General Insights

Highlights

Investment
Investment in energy efficiency over the past decades has shifted our economic, social, and environmental trajectory.

Decoupled Energy Consumption
From 1980 to today, the U.S. decoupled energy consumption and economic growth and doubled energy productivity (GDP per energy consumed).

Efficient Consumption
The U.S. would have produced almost 80% higher carbon emissions in 2021 without energy efficiency investments.

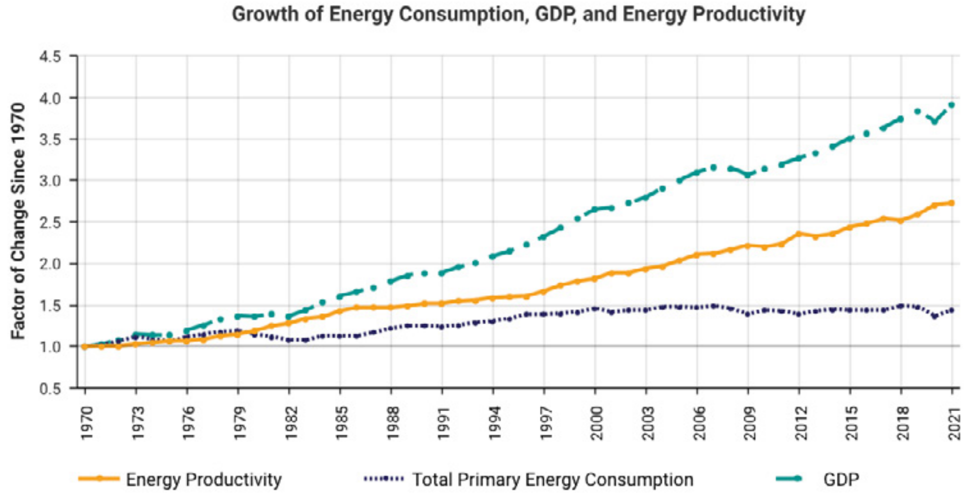
Efficient Consumption
In large part as a result of energy efficiency, energy consumption has remained largely flat in spite of a growing population, increasing use of appliances and devices, and increasing vehicle miles traveled.

Efficiency Policies
Six key energy efficiency policies and programs, including vehicle, appliance, and equipment efficiency standards, ENERGY STAR®, utility sector energy efficiency programs, research, development, and demonstration (RD&D), and building codes, saved approximately 32 quads of energy in 2021 – this is approximately 30% of what energy consumption would have been in their absence.

Cost for Consumers
Without the energy efficiency investments made since 1980, energy consumption and emissions would have been 60% higher, and consumers would be paying nearly $800 billion more per year in energy costs.

1 Energy Productivity

The U.S. has more than doubled energy productivity since 1970



Source: EIA (2022) Monthly Energy Review

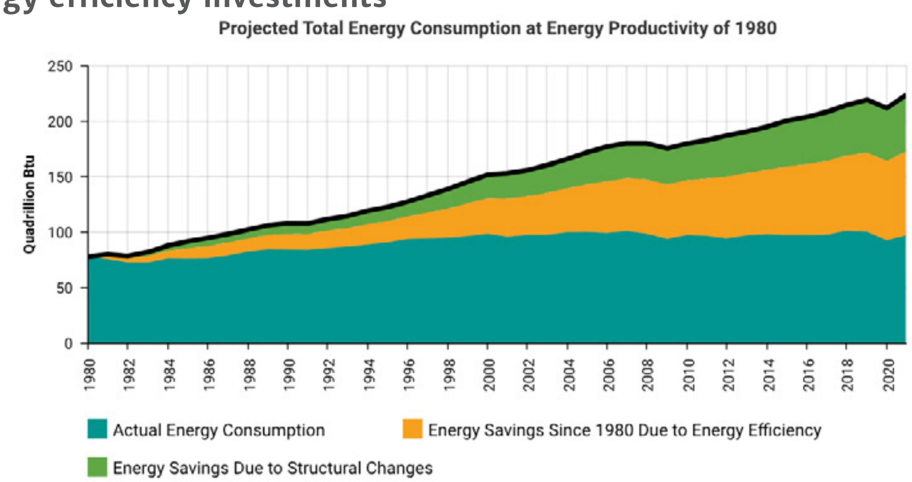
From the 1950s to the 1970s, the economy (GDP) and energy consumption grew at similar rates, an indicator that economic growth and energy consumption were interdependent, or "coupled" with one another.[1]

However, by the mid-1990s, by using energy more effectively, our economic growth surged past energy consumption, decoupling the two quantities and allowing American society to do more with less energy.

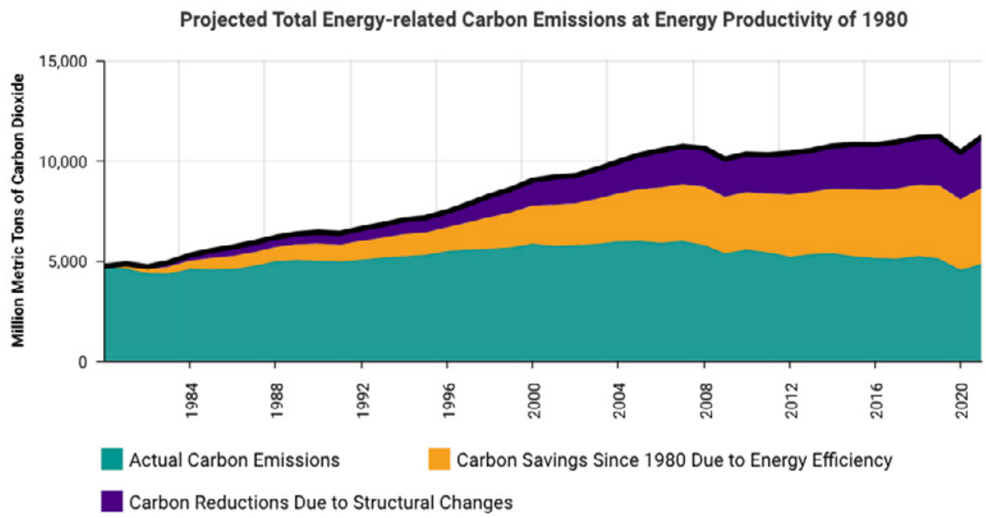
Since 1970, U.S. energy productivity has improved by 170%, driven mostly by improvements in the energy efficiency of homes, buildings, industry, and transportation.

2 Energy Consumption and Emissions Reductions

Energy consumption and carbon emissions would be 60% higher without energy efficiency investments



1 DOE (2022), Energy Intensity Indicators: Highlights



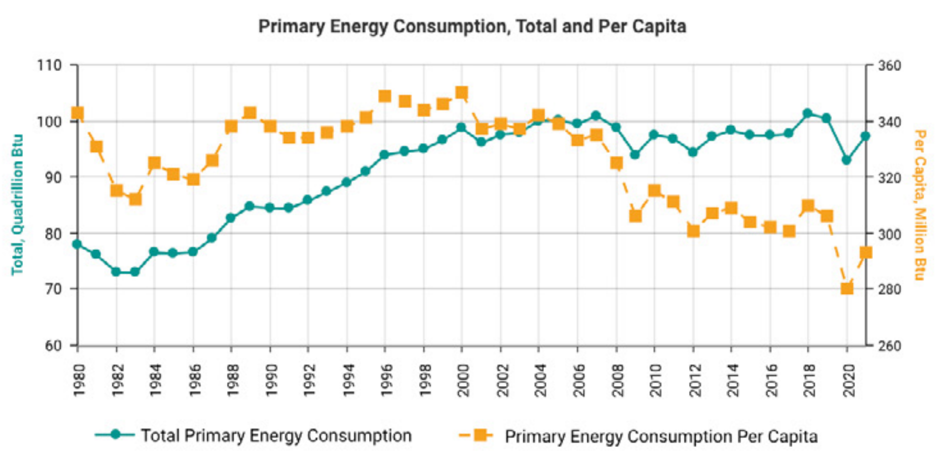
Source: EIA (2022) Monthly Energy Review

Increasing energy productivity is the result of a combination of energy efficiency policies and innovations as well as structural changes in the economy. Had U.S. energy productivity remained at the level observed in 1980, U.S. energy consumption today would need to be more than double its current value in order to achieve the same level of our current economic growth.[2] ACEEE analysis estimates that energy efficiency is responsible for approximately 60% of these energy productivity improvements.[3]

Similarly, the U.S. would have produced 78% higher carbon emissions, or an additional 3,810 million metric tons of carbon dioxide, in 2021 without energy efficiency investments. This highlights the extraordinary scale of energy efficiency as a tool for decarbonization. Similarly, the U.S. would have produced 60% higher carbon emissions, or an additional 3,540 million metric tons of carbon dioxide, in 2018 without energy efficiency investments. This highlights the extraordinary scale of energy efficiency as a tool for decarbonization.[4]

3 Per Capita Primary Energy Consumption

Efficiency has decreased per capita energy use since 2000



Source: EIA (2022) Monthly Energy Review

2 EIA (2022), Monthly Energy Review

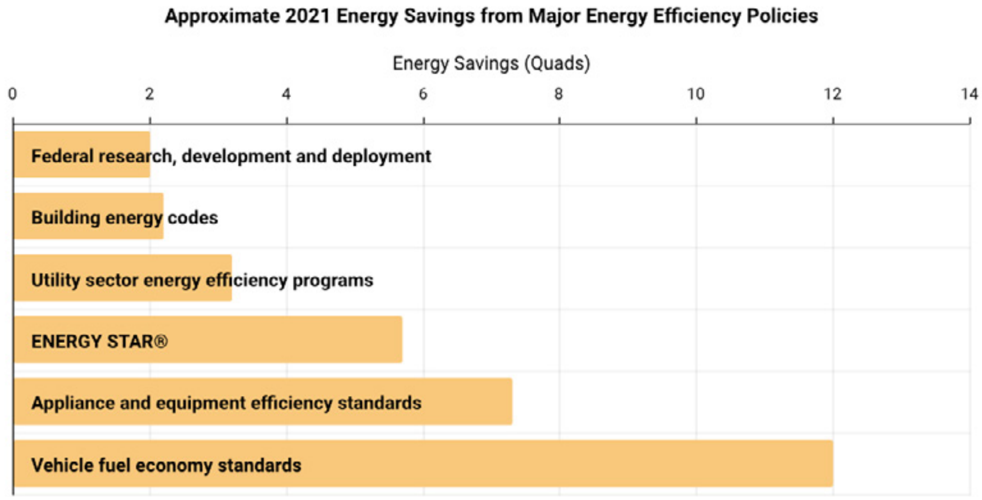
3 ACEEE (2015), Energy Efficiency in the United States: 35 Years and Counting.

4 This chart assumes the same energy intensities as the chart above and uses the actual emissions intensities per quad of energy use for each year.

The 1980-2021 period witnessed trends that could be expected to significantly increase energy demand: the U.S. population grew by 46%,[5] the vehicle miles traveled per capita increased by 41%,[6] the median square footage of new single-family houses completed increased by 42%,[7]and the economy nearly doubled in size.[8] From 1983 to 2000, total and per capita primary energy consumption increased gradually. But over the last 21 years, energy consumption per capita has consistently decreased (by 16%), and overall energy consumption has plateaued (1% decrease). Energy efficiency was a critical element that stabilized energy demand.

4 Energy Efficiency Policy And Program Impacts

Six key energy efficiency policies and programs reduced total U.S. energy consumption by about 30%



Source: ACEEE (2022), ASAP (2022), EPA (2022)

Six key energy efficiency policies and programs reduced total U.S. energy consumption by roughly 32 quads in 2021, equal to roughly 30% of total U.S. energy consumption in that same year, or the energy use of the entire transportation sector.[9, 10]

Each program or policy is described in greater detail in this report: vehicle fuel economy standards (indicators #45-46); appliance and equipment efficiency standards (indicators #24-25); ENERGY STAR® (indicators #26, #33, #44); utility sector energy efficiency programs (indicators #12-19); federal research, development, and deployment investment (part of indicator #6), and building energy codes (indicator #34).

5 U.S. Census (2022), Population Estimates

6 Moving 12-Month Total Vehicle Miles Traveled/Total Population

7 U.S. Census (2022), Characteristics of New Housing

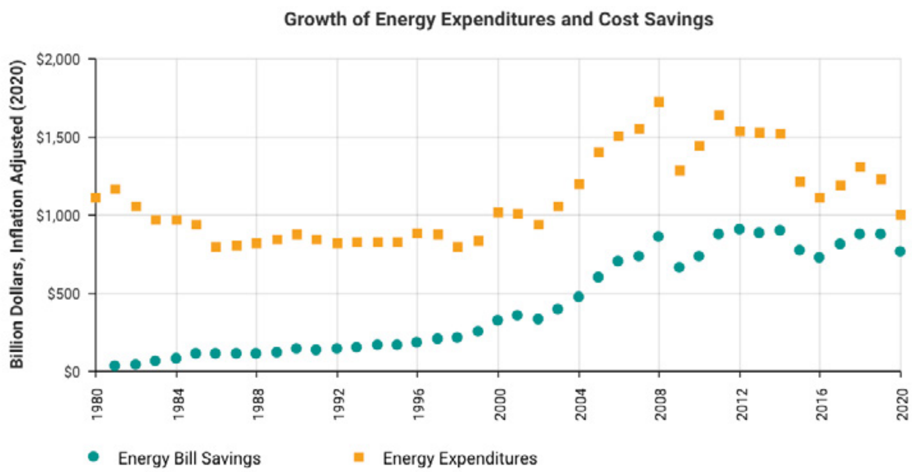
8 BEA (2022), National Income and Product Accounts

9 RD&D savings are a conservative ACEEE estimate informed by NREL (2000); PNNL (2004): DOE (2010).

10 EIA (2022), Use of Energy Explained.

5 Energy Expenditures And Cost Savings

Efficiency investments have reduced today's energy expenditures by approximately $800 billion (2020$)



Source: EIA (2022) Monthly Energy Review

Historical Tables, Budget of the United States Government, Fiscal Year 2022 (2021). Budget FY 2022

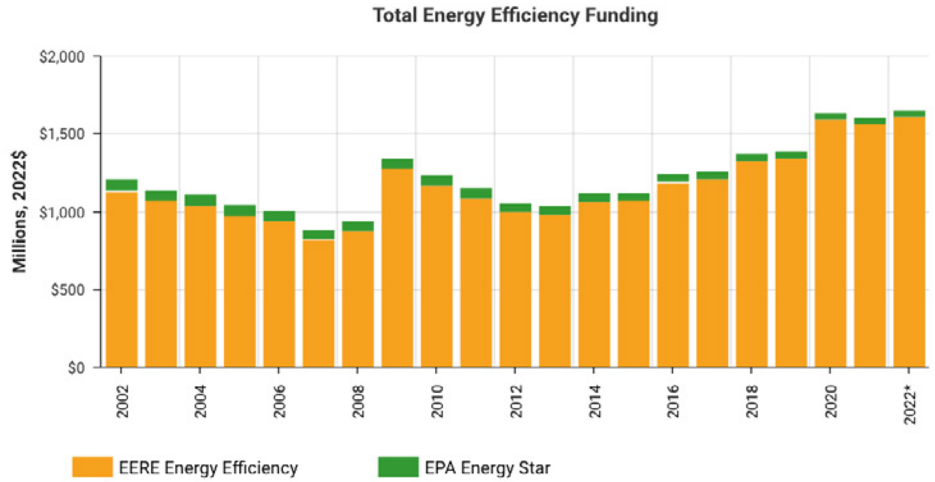
Energy efficiency has also led to enormous bill savings across the economy. Based on some simple assumptions,[11] the chart shows the total energy expenditures across the U.S. economy from 1980 to 2020, and the energy cost savings each year due to energy efficiency investments since 1980. As energy prices overall dropped since 2008 (until this year), the amount of energy saved each year grew, and the dollar savings have remained around $800 billion each year.

To put this number in context: If we had the same level of economic growth without these savings, energy spending would have been 77%, or $774 billion, higher in 2020.

11 Assumptions: EIA estimates total energy expenditures for each year. Based on the energy savings as a fraction of energy use each year, we estimated total energy cost savings as a fraction of expenditures. Note: the energy expenditures are shaped by volatility in energy prices as well as changes in energy use.

6 Energy Efficiency Federal Funding

Federal funding for energy efficiency has increased by over 60% in the last fifteen years



**Total does not include new funding from the 2021 Bipartisan Infrastructure Bill or the 2022 Inflation Reduction Act, as those funds are expected to be spent beginning in 2023.*

Source: ACEEE Analysis (2022)

Federal policymakers continue to value energy efficiency by increasing appropriations for energy efficiency research, development, and demonstration (RD&D), increasing by 60% from $826 million to $2.5 billion in constant dollars from 2008 to 2021 (with a one-time spike in 2009 due to stimulus spending from the American Recovery and Reinvestment Act).

For context, the share of energy efficiency spending relative to the total U.S. federal RD&D spending (reported at $165 billion in FY2021)[12] was only 1.5% in FY2021.

The Bipartisan Infrastructure Law of 2021 and especially the Inflation Reduction Act of 2022 include unprecedented investments in deployment of energy efficiency technologies, including billions of dollars for home energy retrofits, heat pumps, electric vehicles, and more. These programs will be implemented over several years.

12 USASPENDING.gov (2022), Department of Energy (DOE)

Energy Efficiency Impact Report

Co-Benefits with Energy Savings

Highlights

Energy efficiency is often credited for achieving energy savings, but it also provides benefits in other areas, such as:

Job Creation

Efficiency jobs make up 40% of all traditional energy jobs, totaling 2.2 million in 2021. 70% of workers are employed by small businesses.

Public Health

In 2021, avoided air pollution due to energy efficiency was responsible for $430 million in public health benefits, including avoided non-fatal heart attacks and asthma exacerbations.

Addressing the Energy Burden

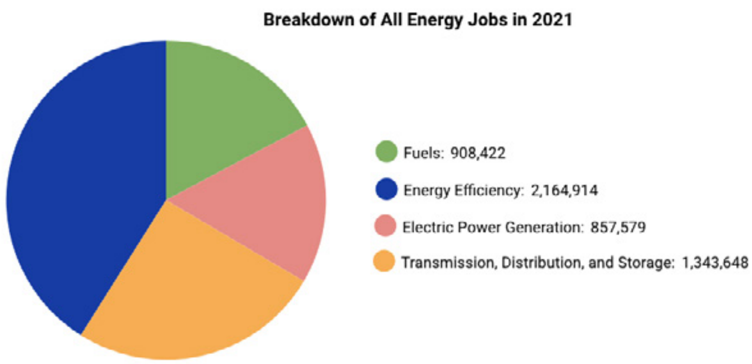
More than 60% of low-income households experience a high financial burden from energy costs. Cost-effective energy efficiency improvements exist in many circumstances that could help consumers save on energy costs.

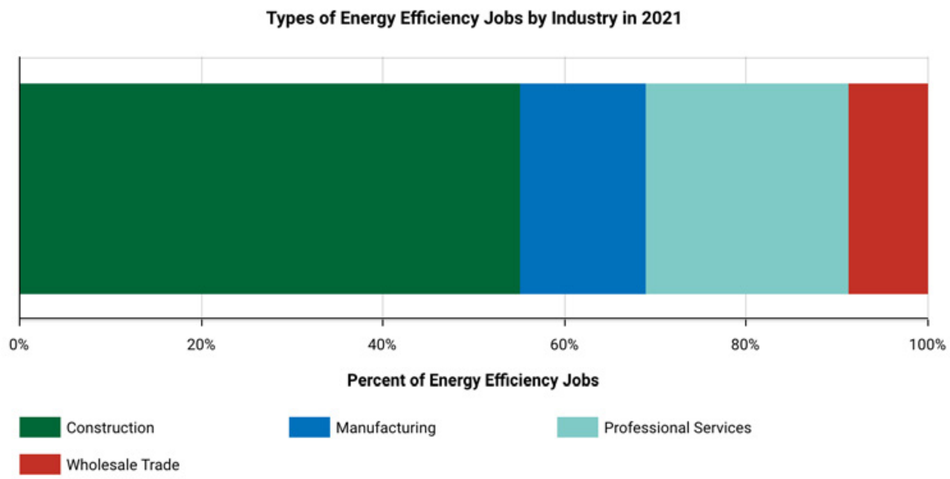
Other Commercial Benefits

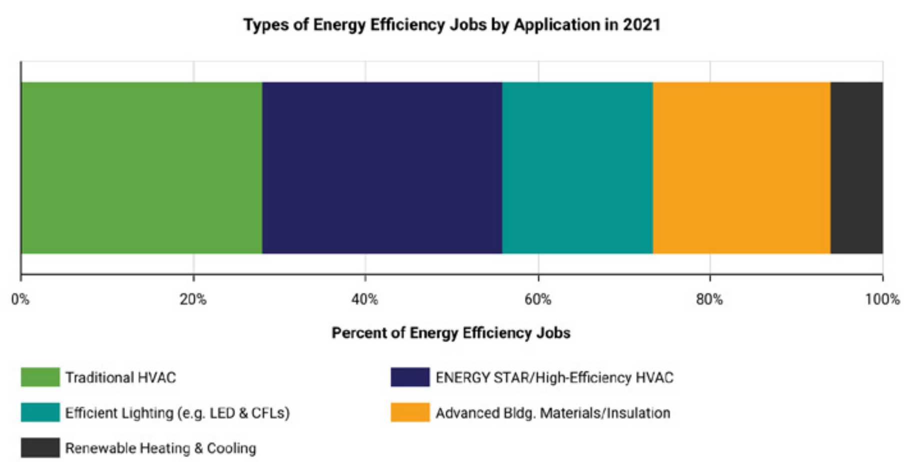
Energy efficiency can unlock higher levels of cost savings in commercial buildings beyond energy savings themselves, including increased worker productivity, health and satisfaction, reduced costs for maintenance and operation, and higher asset values.

7 Energy Efficiency Jobs

Efficiency jobs totaled 2.2 million in 2021, making up roughly 40% of all energy jobs.







Source: United States Energy & Employment Report (June 2022), DOE

There were nearly 2.2 million U.S. jobs in energy efficiency in 2021, making up 40% of all traditional energy and energy efficiency jobs as defined by the 2021 U.S. Energy & Employment

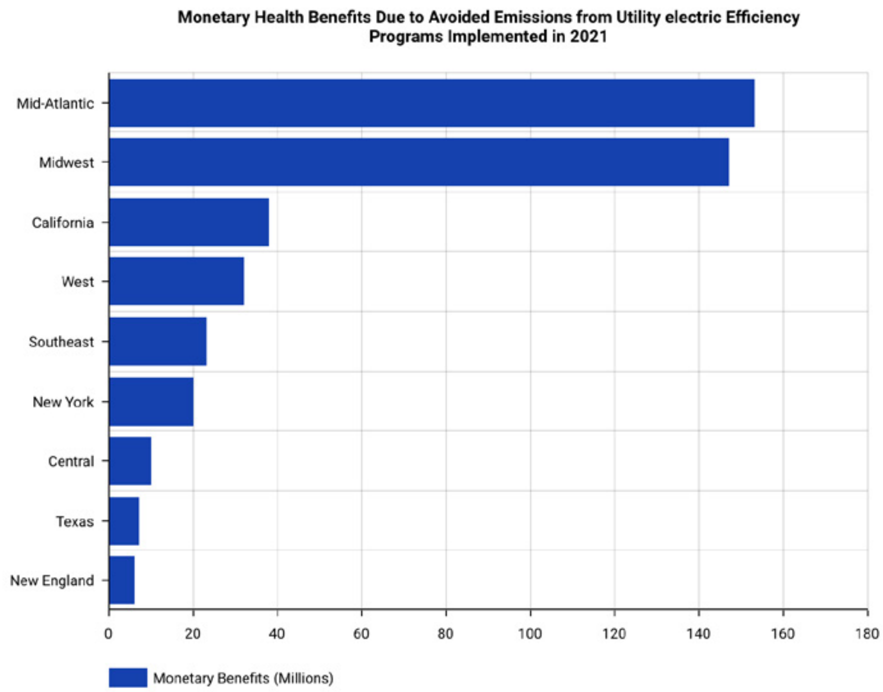
Report (USEER).[1] Not only is energy efficiency a leading job-creator nationwide in the energy sector, energy efficiency jobs are also a key driver of our local economies: More than 70% of workers are employed by small businesses, and energy efficiency jobs exist in 99.8% of counties.

These jobs also represent a wide range of skillsets, many of which cannot be outsourced: More than 50% of energy efficiency jobs are in construction, while professional services (including consulting, engineering, finance, legal, etc.) constitute about 20% of jobs.[2]

Currently, roughly 11% of these workers are covered by a union or project labor agreement, which is nearly double the national average (6%).[3]

8 Public Health Benefits

Power plant pollution reduced by utility-funded electric efficiency programs avoided more than $430 million in health care costs



Sources: EPA (2021), Public Health Benefits per kWh of Energy Efficiency and Renewable Energy in the United States: A Technical Report; LBNL (2021) Still the One: Efficiency Remains a Cost-Effective Electricity Resource

Energy efficiency also has positive impacts on public health, primarily by avoiding particulate matter emissions from additional energy generation.[4]

1 The USEER provides jobs data for the motor vehicles and component parts sector as well. However, this sector is not considered in the report as part of the traditional energy industry. The USEER considers the traditional energy sector to be made up of electric power generation, fuels and transmission, distribution, and storage. DOE (2022), The 2022 U.S. Energy & Employment Report

2 For small business with fewer than 20 employees. E4TheFuture (2018), Energy Efficiency Jobs in America

3 DOE (2022), The 2022 U.S. Energy & Employment Report

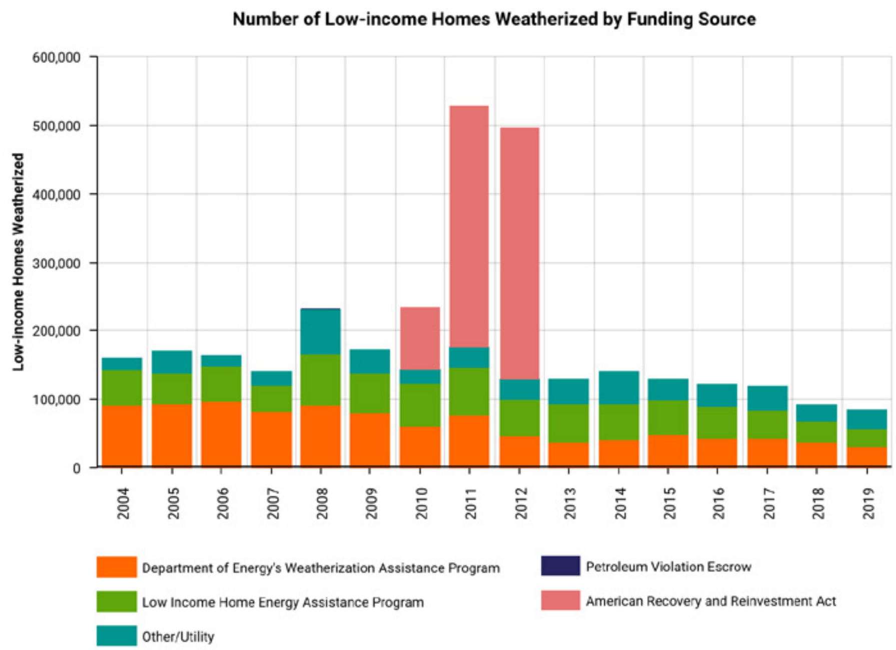
4 Many studies have linked exposure to particulate matter air pollution to various cardiovascular and respiratory issues, including nonfatal heart attacks and aggravated asthma, especially for children. EPA (2022), Health and Environmental Effects of Particulate Matter

There has been increasing work to estimate the health impacts of energy efficiency. The EPA now publishes estimates for monetized health benefits per kilowatt-hour (kWh) of electricity savings by region.[5]

The chart illustrates the total monetary value of health benefits ($437 million) due to reduced particulate pollution from one year of energy savings (also called incremental savings) provided by ratepayer-funded electricity efficiency programs implemented in 2021.[6, 7] This amounts to 37% of the estimated levelized total cost of the electricity savings ($1.2 billion). [8]

9 The Multiple Benefits of Weatherization

Weatherization assistance programs have enhanced the energy efficiency of nearly 3 million homes since 2004



Source: NASCSP Program Year 2019 Survey (and earlier reports)

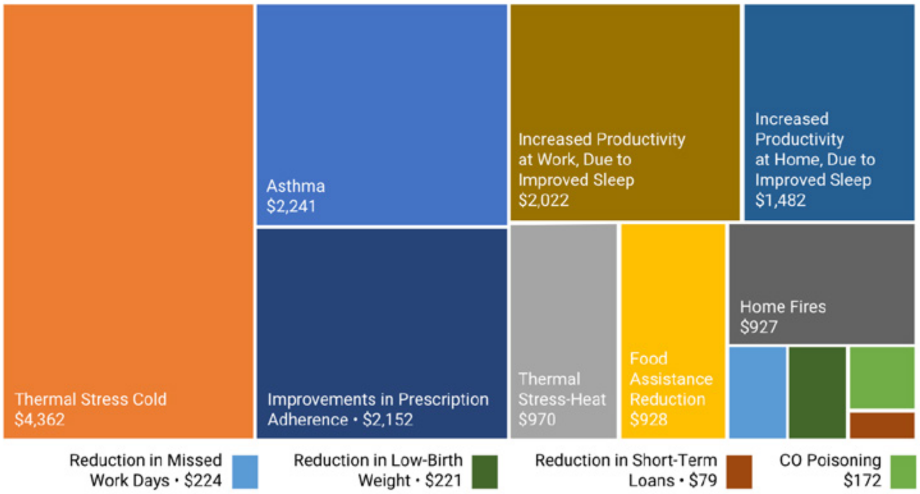
5 EPA's estimates for benefits per kWh in its "Public Health Benefits per kWh of Energy Efficiency and Renewable Energy in the United States: A Technical Report" vary significantly across regions due to difference in the fossil fuel mix used for generation. Also, note that energy efficiency could also curtail renewable energy, but the chart above assumes all curtailment was from fossil fuel generation.

