes repurposing used vehicle batteries) can serve a similar function by shifting electric supply to the time of greatest need.

Scale

Utility and aggregator demand response programs currently can shift a total of about 60 gigawatts (GW) of load, roughly split between retail and wholesale, including significant industrial, residential, and commercial loads (Specian and Aquino 2026; EIA 2025b).[3] This is roughly the capacity of 60 nuclear plants. However, studies have found much higher potential. A detailed study of buildings by the national labs found potential peak demand reduction within 10 years of 96 GW in the summer and 47 GW in the winter; when combined with energy efficiency measures, the peak reduction rises to 181 GW in the summer and 119 GW in the winter (Langevin et al. 2021). A broader study of all economic sectors by the Brattle Group found a combined potential of 198 GW, or 20% of total peak load (Hledik et al. 2019).

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[2] We also would note that utilities can reduce energy waste on the supply side with more efficient plants and transformers and by reducing transmission and distribution line losses (e.g., by reconductoring or conservation voltage reduction).

[3] Demand response is a subset of demand flexibility focused on simply shifting load away from a few hours a year of peak demand rather than routine shifting of load and grid services under automated control.

Key policies

Utilities often run voluntary demand flexibility programs for homes and businesses alongside energy efficiency programs as a way of meeting electricity needs without building more infrastructure. Utilities and regulators also incentivize large commercial and industrial customers to manage demand through time-varying electric rates and peak demand charges. The rates for some residential customers also vary by time of day.

A few states have begun to require new electric water heaters and pool controls to have the electronics and communications capabilities needed to participate in demand flexibility programs, and bipartisan federal legislation has proposed a similar requirement in federal appliance standards (S.4061/H.R. 7962 in the 117th Congress 2022). There also are increasing discussions about requiring new large loads, primarily data centers, to implement demand response in order not to increase costs for other customers. At least one large operator, Google, has announced voluntary demand flexibility programs—both among its own data centers and using a "virtual power plant community-based power" that aggregates many other electric loads—to offset a portion of its rising electricity demand (Crownhart 2026).

Analysis methodology

For each of the eight opportunities, we estimated potential savings through 2050 based on the literature and expert opinion. The estimates rely on existing technologies and typically assume replacement of equipment and vehicles with highly efficient options at the end of their useful life, spurred by widespread implementation of policies and programs throughout the country. We briefly describe key assumptions here and provide full details in Appendix A. Full implementation is mostly by 2050, and savings are additive (e.g., equipment and building efficiency reduce new building energy use).

- Buildings equipment efficiency: two rounds of energy savings in new equipment reaching 4–52% depending on use and fuel, including a shift from electric resistance heat to heat pumps
- Zero-emission new buildings: new buildings by 2030 reduce heating and cooling demand by 50%, along with smaller savings in other energy uses, and 70–90% use electric heat pumps
- Existing building improvements: 80% of existing buildings achieve 40–50% heating and cooling savings, along with smaller savings in other energy uses, and roughly double the amount of electric heat
- Industrial energy efficiency and electric heat: most sectors reduce energy use by 25%; most low-temperature heat, and a substantial portion of high-temperature heat, is electrified
- Reduced industrial materials: reductions range by industry from 0–15% of total products
- Efficient and electric vehicles: recent rates of efficiency improvements continue, and efficient electric vehicles substitute for half of baseline fuel vehicles
- Transportation system efficiency: a 10% reduction in passenger vehicle use and 20% reduction in freight vehicle use compared to business as usual (BAU)
- Demand flexibility: capacity ramps up to 20% of peak electricity load

We used Energy Innovation's Energy Policy Simulator (Energy Innovation 2025a), which models all economic sectors with many subsectors, including interactive effects (e.g., cutting gasoline use reduces the need for oil refining) and a model of electric system buildout and dispatch to meet electricity demand, including transmission and distribution. The version we used is for the United States as a whole, with annual resolution out to 2050. Note that as the model currently uses a 2023 projection of buildings electricity use, before the flurry of new AI data centers, it likely underestimates baseline electricity demand growth. The model allows application of dozens of demand-side and supply-side measures and it includes rebound effects in buildings and transportation: a small increase in how much efficient equipment is used because the equipment costs less to run. The EPS model provides rough estimates of energy costs and of capital and operating implementation costs for the measures, typically per unit of energy saved or produced. With assistance from Energy Innovation, we modified version 4.0.4 so that we could apply different efficiencies to building equipment and vehicles by fuel, and to improve estimates of certain measure costs and rebound effects.

We report costs and savings for our policy case compared to a business-as-usual (BAU) case. Our BAU case is the EPS Repeal and Rollback scenario, which includes rollback of tax incentives in the so-called One Big Beautiful Bill Act enacted in 2025, repeal of federal and state vehicle standards from administrative and legislative action, and repeal of EPA's power plant and methane standards.

Results

This section presents the combined projected impacts of the measures described above. Additional details of the results are in Appendix B.

Energy savings

Overall, we find that total energy costs in all consumer sectors (residential and commercial buildings, industry, and transportation) are reduced by an average of $215 billion per year from 2026 to 2050, rising to $439 billion a year by 2050 (figure 1). In 2050, the savings are 21% of the model's baseline energy spending.

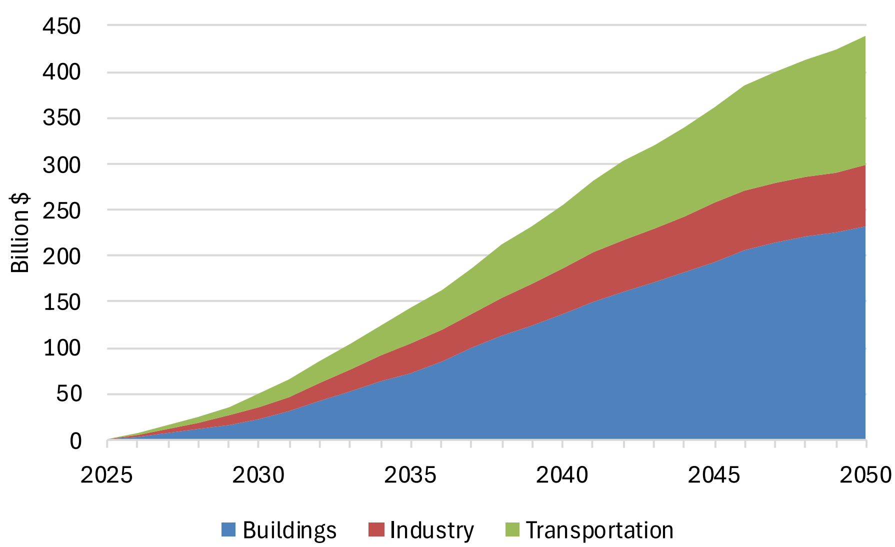

Figure 1. Energy cost savings by year in real 2025 dollars from the set of energy efficiency and demand flexibility measures

Almost half of these energy cost savings go directly to households, with $636 savings per household in the average year, rising to $1,321 in 2050, in homes and in transportation of passengers. Total direct household savings are $98 billion a year on average and $213 billion a year by 2050.