6 To estimate energy savings across regions, the state apportionments by AVERT region (based on generation from 2010 to 2013) were applied to the 2017 incremental energy savings from energy efficiency programs implemented in each state (state data taken from ACEEE's State Energy Efficiency Scorecard). Note that the percentage breakdown of states' savings across regions are based on the share of fossil-fuel generation rather than consumption. Furthermore, the model limits curtailment to plants within the region although in reality electricity transmission between some regions is large. See EPA's AVoided Emissions and geneRation Tool (AVERT) User Manual for more information on the limitations and caveats of AVERT.

7 To estimate monetary health benefits across regions, the estimated incremental energy savings from energy efficiency programs (described in the footnote above) were multiplied by the respective regions' benefits per kWh (BPK) values (using the low estimate for "Uniform EE" at a 3% discount rate) found in EPA's technical report on Public Health Benefits per kWh of Energy Efficiency and Renewable Energy in the United States.

8 LBNL (2021), Still the One: Efficiency Remains a Cost-Effective Electricity Resource

Non-Energy Benefits of Weatherization per Household ($2021)



Source: *Oak Ridge National Laboratory (2014)*

Community action agencies have weatherized nearly 3 million homes since 2004 under DOE's Weatherization Assistance Program (WAP). Additional funding has come from the Low-Income Home Energy Assistance Program (LIHEAP), utility programs, and formerly the Petroleum Violation Escrow (PVE) Funds (1981-2009) and 2009 American Recovery and Reinvestment Act (ARRA) appropriations (2010-2012).

Weatherization not only helps relieve high water and energy bills, but also delivers important non-energy benefits, such as increased comfort, improved health outcomes, and consequently lower out-of-pocket medical expenses.[9, 10] Weatherizing a home could deliver over $15,000 (2021$) in lifetime societal non-energy benefits and $1,800 in lifetime benefits direct to the household.[11] In 2019 alone, the 85,000 low-income homes weatherized delivered an estimated $1.3 billion in societal non-energy benefits.

The 2021 Bipartisan Infrastructure Law included an additional $3.5 billion for WAP to be spent over several years. In addition, the Inflation Reduction Act provides tens of billions of dollars for energy improvements to existing homes and for broad greenhouse gas reduction programs, much of it directed to low-income and disadvantaged communities.

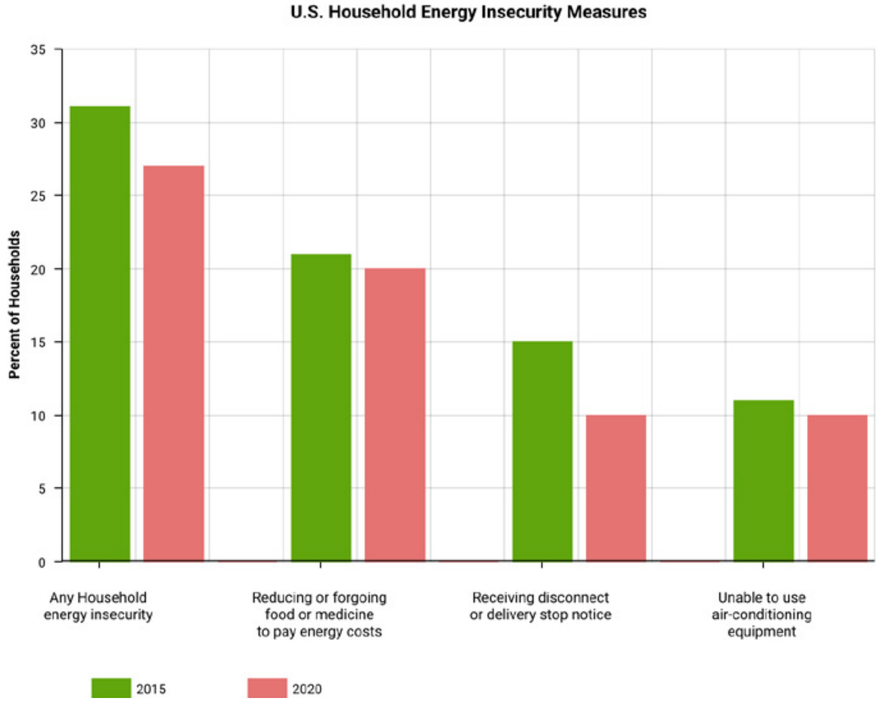
9 DOE (2021), Weatherization Factsheet

10 A 2018 study by APPRISE found that many of these categories are not statistically significant. The study found other categories to be statistically significant, but did not attempt to monetize these.

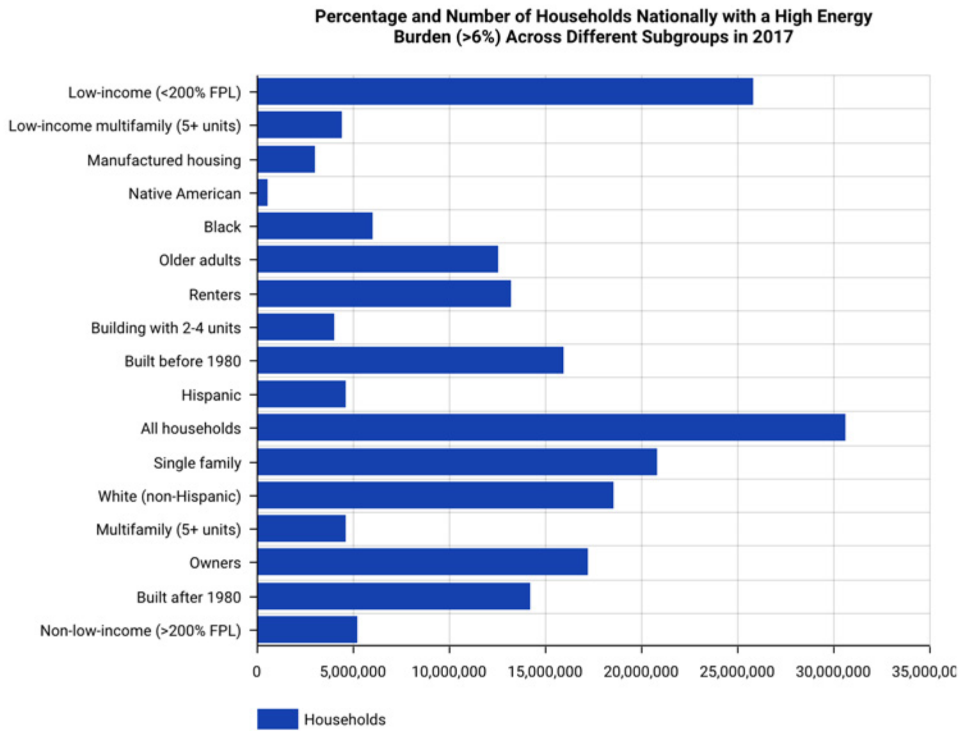
11 ORNL (2014), Health and Household-Related Benefits Attributable to the Weatherization Assistance Program

10 Addressing Energy Insecurity

In 2020, 27% of U.S. households had difficulty meeting their energy needs



Source: *EIA RECS Survey (2022)*



Source: *ACEEE (2020)*

More than 60% of low-income households in the U.S. face a high energy burden, with some paying more than 20% of their income on utility bills.[12] These consumers' lower incomes, coupled with the fact that they often live in less energy-efficient housing, boosts the impacts of energy efficiency investments to enhance quality of life and reduce energy expenditures. High energy burdens can lead households to make sacrifices: 27% of all households reported some sort of energy insecurity, leading them to forego other necessities to pay an energy bill or to maintain their home at an unsafe temperature.

11 Other High-Impact Commercial Benefits

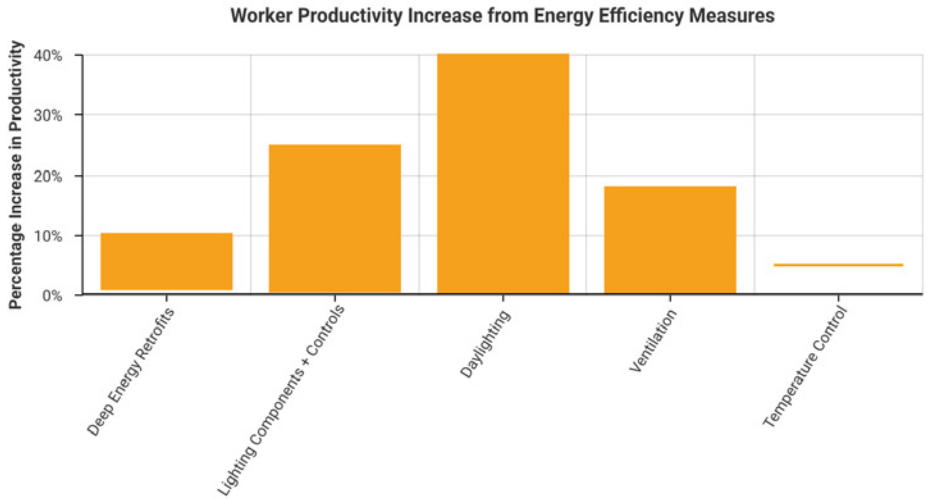
Energy efficiency in commercial buildings increases worker productivity and property value while decreasing energy costs, tapping into new levels of cost savings for companies

Potential Value Beyond Energy Cost Savings

Maintenance Costs Pacific Northwest National Laboratory (2008); Leonardo Academy (2008); Aberdeen Group (2010)	↓ 9.0–14%
Occupant Satisfaction GSA (2011)	↑ 27–76%
Rental Premium Elcholtz, Kok & Quigley (2010); Wiley et al. (2010); Fuerst & MacAllster (2011); Elcholtz, Kok, et al. (2011); Newell, Kok, et al. (2011); Miller, Morris & Kok (2011); Poque et al. (2011); McGraw Hill/Siemens (2012)	↑ 2.1–17%
Occupancy Premium Wiley et al. (2010); Poque et al. (2011); McGraw Hill/Siemens (2012)	↑ 3.14–18%
Property Sale Price Premium Elcholtz, Kok & Quigley (2010); Fuerst & McAllster (2011); Elcholtz, Kok et al. (2011); Newell, Kok et al. (2011)	↑ 11.1–26%
Employee Productivity Lawrence Berkely National Laboratory	↑ 1.0–10%
Employee Sick Days Miller, Poque, Gough & Davis (2009); Cushman & Wakefield et al. (2009); Dunckley (2007); City of Seattle (2005); Romm & Browning (1995)	↓ 0–40%

Source: Jungclaus, M., et al. (2017) ASHRAE Transactions.

12 ACEEE (2020), How high are household energy burdens?



Source: ACEEE compilation; CMU Center for Building Performance and Diagnostics (2004), Guidelines for High Performance Buildings

Energy-efficient buildings have many advantages: They consume less energy, require less maintenance, have lower operating costs and higher asset values, and tend to be more comfortable, healthy, and productive work environments for occupants. The table above shows the range of impacts different studies found from deep energy retrofits.

The table of productivity values shows estimates from different studies of the range of impacts of specific energy efficiency measures on the productivity of office workers due to lower rates of absenteeism, employee turnover, and health symptoms, and enhanced job satisfaction and self-assessed performance. The wide ranges show the difficulty of measuring productivity impacts as well as the varying circumstances.

The "3-30-300" rule provides a scale-of-magnitude illustration of the impacts of productivity on a business, noting that a company typically pays $3 for utilities, $30 for rent, and $300 for payroll per square foot; saving 10% on utility costs saves 30 cents per square foot, but saving 10% on payroll costs as a result of increased worker productivity would cover the cost of the real estate.

Energy Efficiency Impact Report

Energy Efficiency in Utilities

Highlights

Cost-effective Programs

Energy efficiency can be considered a highly cost-effective utility resource. The ratio of lifetime costs to energy production is often cheaper than for nuclear, coal, natural gas, and in many cases for wind and solar energy generation.

Primary Energy Provider

Electricity and natural gas utilities are the primary energy provider for most consumers in residential, commercial, and industrial sectors. In this role, utilities, especially where incentivized by decoupling, incentives, or energy efficiency resource standards, have managed energy efficiency programs for consumers that have resulted in some of the largest savings of any subnational energy efficiency policy tool.

Tripling Savings

Since 2006, spending on and savings from electricity efficiency programs have more than tripled. Since 2011, spending on natural gas efficiency programs has increased by 28% while their energy savings have nearly doubled.

Advanced Metering

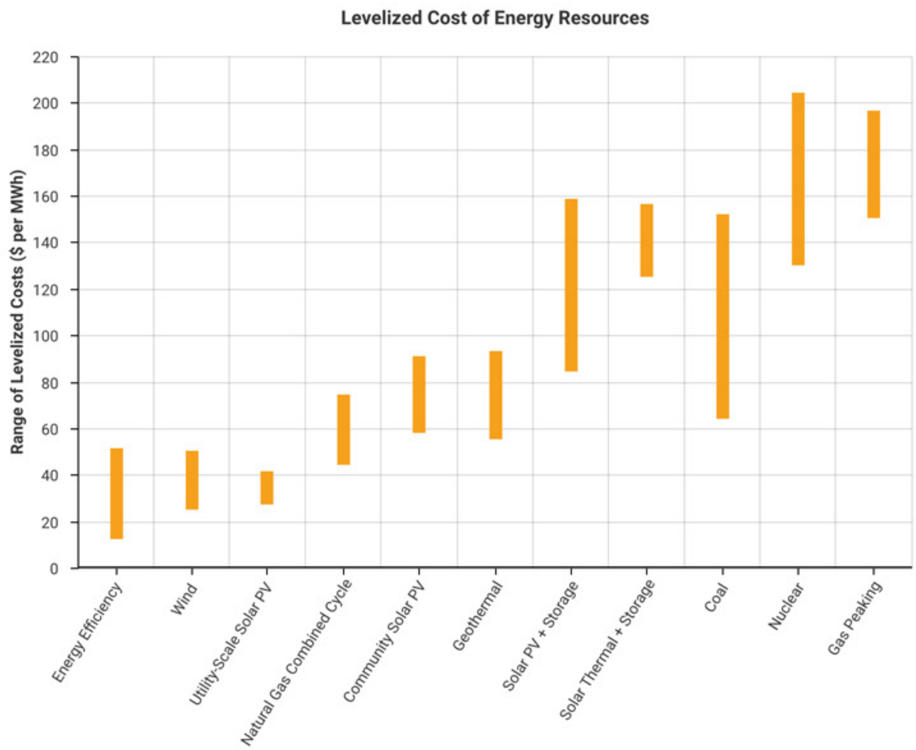
One enabler of a more flexible and responsive grid is the rapid deployment of advanced metering infrastructure. Smart meter installations, which were an emerging technology in 2008, have reached more than 60% of the installed meter base today.

Demand Response Programs

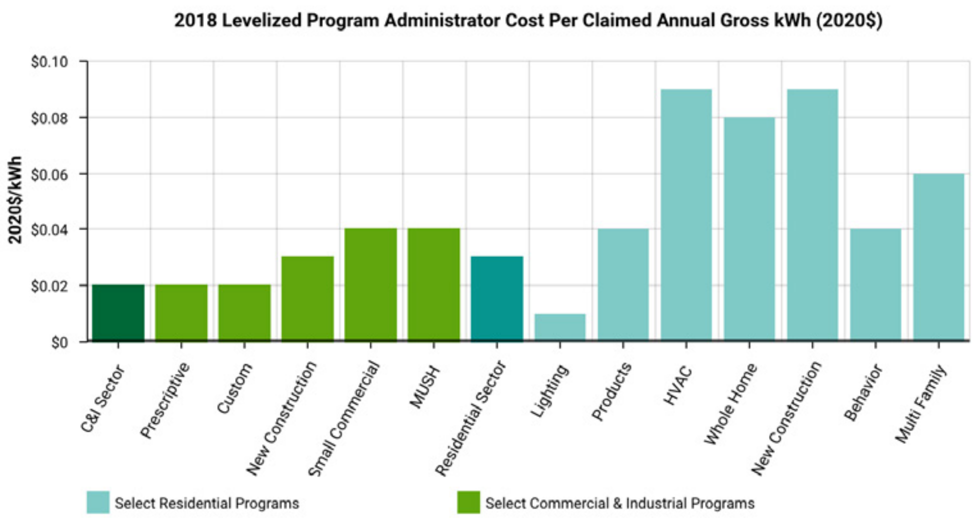
Demand response programs contributed 10.4 GW in peak demand savings in 2020. These savings were primarily driven by the industrial sector, but the residential and commercial sectors have enormous potential for growth.

12 Energy Efficiency is a Low-Cost Resource

Energy efficiency is a cost-effective, reliable, zero-carbon resource



Sources: ACEEE (2021); Lazard (2021)



Source: LBNL (2021)

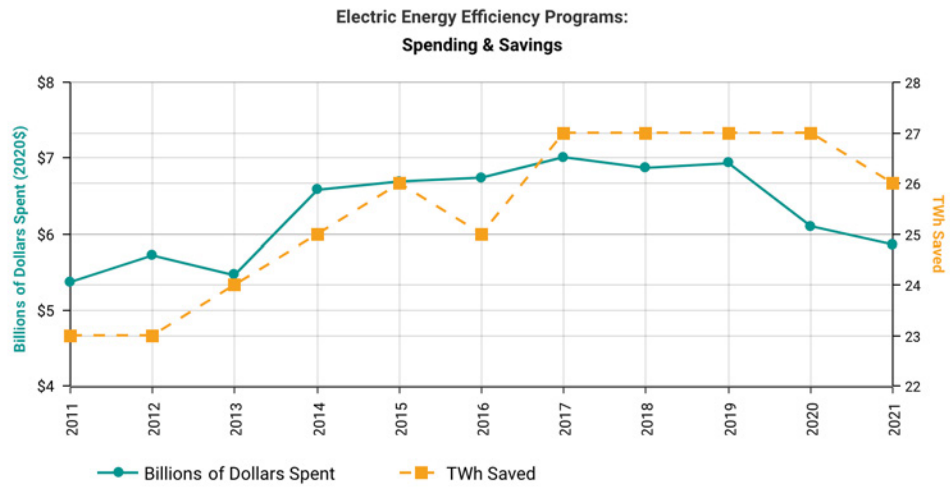
Energy efficiency allows utilities to meet state energy or emissions reduction requirements, as well as reliably meet its customers' overall electricity demand. Thus, it is informative to consider energy efficiency as an energy resource: one that is distributed, zero-carbon, and often the most affordable option to satisfy energy needs relative to other generation technologies, even compared with wind and utility-scale solar.

Utilities and other program administrators develop and implement a diverse portfolio of programs that help different customers and sectors save energy using a variety of strategies. The cost-effectiveness of different programs can be quantified through several approaches, including by dividing the expenses by the number of kilowatt-hours saved for a levelized cost of saved electricity. The levelized costs shown above include only the program administrator costs, not any additional costs paid by customers.

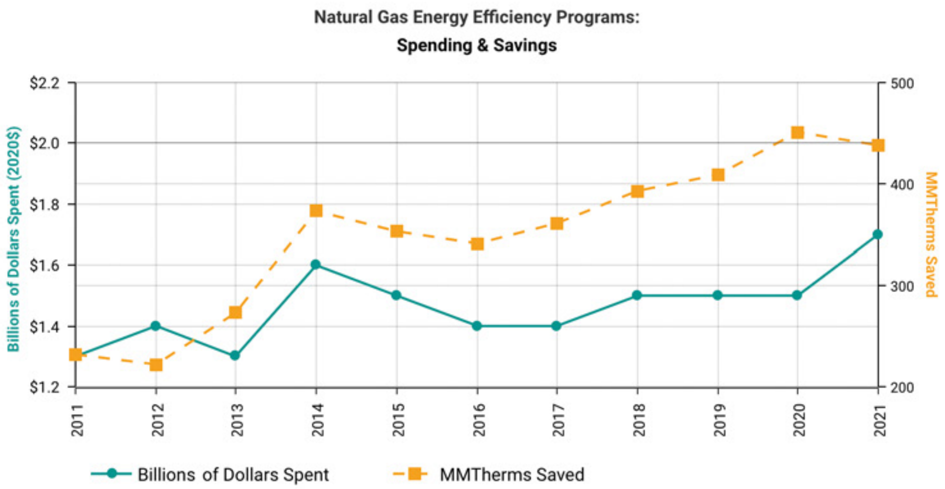
Lawrence Berkeley National Laboratory considered the levelized program administrator cost of saved electricity for a variety of utility ratepayer-funded efficiency program types in 2018, finding that costs ranged from residential lighting rebate programs (1.2 cents/kWh) to HVAC retrofits (8.6 cents/kWh).[1]

13 Utility Programs Spending and Savings

Utility investments in energy efficiency have grown, achieving 14% more electricity savings and 89% more gas savings in 2021 than in 2011



Source: ACEEE (2022), The State Energy Efficiency Scorecard



Source: ACEEE (2022), The State Energy Efficiency Scorecard

Electric and natural gas utilities, as the main providers of energy for households and businesses, invest significant resources in programs that boost energy efficiency. Though overall savings and spending have increased since 2011, investments in utility energy efficiency programs have plateaued since 2017.

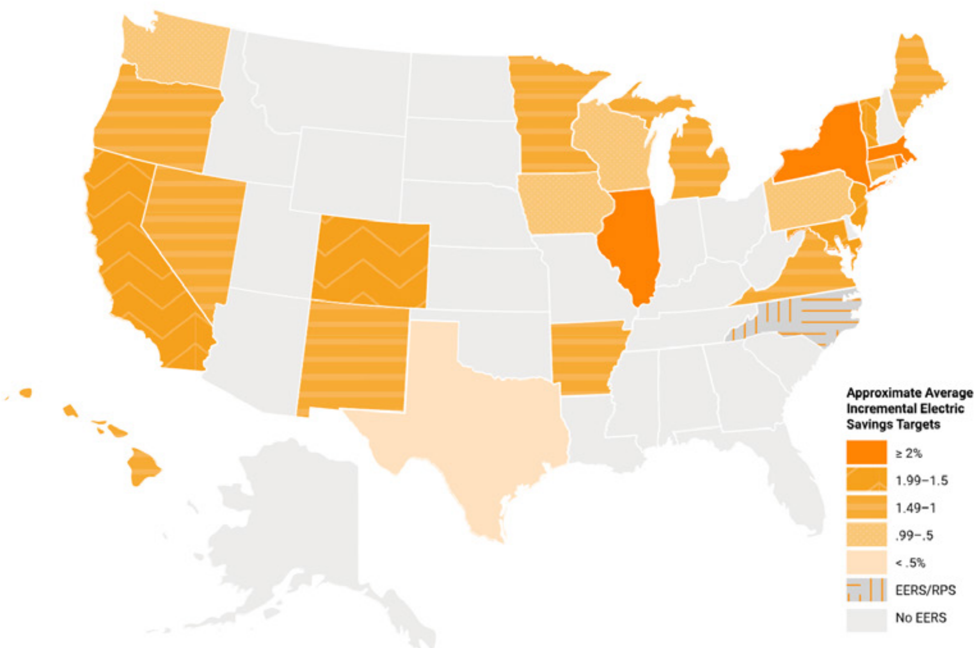
1 LBNL (2021), Still the One: Efficiency Remains a Cost-Effective Electricity Resource

In 2020, utility energy efficiency programs faced obstacles due to the pandemic. Despite these challenges, many utilities adapted by developing remote energy assessments and other virtual work. Though some utility energy efficiency programs have returned to full capacity since the beginning of the pandemic, the industry still faces systemic challenges. Savings opportunities from lighting, often the lowest cost measures, have been reduced as LED bulbs become the norm, meaning utilities face new challenges in continuing to grow cost-effective residential energy efficiency portfolios.

14 Energy Efficiency Resource Standards

The majority of states are implementing energy efficiency resource standards and have seen 4x energy savings

State Energy Efficiency Resource Standards (EERS)
December 2020



Approximate Average Annual Electric Savings Targets			
Massachusetts	*2.70%*	*Virginia*	*1.20%*
Illinois	*2.00%*	*Connecticut*	*1.10%*
*New York**	*2.00%*	*Nevada*	*1.10%*
Rhode Island	*2.00%*	*Maine**	*1.00%*
Colorado	*1.70%*	*Michigan*	*1.00%*
Vermont	*1.70%*	*New Mexico*	*1.00%*
*Maryland**	*1.60%*	*Iowa**	*0.90%*
New Jersey	*1.60%*	*District of Columbia*	*0.80%*
*California**	*1.50%*	*Washington**	*0.70%*
Hawaii	*1.40%*	*Wisconsin*	*0.70%*
*Minnesota**	*1.40%*	*Pennsylvania*	*0.60%*
Arkansas	*1.20%*	*Texas*	*0.20%*
*Oregon**	*1.20%*	*North Carolina*	*Combined EERS/RPS*

**For states reporting electric savings on a gross basis, a net-to-gross adjustment was applied to make them comparable with states reporting net savings. States with voluntary targets are not listed in this table. Targets in states with cost caps reflect the most recent approved savings levels under budget constraints.*

Source: ACEEE (2022), The State Energy Efficiency Scorecard

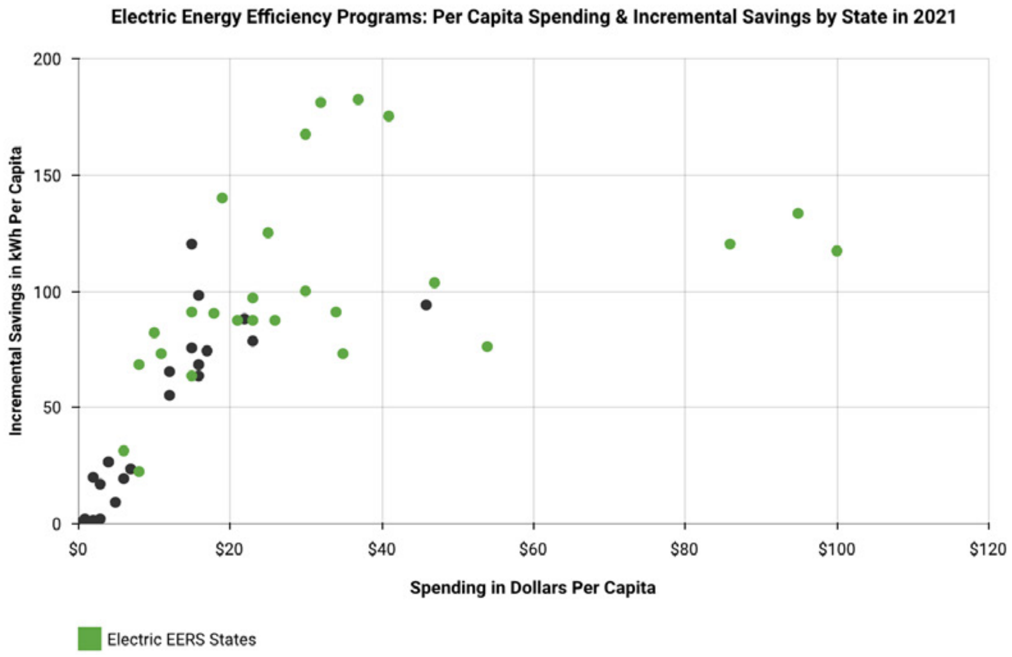
An energy efficiency resource standard (EERS) is a state-level energy efficiency mandate, similar to a renewable portfolio standard (RPS), that requires an electric and/or natural gas utility to achieve a targeted level of energy savings from energy efficiency measures. As of 2021, 26 states have EERS policies in place. In 2017, states with EERS saved on average more than four times as much electricity as those that did not have targets (1.3% of retail sales compared to 0.3%).[2]

The strongest EERS requirements are in Massachusetts, which requires more than 2.5% new savings annually.[3] Massachusetts, Rhode Island, and Vermont make up the top three states for most utility investment in energy efficiency programs.[4]

In recent years, some states have taken a few steps backward. In 2021, New Hampshire's public utility commission removed the requirement for the state's utilities to pursue all cost-effective energy efficiency, effectively removing the EERS.[5] In 2022, Arizona's Corporation Commission rejected rules that would have extended the state's EERS. The previous EERS was estimated to have saved ratepayers nearly $1.4 billion and help avoid the build out of gas combustion turbines.[6]

15 Utility Programs Spending and Savings Per Capita

States that invest in utility energy efficiency programs save more for customers



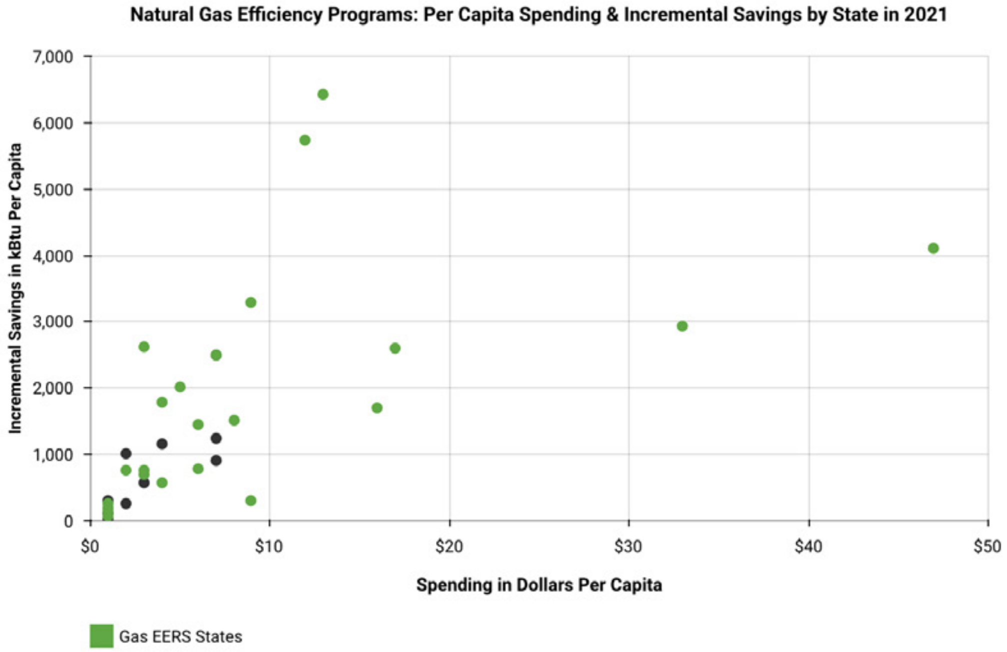
2 ACEEE (2019), State Energy Efficiency Resource Standards (EERS) May 2019

3 ACEEE (2022), 2022 State Energy Efficiency Scorecard

4 ACEEE (2022)

5 Utility Dive, Advocates vow to fight 'outrageous' decision

6 Solar Builder, Arizona Regulators Reject Their Clean Energy Rules at Last Second



Source: ACEEE (2022), Census (2021)

While different states have different efficiency opportunities depending on their climate, geography, and economy, there is a clear trend that states incentivizing energy efficiency by EERS or other policies typically realize the greatest benefits from utility (ratepayer-funded) energy efficiency programs.[7]

Comparing each U.S. state's annual per capita spending on efficiency programs (including residential, commercial, and industrial programs) and the per capita incremental energy efficiency savings provides a measure of each state's utility efficiency program impact regardless of the state's size.

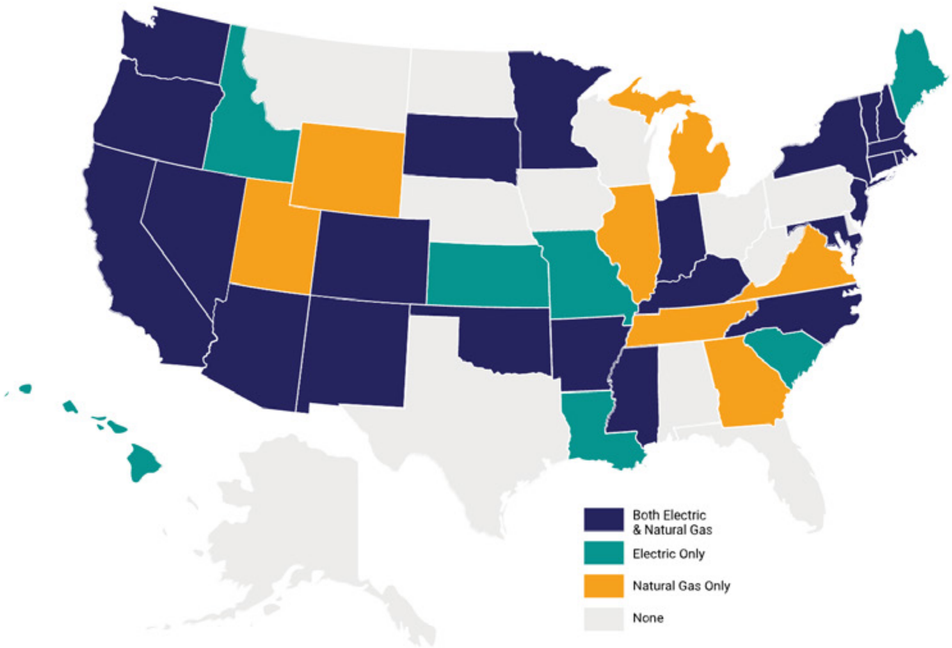
On this basis, those with an EERS stand out. Maryland, Illinois, Massachusetts, Vermont, Michigan, and Minnesota, as well as Washington, D.C., all dedicate significant investment to efficiency programs and experience the highest per capita savings. However, note that energy savings are self-reported and may not be comparable. Some states also include spending on efficiency of non-regulated fuels such as propane under electricity spending, but include the fuel savings under natural gas.

7 States with electric energy efficiency resource standards are highlighted in green on the scatter plot. State-level total spending and savings data are self-reported and may include differences in methodology. Energy efficiency programs also apply to different combinations of residential, commercial, or industrial customers, such that the kWh savings per capita is not intended as a measure of residential energy efficiency savings, but a generalized measure of energy efficiency benefits.

16 Decoupling and Shareholder Incentives

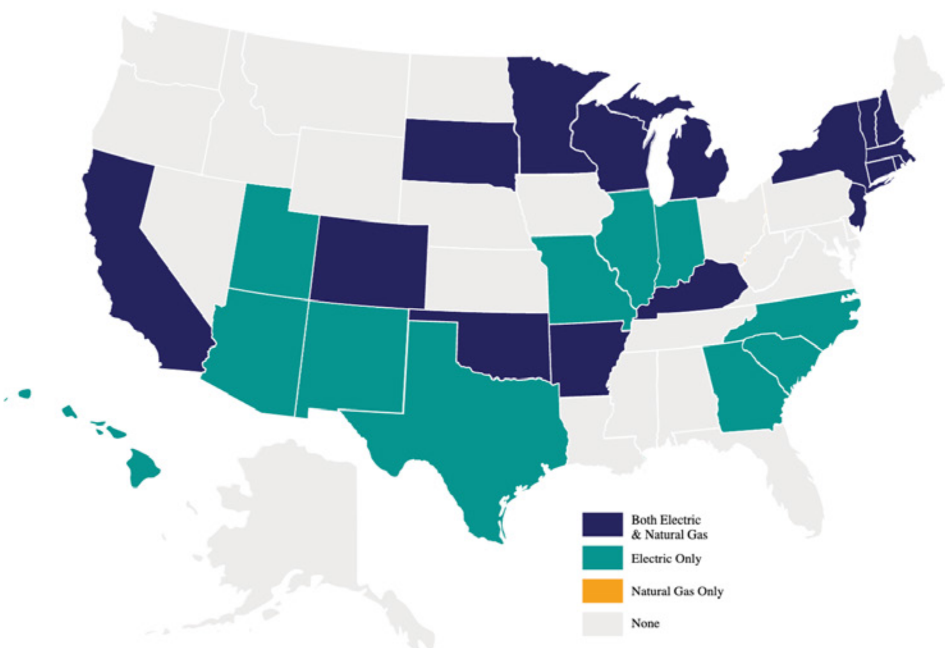
Decoupling and shareholder incentives encourage utilities to implement energy efficiency

2021: States with Decoupling or LRAM for Electricity and/or Natural Gas



Source: ACEEE (2022), The State Energy Efficiency Scorecard

2021: States with Performance Incentives for Electricity and/or Natural Gas



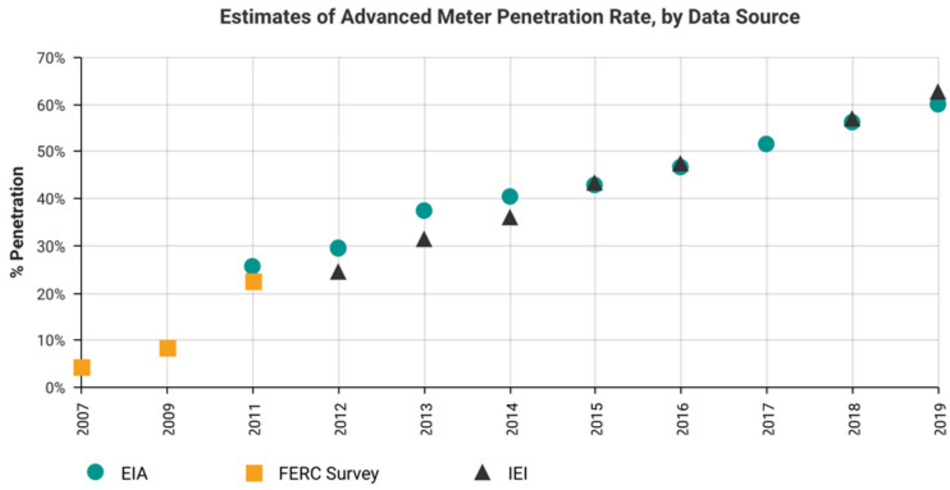
Source: ACEEE (2022), The State Energy Efficiency Scorecard

Traditional utility regulation has tied ("coupled") utility sales to profits: i.e., more sales results in more profits.[8] This is a direct disincentive to energy efficiency, and it can be corrected with specific policies, such as Decoupling and the Lost Revenue Adjustment Mechanism (LRAM).

Performance incentives can complement those strategies by rewarding savings from energy efficiency programs. Of the top 10 states for electricity savings, nine deploy at least one of these strategies to incentivize energy efficiency – decoupling, LRAM, or performance incentives – and eight use performance incentives in concert with a decoupling or LRAM strategy.[9]

17 Smart Meters

Smart meter installations have surpassed 60% of the installed meter base



Source: FERC (2020), 2020 Assessment of Demand Response and Advanced Metering

Electricity generation presents varying costs, both financial and in terms of emissions, that depend on the time of day, weather, and other factors, such as a downed power plant or disrupted power lines. However, most consumers pay flat rates for electricity, insulating them from these challenges that result from high-demand periods and disincentivizing energy-efficient behaviors that could help stabilize the grid.

Grid modernization technologies that enhance the responsiveness of the grid and enable greater communication between consumers and utilities are evolving rapidly, and utilities are preparing for the increasing role that they may play in their operations. One such example is in advanced metering infrastructure (AMI).

Such technology is the foundation for a more responsive energy system, allowing customers to alter their energy use to reflect grid conditions, and generating data that would allow energy efficiency program implementers to better design energy efficiency programs including demand response, measurement and verification, and peak-hour savings.[10] While one component of this system – smart meters – was uncommon before 2008, they have grown rapidly in the last decade, now surpassing 60% of the total installed stock of meters in 2019.

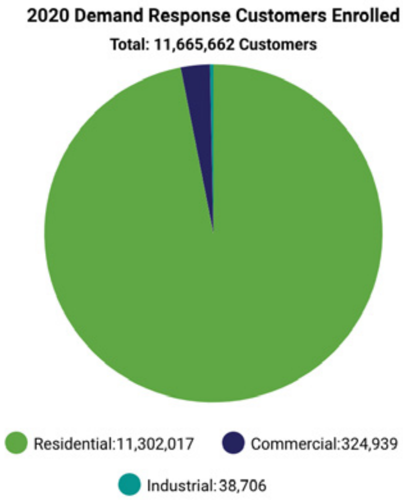
8 Under traditional regulation, utilities may have an incentive to increase sales between rate cases.

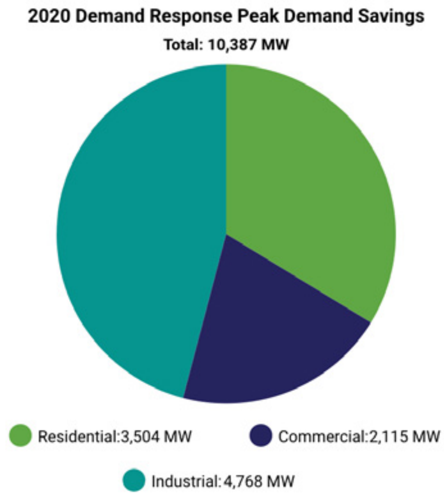
9 Top 10 states for absolute electricity savings: CA, IL, NY, MI, MD, MN, MA, TX, PA, AZ. Pennsylvania is the only state in this list that does not have decoupling, LRAM, or performance incentives.

10 Todd, A., Perry, M., Smith, B., Sullivan, M., Cappers, P., Goldman, C. (2014), Insights from Smart Meters: The Potential for Peak-Hour Savings from Behavior-Based Programs. LBNL.

18 Demand Response

Although the industrial sector made up only 0.3% of demand response participants by number, it was responsible for 46% of peak demand savings in 2020





Source: EIA (2020), Monthly Energy Review

Demand response is a tool that allows electricity demand to be more flexible, which enhances the energy efficiency and reliability of the grid, responds to unexpected shortages and periods of high peak demand, and supports the greater incorporation of intermittent renewables.

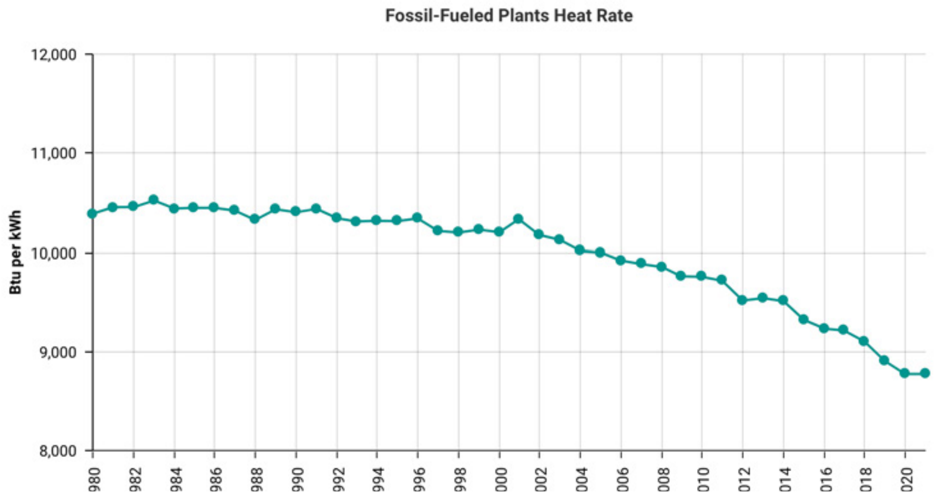
The main entities involved in demand response programs are utilities, end-users, and in many cases, load aggregators, which enable the bundling of demand response capabilities for wholesale and retail markets. In 2020, industrial users were the primary demand response participants. Although the industrial sector made up only 0.3% of demand response participants by number, it was responsible for 46% of peak demand savings in 2020. In contrast, the residential sector accounted for 96.8% of participants in demand response programs and only 34% of peak energy savings.

However, the potential for demand response is likely much higher. A recent study from the Brattle Group estimates that if real-time demand response programs and investments were scaled up significantly, they could potentially provide 200 GW of load flexibility and approximately 20% of forecasted U.S. peak load in 2030, saving more than $15 billion a year in avoided system costs.[11]

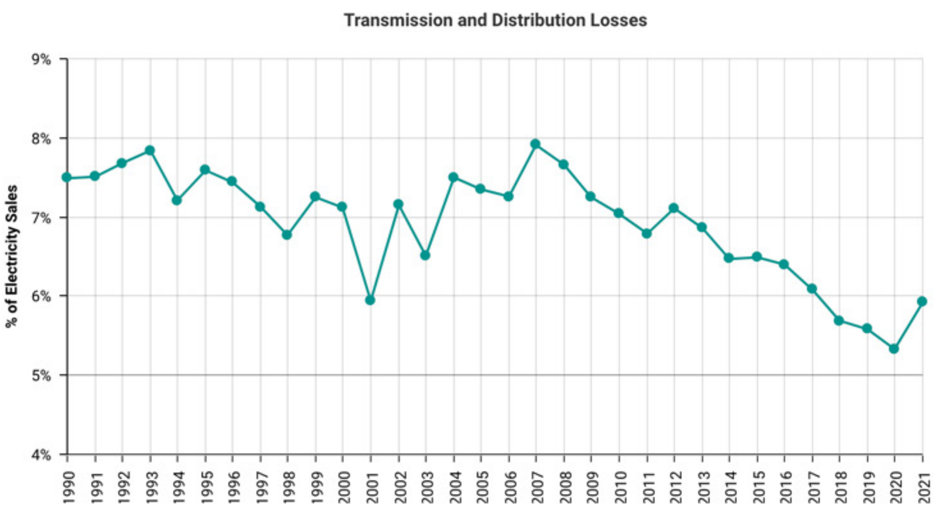
11 The Brattle Group (2019), The National Potential for Load Flexibility

19 Energy Efficiency and Losses in Power Systems

Since 2002, the heat rates at fossil-fueled plants have fallen by 14% and power transmission and distribution losses fell by 9%



Source: EIA (2022), Annual Energy Review



Source: EIA (2022), Monthly Energy Review

While end uses are often the focus of energy efficiency programs, there are massive opportunities for greater energy efficiency in power generation, transmission, and distribution systems. Fossil-fuel power plants produced more than 1.5 trillion kWh in 2021, or 38% of U.S. power generation, and roughly 24% of U.S. greenhouse gas emissions.[12, 13] These plants have also made gains in thermal efficiency, as measured by their heat rate, which fell by 14% from 2002 to 2021.[14] Improving the heat rate of a typical 500-MW unit by only 1% can amount to fuel savings[15] of greater than $600,000 annually.[16, 17]

12 EIA (2018), What is U.S. electricity generation by energy source?

13 EPA (2018), Greenhouse Gas Inventory Data Explorer

14 EIA (2019), Monthly Energy Review

15 The cost of fuel is 60-80% of the overall cost of producing electricity.

16 EPRI (2019), 2019 Heat Rate Improvement Conference Proceedings

17 EPRI (2016), Sustainability of Heat Rate Improvements

Until 2021, transmission and distribution systems had seen significant decreases in electricity losses. Losses, while not entirely avoidable, can be costly. In 2021, U.S. losses were estimated at 225 TWh, about one third of the net generation in the state of California in that same year.[18] From 1990 through 2002, the U.S. experienced losses of roughly 7%. However, from 2002-2017, losses fell to roughly 5%. While the U.S. electric transmission and distribution system is now more efficient, some countries have achieved lower levels of losses, including Singapore (2%), Iceland (3%), South Korea (3%), and Germany (4%).[19]

18 EIA (2019), Electricity

19 The World Bank (2014), Electric power transmission and distribution losses

Investment and Financing

Highlights

Investment Levels Increasing

Overall, U.S. investment levels in energy efficiency increased by roughly 15% from 2015 to 2022 after years of stalled investment.

Investments

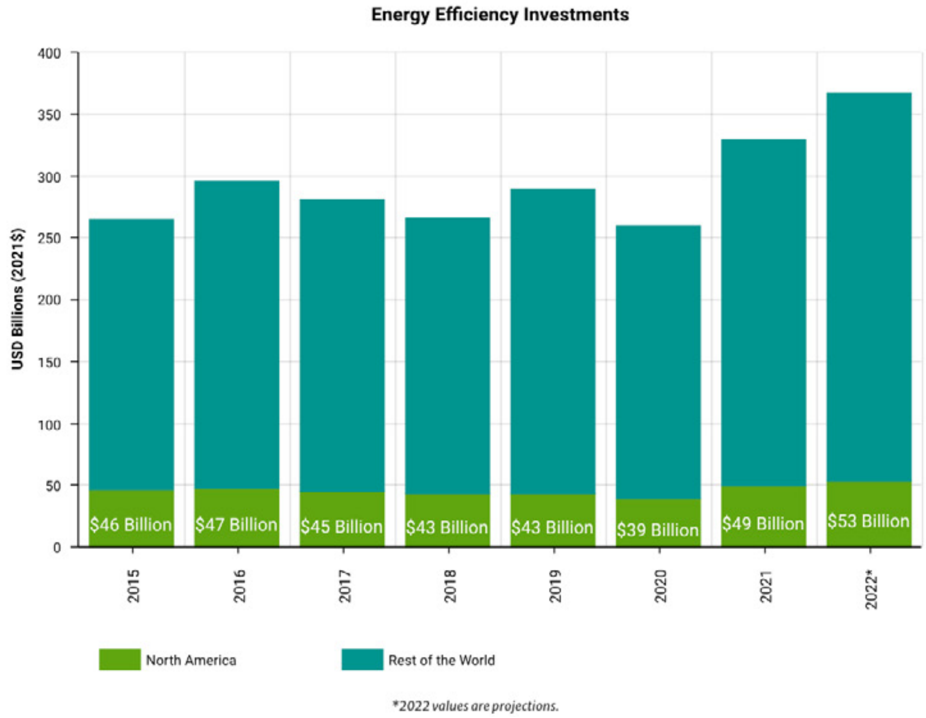
Many investments, especially ESPCs, are implemented by energy service companies, or ESCOs. The ESCO market is seeing a leveling of revenues at approximately $6 billion between 2011 and 2018. This is just a fragment of the ESCO market potential, estimated at $101-$220 billion (2021$).

Green Bank Investments

Green Bank investments have nearly tripled since 2018, driven mainly by investments by the Connecticut and New York Green Banks.

20 Energy Efficiency Investments

North American energy efficiency investment levels increased by 15% between 2015 to 2022



Source: IEA (2022), World Energy Investment 2022 database

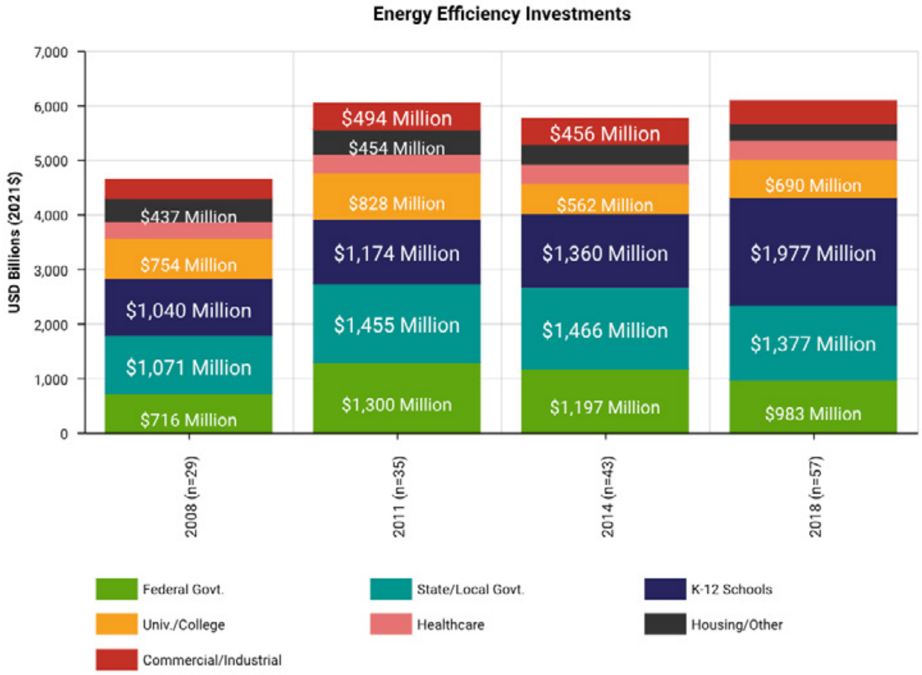
Industry estimates of annual energy efficiency investments vary due to differences in how efficiency investments are defined, how the data is collected, and what data are available. According to the IEA, global investment in energy efficiency, electrification, and renewables reached new highs in 2021, despite some rising costs and supply chain challenges.

In 2021, incremental investments in energy efficiency across buildings, transportation, and industry sectors in North America increased after years of stalled investment, and IEA projects a further increase in 2022. These increases are most evident in transportation investments, with slower growth in buildings and industry.[1] We can expect the levels of investments to rise as a result of the Inflation Reduction Act and Bipartisan Infrastructure Law, which provide record levels of federal investment in energy efficiency over the next five to 10 years.

1 IEA (2022), World Energy Investment

21 Energy Service Company (ESCO) Investments

ESCO revenues have resumed their rise, reaching $6.1 billion in 2018



Source: LBNL (2016), U.S. Energy Service Company (ESCO) Industry: Recent Market Trends
LBNL (2021), ESCO Market Study

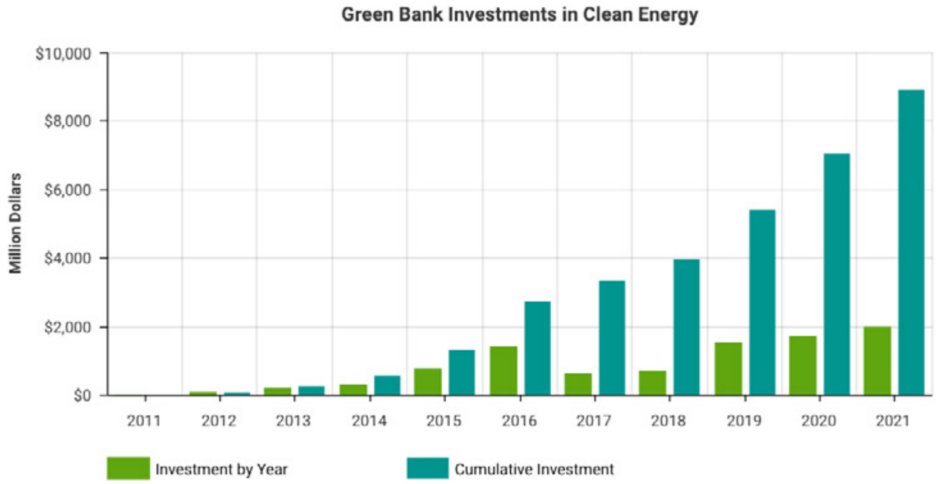
Studies show that the ESCO market had been growing steadily since the 1990s, but reached a plateau between 2011 and 2014. By 2018, the ESCO market grew once again, with industry revenue rising from approximately $5.8 billion in 2014 to $6.1 billion (in 2021 dollars).