But the business savings in all three sectors are equally important to the economy. Industry energy savings are almost as large as for buildings, and much larger than for transportation, when measured in site Btu; the cost savings are smaller because industrial energy prices are cheaper and the relative prices of gas and electricity (spark gap) limit cost savings from electrification.

The changes by energy source are shown in figure 2. The dark colors are site or final energy use and the light colors are the additional source or primary energy that generates the electricity, goes into industrial products (feedstocks), or is exported. Despite a significant shift to electric equipment in all sectors, improved electric efficiency holds electric use flat in the policy case in 2050, and a larger percentage is supplied by solar and wind power. Gas and oil use decrease dramatically. (They could decrease even more with additional support for renewables, but that was not modeled here.)

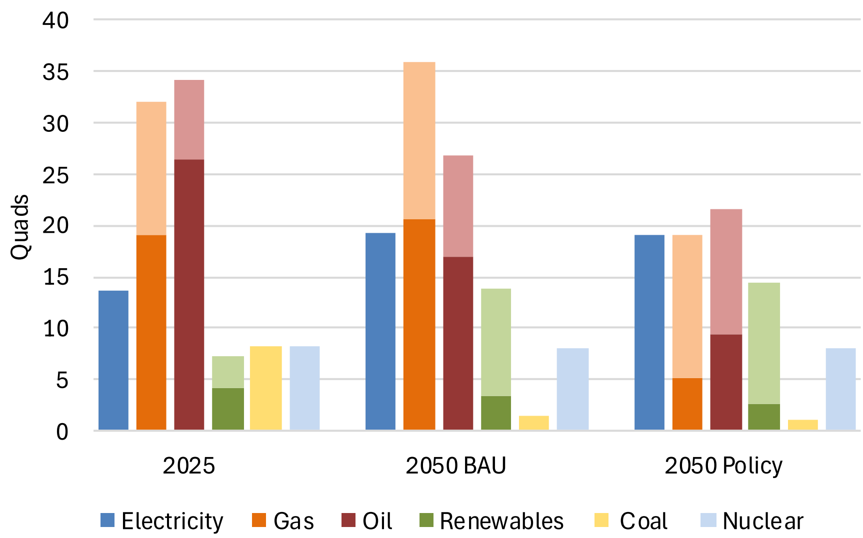

Figure 2. Energy use by fuel in quadrillion Btu. The dark colors are site energy use. The pastel colors show energy used to make electricity or industrial products. The left side is current energy use in the model, the middle is the 2050 energy use in the baseline scenario, and the right side is the 2050 energy use with added efficiency and demand flexibility. Gas includes natural gas and liquefied petroleum gas/propane.

Net financial savings

Shifting to more efficient equipment and vehicles generally requires upfront investment and often reduces ongoing operations and maintenance costs; to get a full picture of the financial benefits for energy consumers, we must examine these in addition to the energy cost savings. The EPS model includes rough estimates of capital and operating costs, which we use for this purpose, typically a set cost per Btu saved. The combined financial savings are shown in figure 3. These savings are for the energy-consuming sectors: buildings, industry, and transportation. As the EPS model does not include financing in these sectors, we modified the financial results by assuming that a portion of capital investments would be financed, thus delaying and slightly increasing those costs (see Appendix A for details).

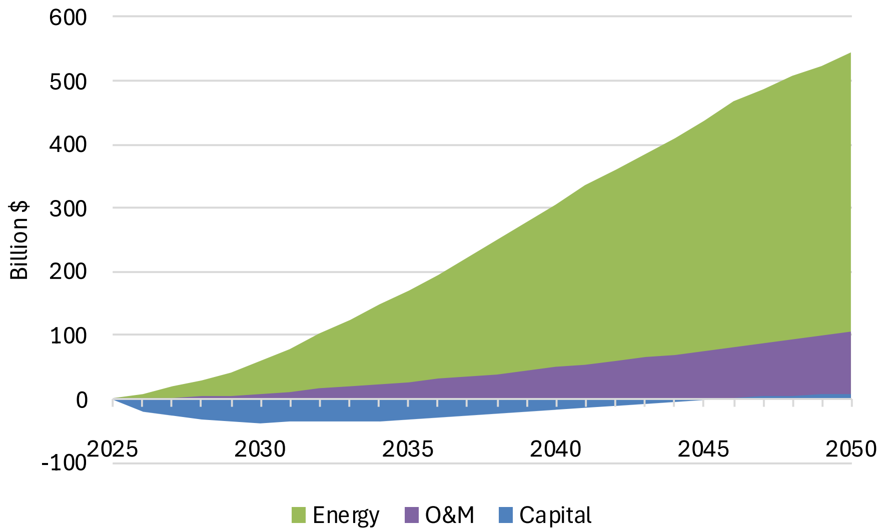

Figure 3. Financial savings for energy consumers from the suite of energy efficiency and electrification measures. In addition to the energy cost savings, it shows the net change in capital spending after some financing (the early increase in spending is negative, turning positive when there are net capital savings) and the savings in operations and maintenance costs by year in billions of 2025 dollars.

Not surprisingly, the enormous savings in energy costs dominate the financial impacts after the first few years, yielding net overall savings as early as 2029. More surprisingly, there are also net savings in non-energy costs. Capital spending does increase for the first 20 years, due to higher upfront costs for more efficient building equipment, industrial plants, and vehicles. The shift to building and industrial heat pumps also increases capital spending in this model, but electric vehicles generally cost less. Reducing industrial materials and a shift away from cars, SUVs, and trucks to other transportation modes also reduce net capital costs, and ultimately result in a net reduction in capital spending starting in 2046. The broader industrial and transportation shifts also reduce operating costs other than energy, and along with lower operating costs for electric vehicles, result in a steady reduction in operating costs.

Consequently, after the first few years, the net financial savings for energy consumers are even larger than the energy savings, and they increase to $544 billion a year by 2050.

To look at the cumulative impacts, we include new capital investments through 2050 but assume that energy and operations savings from the measures continue—they decrease linearly for another 15 years—and we include loan repayments on capital costs as long as they last (30 years for buildings). We discount all cash flows to a net present value in 2025 at a 3% real discount rate. The cumulative value of the energy savings is $4.5 trillion, and the total cumulative financial savings is $4.8 trillion. This does not include the value of health and environmental benefits described below. For comparison, the savings are more than the $3.6 trillion that Americans spent on housing in 2024 (U.S. Bureau of Labor Statistics 2025), and more than the $4 trillion annual gross domestic product of the United Kingdom in 2025 (UK Office for National Statistics 2026). The cumulative savings per household total is $30,726 and per capita it is $13,162, based on the projected population and number of households each year (EIA 2025a).