In contrast, LBNL has estimated that the market potential for the U.S. ESCO industry – including through Energy Savings Performance Contracts (ESPCs) – could reach $101 to $220 billion (in 2021 dollars).[2]

2 LBNL (2017), Updated Estimates of the Remaining Market Potential of the U.S. ESCO Industry

22 Green Banks

Green Bank investments catalyzed more than $8.9 billion into clean energy through 2021 and have been rapidly accelerating since 2018



Source: Coalition for Green Capital (2022)

Led by the Connecticut Green Bank and New York Green Bank, the most mature in the country, U.S. Green Banks have stimulated cumulative investment of more than $8.9 billion in clean energy, including energy efficiency.[3, 4]

While overall energy efficiency-specific breakdowns are not available, the Connecticut Green Bank reports closing 1,300 energy efficiency projects in 2021, while the New York Green Bank has invested roughly $95 million in energy efficiency projects to date and plans to invest $100 million in energy efficiency and building electrification by 2025.[5] However, incremental Green Bank investments fell in 2017 and 2018 relative to 2015-2016.

3 Other U.S. Green Banks include Michigan Saves, NYCEEC, Rhode Island Infrastructure Bank, the Climate Access Fund, Montgomery County Green Bank, DC Green Bank, the Solar and Energy Loan Fund, Nevada Clean Energy Fund, Colorado Clean Energy Fund, California Lending for Energy and Environmental Needs Center, and GEMS.

4 American Green Bank Consortium (2022)

5 Connecticut Green Bank; NY: 2021-2022 Impact Report, 2022-2023 Annual Plan

Buildings

Highlights

Efficiency Opportunities

Residential and commercial energy consumption primarily occurs indoors. Buildings are home to many energy efficiency opportunities (e.g., improving the building envelope, sourcing of construction materials, water efficiency, energy management systems, smart buildings) as well as energy-consuming products (e.g., appliances, plug loads, HVAC systems)

Residential Building Energy Use

Residential energy use per household has fallen by roughly 16% from 2001 to 2021.

Energy Efficiency Gains for Appliances and Devices

The energy efficiency of appliances has increased dramatically since 1980, due to a combination of federal standards and the ENERGY STAR® product certification program. A typical household saves about $500 per year on utility bills due to minimum energy performance standards for appliances, and ENERGY STAR® has helped drive down energy use by refrigerators and clothes washers by 24% (since 1996) and 30% (since 2004), respectively.

Tools to Understand and Enhance Building Efficiency

Benchmarking; energy rating, such as through the Home Energy Rating System or Home Energy Score; and certification (including ENERGY STAR® and LEED) can drive efficiency in buildings. Zero net energy buildings and smart buildings are also growing rapidly.

Model Building Energy Codes

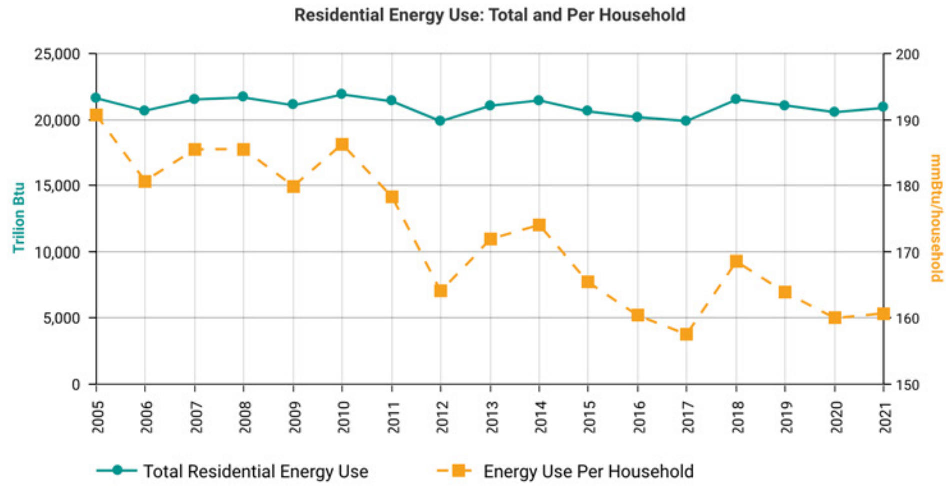
Model building energy codes are expected to save $138 billion in energy costs and 13.5 quads of primary energy over the 2010 to 2040 timeframe.

Benchmarking and Building Performance Standards

As of 2021, 14% of all commercial floorspace in the U.S. is subject to benchmarking requirements and over 30 jurisdictions have committed to adopting energy performance standards for existing buildings.

23 Energy Efficiency and Household Cost Reductions

Energy efficiency has driven down energy consumption per household by approximately 16%

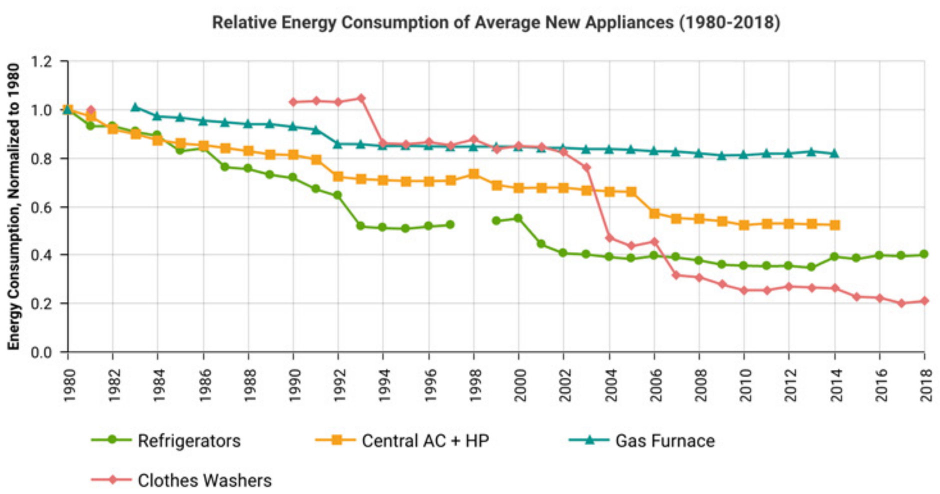


Sources: EIA (2022), Monthly Energy Review; Census (2021)

Energy consumption in residential buildings is responsible for approximately 13% of total energy consumed in the U.S.[1] Despite some variability, total residential energy use has remained largely constant, falling only 3% between 2005 and 2021. Due to energy efficiency, per-household energy consumption has fallen by roughly 16% over the same period. This is notable, given that the average U.S. resident lives in a larger, better-acclimated home with significantly more devices.

24 Appliance Energy Efficiency Improvements

Appliances and equipment have become more efficient across the board, using a fraction of the energy required in 1980



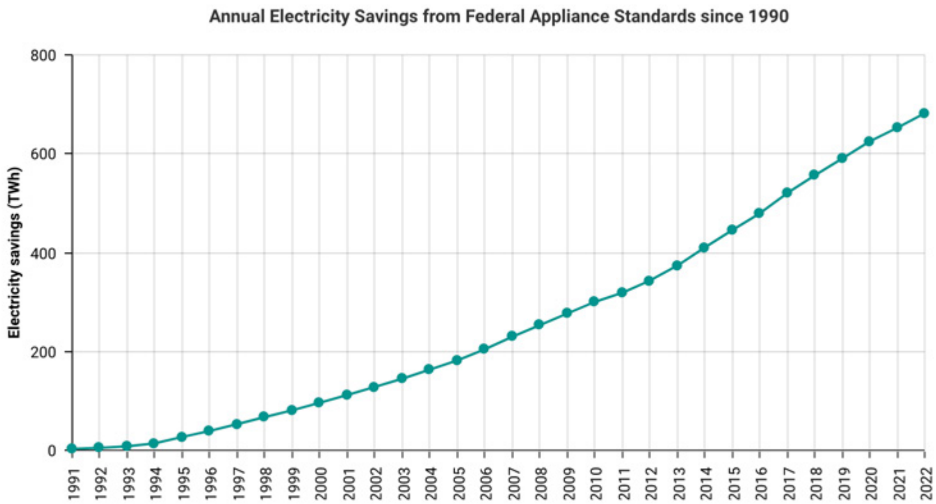
Source: AHAM data (2018)

1 EIA (2022), Monthly Energy Review

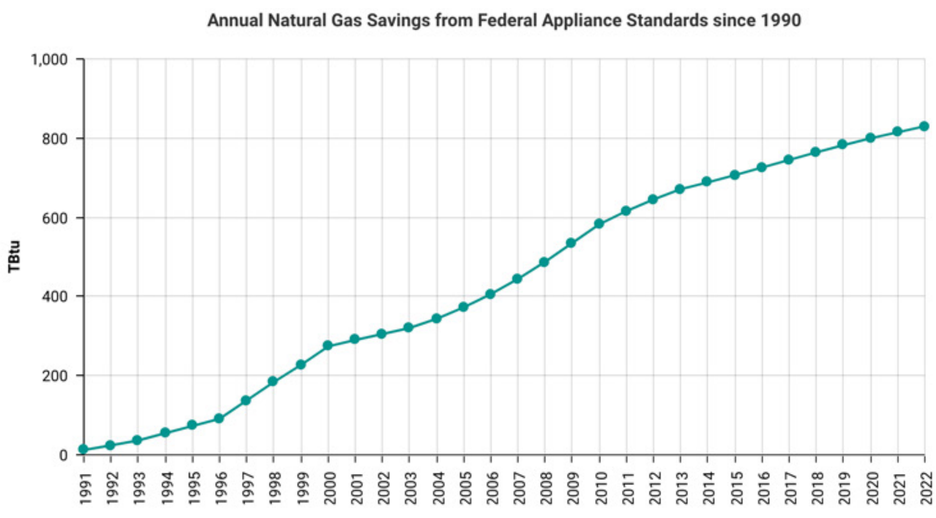
The efficiency of appliances has increased significantly in the last decades. The chart shows the relative average energy consumption of new appliances sold over the 1980-2018 period. Clothes washers and refrigerators showed the greatest improvements (80% and 60% reductions in energy consumption, respectively) but have begun to plateau in recent years.[2] Similarly, improvements in gas furnaces, central air conditioners, and heat pumps have slowed after significant efficiency gains between 1980 and 2010. The overall gains were driven in large part by federal standards (indicator #26), ENERGY STAR® (indicator #27), tax credits, and utility rebates.

25 Policy Impact: Federal Appliance Standards

Policies for appliance efficiency are saving 14% of the total electricity generated in the U.S. and 6% of delivered natural gas



Source: ACEEE & ASAP (2022)



Source: ACEEE & ASAP (2022)

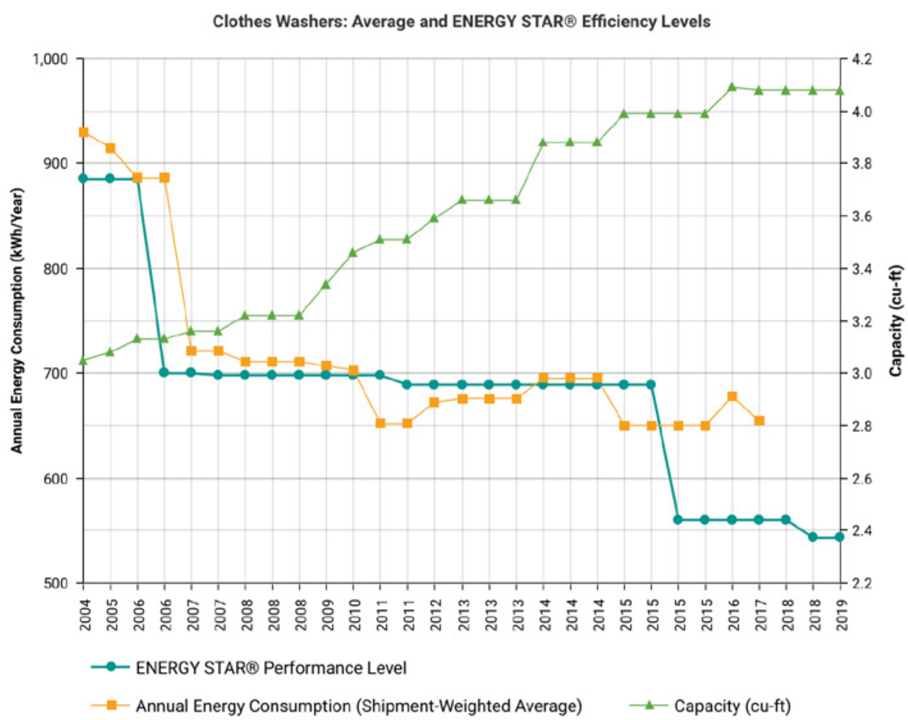
Federal appliance standards ensure a base-level efficiency for all appliances on the market and have led to large-scale energy savings of both electricity and natural gas since 1990. These savings add up to enormous benefits for U.S. households and businesses. A typical household saves about $500 per year on utility bills because new household appliances and heating, cooling,

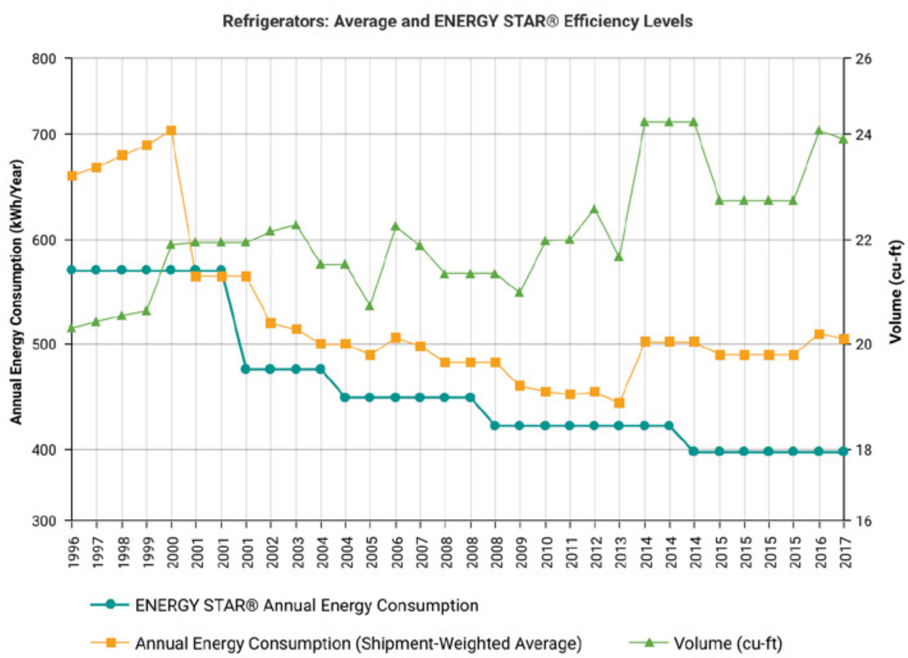
2 ASAP (2022), Refrigerators and Freezers

and lighting products comply with minimum standards.[3] Estimates suggest the federal appliance standards program saved nearly 680 TWh in 2021 relative to efficiency levels without standards, which is over 16% of the total electricity that was generated in the U.S. in 2021 (4,115 TWh).[4]

26 Market Impact: ENERGY STAR®

The ENERGY STAR® voluntary certification program has enhanced the market value of efficiency and raised consumer awareness about its benefits





Source: EPA (2019)

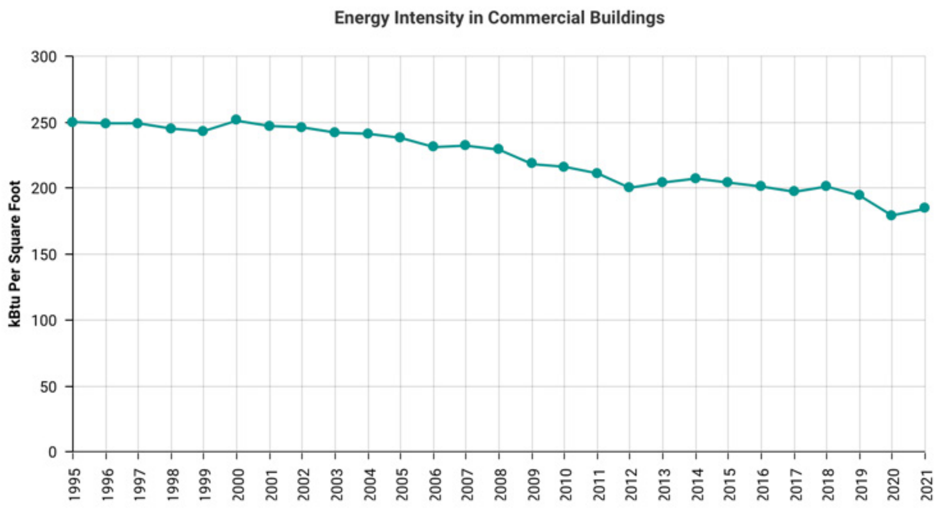
3 ACEEE (2017), Energy-Saving States of America: How Every State Benefits from National Appliance Standards

4 EIA (2022), Electricity Data Browser

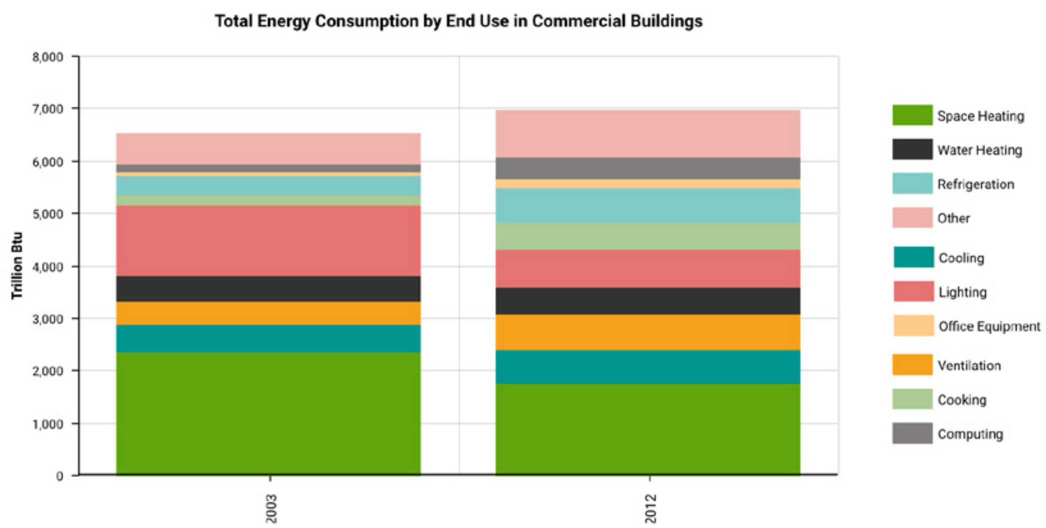
ENERGY STAR Products®, a part of the ENERGY STAR® program, has grown to cover more than 75 product categories and 60,000 product models, some of which have reached market penetrations as high as 90%.[5, 6] For example, ENERGY STAR® specification for refrigerators was established in 1996 and has been revised and strengthened multiple times, helping to reduce the average energy consumption of refrigerators by 24% while the average volume increased 18% from 1996 to 2017. Established in 1997, ENERGY STAR® specifications for clothes washers were also strengthened multiple times, facilitating a 30% drop in energy consumption while the average capacity increased 34% from 2004 to 2017. Americans purchase more than 300 million ENERGY STAR®-certified light bulbs annually, with an overall annual market value of more than $100 billion.

27 Commercial Building Energy Intensity

Gains in lighting and space heating efficiency have decreased energy intensity in commercial buildings, but demand in other areas is driving increased commercial energy use overall



Sources: EIA (1995–2012), CBECS (interpolation of square footage); AEO (2017–2019; interpolation of square footage); AEO2022 (2021 square footage); AEO2021 (2020 square footage); AEO2020 (2019 square footage), EIA



Sources: EIA (2003–2012), CBECS

5 ENERGY STAR® (2019), ENERGY STAR By the Numbers and About Products

6 As in the case for ENERGY STAR® dishwashers. ENERGY STAR Unit Shipment data

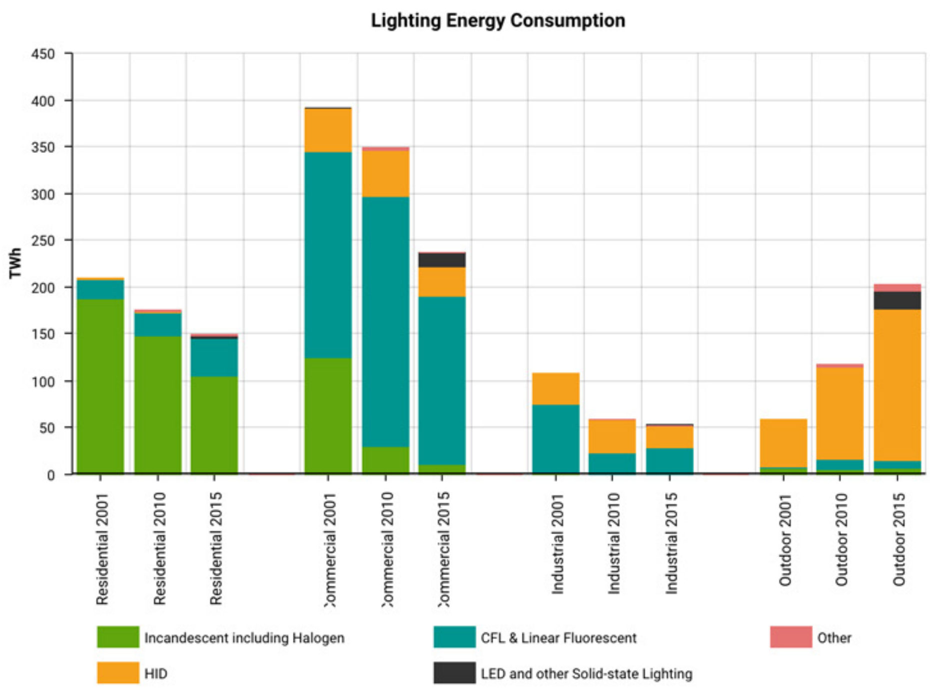
Gains in lighting and space heating efficiency have decreased energy intensity in commercial buildings, but demand in other areas is driving increased commercial energy use overall.

Total commercial building energy consumption per square foot has been declining, in large part due to significant savings in lighting and space cooling, which fell by roughly 600 and 1,000 trillion Btu, respectively, from 2007 to 2021.[7]

However, total energy consumption in this sector has been rising due to increased development – with square footage rising from 77 billion in 2007 to 94 billion in 2021 – and increases in certain areas, such as the energy consumed by office equipment and computing, cooling, ventilation, and other loads.

28 Market Impact: Efficient Lighting from 2001 to 2015

Rapid gains in more efficient lighting, including CFLs and LEDs, have reduced energy use in lighting by 16% in 14 years, while inventory grew 25%



Source: Navigant Consulting (2001, 2010, 2015), U.S. Lighting Market Characterization

A success story of bringing RD&D technologies to market, drastic efficiency gains in light bulbs have allowed the U.S. to decrease its energy use from lighting by 16% while increasing lamp inventory by 25% from 2001 to 2015.[8] Compared to a traditional 60W incandescent bulb, an 8.5W light emitting diode (LED) consumes 85% less energy[9] and lasts from 10 to 25 times as

7 EIA (2022), AEO 2020 through AEO 2010

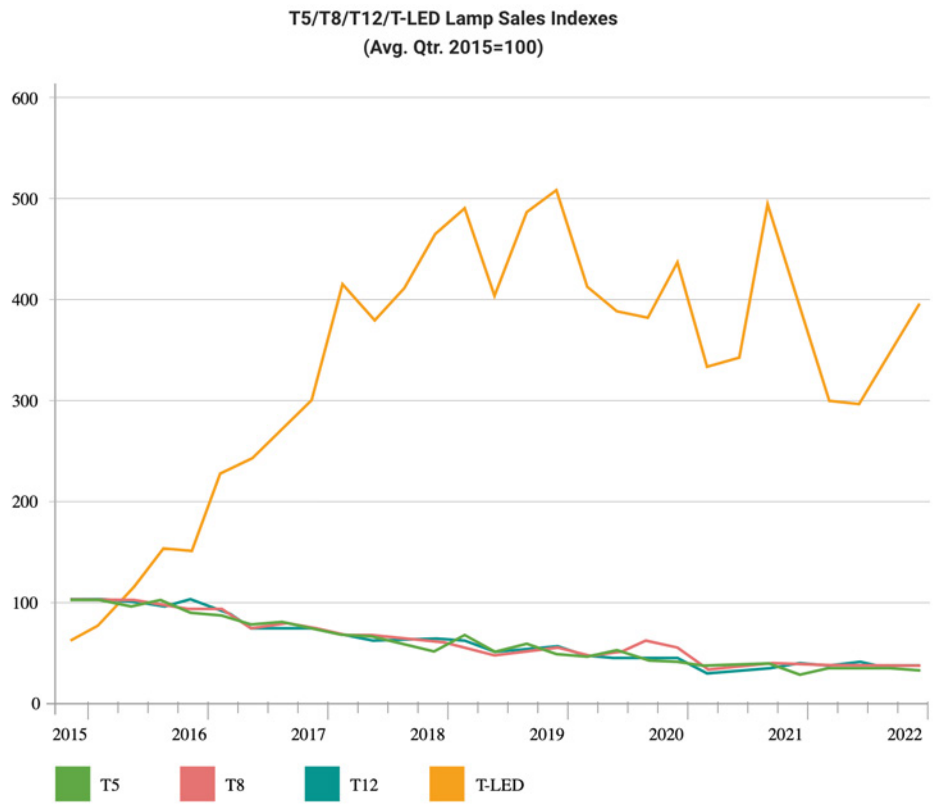
8 Navigant Consulting (2001, 2010, 2015), U.S. Lighting Market Characterization

9 ASAP/ACEEE (2018), U.S. Light Bulb Standards Save Billions for Consumers, But Manufacturers Seek a Rollback.

long.[10] Furthermore, the price of LEDs per lumen has fallen by 75% from 2012 to 2016, and the market penetration has grown from less than one percent to 13.5% over that same time period. In contrast, energy use from high-intensity discharge lamps (HIDs) – a less efficient high-output lamp used in street lighting, warehouses, and sports arenas – continues to grow for outdoor uses.[11] Nevertheless, DOE's September 2019 rule that rolls back energy efficiency standards for light bulbs creates uncertainty in the future of the market.[12, 13]

29 Growth in LED Sales After 2015

LED light bulbs represent the largest share of the market since 2017



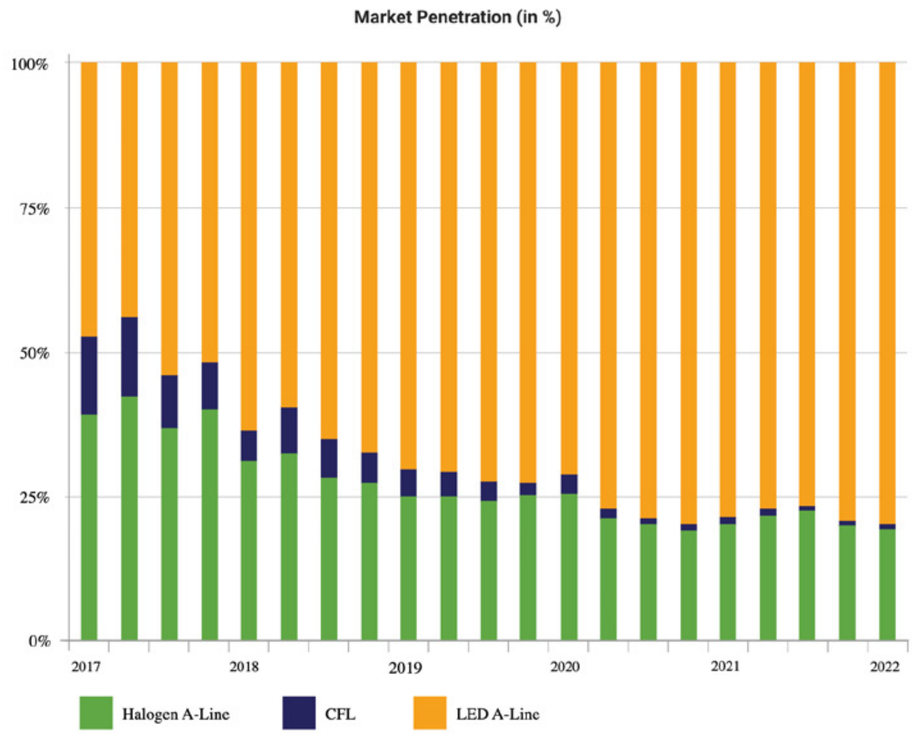
Source: NEMA (2022)

10 DOE (2022), Diode (LEDs) consumes 90% less energy and lasts 25 times as long.

11 BCSE & BloombergNEF (2019), 2019 Sustainable Energy in America Factbook

12 DOE (2019), Energy Conservation Program: Definition for General Service Lamps

13 ASAP (2019), Rollback of light bulb standards would cost consumers billions



Source: NEMA (2022)

Though they were only introduced in the 2000s, LED sales of A-line bulbs have grown quickly, resulting in a growth of market penetration from nearly zero to almost 50% within a span of five years (2012-2017), and has since grown to over 75%. The LED bulbs also last much longer. However, market growth has slowed in recent years. Since 2020, the market share of LEDs has hovered around 75%.