Electricity demand

The impacts on electricity demand reflect the interplay of energy efficiency, electrification, and demand flexibility. Here, we split the measures across all sectors between electric efficiency measures that reduce energy use of electric equipment and vehicles, and fuel-switching measures that add electric load but reduce direct fuel use by more. By 2050, electric efficiency measures reduce baseline electricity use by 1,788 TWh (32%), more than twice as much as the electricity currently supplied by nuclear power. The impact on peak electric loads is even greater. Figure 4 shows the peak electricity demand by year, which would be on a hot summer day. The electric efficiency measures greatly reduce peak demand, by 208 GW (20%) on average through 2050, and by 440 GW (37%) in 2050. A typical large power plant has a capacity of about 500 MW, so by 2050 that is avoiding the need for nearly 900 new power plants.

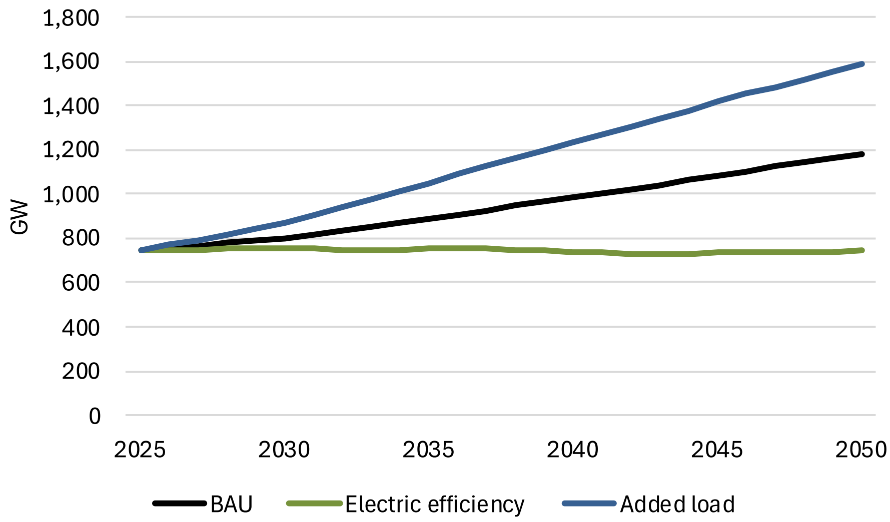

Figure 4. Peak electric demand in gigawatts by year (on a peak summer day in all cases). This figure shows the baseline case, only electric efficiency measures, and only measures that switch from fuels to electricity (added load).

This frees up generation, transmission, and distribution capacity to accommodate new loads, whether added data centers or efficient electric equipment and vehicles. The need is illustrated by the peak demand increases if the fuel-switching measures in our scenario are applied without any added efficiency measures. The efficiency measures reduce the added electricity load as well as the base load, saving an additional 935 TWh and 129 GW on the summer peak in 2050.

The combined result, including applying the efficiency measures to the new electricity demand, is that the full set of measures slightly increases peak demand for 10 years and then significantly decreases it. As shown in figure 5, widespread energy efficiency enables a switch to electricity use with very little increase in peak demand (1% in 2032) and as energy efficiency continues to improve, it eventually reduces it (14% in 2050).

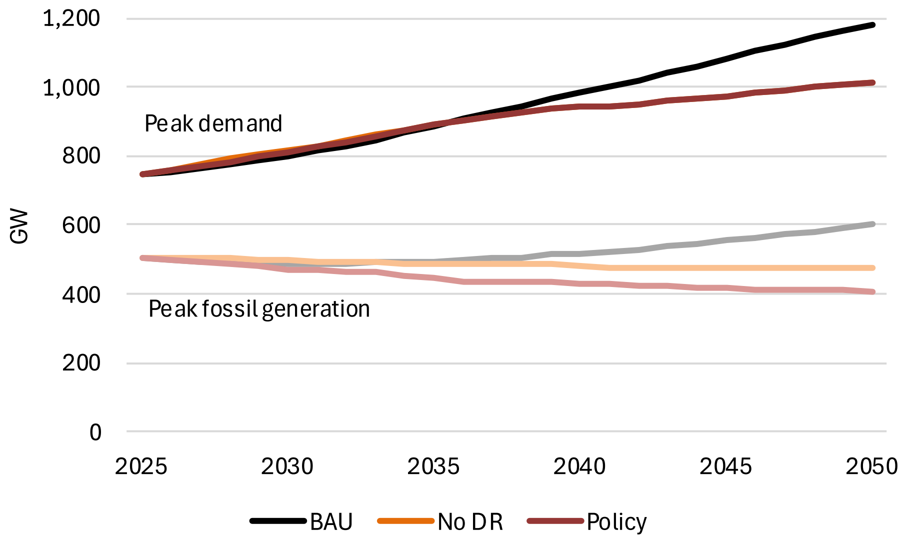

Figure 5. Peak electric demand and peak electric load supplied by fossil fuels in gigawatts by year (on a peak summer day in all cases). This figure shows the full suite of measures and the same measures except for demand response, as well as the baseline case. The peak demand in the policy and no DR cases are almost indistinguishable (discussed in the text).

The impact is clearer if we focus on traditional power plants. It is most important to reduce demand not at the time of total peak demand, because much of that is met with solar power at the time it is most abundant, but rather when the grid is most constrained, also known as net peak load. That reduces the peak need for the most expensive dispatchable power, typically from gas and oil plants. The combined measures barely increase peak load met by fossil plants (0.5% in 2026) and in a few years start reducing net peak, ultimately reducing it by 193 GW (32%) in 2050. Figure 5 also illustrates the importance of demand flexibility by showing the impact of the rest of the measures without it (no DR case). In the EPS model demand response is used to reduce net peak load. Thus, it does not affect total peak demand noticeably, but it significantly reduces peak load met by fossil plants (14% by 2050). The impacts on winter peak electricity demand are similar, but winter peaks remain below summer peaks in these scenarios.

Job creation

Energy efficiency investments create domestic jobs in manufacturing efficient equipment, installing measures, and managing projects. They also create jobs by reducing monthly expenses for families and companies, allowing them to spend extra money elsewhere in the economy. The services, goods, food, and healthcare they buy all create more jobs per dollar than the energy sector, which loses some revenue. Electrification also shifts jobs from fuels drilling, mining, and refining to the electric sector.

EPS includes an input-output model that estimates economic effects of shifting spending between economic sectors, including job impacts, somewhat similar to ACEEE's own DEEPER model (ACEEE 2011). It finds for a slightly revised scenario (see Appendix A) net job creation rising to 1.8 million jobs by 2050, mostly in the services sectors, as shown in figure 6. Cumulative net job creation through 2050 is 26 million job-years (a job-year is one added full-time position for one year), or 1.0 million added jobs in the average year. While one might expect smaller energy bills to result in job losses in the energy sector, the estimated impact on energy jobs here is relatively small and reflects a balance between some added electric utility jobs and some lost fuel jobs.

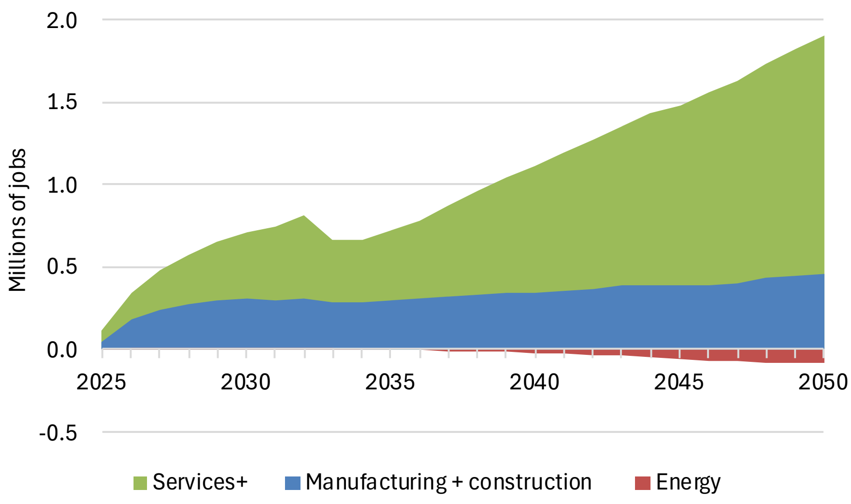

Figure 6. Number of net additional (or lost) jobs by year and category due to the suite of measures

Environmental and health benefits

The reduction in energy use and shift to clean electricity also have major benefits in reducing climate pollution and other harmful air pollution. Figure 7 shows direct greenhouse gas emissions by sector in the policy scenario, and the reduction in emissions from the baseline scenario are in black stripes. The set of measures reduce greenhouse gas emissions by 1.6 billion metric tons of carbon dioxide equivalent (CO_2e) in 2050 compared with the baseline in that year, a 34% reduction. Almost half the reductions are from the industrial sector (including process emissions), though its direct emissions remain the largest. Cumulative emissions reductions through 2050 are 22 billion tons of CO_2e.

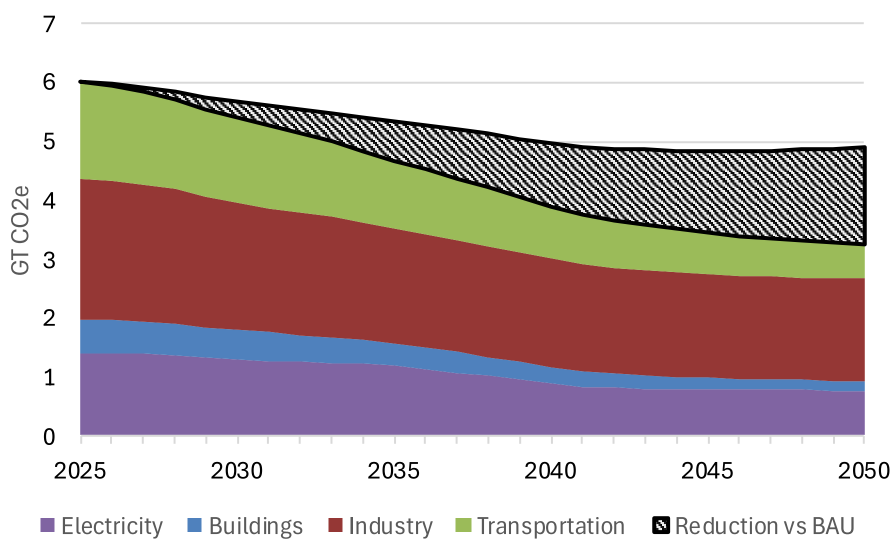

Figure 7. Greenhouse gas emissions in billion metric tons of carbon dioxide equivalent in the policy scenario by sector by year (direct emisisons). It also shows the total reduction in emissions compared to the baseline case in black stripes. Land use emissions are not affected by these measures and are not included here.

EPS also calculates emissions of several other air pollutants. Some of the significant emissions reductions from the set of measures include, in thousand metric tons (KT) per year by 2050:[4]

- Small particulates: 329 KT of $PM_{2.5}$ and 409 KT of PM_{10} (25% and 24% of energy-related emissions)
- Nitrogen oxides: 1,732 KT (33%)
- Sulfur oxides: 229 KT (22%)

The reduced air pollution also has major health benefits for reducing heart attacks, bronchitis, asthma, and other cardiovascular and respiratory diseases. EPS estimates the reduced air pollution, specifically particulates, would result in 278,000 fewer premature deaths cumulatively through 2050.

Savings by measure

We can examine the impacts by measure by applying them sequentially. Interactive effects mean that the order of applying the measures matters, but mostly within the same economic sector. Figure 8 shows the growth in energy cost savings by measure. The largest cost savings are from appliance efficiency and fuel economy, with plant efficiency and building shell improvements also major contributors. The shift from fuels to heat pumps and electric vehicles (in the light shades) has smaller financial benefits due to the relative cost of electricity and gas currently. Demand flexibility also shows small cost savings as the cost of the programs in the model is similar to the grid cost savings.

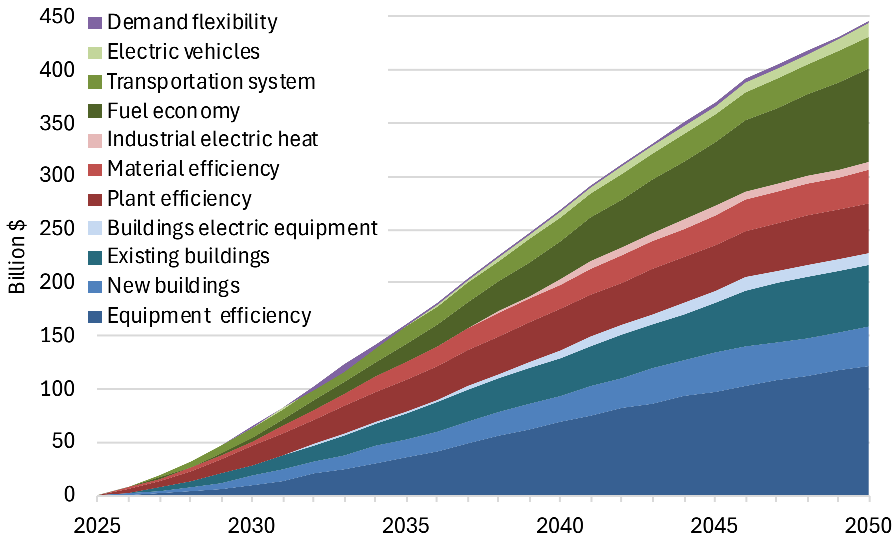

Figure 8. Energy cost savings in billion 2025 dollars by measure by year

[4] These reductions are based on the amount of fossil fuels that are not burned; EPS does not model changes in pollution controls or impacts of criteria pollutant policies.