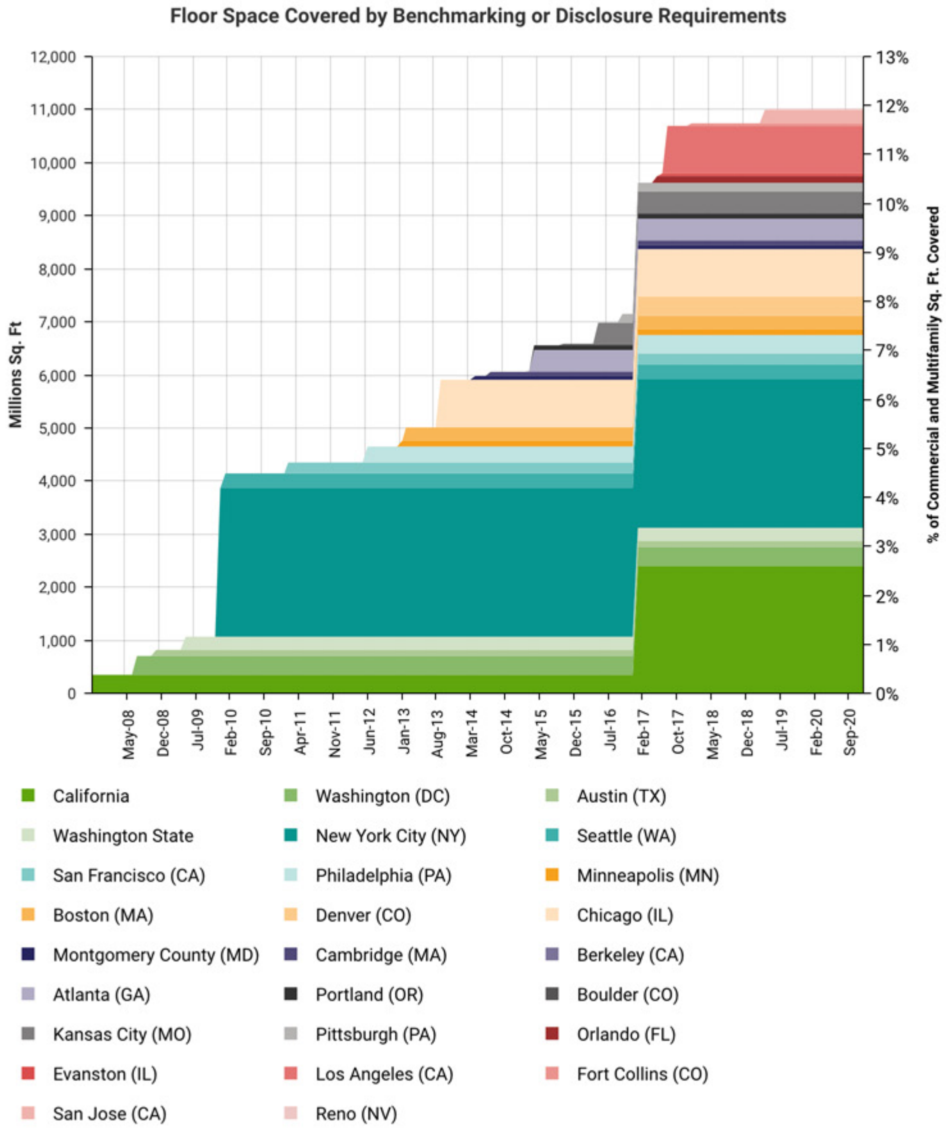
The market share of LEDs also showed rapid acceleration for tubular bulbs (primarily used in the commercial and industrial sectors), achieving more than 30% of the fluorescent lamp market share by 2022. As of the first quarter of 2022, T-LED shipments had an annual increase of 6.6%.[14] Their adoption has also been driven by their greater controllability, which leads to additional energy savings in commercial buildings. For example, LEDs are more easily paired with digital control systems, can feature both dimmable and color-changing features, and expel less waste heat.[15]

14 NEMA (2022), LED Lamp Shipments Index

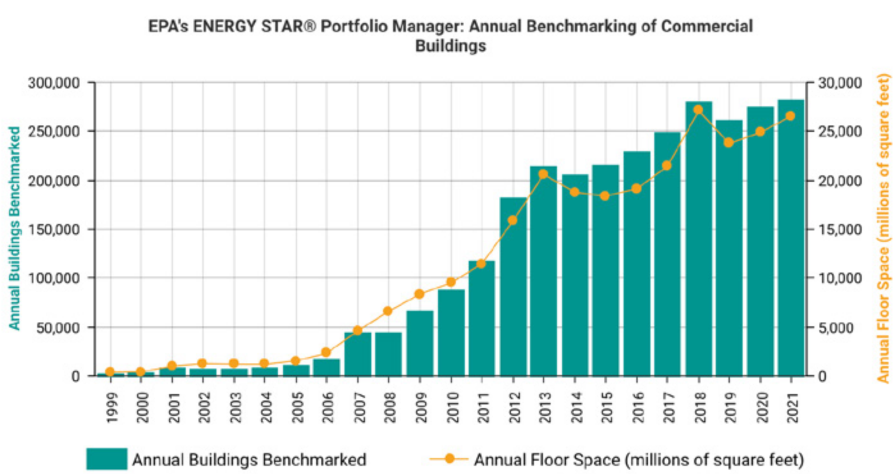
15 LCA (2016), Seven Trends in LED Lighting Control

30 Building Energy Performance Benchmarking and Transparency

Commercial building energy performance benchmarking incentivizes energy efficiency and is increasingly required by cities and states



Source: BCSE & BloombergNEF (2022), 2022 Sustainable Energy in America Factbook



Source: EPA (2022)

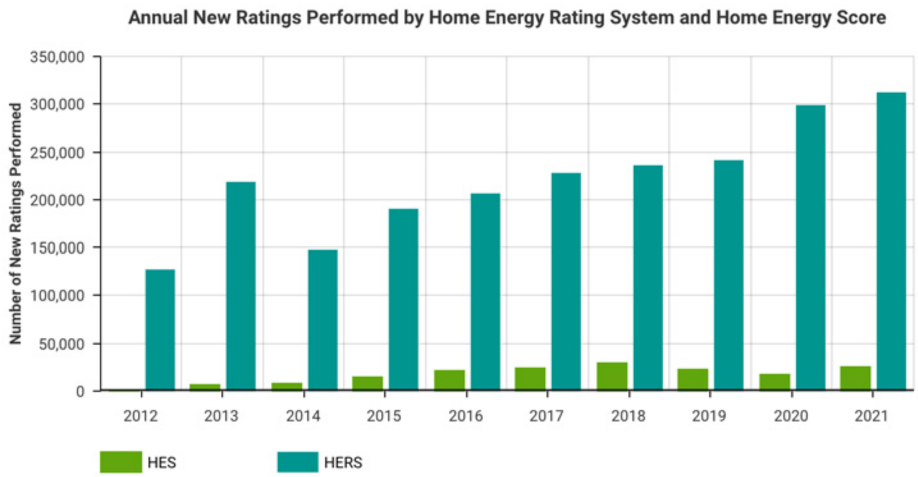
Benchmarking can help facility managers set reasonable energy efficiency goals, discover energy waste, and assess the effectiveness of energy savings programs. The U.S. Environmental Protection Agency found that buildings that were consistently benchmarked reduced energy use by an average of 2.4% per year.

A number of states and localities have implemented benchmarking requirements using ENERGY STAR® Portfolio Manager in the last decade, such that the square footage of floor area required to be benchmarked has increased dramatically. Benchmarking through ENERGY STAR® Portfolio Manager has grown to represent close to 25% of U.S. commercial floorspace.[16]

Benchmarking requirements typically apply to commercial, public, and sometimes multifamily buildings. Benchmarking can benefit residents by motivating building owners to pursue energy-efficiency investments. In Massachusetts, multifamily benchmarking data was used to target low-performing buildings for improvements. Austin, Texas is the only city to require benchmarking for single-family homes.

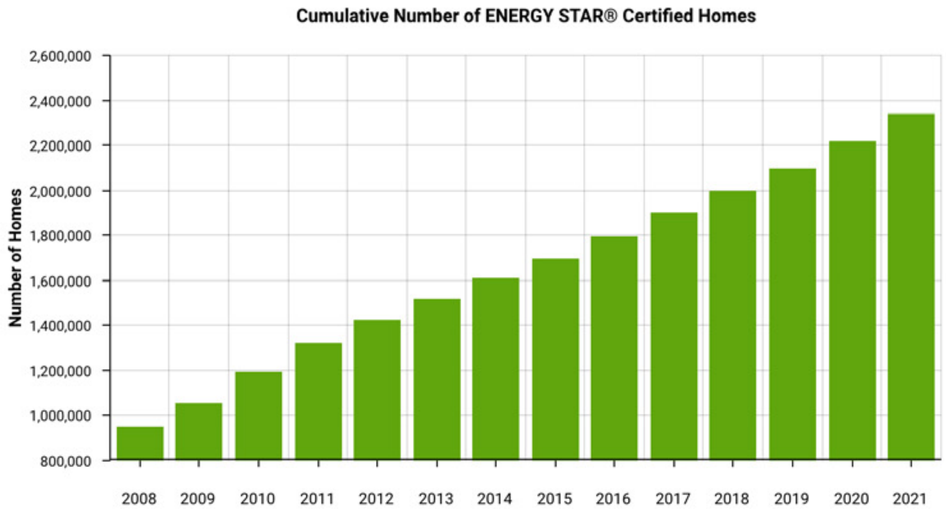
31 Residential Home Energy Use Rating and Certification Tools

More than 4 million energy performance ratings and certifications have been performed since 2012



Source: RESNET (2022); DOE (2022)

16 EPA (2022), ENERGY STAR Portfolio Manager



Source: EPA (2022)

Ratings and certifications bring greater transparency to energy efficiency opportunities and can result in a clearer understanding of utility bills and opportunities for savings, incentives to invest in energy-efficient construction, and help for homebuyers to qualify for loans.[17, 18] Residential homeowners, builders, and property developers have several tools that can be used to achieve a deeper understanding of a home's energy performance, including the Home Energy Rating System (also known as a HERS rating), and Home Energy Score (HES rating).

HERS provides an estimate of energy performance in new homes, while HES ratings apply to existing homes. The first chart shows annual ratings performed by year, with increases in the use of both rating systems. Cumulatively, more than 2.2 million homes are estimated to have HERS ratings, or approximately a fifth of new homes today.[19] More than 170,000 homes have received HES ratings.

While HERS and HES provide an energy efficiency rating regardless of the home's performance, ENERGY STAR® certifies new homes that have achieved higher levels of energy efficiency. The cumulative number of ENERGY STAR® certified homes reached more than 2.3 million in 2021. (Note that many homes receive more than one rating or certification.)

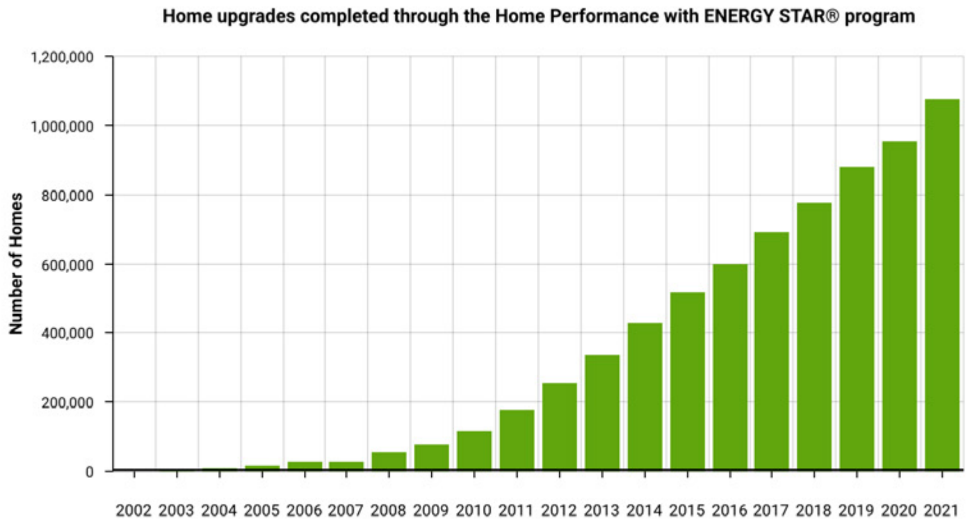
17 While ENERGY STAR®, HERS, and HES are the most common certification and rating systems, there are also others, including Net Zero Energy Building Certification, Passive House Certification, Green Built Homes, and LEED Zero.

18 DOE (2016), DOE's Home Energy Score and FHA Mortgages: New Tools to Help You Shop for and Buy an Energy Efficient House

19 Census (2021), New Residential Construction

32 Home Performance Data

More than 1 million homes have received energy upgrades through the Home Performance with ENERGY STAR® program

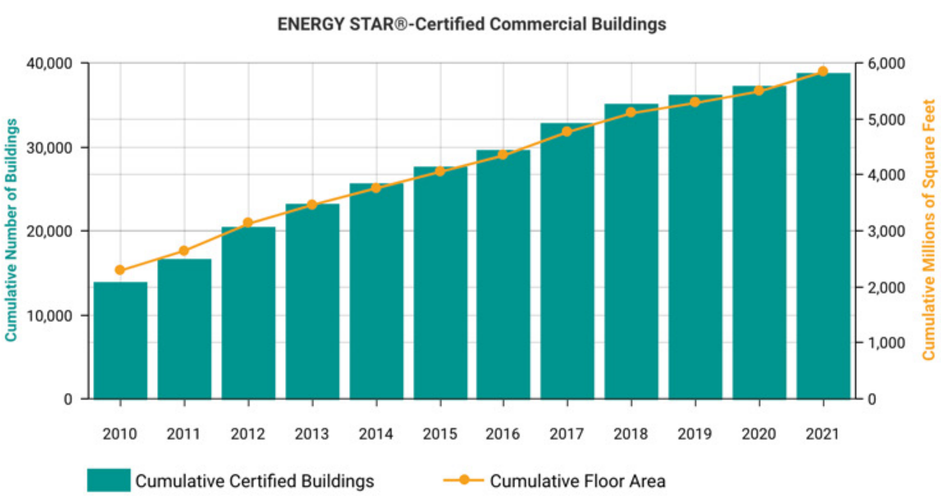


Source: EPA (2022)

The Home Performance with ENERGY STAR® program is a national home energy upgrade program coordinated by the U.S. Environmental Protection Agency and the Department of Energy through a network of local utilities, non-profits, and contractors. As of 2021, over 1 million homes have been upgraded through the program. The Home Performance program uses a whole-home approach to achieve as much as 20% energy savings, as well as to improve comfort and health by addressing mold, pests, and air quality. These homes include single-family, multifamily, and some manufactured homes.[20]

33 Building Certification by ENERGY STAR® and LEED

ENERGY STAR® and LEED commercial building certifications have increased by nearly 3- and 6-fold since 2010



Source: EPA (2022), ENERGY STAR® Certified Building and Plant Locator (database)

20 Home Performance with ENERGY STAR®. Data from EPA

Source: USGBC (2022)

ENERGY STAR® certifies buildings that exhibit better energy performance than 75% of similar buildings nationwide, verified by a third party. On average, ENERGY STAR®-certified buildings use 35% less energy and cost $0.54 less per square foot to operate than their peers.[21] In 2021, more than 280,000 buildings, comprising 27 billion square feet of floor space, used ENERGY STAR® Portfolio Manager to measure and track their energy use, water use, and waste and materials.[22]

LEED certifies the design, construction, and operations of a building. LEED requires the modeled design for its certified buildings to be better than a baseline building's energy performance by 5% for new construction and by 3% for major renovations, but most LEED buildings are much more efficient than the minimum requirement.[23, 24] A 2014 study documented that the average design efficiency of LEED projects in the study was approximately 27% better than the reference code.[25]

Post-occupancy studies have also borne out the energy performance of LEED buildings: a 2015 assessment of buildings in Washington, D.C., found that LEED-certified office buildings exhibited 13% less energy use intensity than their peers, and a 2016 report by the State of Washington found that by implementing green building practices, state agencies and higher educational facilities reduced their energy use by an overall average of 37%.[26, 27] A 2018 GSA latitudinal study also examined 200 buildings over a three-year period, finding that compared to legacy buildings, GSA's high-performing buildings showed 23% less energy use.[28]

21 ENERGY STAR® (2022), ENERGY STAR® certification for your building

22 EPA (2022), ENERGY STAR® Impacts

23 According to ANSI/ASHRAE/IESNA Standard 90.1–2010, Appendix G (Note: LEED's current system being tested includes update to Standard 90.1-2016, see USGBC (2019), LEED v4.1).

24 USGBC (2019), LEED BD+C: New Construction | v4 – LEED v4

25 USGBC (2014), The LEED Plaque Unpacked: What a Decade of LEED Project Data Reveals About the Green Building Market

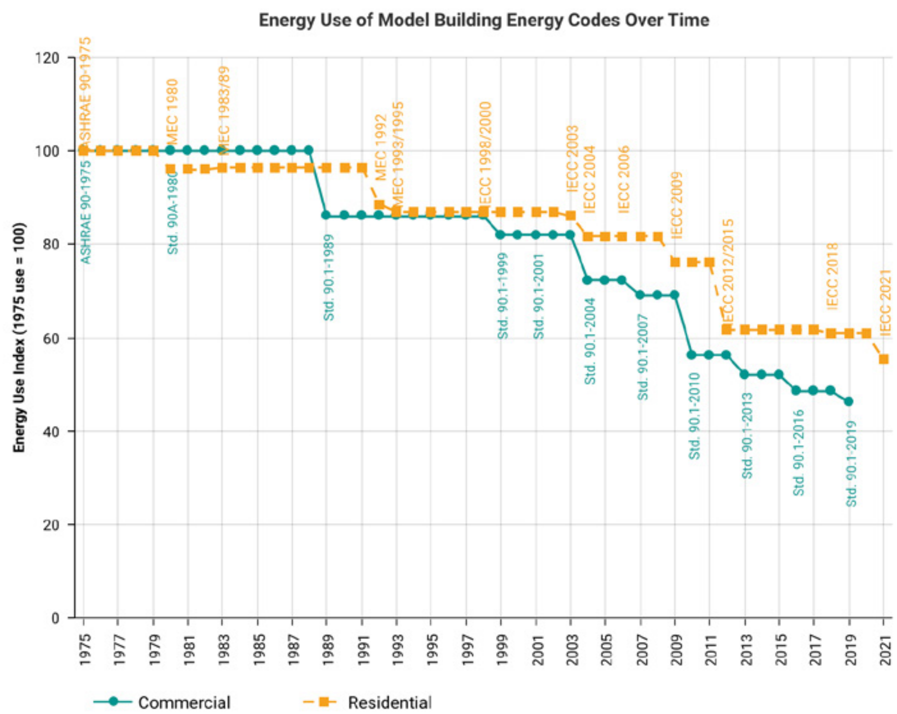
26 USGBC (2015), LEED buildings outperform market peers according to research

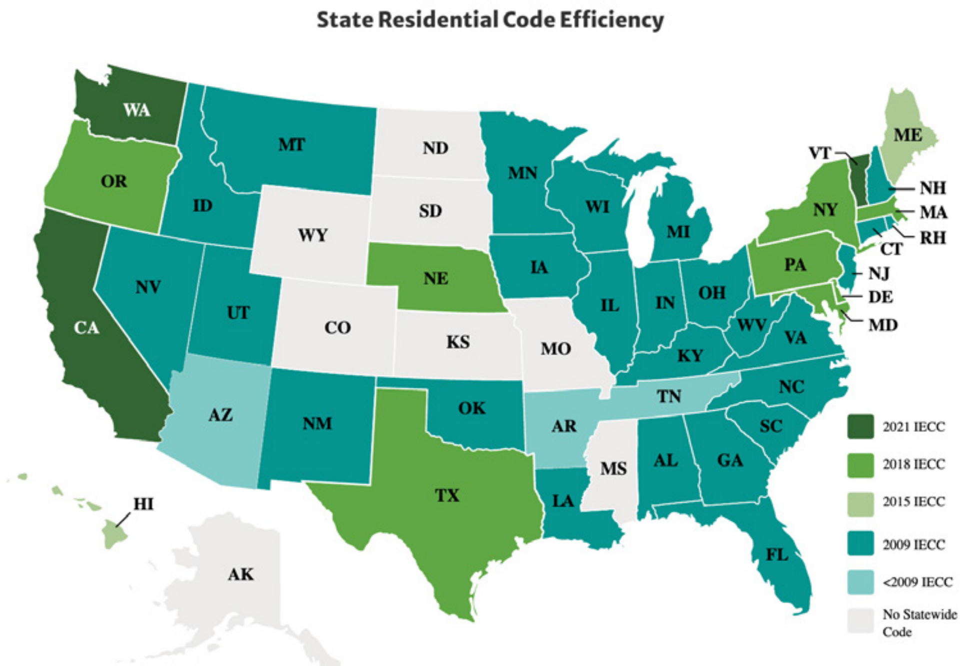
27 Washington State Department of Enterprise Services (2016), High Performance Public Green Buildings

28 U.S. General Services Administration (2018), The Impact of High Performing Buildings

34 Model Building Energy Codes

Building energy codes have reduced covered energy use in buildings by more than 40% over four decades



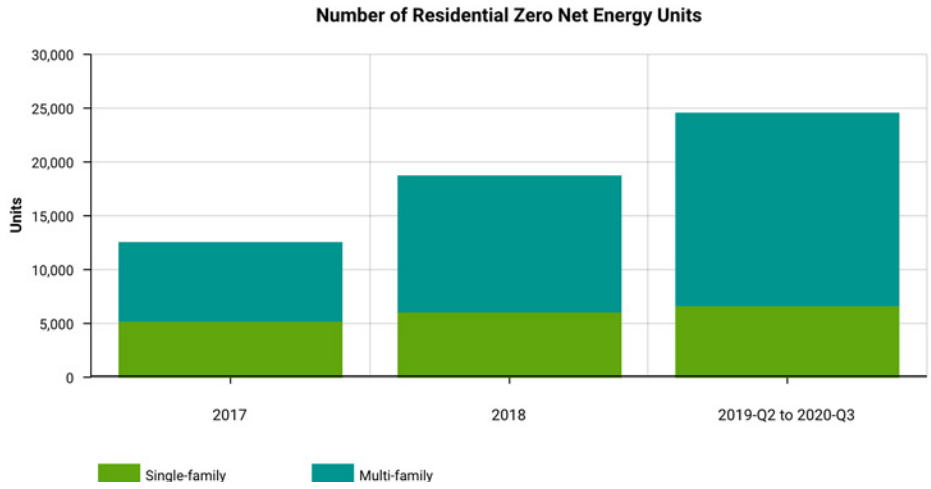


Source: PNNL (2022)

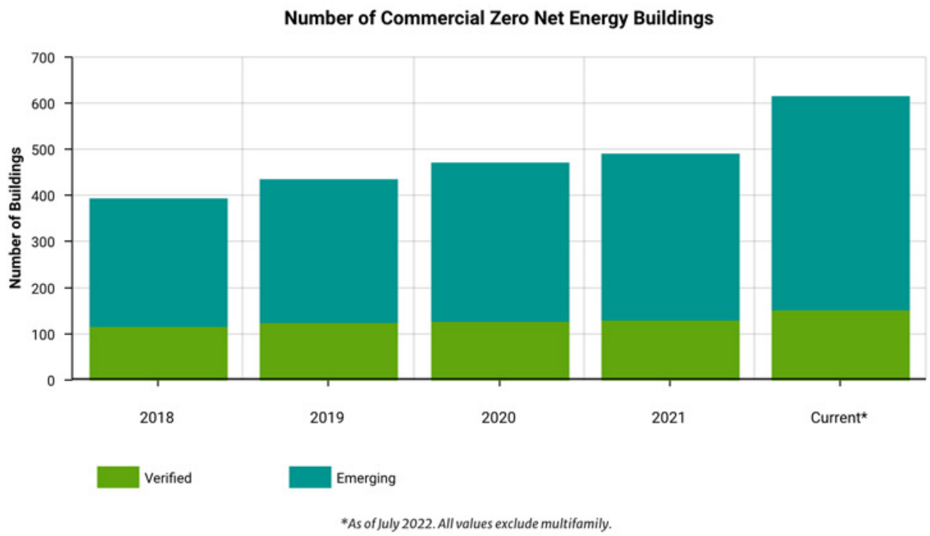
Building energy codes set minimum efficiency requirements for renovated or new buildings, often locking in savings through the building's lifespan (which can reach over 50 years).[29] Model energy codes are conservatively expected to save $138 billion in energy costs and 13.5 quads of primary energy from 2010 to 2040.[30] A home built to the specifications of the International Energy Conservation Code of 2021 would use roughly 45% less energy than if it had been built using standard practices from 1975. As of 2022, only three states have adopted efficiency standards comparable to the International Energy Conservation Code of 2021.[31]

35 Zero Net Energy Buildings

The U.S. market for zero net energy buildings is growing rapidly



Sources: Team Zero (2021), Inventory



Sources: New Buildings Institute (2022), Number of Zero Energy Buildings Chart & Getting to Zero Buildings Database

29 Building Codes Assistance Project, Energy Codes 101

30 DOE (2021), The Impact of Building Energy Codes

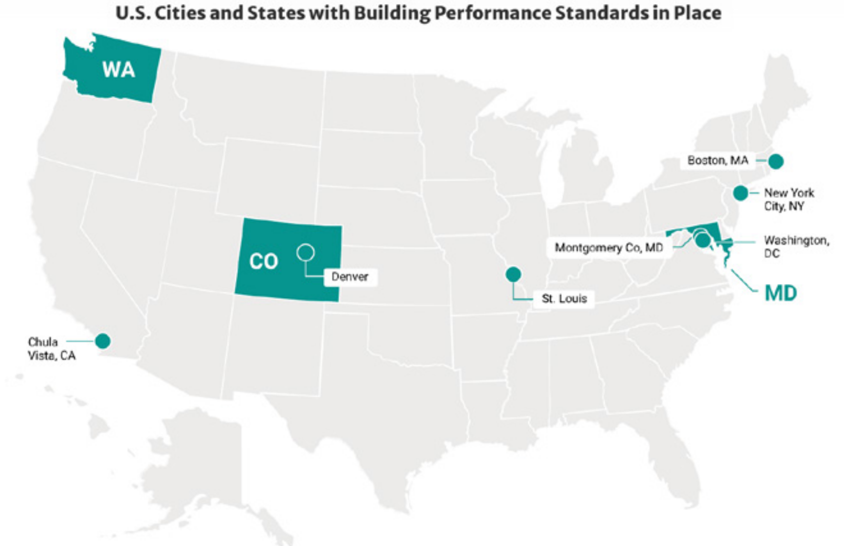
31 PNNL (2022), Status of State Energy Code Adoption: Residential Buildings

The construction of zero net energy and zero energy ready buildings is a very recent trend that still constitutes a small fraction of the building market, but is growing rapidly.[32] From 2017 to 2020, the total number of residential units nearly doubled. As of July 2022, the number of verified commercial buildings has reached 154 and the number of emerging commercial buildings striving for zero net energy has reached 462, respectively representing a 30% and 70% increase since 2018.[33] Certifications such as LEED Zero may help drive more zero net energy projects by facilitating recognition and incentives. States and cities are also beginning to incorporate zero net energy into codes and stretch codes.[34]

36 Building Performance Standards

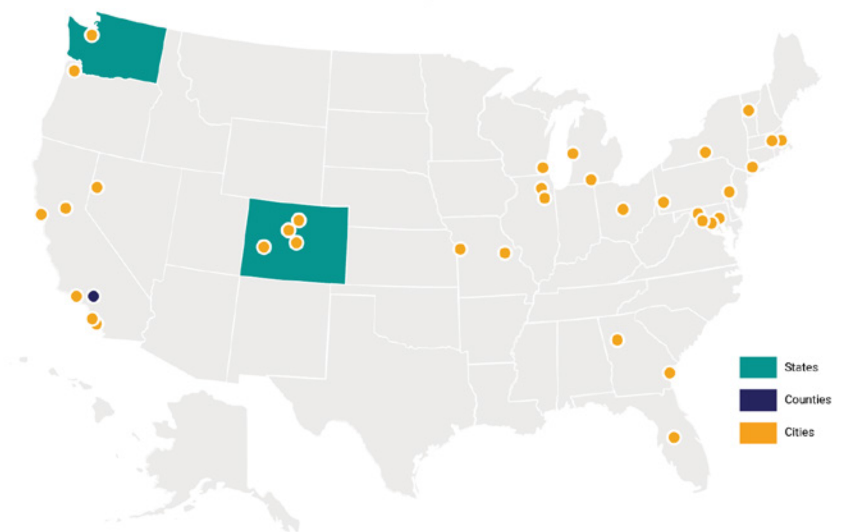
Over 30 jurisdictions are committed to passing building performance standards by 2024

U.S. Cities and States with Building Performance Standards in Place



Sources: IMT (022) Building Performance Standards

Jurisdictions in the National Building Performance Standards Coalition



32 970,000 single-family homes and 371,000 multifamily units were completed in 2021. Census Bureau (2019), Characteristics of New Housing

33 New Buildings Institute (2022), Getting to Zero Buildings Database

34 ZERO Code – California commercial (proposed/alternate); Title 24-2019 – California residential statewide code Residential; Appendix Z – Washington D.C. commercial alternate compliance path; Executive Order No. 10-20—Oregon Residential Zero Energy Ready Home by 2022.