The relative impacts on climate, pollution, and health are quite different. Figure 9 shows greenhouse gas emissions abatement by measure; other pollution measures would be somewhat similar. The abatement due to reduced energy use is still very large, but a shift to efficient electric use is equally important. These scenarios assume baseline policies on electric supply. If we also included renewed support for zero-emissions electricity such as solar and wind, the environmental benefits from a shift to electricity would be even greater.

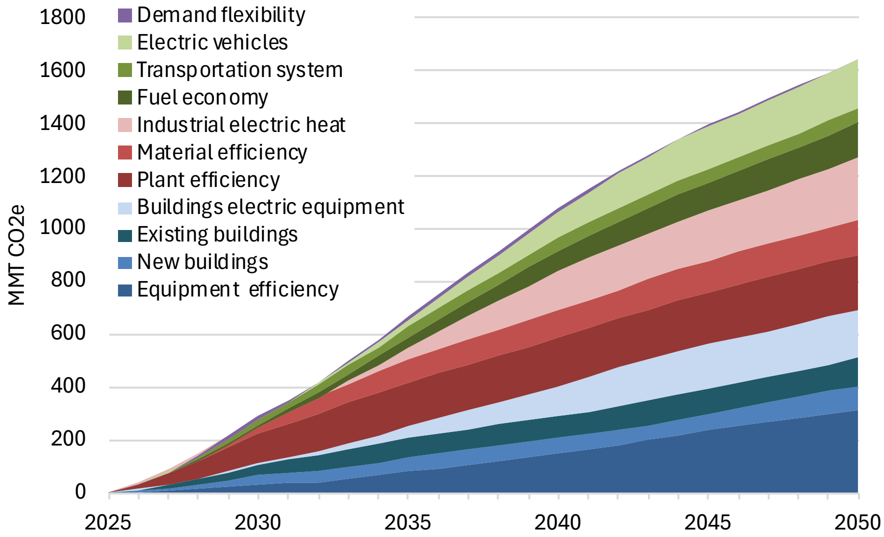

Figure 9. Reduction in greenhouse gas emissions by measure by year in millions of metric tons carbon dioxide equivalent

Conclusion

Energy efficiency throughout the economy, including a shift to efficient electric equipment and vehicles and electric demand flexibility, has the power to help solve our pressing energy issues from the demand side:

- Slow rising energy costs with $4.8 trillion in savings for families and businesses ($31,000 per household)
- Reduce electricity demand by cutting peak load on gas and coal plants by 32%
- Help avoid the worst impacts of climate change by eliminating 22 billion tons of climate pollution

Demand-side solutions are especially important for reducing the bills and improving the health of underserved communities. And efficiency can lay the groundwork to meet remaining energy needs with clean supply, eliminating climate and air pollution from energy use.

But these benefits will not just happen. We know from decades of experience that vast amounts of cost-effective energy savings lie dormant because of market barriers, behavioral economics, and other roadblocks. We need long-term concerted government policies to reap these benefits. Standards and codes set a baseline to protect consumers from high energy waste. Incentive and information programs help consumers choose higher-efficiency options. Utility rate and zoning reforms allow markets to work to meet demand for energy savings. Emissions policies value the environmental and health benefits.

Unfortunately, federal agencies today are working against all these common-sense policies. In trying to avoid the relatively small initial investments needed to implement some of these policies, they risk losing out on the enormous savings the policies will yield (see figure 3). To meet our energy needs, federal, state, and local governments must all take action to help Americans get the services they need with less energy waste, so our energy system will work for all.

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Appendix A: Detailed methodology

We first discuss our assumptions for the scale and implementation timeline of each measure, along with how we entered the measure in the EPS model. We then discuss tweaks we made to the EPS model and financial assumptions we made in reporting results from that model.

Measures

We generally developed estimates for how much we could reasonably improve efficiency in our selected areas based on the literature and our expert judgment. Here for clarity we split out measures that shift energy use from fuels to electricity from measures that reduce use of the same kind of energy. Tables A1–A7 show the specific assumptions we used and how they were input into the EPS model.

We note that the assumptions we make here differ from those we made in *Halfway There* (Nadel and Ungar 2019). There are many reasons. We now have six fewer years in which to act, though some measures have become common and included in the baseline, and some technologies have advanced. The EPS model is both more refined than the spreadsheet calculations in *Halfway There*, with many subsectors and consistent treatment of interactive effects, and more limited in application of efficiency measures and policies. The baseline assumptions differ. We also include fewer opportunities here. Broadly speaking, we now include a greater shift to electric equipment in buildings and industry, but not in transportation only because the newer baseline includes many more EVs, with somewhat smaller savings from energy efficiency.

Buildings equipment efficiency

As a starting point, we generally considered the policy scenario for a first round of improvements based on the highest efficiency levels that are technologically feasible in DOE analyses, and in some cases added a second round based on additional demonstrated technologies. However, we note that any standard that DOE adopts must be economically justified, considering impacts on both consumers and manufacturers.

We used recent analyses to determine the energy use and sales of new appliances in the base case (Mauer and Margolis 2026; Margolis and Mauer 2025); for buildings the EPS baseline is calibrated to the 2023 Annual Energy Outlook. We calculated the percentage energy savings for specific product categories and took a weighted average for the broader use categories in EPS and over residential and commercial equipment. For the first round of potential updated efficiency standards, we assumed compliance dates of 2035 for all products, with the exception of lighting, which is based on expected savings from the 2024 general service lamp final rule, which requires compliance in late 2028.

For certain products (residential air conditioners and heat pumps, commercial rooftop air conditioners, lighting, and electric motors), we considered a second round of updates six years later (2041 except 2035 for lighting). For electric motors, which account for a significant portion of commercial and industrial electricity use, we assumed that variable frequency drives could reduce electricity consumption by an additional 20% (Rao et al. 2022) (which would require a new DOE test procedure). We assumed that savings would ramp up linearly from 2026 to 2035/2029 and then to 2041/2035 because of utility programs and other policies encouraging beyond-standard performance.

We also assumed that by 2035, every new sale of heating equipment is a heat pump (including gas heat pumps, though many of those are shifted to electric in the fuel-switching opportunity discussed below), which has also been spurred by rebates and other programs.

Table A1. Equipment efficiency assumptions

Energy use	Savings 1	Ramp-up 1	Savings 2	Ramp-up 2
Heating – electric	42%	2026–35	52%	2036–41
Heating – gas + propane	9%		31%	
Heating – oil	4%		4%	
Cooling – electric	22%		33%	
Lighting – electric	22%	2026–29	50%	2030–35
Appliances – electric	23%	2026–35	23%	2036–41
Appliances – gas + propane	18%		18%	
Other – electric	9%		19%	
Other – gas + propane	12%		12%	

All savings apply to both residential and commercial equipment. The second round of savings is cumulative, including the first round.

EPS inputs: These assumptions were directly input into EPS "Building Energy Efficiency Standards."

Zero-emissions new buildings and existing buildings improvements

New zero-emissions buildings typically use highly efficient all-electric equipment; a tight building shell, good building design, and advanced controls to further reduce the energy use of the equipment; and solar cells to supply the remaining energy needs. Existing buildings improvements use similar strategies, though with more limitations. Savings from efficient equipment are included under appliance efficiency, and savings from a shift to electric equipment under building electric equipment below. We do not include measures for renewable energy here, although the EPS electric sector model supplies much new electricity demand from renewable sources. So only savings from building design, shell, and controls are included under these measures.

Experience with zero-emissions buildings and work on advanced building codes show that whole-home or building energy use reductions of 50% are typically feasible (Duer-Balkind et al. 2019). Passive House buildings (with a focus on tight building shells) can achieve much greater reductions in HVAC energy use (Passipedia n.d.). These improvements are consistent with the average 8–10% improvement in the stringency of residential and commercial energy codes over the last six three-year cycles, that is, (1–8%)^((2050-2025)/3) = 50% (BECP 2025b).

Building Performance Standards are requiring almost as great a savings in existing large commercial and multifamily buildings. A 10-city analysis found that meeting the ASHRAE Standard 100 targets would require average savings of 30–40% (Webb and McConnell 2023). Remarkable savings can be achieved in new and existing buildings, especially commercial buildings, just with better controls. A Minnesota study found 33–43% savings from retrofits of commercial rooftop unit HVACs, including use of variable speed drives (Haynor et al. 2023). A California study found 38–66% savings from controls to turn off office equipment and other commercial plug loads (Chia et al. 2025). A study of a broad swath of commercial buildings in North America found an average of 49% savings in electricity use for lighting from networked lighting controls, and 63% savings from luminaire level controls (Wen et al. 2020).

Data centers are a fast-growing element of commercial building energy use, with both HVAC use and processor use (included under "other") significant. Studies have found large savings possible even in large data centers (Nadel 2025a)

Table A2. Buildings efficiency assumptions

Energy use	Savings			Coverage		Ramp-up
	Residential		Commercial			
	New	Existing		New	Existing	
Heating + cooling	50%	40%	50%	100%	80%	2026–50*
Lighting	10%		50%			
Appliances + other	5%		25%			

* New building heating and cooling ramp up to 30% savings, and existing building to 24%, 2026–2030, and then to the values in the table in 2050. By 2050 existing building savings apply to 80% of buildings built by 2029.

EPS inputs: To avoid interactive effects, we apply heating and cooling savings for both new and existing buildings as envelope improvements under building energy efficiency standards (which affect the energy use of new HVAC equipment). We apply lighting, appliances, and other savings in both new and existing buildings using "Retrofit Existing Buildings." To set the magnitudes we use the Annual Energy Outlook 2025 (EIA 2025a) to estimate the proportion of buildings that are new each year (0.9% residential, 2.7% commercial), and the proportion in 2050 that are built starting in 2030 (17% residential, 49% commercial) and adjust the magnitudes accordingly.

Buildings electric equipment

Heat pumps have overtaken gas furnaces as the most common home heating system installed in the United States (AHRI 2026). We assume that 90% of new homes and 70% of commercial buildings could be all-electric by 2030, as is typical for zero-emissions buildings. EIA projects that 37% of all homes will primarily use electric heat in 2050, about the same as now (EIA 2025a). In our policy case we double that proportion of existing homes by 2050. For commercial buildings we only have data by energy use, not by building space. Because the electric systems are more efficient, the electric percentage of use is smaller—we triple the baseline percentage. The corresponding reduction in fuel usage is calculated using the EPS assumption that for heating, electric use is 64.4% lower than the corresponding fuel use.

For appliances and "other" in new homes and commercial buildings, we assume if the heating is electrified, the rest of the energy use is as well, so the same percentage of fuels is switched. For existing buildings, we also use the same percentage switched as for heating, but only switch appliances (water heating, cooking, and clothes dryers), not "other."

Table A3. Buildings electrification assumptions

Energy use	BAU electric		Policy electric		% fuels switched		Ramp-up	
	New	Existing	New	Existing	New	Existing	New	Existing
Residential							2026–30	2026–50
Heating	61%*	37%*	90%*	74%*	74%	59%		
Appliances					74%	59%		
Other					74%	0%		
Commercial							2026–30	2026–50
Heating	12%	9%	70%	27%	82%	38%		
Appliances					82%	38%		
Other					82%	0%		

* The BAU and policy reesidential percentages are for the number of homes (single-family and multifamily units). Other percentages are of energy use. BAU percentages are from EIA or the U.S. Census (U.S. Census Bureau 2025; EIA 2025a, 2022).

EPS inputs: We use the EPS "Building Component Electrification" policy, which applies as a percentage reduction to the fuel use of new equipment and an associated increase in electric use. Because it applies to all equipment, we multiply the fuel savings by the same proportions as in the previous subsection for buildings built starting in 2030 (new) versus before (existing).

Industrial energy efficiency, electrification, and reduced materials

Energy Innovation has developed a separate tool for modeling industrial decarbonization scenarios called the Industrial Transformation Technology and Investment Model (ITTIM) (Energy Innovation 2025b). However, it does not cover all sectors, notably missing non-manufacturing sectors including construction, mining and drilling, and agriculture. We entered a scenario to achieve a 100% clean industrial sector with clean electricity by 2050 with no carbon price, and used its scenario for the energy efficiency, material efficiency, and electrification of high temperature fuel uses and some low-temperature and nonthermal fuel uses by industrial sector. We estimated these potentials for other sectors based on the literature and staff expertise. While electric technologies can achieve low process heat temperatures, many industrial subsectors use combined heat and power (CHP) units and/or combust byproduct fuels, like black liquor in pulp and paper facilities. For that reason, we based some low-temperature electrification assumptions on the remaining heat opportunities identified in the 2035 Initiative's *The Clean Heat Climate Opportunity* report and other subsector estimates from a Schneider Electric report (The 2035 Initiative 2025; Petit 2024). Since EPS does not include material efficiency for energy sectors (as redundant with the rest of the model) or agriculture, we do not either.

Table A4. Industrial assumptions

Industry	Energy savings	Electrification		Reduced materials
		Low T and nonthermal	High T, boilers + steam	
Food, beverage, and tobacco	25%	76%	76%	
Textiles, apparel, and leather	25%	85%	85%	
Wood products	25%	80%	80%	
Pulp, paper, and printing	25%	17%	17%	15%
Chemicals	25%	47%	47%	8%
Rubber and plastic products	25%	66%	66%	
Glass and glass products	25%	100%	30%	12%
Cement and other nonmetallic minerals	25%	100%	30%	15%
Iron and steel	25%	38%	11%	15%
Other metals	25%	100%	88%	15%
Metal products except machinery and vehicles	25%	100%	100%	
Computers and electronics	25%	71%	71%	
Appliances and electrical equipment	25%	51%	30%	12%
Other machinery	25%	57%	57%	
Road vehicles	25%	100%	100%	
Nonroad vehicles	25%	100%	100%	
Other manufacturing	25%	55%	55%	
Refined petroleum and coke	25%	47%	5%	
Agriculture and forestry	25%	100%	100%	
Coal mining	30%	100%	90%	
Oil and gas extraction	25%	100%	100%	
Other mining and quarrying	30%	90%	90%	10%
Energy pipelines and gas processing	20%	90%	20%	
Water and waste	30%	100%	10%	8%
Construction	25%	100%	35%	15%

EPS inputs: These assumptions are directly input into “Industry Energy Efficiency Standards,” “Industry Electrification,” and “Material Efficiency, Longevity, & Re-Use.”