Contributing Cities and Counties

Ann Arbor, MI	Evanston, IL	Pittsburgh, PA
Annapolis, MD	Fort Collins, CO	Portland, OR
Aspen, CO	Grand Rapids, MI	Prince George's County, MD
Atlanta, GA	Ithaca, NY	Reno, NV
Boston, MA	Kansas City, MO	Sacramento, CA
Boulder, CO	Los Angeles, CA	San Diego, CA
Cambridge, MA	Milwaukee, WI	San Francisco, CA
Chicago, IL	Montgomery County, MD	Savannah, GA
Chula Vista, CA	Montpelier, VT	Seattle, WA
Columbus, OH	New York, NY	St. Louis, MO
County of Los Angeles	Orlando, FL	Washington, DC
Denver, CO	Philadelphia, PA	

Sources: IMT(2022) National Map of BPS Coalition Participating Jurisdictions

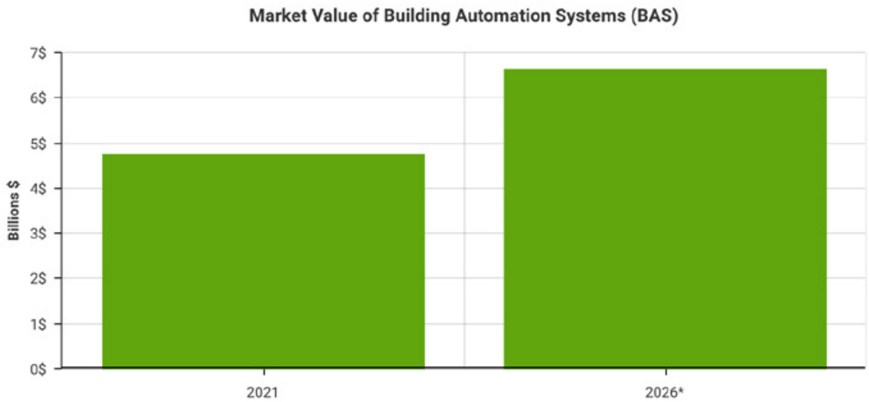
While building efficiency codes are an effective policy solution for improving building energy performance, codes only impact new construction or alterations, which only slowly affects the total building stock. As of 2018, roughly 91% of all commercial buildings were over eight years old (built before 2010).[35] Typically, building structures last 70 to 80 years.

A building performance standard (BPS) is a policy that sets energy use or greenhouse gas emission targets for existing buildings. BPS policies can complement codes for new buildings and can be adapted based on the jurisdiction. BPS policies typically set increasing targets over time, with timelines often varying based on the size of the building or equity considerations, such as allowing extended timelines for compliance for affordable housing (e.g., St. Louis and DC).[36]

In January 2022, the federal government launched the National BPS Coalition. Over 30 participating jurisdictions are committed to passing a building performance policy by Earth Day 2024.[37]

37 Smart Buildings

Market value of building automation systems in the United States is expected to grow by nearly 40% in the next 6 years



Source: Mordor Intelligence (2022), Industry Growth

35 CBECS (2019), 2018 CBECS Survey Data

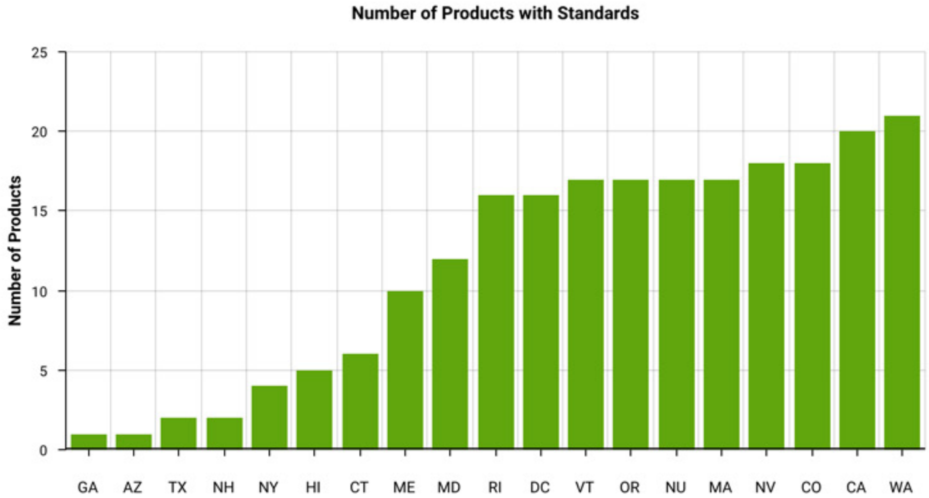
36 IMT (2022), Comparison of U.S. Building Performance Standards

37 National BPS Coalition (2022), About the National BPS Coalition

Building automation systems relate and integrate different facility technologies, ranging from surveillance, lighting, HVAC, and more, all through a central monitoring point. In the United States, the commercial building automation systems (BAS) market was valued at $4.75 billion as of 2020. Forecasts expect it to reach $6.63 billion by 2026. From 2021 to 2026, there is an expected compound annual growth rate of 6.31%.[38]

38 State-Level Appliance Efficiency Standards

Eighteen states and the District of Columbia have established appliance efficiency standards



Source: ASAP (2022), State Adoption of Energy Efficiency Standards

Since 2019, the number of state-level appliance standards has more than doubled, with a total of roughly 220 new standards in place. Currently, 18 states and the District of Columbia have established appliance efficiency standards across a range of 32 different product types that are either allowed to exceed or are not covered by the U.S. Department of Energy's minimum energy performance standards.[39]

For products that are not yet covered nationally, state standards can build momentum around efficiency for new types of equipment. For instance, California was the first state to adopt a commercial clothes washers efficiency standard in 2002, shortly followed by eight more states, before the first federal standard for clothes washers was adopted by Congress in 2005.[40] In 2021, the first state-level standards were adopted for commercial ovens, electric vehicle supply equipment, and gas fireplaces.

38 United States Commercial Building Automation Systems Market Size, Share | 2022 – 27 | Industry Growth (mordorintelligence.com)

39 ASAP (2022), States

40 ASAP (2022), Clothes Washers, Commercial

Energy Efficiency Impact Report

Industrial

Highlights

Double Economic Output

The industrial sector halved energy intensity from 1977 to 2021, while more than doubling economic output.

Industrial Energy Programs

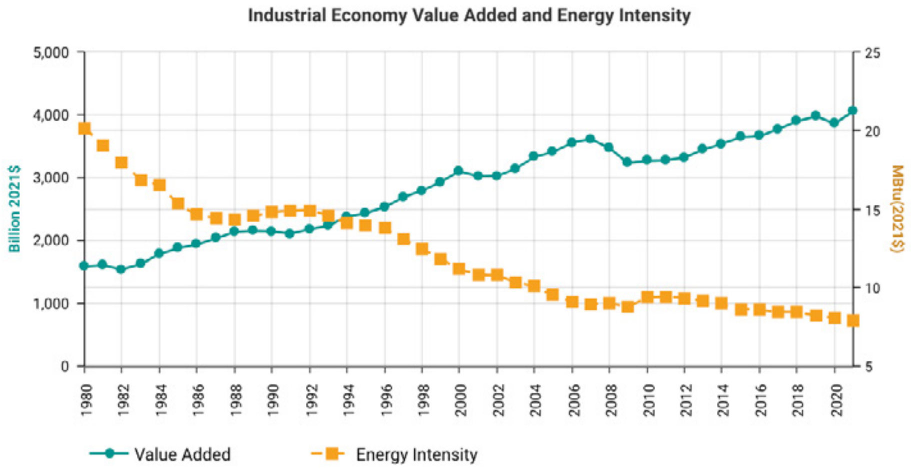
Programs such as Better Plants and ENERGY STAR® for industry have led to higher levels of facility certification and nearly 5 quads of primary energy savings.

Industrial Energy Management

22% of manufacturers said that energy consumption is becoming a higher priority for the establishment and over 90% said energy efficiency is part of their purchasing decisions.

39 Industrial Energy Intensity

Industrial energy intensity has halved since 1970, while driving economic gains



Source: EIA (2021), *Total Energy Monthly*

The U.S. industrial sector consumes more total energy than any other end-use sector, and is responsible for 24% of total U.S. greenhouse gas emissions.[1] It was also responsible for slightly more than 23% of the U.S. gross domestic product in 2021.[2] As a result, this sector is a natural space to invest in energy efficiency; from 1980 to 2021, the industry halved energy intensity, while more than doubling value added. Energy efficiency contributed to this trend,

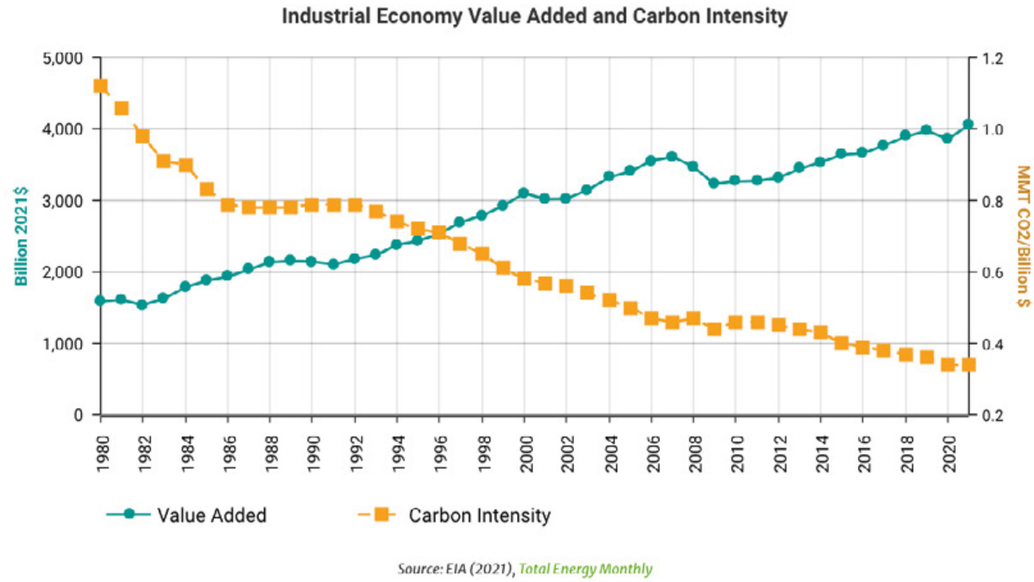
1 EPA (2020), Sources of Greenhouse Gas Emissions

2 BEA (2022), Interactive Data

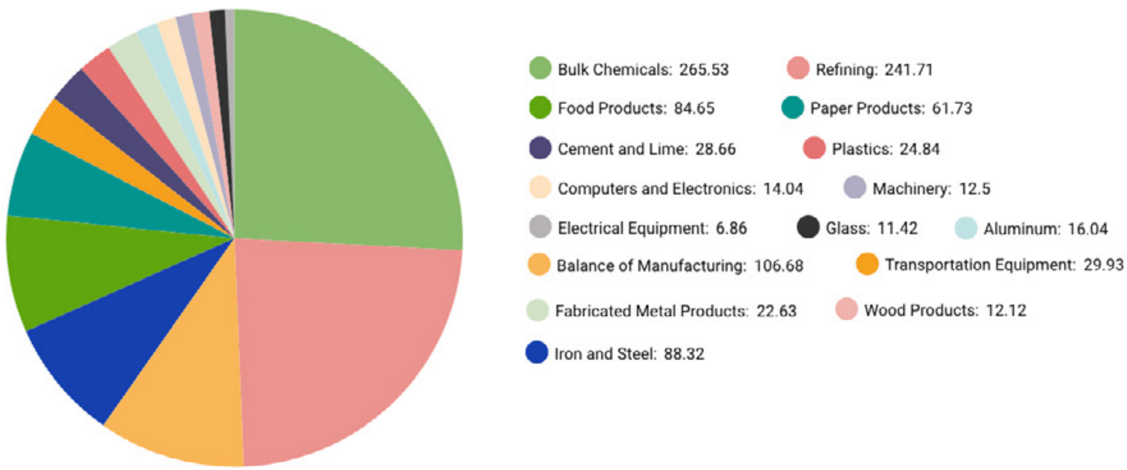
with the deployment of innovative industrial processes, smart manufacturing, strategic energy management, and other strategies.[3]

40 Industrial Carbon Intensity

Industrial carbon intensity has declined 70% since 1980



Source: EIA (2021), Total Energy Monthly



Source: EIA (2021)

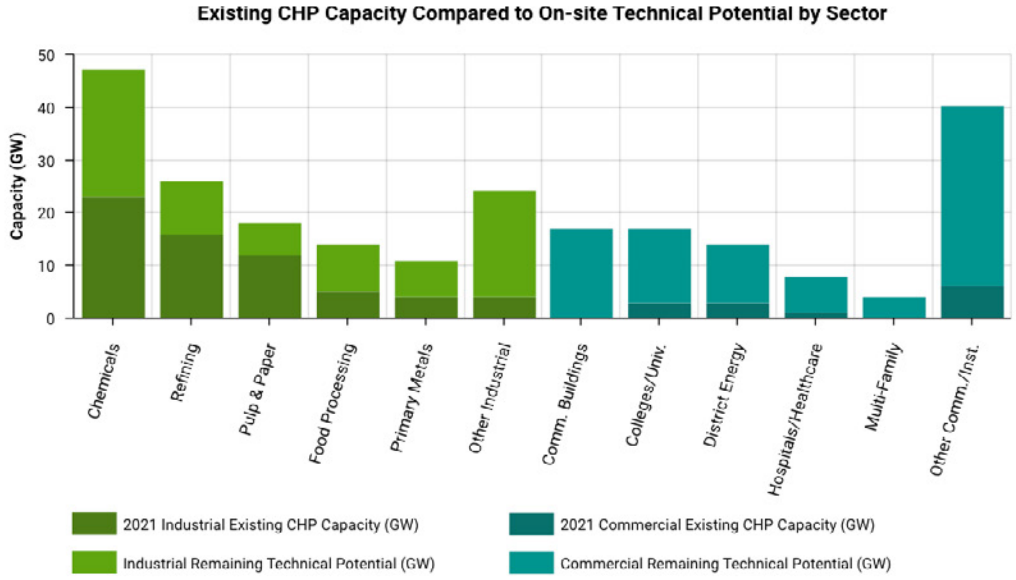
The carbon intensity (carbon emissions per value of output) from the industrial sector has steadily declined over the last five decades. Between 1980 and 2021, industrial carbon intensity has fallen by 70%. This decline is due to various factors, including energy efficiency, a shift to producing higher-value goods, and changes in energy source. However, this progress has slowed in the last decade or so.

Manufacturing makes up roughly 80% of industrial emissions, while non-manufacturing subsectors of construction, mining, and agriculture make up the balance of industrial emissions.

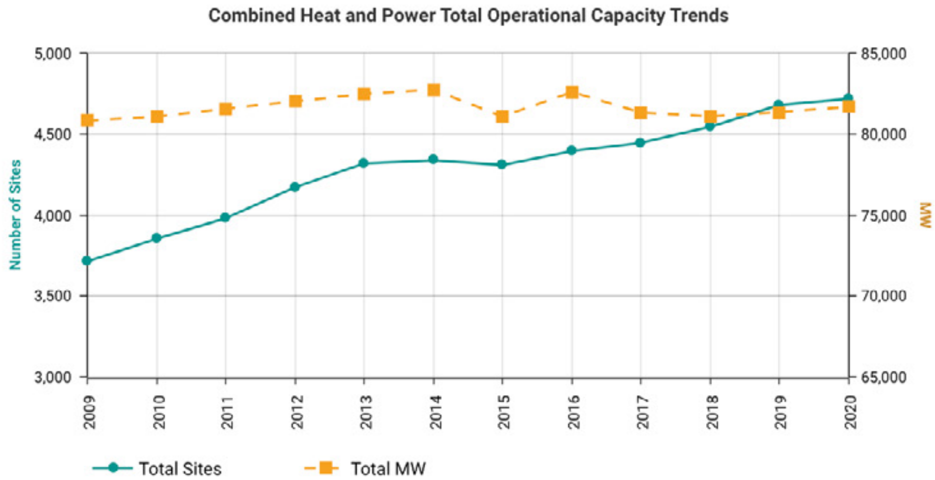
3 ACEEE (2017), Energy efficiency and industry: the national trend

41 Combined Heat And Power

The industrial sector has largely driven CHP investments, a tool to enhance energy efficiency; commercial installations have significant potential



Source: DOE (2021) ; DOE (2016), Combined Heat and Power Technical Potential in the United States



Source: DOE/ICF (2020), CHP Installation Database

Combined heat and power (CHP) technologies are accompanied by significant efficiency gains; where separate systems to provide heat and electricity may reach 50% energy efficiency, CHP can often reach 75% efficiency. Most CHP installations are used for industrial applications, such as chemicals, refining, paper, primary metals, food processing, and other industrial processes, and natural gas is the most common CHP fuel, accounting for approximately 70% of U.S. CHP capacity in 2021.[4, 5, 6] However, a wide variety of other commercial institutions are estimated to have significant untapped technical potential, collectively adding up to over 30 GW of potential

4 DOE (2019), Combined Heat and Power Basics

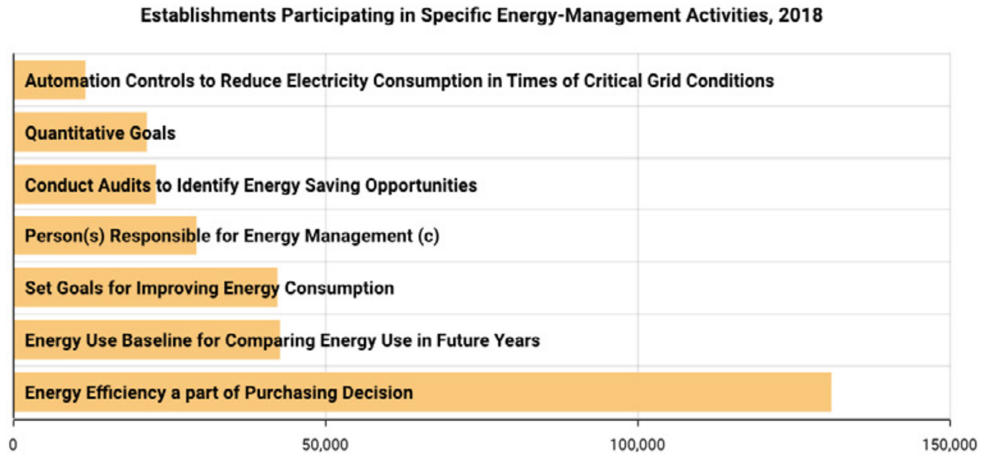
5 EPA (2019), What Is CHP?

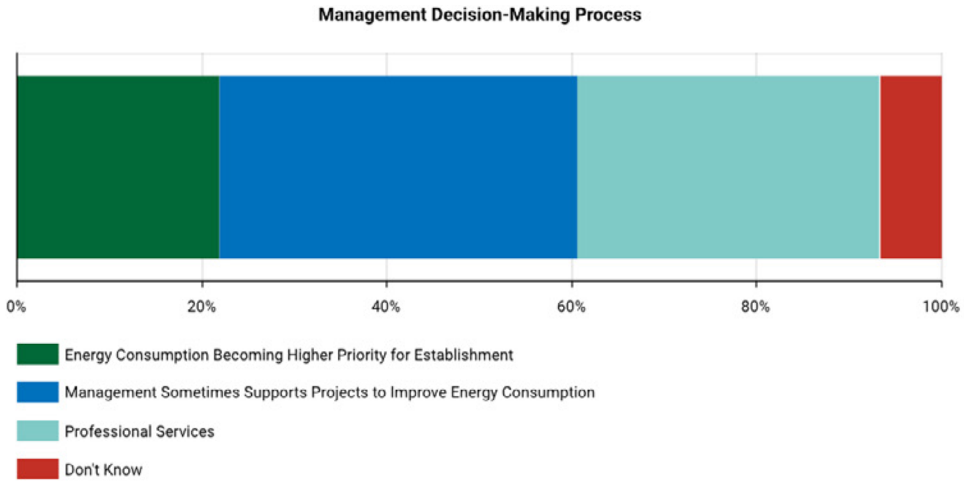
6 DOE (2021), CHP Database

capacity.[7] The total electrical capacity of CHP generation has remained largely constant from 2009 to 2020, though the number of sites has increased by approximately 27% over the same time period, largely driven by minor decreases in larger industrial installations, and increases in smaller commercial installations.

42 Industrial Energy Management

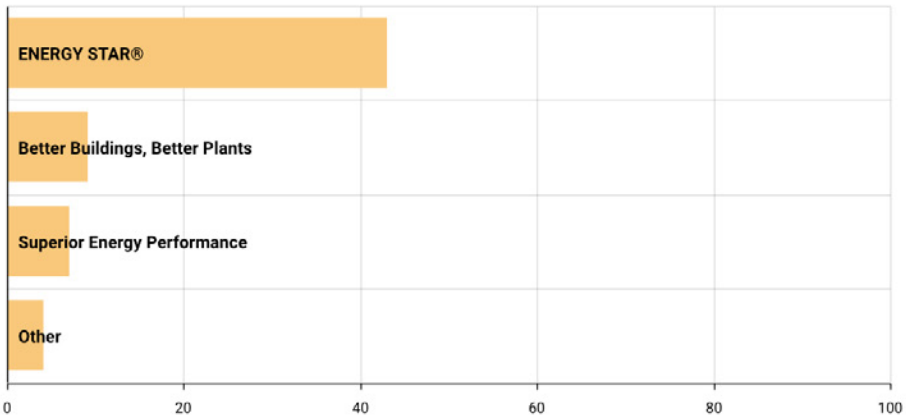
Over 131,000 manufacturing establishments use energy efficiency as part of their purchasing decision





7 The “Other Industrial” includes an aggregate of smaller-capacity categories of industrial facilities, including Agriculture, Mining, Oil/Gas Extraction and all other facilities listed in Table III-3 of DOE’s 2016 report titled “Combined Heat and Power Technical Potential in the United States.” The “Other Comm./Inst.” bar shown above includes an aggregate of smaller-capacity categories of commercial facilities, including Utilities, Unknown and all other facilities (aside from Comm. Buildings, Colleges/Univ., District Energy, Hospitals/Healthcare, and Multi-Family, which are separately shown in the chart) listed in Table III-4 of the DOE 2016 report.

Participation in Energy Consumption Improvement Programs



Sources: LBNL (2022)

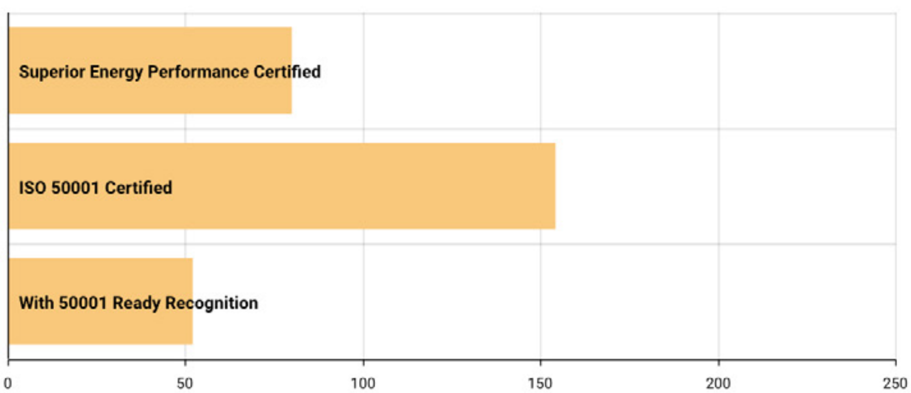
Industry accounts for more than 25% of U.S. energy use and greenhouse gas (GHG) emissions. Reducing this energy use through proven, cost-effective energy management techniques will improve the competitiveness of firms, helping maintain well-paying jobs in manufacturing. In order to reach long-term GHG reduction goals, it is vital that industrial emissions decline significantly. Energy management can deliver near- and longer-term reductions with low capital cost and can provide a host of energy and non-energy benefits.

While over 131,000 manufacturing establishments use energy efficiency as part of their purchasing decisions, fewer have taken specific steps to improve efficiency, such as establishing baseline energy use, conducting audits to identify opportunities, or setting energy consumption goals. However, nearly 20% of establishments identified that energy consumption is becoming a higher priority. ENERGY STAR® is the most common program for those who participate in some sort of energy management program.