Efficient and electric vehicles

Congress and the Trump administration last year moved to reverse both federal and state policies and funding in support of electric vehicles and vehicle efficiency. Our base case includes the end of the federal tax credits and state greenhouse gas emission standards and assumes that the 2024 federal emission standards are reversed, as EPA has done. For the policy case, we start by restoring those policies, though we do not restore renewables and other policies that also were reversed:

- Federal tax credits for passenger and commercial vehicles and EV chargers (30D, 45W, 30C)
- EPA tailpipe emission standards for light-, medium-, and heavy-duty vehicles
- Waiver for California Advanced Clean Cars II and Advanced Clean Trucks rules (also adopted by several other states)

We then add longer-term efficiency improvements and shift to electric vehicles to continue improvements out to 2050. For efficiency, we assume long-term rates of savings consistent with what we have seen. For ZEVs, we assume that the base case percentage of vehicles that are ICE in 2050 can be cut in half.

Table A5. Vehicle efficiency and zero-emissions-vehicle assumptions

Vehicle type	Savings		Ramp-up
Fuel economy			
Fuel vehicles	35%		2029–2050
Electric vehicles	45%		
New zero-emission vehicles	**% vehicles**		
	BAU	Policy	
Cars + SUVs	79%	90%	2031–2050
Light + medium trucks	56%	78%	
Heavy trucks	31%	65%	
Buses	50%	75%	

The efficiency improvements apply to light-, medium- and heavy-duty vehicles. Electric vehicles here include plug-in hybrids and the few hydrogen vehicles. For ZEVs the BAU percentages are for a modified base case in which the above federal policies have been restored.

EPS inputs: The former policies are restored using the relevant policies in the EPS January 2025 Frozen Policies scenario. The additional measures are applied as "Fuel Economy Standard" and "Federal Zero-Emission Vehicle Sales Standard." We set the initial ZEV requirements to 50% of the final numbers, and adjusted the start dates for each category between 2031 and 2035 in order to make a smooth transition.

Transportation system efficiency

We combine multiple ways of reducing the need for driving both passenger and freight vehicles as described in the text. These savings come in slowly but by 2050 we estimate we can reduce the number of miles driven by cars, SUVs, and buses by 10% and by delivery vans and trucks by 20%.

Table A6. Transportation system efficiency assumptions

Vehicle type	Savings	Ramp-up
Passenger vehicles	10%	2027–2050
Freight vehicles	20%	

EPS inputs: We implement the reduction in miles driven due to system efficiency as "Mode Shifting," which moves demand from cars, SUVs, buses, and trucks primarily to rail.

Demand flexibility

We include electric demand flexibility in the buildings, industrial, and transportation sectors. Since the EPS model only uses a single overall annual magnitude, we only set assumptions at that level. Based on studies cited in the text, we assumed we could reduce peak demand by a total of 20%.

Table A7. Demand flexibility assumptions

Sector	Peak demand reduction	Ramp-up
Overall	20%	2026–2050

EPS inputs: We implement in "Demand Response," which simply reduces electricity demand in the hours on peak summer and winter days when net peak load (not absolute peak) is highest. We run the scenario without demand response in order to find the peak demand, and take 20% of the winter peak since the demand reduction applies in both winter and summer, and in our scenarios winter peak is lower. We then translate this to a percentage of EPS's 2050 potential: 392 GW in 2050 in addition to 59 GW baseline capacity. Because EPS ramps up the demand response potential through 2050, we ramp up the percentage of that potential 2026–2030. We note this is a potential; actual demand reduction applied by EPS is more complicated.

Model

Energy Policy Simulator

We implement these measures in Energy Innovation's Energy Policy Simulator 4.0.4 (Energy Innovation 2025a). Because of our focus on efficiency, Energy Innovation provided us with a slightly modified version of the model with additional subscripts on a couple policies, and this allowed us to set different efficiency improvements by fuel for building equipment and vehicles.

In addition, we modified a few assumptions when results did not seem reasonable. These include

- Rebound:
  - For buildings, EPS includes elasticity of both energy use and new component efficiency with respect to energy costs and hence to energy efficiency. We modified the elasticity of energy use to be –0.1 for all fuels (hence 10% rebound). We set the new component efficiency elasticity for residential electric equipment to –0.1 as well.

  - For transportation, EPS similarly includes elasticities of vehicle use and new vehicle fuel economy with respect to energy costs, though only the former is affected by energy efficiency. Based on a recent review of elasticities by EPA (EPA 2024b), we set the heavy-duty vehicle use elasticity to 0.

- Building improvement costs:
  - EPS calculates the cost of improved building component efficiency using elasticities based on the underlying cost of the components, but had zero cost for many of the components, and hence zero improvement costs. Energy Innovation supplied corrected values for some, and we added missing values, which were somewhat arbitrary, but better than zero: we set "envelope costs" so that the measure costs would be similar to EPS default retrofit costs (corrected by Energy Innovation for commercial). These retrofit costs likely are conservative for new construction. We based "other" costs on appliance costs, adjusted based on relative baseline energy use.
  - EPS only includes heating and cooling upgrades in their building retrofits. Because we are using that measure to also include lighting, appliance, and other upgrades, we not only modified the savings as in table A2 but also added costs. We set the costs so that electricity measures would have roughly a five-year payback (Chia et al. 2025; Integrated Design Lab 2020), yielding costs of 0.000152 $/Btu for residential and 0.000129 for commercial. If these are low for other measures, that may partially balance the high HVAC control and envelope costs.
  - EPS reduces the number of retrofits based on assumed survival of buildings. Because this was not needed in our calculations, we set the lifetime to effectively infinite.

- Transportation system improvements costs:
  - EPS for public transit includes both the cost of the vehicles and fuels and the cost of fares to cover those expenses, though most are actually covered by government support. To include both in transportation costs would in effect double-count the cost of adding transit. We zeroed out the cost of the fares, though for the macroeconomic model this misses the transfer of funds from taxpayers and passengers to the transit agencies.

- Jobs:
  - Industrial material efficiency in EPS yields incorrect macroeconomic impacts because the savings simply disappear rather than being spent or invested in other areas. For the reported jobs impacts only we replaced material efficiency with increased energy efficiency in the same industries.

We do not discuss measure or energy costs here, other than a couple assumptions we changed, but those are well documented in the files in the downloaded version of EPS.

Financial assumptions and results

We report all financial results in real 2025 dollars (using a gross domestic product price deflator).