43 ISO 50001

Facilities that have been certified to ISO 50001 demonstrate improved energy performance

Number of Recognized or Certified Facilities/Sites (2021)

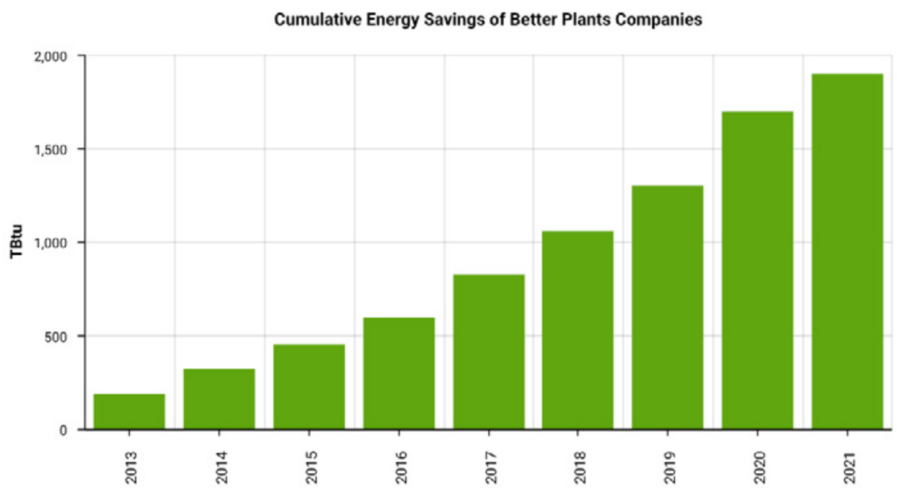


Sources: ISO Certified – ISO (2022), The ISO Survey

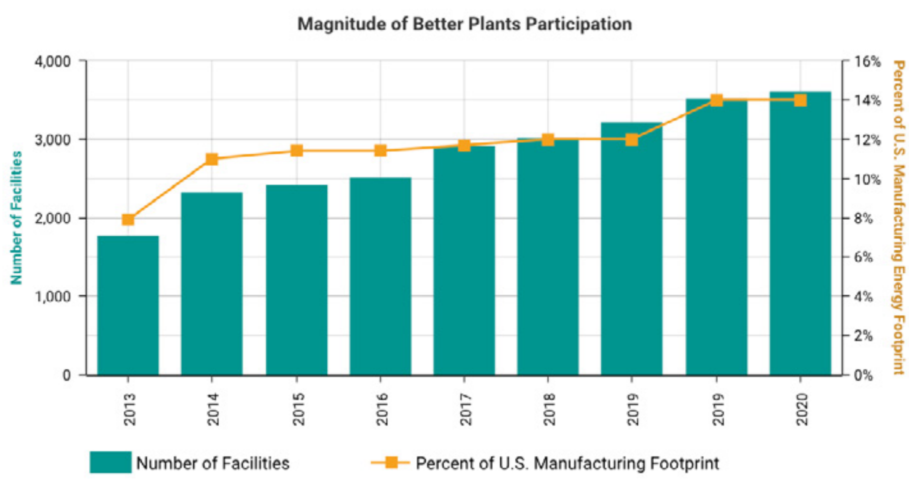
ISO 50001 is an internationally recognized voluntary standard to support continuously-improving energy performance. DOE's 50001 Ready is a simpler, self-guided energy management program. Facilities that have been certified to ISO 50001 and can demonstrate improved energy performance are eligible to be certified to DOE's Superior Energy Performance (SEP) program. SEP-certified facilities have improved energy performance 4.6% annually, on average, through mostly (75%) no/low cost operational improvements.[8] While the early adopters of ISO 50001 are realizing significant savings, there is enormous market potential for ISO 50001 to grow. Internationally, it is estimated that full ISO 50001 implementation could drive a cumulative energy savings of 59 quads, over $600 billion in energy costs, and avoid 6,500 Mt of carbon dioxide emissions to 2030.[9]

44 Better Plants

Better Plants participants make up 14% of the U.S. manufacturing footprint and have cumulatively saved 1.9 quads since 2011



Source: DOE (2022), Better Plants Program Information



Source: DOE (2022), Better Plants Program Information

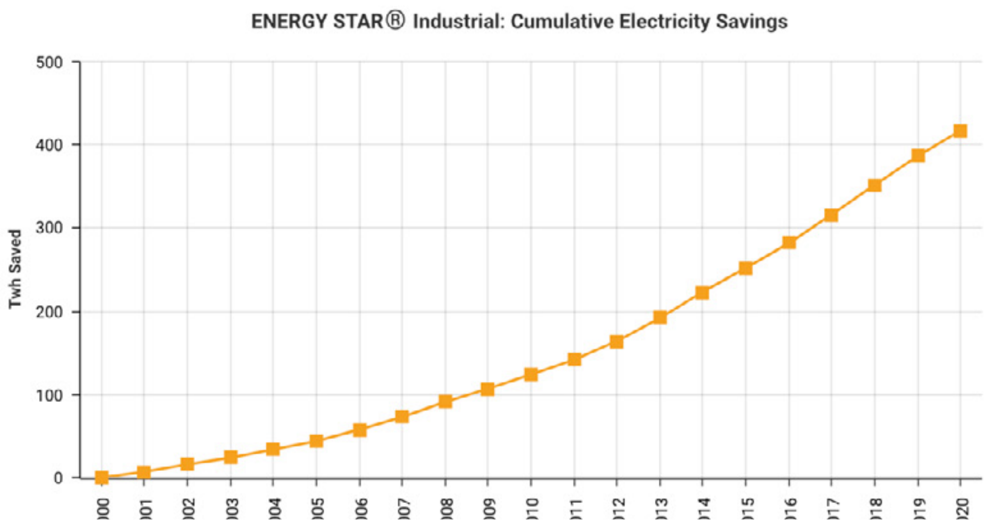
8 Paul Scheihing (2019), Presentation: Accelerating Energy Savings with ISO 50001

9 LBNL (2016), Global Impact Estimation of ISO 50001 Energy Management System for Industrial and Service Sectors

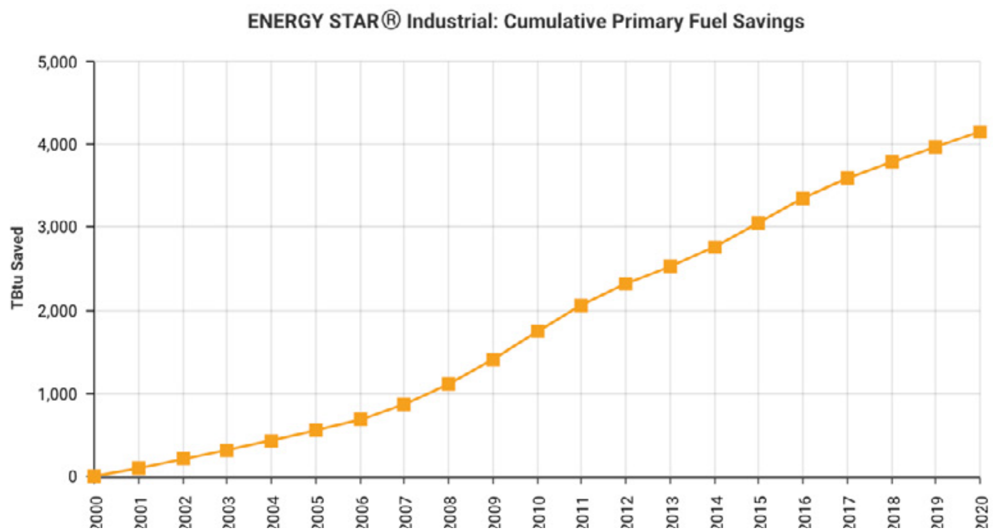
The Better Plants Program's 250+ partners make up 14% of the U.S. manufacturing energy footprint, span a diverse set of subsectors, and have already saved a cumulative 1.9 quads since the program's inception.[10] The number of Better Plants participants has steadily increased since 2014, with a slower growth as a share of manufacturing energy footprint.

45 ENERGY STAR® in Industry

The ENERGY STAR® program for industrial plants saved $3 billion in energy costs in 2017



Source: EPA (2019)



Source: EPA (2019)

In 2020 alone, the ENERGY STAR® program for industrial plants helped businesses save 30 billion kilowatt-hours of electricity (roughly 3% of all industrial electric use in that year),[11] avoid $2 billion in energy costs, and achieve 30 million metric tons of greenhouse gas reductions by partnering with hundreds of companies to deploy ENERGY STAR® strategic energy management (SEM) resources to develop an organizational culture on continuous improvement of energy

10 DOE (2021), Better Plant Program Information

11 EIA (2021), Electricity Explained

performance. EPA has convened 33 "Industrial Sector Focuses" to collaborate and develop industry-specific resources. Between 2000 and 2021, associated cumulative savings were 417 TWh of electricity and more than 4 quads of primary fuel savings.

ENERGY STAR® will continue to deliver industrial savings. In 2021, 93 new plants earned the ENERGY STAR® certification—earning above an ENERGY STAR® score of 75 out of 100—and another 28 industrial plants committed to reduce their energy use by 10% over 5 years.[12]

12 EPA (2022), About ENERGY STAR® for Industrial Plants

Transportation

Highlights

CAFE Standards
Corporate Average Fuel Economy (CAFE) standards have had the greatest impact of any energy efficiency policy in terms of energy savings, improving the miles per gallon of new passenger cars by more than 90% since 1975.

Medium and Heavy-Duty Vehicles
Medium and heavy-duty vehicles make up 9% of total vehicle miles traveled yet account for about 25% of all highway energy use. This segment's vehicle miles traveled is expected increase by more than 30% by 2050.

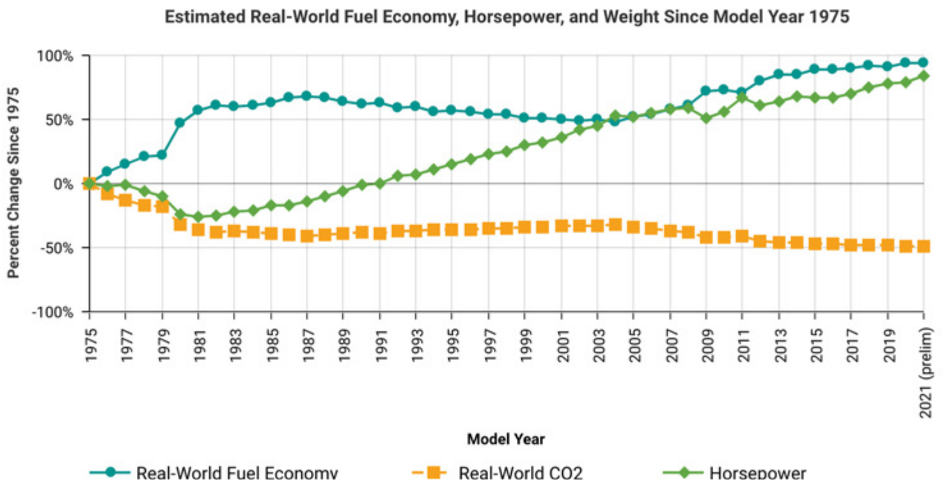
Electric Vehicle Sales
Electric vehicles sales have more than doubled and the number of charging stations has more than tripled since 2019. The U.S. now has an estimated 1.5 million electric vehicles on the road.

Increasing Miles Traveled
The number of vehicle miles traveled has tripled since 1970, leading to significant increases in traffic congestion, which leads to increased consumer costs and air pollution.

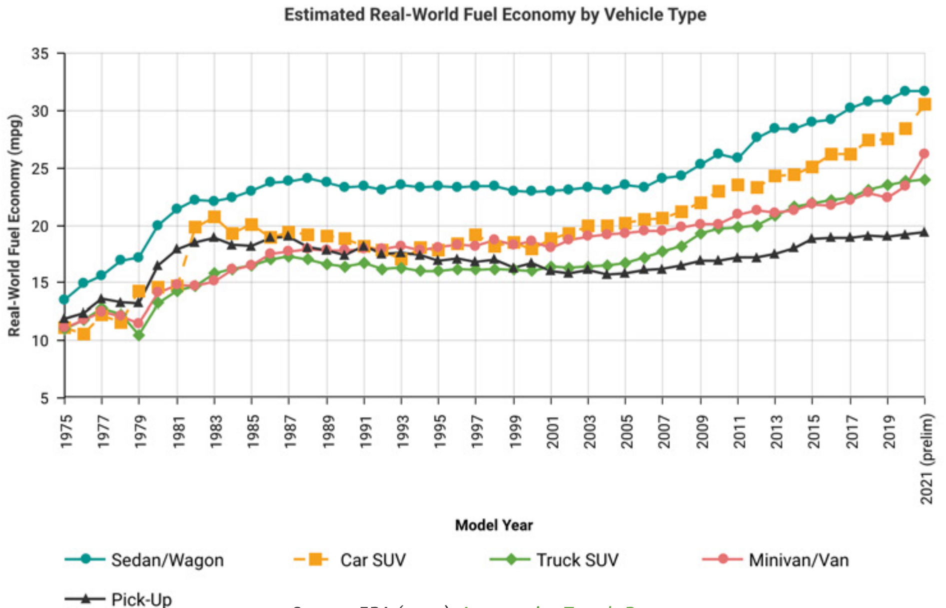
Vehicle Occupancy Also Matters
The efficiency of transportation modes depends on the vehicle's fuel economy, but also on how a specific vehicle is utilized. Vehicles that are efficient and travel full are the best options to reduce strain on infrastructure and traffic congestion while transporting goods and people to their destinations.

46 Light-Duty Fuel Economy Standards

Fuel economy of new light-duty vehicles has improved by more than 90%, but the future trajectory will be determined by policy



Source: EPA (2021), Automotive Trends Report



Source: EPA (2021), Automotive Trends Report

Transportation currently accounts for the largest proportion of U.S. greenhouse gas emissions of any sector (27%) and approximately 67% of U.S. oil use.[1, 2] Corporate Average Fuel Economy (CAFE) standards (and since 2012, the accompanying greenhouse gas emissions standards), have had the largest impact of any U.S. energy efficiency policy. Average fuel economy for light-duty vehicles has improved from approximately 13.1 miles per gallon (mpg) in 1975 to 25.3 mpg in 2021, with dramatic initial gains, a 17-year decline, and since 2005 significant though slowing improvement again. During this period, passenger cars experienced impressive growth in horsepower. The second chart shows the improvement in real-world miles per gallon of several different light-duty vehicle types.

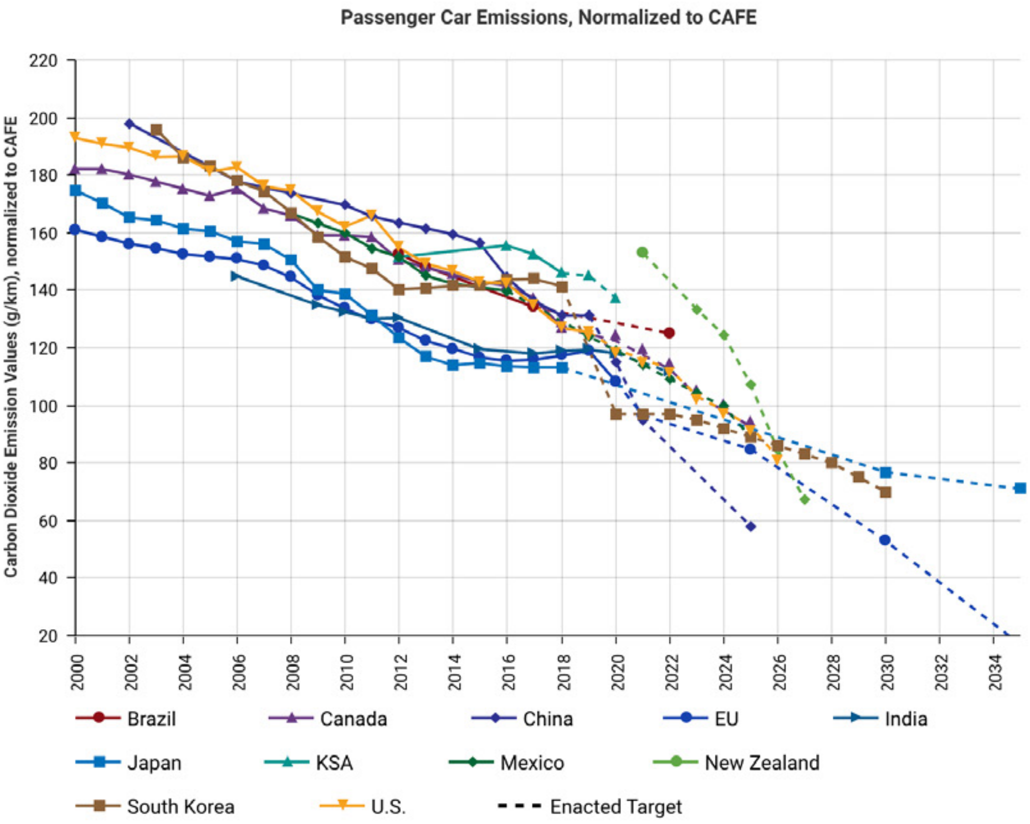
1 EPA (2022) Greenhouse Gas Inventory Data Explorer

2 EIA (2022)

The Biden administration has begun to make up for stalled progress by putting in place new fuel standards that will require carmakers to achieve average fuel efficiencies of 49 miles per gallon. The California Air Resources Board (CARB) has taken an even more aggressive route, requiring all vehicles sold in the state to be zero-emissions vehicles by 2035.

47 International Fuel Economy Standards and Targets

Many countries plan to implement fuel economy standards that would surpass U.S. levels

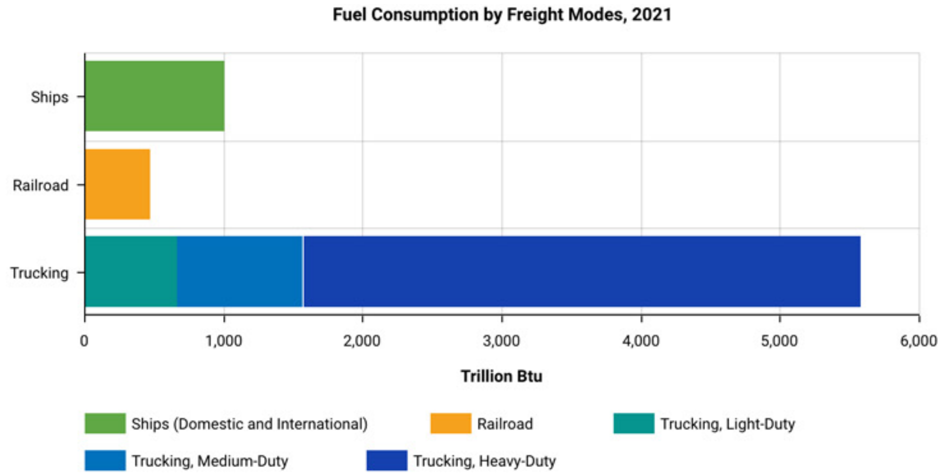


Source: ICCT (2022)

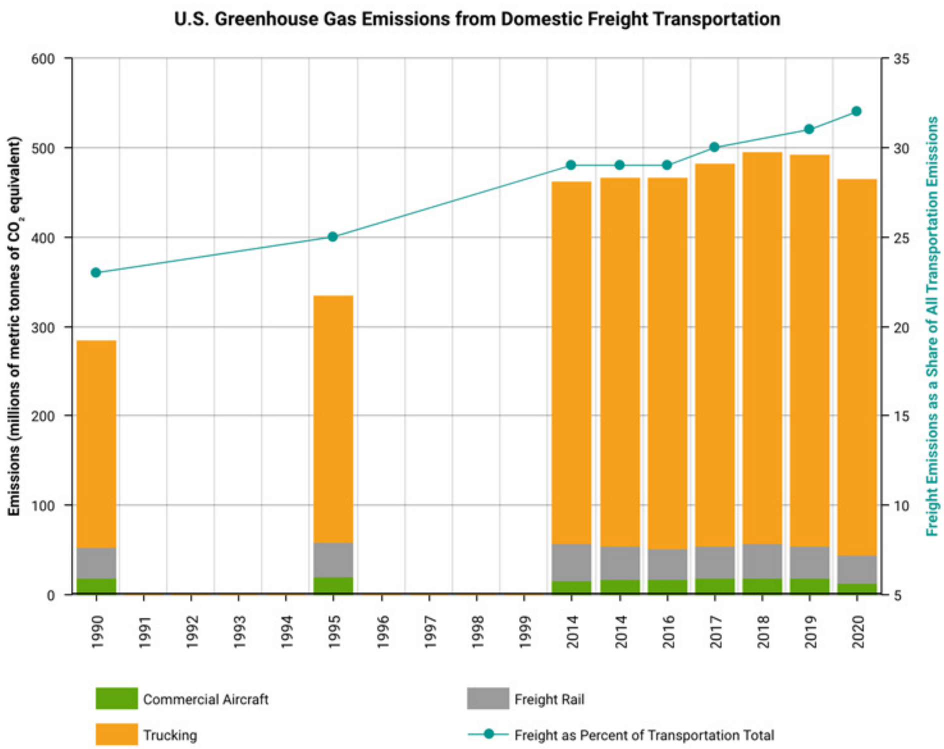
The U.S. has set aggressive new the fuel economy standards. In 2022, it has only the second most stringent standards, after Brazil. Other countries are further along in strengthening fuel economy targets for their own fleets. By 2025, U.S. fuel standards fall behind China and New Zealand. The European Union is considering net-zero fuel standards by 2035, the strongest of any other country. Their regulations will likely have important impacts for U.S. competitiveness in the auto market, as well as for U.S. greenhouse gas emissions and energy use overall.

48 Medium and Heavy-Duty Modes

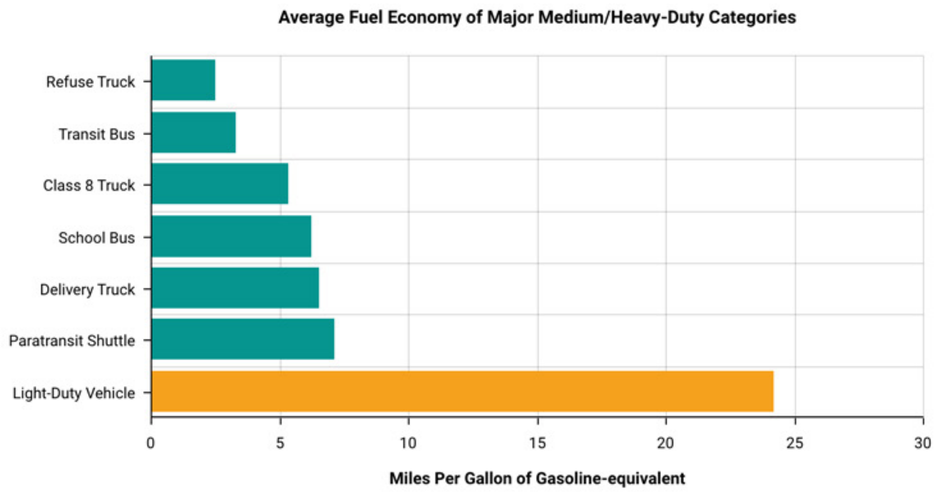
Long-haul freight trucking performs only 9% of vehicle miles traveled, but is responsible for 25% of all highway energy use, and is projected to increase



Source: EIA (2022), Annual Energy Outlook 2022



Source: EPA (2022)



Source: AFDC (2020), Average Fuel Economy by Vehicle

While a small percentage of vehicles, medium and heavy-duty vehicles make up a significant part of pollution impacts relative to other highway transportation modes. In particular, the heavy truck segment was responsible for approximately one-quarter of total energy consumption and the carbon dioxide emissions for all highway transportation in 2021, in spite of the fact that it was only responsible for 9% of the vehicle miles traveled. Additionally, the vehicle miles traveled by this segment are projected to increase by more than 30% by 2050.[3]

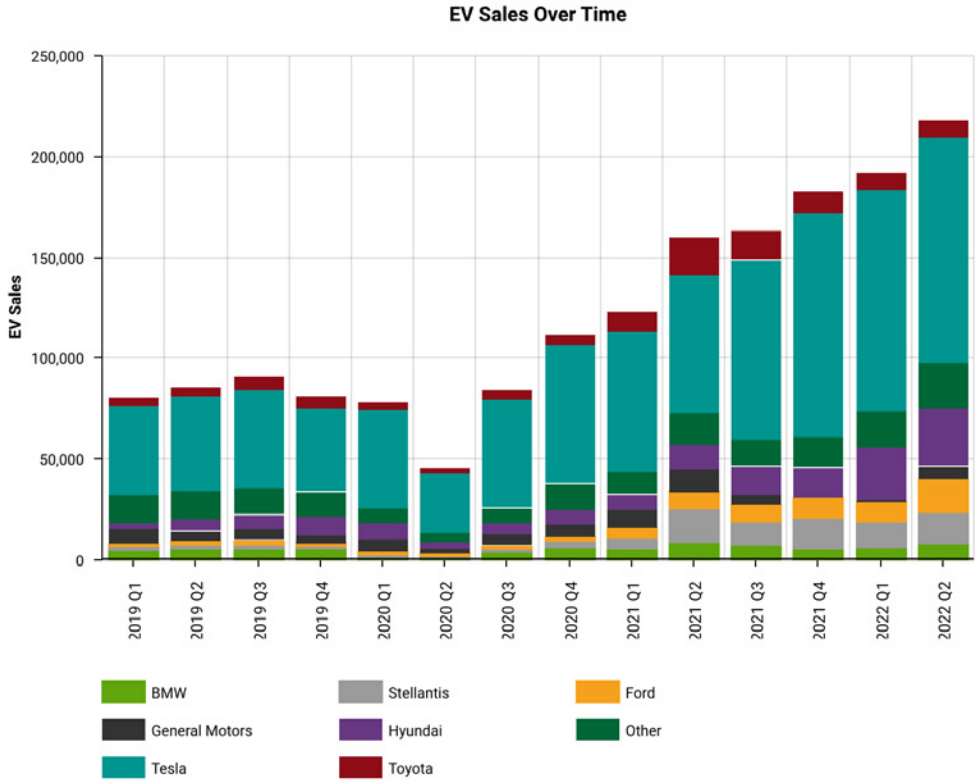
Advances in fuel economy, utilizing alternative freight modes like rail and waterways, alternative fuels in highly efficient engines (such as hydrogen and renewable natural gas – a prime example of redirecting energy waste to productive energy use with a wide variety of applications),[4] and streamlining logistics will likely be important to keep this segment energy-productive, and reduce local particulate, NOx, and carbon emissions.

3 EIA (2022), AEO2022 Reference Case

4 Johnson, K., George, K., Cavan, (2018), Ultra-Low NOx Near-Zero Natural Gas Vehicle Evaluation ISX12N 400. UC Riverside.

49 Light-Duty Electric Vehicles

The size of the light-duty electric vehicle market has tripled from 2015 to 2022



Source: Atlas (2022), EV Hub

Electric vehicles (EVs) in the light-duty segment (which include battery-electric, plug-in hybrid, and fuel-cell electric vehicles) present significant efficiency gains over conventional vehicles, with battery-electric cars estimated to be twice as efficient as a conventional car on a well-to-wheel basis.[5] The U.S. market for these vehicles has grown quickly in the last decade, driven in part by Zero-Emission Vehicle mandates in select states, and federal and state tax credits. In the first two quarters of 2022, the annual U.S. sales of EVs have already exceeded total sales in 2015 by more than a factor of four, to 430,000, primarily due to battery-electric vehicle growth. The U.S. currently has an estimated 1.5 million electric vehicles, and there are 84 different makes and models of plug-in hybrid and battery-electric vehicles on the U.S. market as of September 2022.[6, 7]

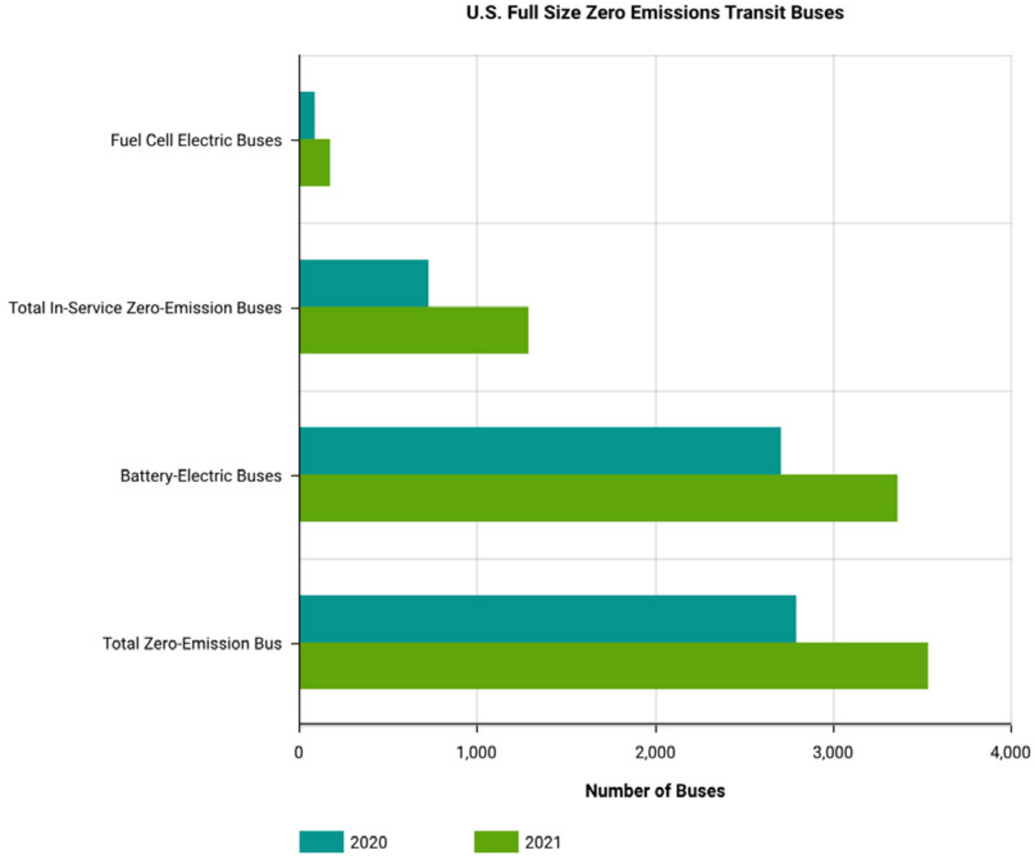
5 Argonne National Laboratory (2018), Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) Model, 2018 WTW Calculator. GREET estimates well-to-wheel efficiency gains (in Btu/mile) for different passenger car types relative to a conventional gasoline vehicle: 40% for hybrid electric vehicles, 223% for battery electric vehicles running on the average U.S. electricity mix, and 50% for fuel cell electric vehicles running on hydrogen produced by centralized natural gas steam methane reforming.