For reporting financial impacts from the measures, we focus on the energy-consuming sectors: buildings, industry, and transportation. We exclude the electric sector because the capital and fuel costs are already included in electricity prices for the other sectors. Similarly, we exclude refinery feedstocks because they are included in gasoline, diesel, and other petroleum products, and exclude transit fares, which are redundant with spending on transit vehicles and fuels. However, the model does include interactive effects among the sectors, for example, less fuel use means less refinery and transportation costs.

Because EPS does not include financing, other than electric system costs amortized in electric rates, we add financing of capital costs outside the model. Specifically, based on past ACEEE work, we assume loan parameters in table A8.

Table A8. Financing assumptions

Sector	% financed	Real interest rate	Loan duration (years)
Buildings	60%	2.5%	30
Industry	50%	3.0%	7
Transportation	70%	3.3%	5

Because we incorporate financing into the results rather than directly into the EPS model, the jobs results do not include financing.

We discount cumulative results to 2025 with a real 3% discount rate, taken from EPS. In order to include the full impacts of measures through 2050, for cumulative results we extend both energy savings and O&M costs with a linear decrease for 15 years. We include repayment of capital financing for the duration of the loans, up to 30 years.

Appendix B: Detailed results

See the "Results" section for more description of the results and Appendix A for detailed assumptions.

Table B1. Baseline and policy energy use by sector and fuel

Baseline	2025	2030	2035	2040	2045	2050
Electricity (TWh)	*3,991*	*4,203*	*4,488*	*4,794*	*5,201*	*5,655*
Buildings	2,874	2,970	3,034	3,066	3,200	3,415
Industry	1,068	1,087	1,107	1,132	1,161	1,208
Transportation	49	146	346	597	840	1,032
Gas (TBtu)	*19,133*	*19,623*	*19,748*	*19,831*	*20,122*	*20,626*
Buildings	9,587	9,688	9,637	9,571	9,541	9,507
Industry	9,500	9,908	10,096	10,250	10,569	11,106
Transportation	46	27	15	11	11	13
Oil (MBD)	*13*	*12*	*11*	*9*	*9*	*8*
Buildings	0	0	0	0	0	0
Industry	2	1	1	1	1	1

Baseline	2025	2030	2035	2040	2045	2050
Transportation	11	10	9	8	7	6
Policy	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Electricity (TWh)	*3,997*	*4,402*	*4,801*	*5,070*	*5,334*	*5,577*
Buildings	2,874	2,900	2,826	2,672	2,579	2,541
Industry	1,068	1,266	1,411	1,517	1,632	1,791
Transportation	55	236	563	881	1,123	1,244
Gas (TBtu)	*19,133*	*15,869*	*12,064*	*8,762*	*6,340*	*5,158*
Buildings	9,587	8,464	6,528	4,605	3,163	2,715
Industry	9,500	7,379	5,524	4,151	3,172	2,439
Transportation	46	25	12	6	5	4
Oil (MBD)	*13*	*11*	*9*	*7*	*5*	*4*
Buildings	0	0	0	0	0	0
Industry	2	1	1	1	1	0
Transportation	11	9	8	6	5	4

Final energy use (does not include fuels used for electric generation or as industrial feedstocks). Gas savings include propane and liquified petroleum gas (mostly from natural gas drilling). Coal and direct use of renewables are not shown. Units are terawatt-hours (TWh), trillion Btu (TBtu), and million barrels a day (MBD).

Table B2. Energy savings by measure and fuel

Measure	Electricity (TWh)		Gas (TBtu)		Oil (MBD)	
	2035	2050	2035	2050	2035	2050
Equipment efficiency	199	725	382	1,899	0.00	0.01
New buildings	87	208	341	798	0.01	0.03
Existing buildings	114	276	483	1,143	0.02	0.04
Buildings electric equipment	–198	–337	2,079	3,477	0.05	0.09
Plant efficiency	167	299	1,537	2,645	0.11	0.18
Material efficiency	41	68	265	412	0.07	0.12
Industrial electric heat	–507	–948	2,606	5,059	0.36	0.57
Fuel economy	22	225	5	11	0.20	0.65
Transportation system	–10	13	2	5	0.29	0.40
Electric vehicles	–232	–450	–20	21	0.80	1.53
Demand flexibility	2	2	2	1	0.00	0.00

Measure	Electricity (TWh)		Gas (TBtu)		Oil (MBD)	
Total	**–314**	**79**	**7,684**	**15,469**	**1.90**	**3.63**

Final energy savings (hence does not include fuels used for electricity generation). Gas savings include propane and liquified petroleum gas (mostly from natural gas drilling). Coal and direct use of renewables are not shown. Units are terawatt-hours (TWh), trillion Btu (TBtu), and million barrels a day (MBD).

Table B3. Changes in capital and operating costs by sector ($ billion)

	2030	2035	2040	2045	2050
Capital investment (no financing)					
Buildings	67	76	81	88	93
Industry	25	–0	–27	–45	–56
Transportation	–22	–22	–25	–33	–45
Total	70	55	30	9	-7
Capital spending (including financing)					
Buildings	33	47	60	75	90
Industry	21	8	–19	–41	–55
Transportation	–16	–23	–25	–32	–43
Total	39	32	16	2	–9
O&M spending					
Buildings	-	-	-	-	-
Industry	–0	–0	–1	–1	–1
Transportation	–9	–26	–48	–73	–95
Total	–9	–27	–49	–74	–96
Energy spending					
Buildings	–23	–73	–137	–194	–232
Industry	–13	–31	–50	–63	–67
Transportation	–14	–38	–70	–104	–140
Total	–50	–142	–257	–361	–439
Total spending					
Buildings	10	–26	–77	–119	–143
Industry	9	–23	–70	–105	–123
Transportation	–39	–88	–144	–209	–278
Total	–20	–137	–290	–434	–544

All amounts in real 2025 dollars. Capital "spending" is the same as capital "investment," except it reflects partial financing. Negative numbers reflect savings. Electric sector spending is not shown directly, but it is incorporated in the energy spending.

Table B4. Peak summer electricity demand for various scenarios (gigawatts)

	2030	2035	2040	2045	2050
Peak demand					
Baseline	801	888	983	1,082	1,182
Electric efficiency	750	751	740	732	742
Added load	870	1,051	1,236	1,415	1,583
Policy—no DR	815	890	941	975	1,015
Policy	811	890	941	974	1,014
Peak demand met by fossil plants					
Baseline	489	494	517	554	600
Electric efficiency	442	390	346	322	316
Added load	547	619	704	797	894
Policy—no DR	497	486	481	472	474
Policy	472	443	431	415	407

Table B5. Greenhouse gas emissions abatement by sector (MMT CO_2e)

	2030	2035	2040	2045	2050
Electricity	–100	–104	–33	31	129
Buildings	72	181	288	370	393
Industry	222	398	532	635	728
Transportation	80	195	290	358	393
Total	**273**	**670**	**1,077**	**1,393**	**1,643**

Direct emissions reductions from measures in each of the sectors.