6 DOE (2022), Alternative Fuels Data Center

7 EV Adoption (2022), EV Models Currently Available in the U.S.

50 EV Transit

Electric transit buses can provide clean, efficient, and affordable transportation



Source: Calstart (2021)

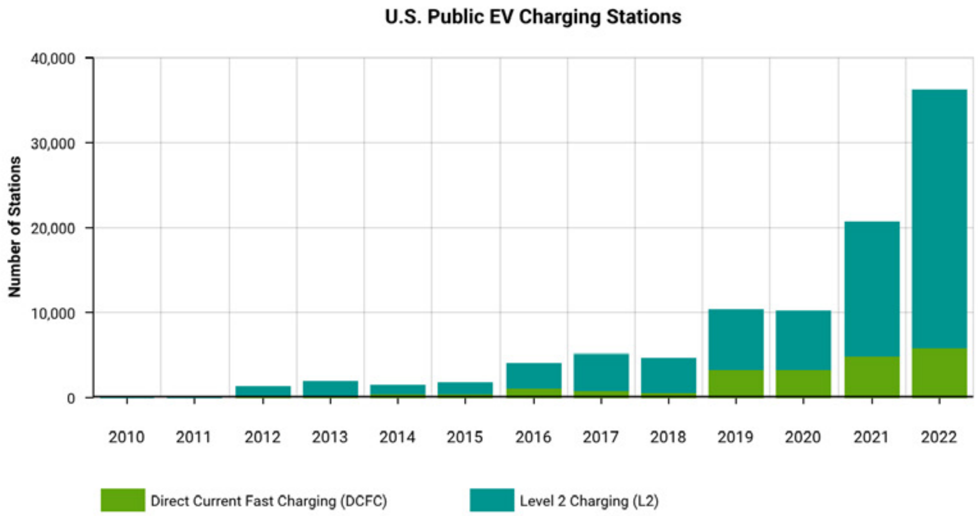
The adoption of full-size, zero-emissions transit buses grew by 27% between 2020 and 2021 in the U.S. California has the largest number of zero-emissions transit buses (1,371) and has passed regulation that transit buses must be zero-emission by 2030. Nationally, the number of zero-energy buses is expected to increase as a result of new funding through the Infrastructure Investment and Jobs Act.

Battery-electric buses make up the large majority of zero-emissions transit buses in the country today, likely due to their cost, charging infrastructure requirements, and other operational considerations. Fuel cell adoption is also expected to increase as these buses perform better on longer routes and transit agencies are increasingly considering these buses for longer routes.[8]

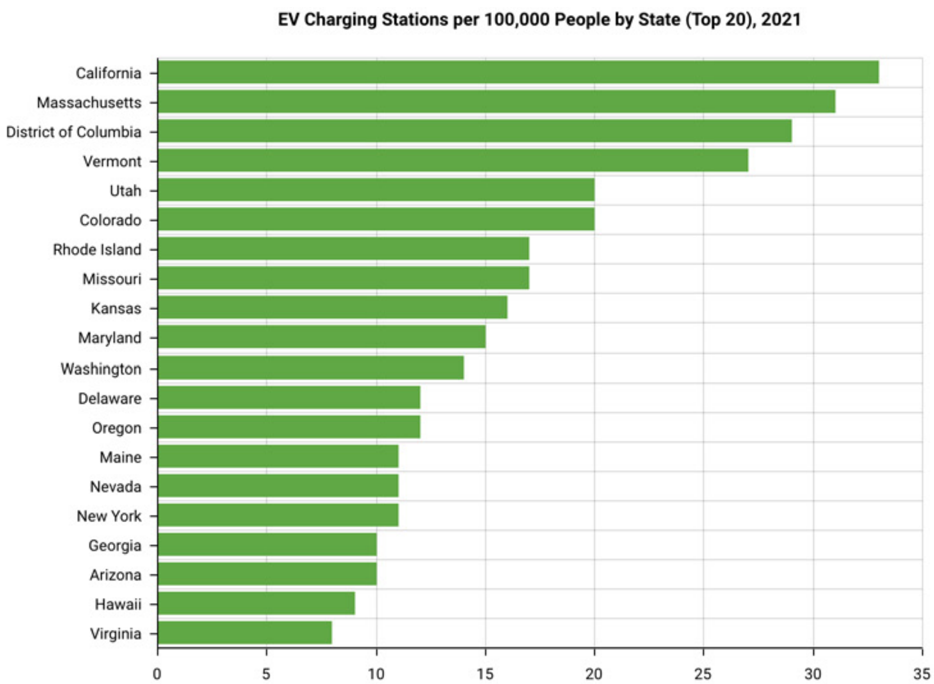
8 Calstart (2021), Zeroing In On Zebs

51 EV Charging Infrastructure

The number of EV charging stations has increased by more than 5-fold since 2009



Source: DOE (2022), Alternative Fuels Data Center



Source: DOE (2022), Alternative Fuels Data Center

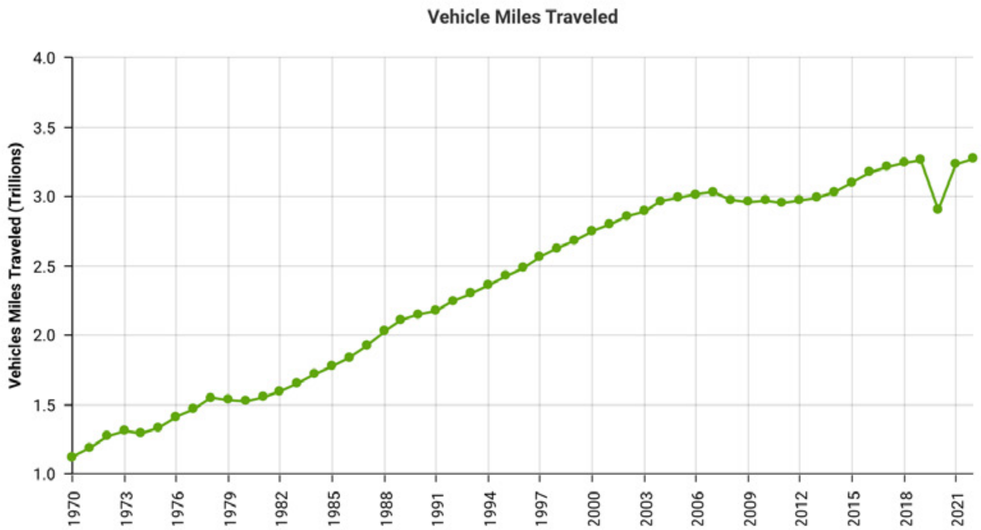
EVs require wide availability of EV-charging infrastructure to mitigate the market barrier caused by range anxiety.[9] The number of charging stations available in the U.S. has grown dramatically in the last 10 years, expanding in number and geographical coverage. As of September 2022, there were 36,213 publicly available charging stations that were Level-2 or Direct Current Fast Charge (DCFC) stations, which are capable of charging most vehicles in 20 to 30 minutes. This is an over 200% increase in chargers relative to 2019, when it was estimated that roughly 10,000 of these charging stations were installed nationwide.[10]

9 Forbes (2021), Range Anxiety Is Very Real, New J.D. Power EVs Survey Finds

10 DOE (2022), Alternative Fuels Center

52 Vehicle Miles Traveled

Vehicle miles traveled have tripled since 1970, increasing traffic congestion and costs

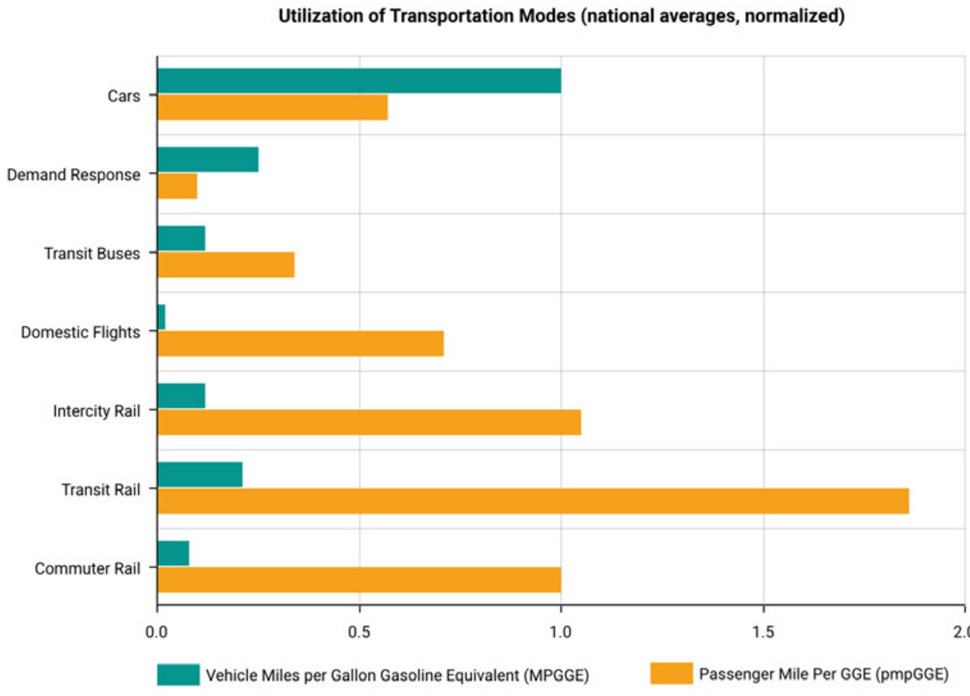


Source: DOT (2019), Travel Monitoring

Since 1970, Americans have nearly tripled the number of vehicle miles traveled by cars and trucks. Though COVID led to a dramatic decrease in vehicle miles traveled in 2020, the U.S. is already on track to exceed its 2019 levels. More driving leads to traffic congestion, resulting in increased energy waste, air pollution, time waste, and costly infrastructure degradation.

53 Utilization Of Transportation Modes

Transportation modes have lower energy intensity when used at higher capacity



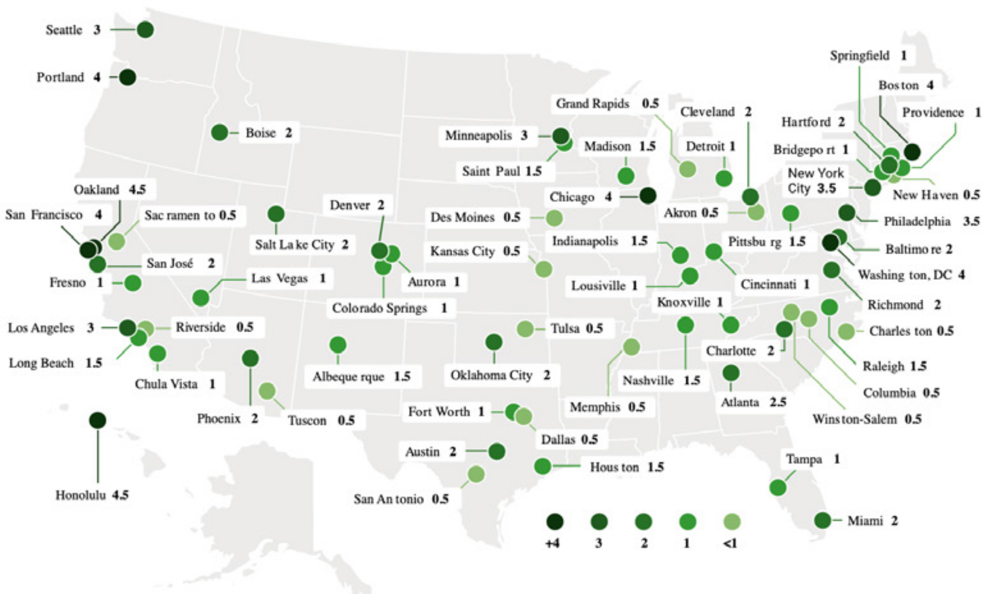
Source: ORNL (2022), Transportation Energy Data Book 40, Table 2.13

Efficiency in the transportation sector is related to the efficiency of the vehicles, but also to the load factor, which reflects vehicle occupancy. These factors can be combined to consider the passenger miles per gallon of gasoline (pmpG), which quantifies the efficiency of moving one person one mile at a given vehicle fuel economy and vehicle occupancy. On a pmpG basis, rail options tend to be the most efficient travel modes (80-140 pmpG), but domestic flights, which exhibit the lowest fuel economy (0.45 pmpgG) appear relatively efficient per passenger due to a high load factor (averaging 120 passengers per flight) — a reflection of airlines' efforts to ensure planes fly full. In contrast, transit buses currently exhibit lower pmpG (26) than cars (43) due to lower average levels of national bus ridership. However, during high ridership periods, transit bus pmpG is estimated to be over four times higher (137).[11] This illustrates the value of increasing not only fuel economy, but the utilization of such modes.

54 Transit Equity Metrics

Access to clean, efficient transit is an essential equity consideration

Clean, Efficient Transportation for Low-Income Communities Scores (out of 6 possible points)



Source: ACEEE (2021) City Scorecard

Creating a broad low-carbon transportation system is an essential part of reducing transportation-related greenhouse gas emissions (GHG), localized pollution, creating livable communities, and ensuring that our transportation system serves everyone.[12]

As cities have sprawled and jobs have moved away from urban cores, many low-income communities have become geographically isolated and inadequately served by affordable, efficient transportation. These communities' transportation options are often limited to automobiles and unreliable public transport services. Expenditures for vehicles, including the cost of fuel, insurance, and maintenance, can be large and unpredictable for these households. Cities can use a number of policy levers to increase access to mobility options other than personal vehicles in low-income communities, such as low-income housing near transit, low-income access to high-quality transit, and subsidized access to efficient transportation options.[13]

11 DOE (2022), Alternative Fuels Data Center – Public Transportation

12 ACEEE Transportation System Efficiency

13 ACEEE (2021), City Scorecard

Energy
Efficiency
Impact Report

States, Cities, and Countries

Highlights

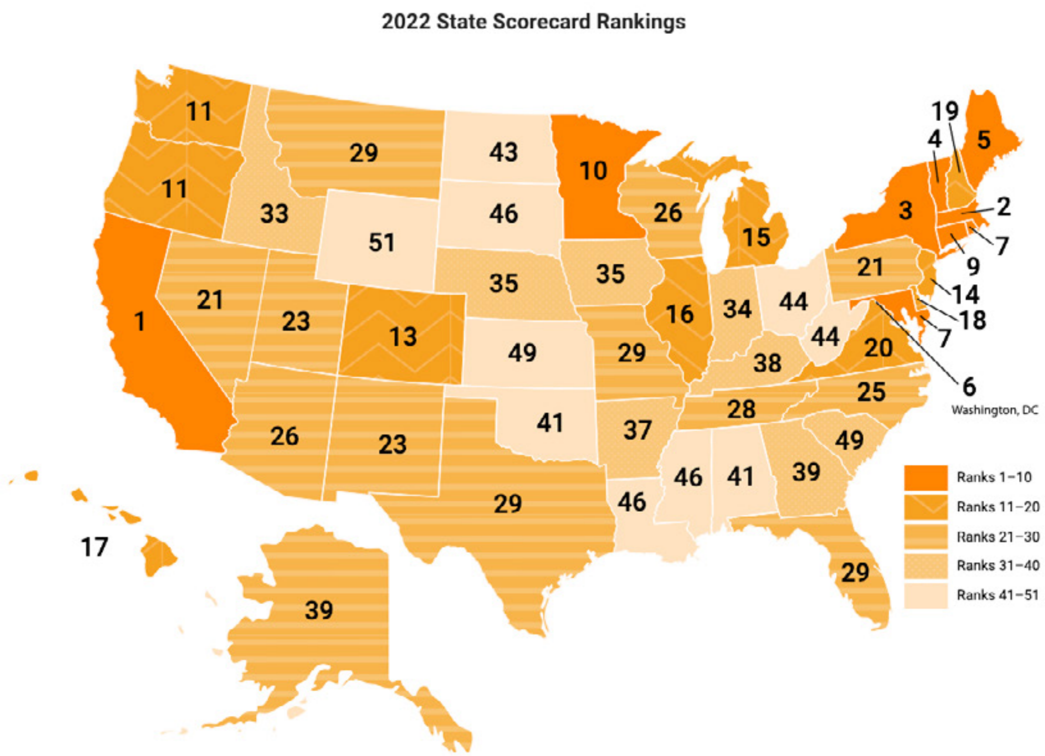
City Rankings
San Francisco, Seattle, and Washington have demonstrated the most leadership for cities in prioritizing energy efficiency.

State Rankings
California, Massachusetts, and New York lead the nation on establishing strong energy efficiency commitments.

Global Rankings
The U.S. ranks 10th for energy efficiency deployments globally.

55 State Scorecard Rankings

U.S. states are accelerating their energy efficiency efforts



Source: ACEEE (2022), The 2022 State Energy Efficiency Scorecard

Efforts to advance clean energy goals continued to lag following the global pandemic. Annual savings from ratepayer-funded electric efficiency programs dipped slightly lower (2.43%) in 2021 compared to 2020. Savings totaled approximately 26 million megawatt-hours, enough to power almost 2.4 million homes for a year.

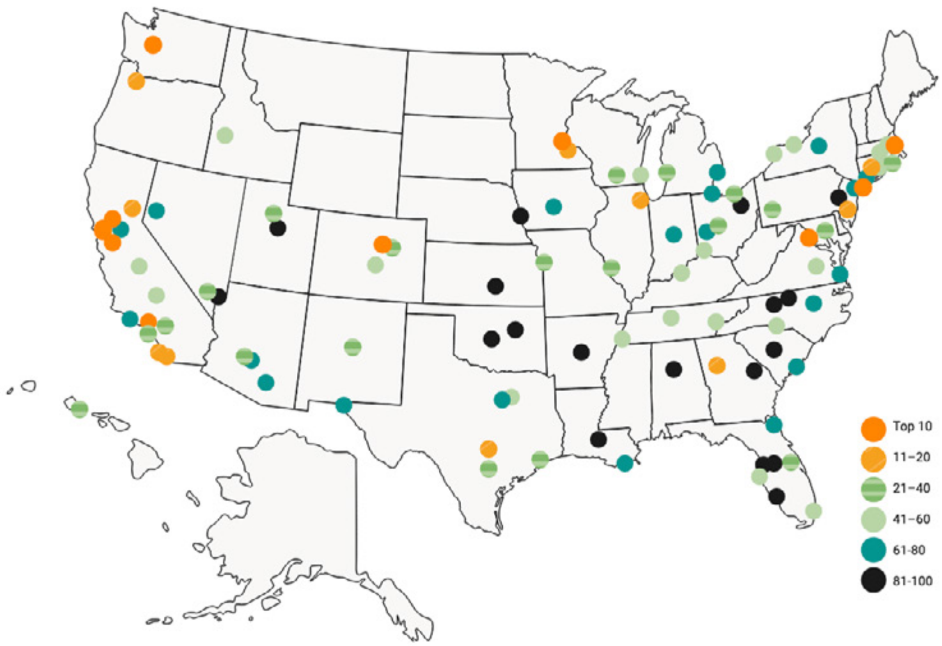
California was an energy efficiency leader thanks to its adoption of advanced clean energy building codes, stringent vehicle emissions standards, and industry-leading appliance standards. Seventeen states and the District of Columbia have adopted California's low-emissions vehicle regulations. The most improved state in 2021 was Maine, which signed laws to promote electrification and decarbonization for affordable housing, adopted energy- and water-saving standards for more than 15 products, and continues to invest in weatherization and heat pump incentive programs. The state has also developed a Clean Transportation Roadmap to equitably advance electric vehicle adoption. State-driven appliance standards also remained extremely important: State standards have been critical to helping consumers save on utility bills and spurring adoption of stronger national standards. Maryland, New Jersey, Oregon, and Washington have passed efficiency standards for up to 17 types of products, and New York is expected to adopt appliance standards through a rulemaking process by the end of 2022.[1]

1 ACEEE (2021), State Scorecard

56 City Scorecard Rankings

U.S. cities are prioritizing energy efficiency

2021 City Clean Energy Scorecard



Source: ACEEE (2021), City Clean Energy Scorecard

Top 10 cities
1. San Francisco
2. Seattle
3. Washington
4. Minneapolis
5. Boston
6. New York
7. Denver
8. Los Angeles
9. San Jose
10. Oakland

Cities 11-20
11. Portland
12. Chicago
13. Philadelphia
14. Austin
15. Atlanta
16. San Diego
17. Chula Vista
18. Hartford
19. Sacramento
20. Saint Paul

Cities 21-40
21. Pittsburgh
22. Orlando
23. Phoenix
24. Honolulu
25. Baltimore
26. Providence
27. Long Beach
28. Columbus
29. St. Louis
30. Aurora
31. Albuquerque
32. Las Vegas
33. Grand Rapids
34. Houston
35. Salt Lake City
36. Kansas City
37. San Antonio
38. Cleveland
39. Madison
40. Riverside

Cities 41-60
41. Boise
42. Charlotte
43. Knoxville
44. Dallas
45. Cincinnati
46. Nashville
47. Fresno
48. Richmond
49. Miami
50. Springfield
51. St. Petersburg
52. Rochester
53. Buffalo
54. Milwaukee
55. Worcester
56. New Haven
57. Bakersfield
58. Colorado Springs
59. Louisville
60. Memphis

Cities 61-80
61. Reno
62. Detroit
63. Oxnard
64. Indianapolis
65. Raleigh
66. Des Moines
67. Stockton
68. New Orleans
69. Mesa
70. Bridgeport
71. Tucson
72. Fort Worth
73. Newark
74. Syracuse
75. Virginia Beach
76. Dayton
77. El Paso
78. Toledo
79. Charleston
80. Jacksonville

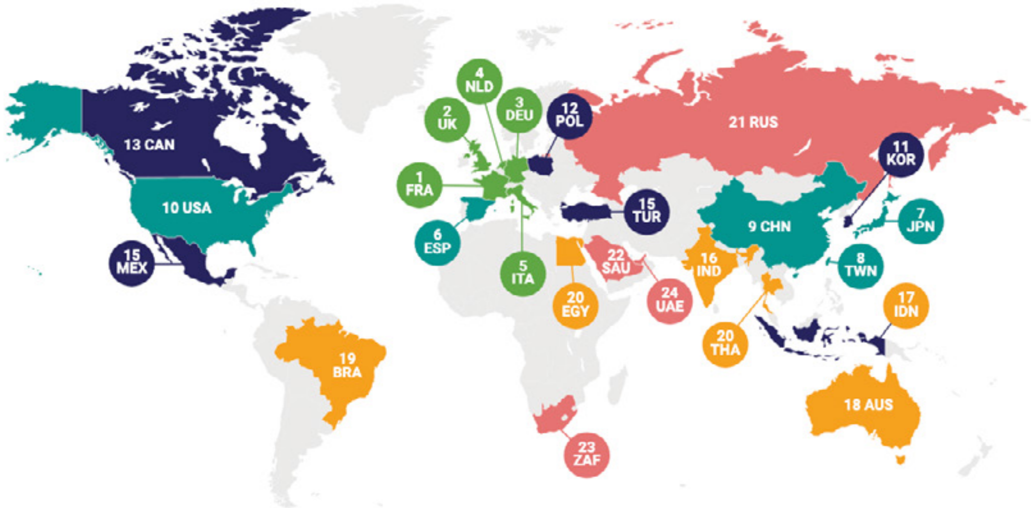
Cities 81-100
81. Tampa
82. Henderson
83. Tulsa
84. Oklahoma City
85. Akron
86. Birmingham
87. Winston-Salem
88. Allentown
89. Omaha
90. Columbia
91. Greensboro
92. Lakeland
93. San Juan
94. Little Rock
95. Augusta
96. Provo
97. McAllen
98. Cape Coral
99. Wichita
100. Baton Rouge

A number of U.S. cities also lead in their commitment to energy efficiency and renewable energy. According to the ACEEE City Clean Energy Scorecard, the top performer in 2021 was San Francisco, followed by Seattle, Washington, Minneapolis, Boston, New York City, Denver, Los Angeles, San Jose, Austin, and Oakland. Between May 2, 2020, and July 1, 2021, the cities took at least 177 new actions to advance clean energy.

While the COVID-19 pandemic led many cities to delay or modify work they had planned for 2020, cities increased their clean energy work in late 2020 and early 2021. Rankings were based on local government operations, community-wide initiatives, buildings policies, commitment to racial and social equity, energy and water utilities programs, and transportation policies.[2]

57 International Scorecard Rankings

Energy efficiency ambitions vary internationally



Source: ACEEE (2022), International Energy Efficiency Scorecard

The ACEEE International Scorecard scores and ranks the energy efficiency deployments of the 25 top energy-consuming countries in the world, which collectively represent 82% of all energy consumption and over 80% of the world's GDP in 2014, on the basis of 36 policy and performance metrics.

France led with an overall score of 74.5 out of 100 possible points, and also earned the top spot in the transportation category. The remaining top five were the United Kingdom, Germany, the Netherlands, and Italy. No country achieved a perfect score, and the average score declined slightly from 2018, indicating that countries have achieved limited progress in the past few years. Energy efficiency is an important tool to address climate change and reduce energy consumption. Countries will need to step up their efforts to make progress on their climate goals.[3]

2 ACEEE (2021), City Scorecard

3 ACEEE (2022), International Scorecard

Looking to the Future

Highlights

Revolutionizing Energy Efficiency

Digitalization, and the evolution of new smart technologies utilizing artificial intelligence, grid edge, cloud, and internet of things technologies are revolutionizing many industries, including energy efficiency.

Control and Connectivity

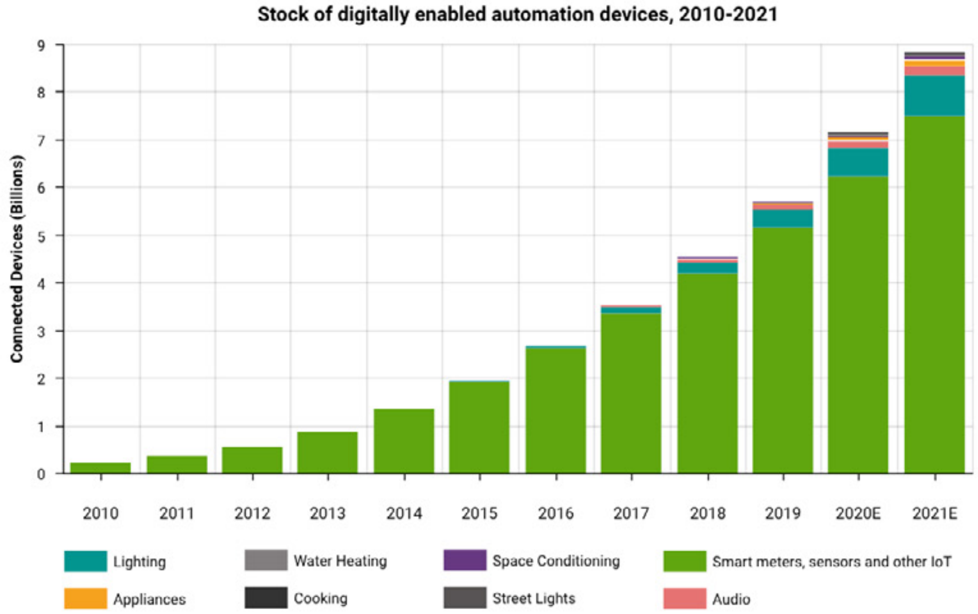
Smart appliances and building automation market penetration are projected to continue to grow. In the residential sector alone, control and connectivity are expected to be included in half of new construction by 2023.

Untapped Potential

As a foundational tool for decarbonization, energy efficiency still has enormous untapped potential, and could reduce U.S. greenhouse gas emissions by 50% by 2050.

58 Digitalization

Over the last five years, the global stock of connected appliances, sensors and devices has grown by roughly 33% annually, reaching around 9 billion in 2021



Source: IEA (2021), Digitally Enabled Automation Devices

Digitalized technologies signal ample opportunities for greater optimization of energy use to time- and location-dependent needs. In fact, in 2021, the stock of connected appliances, sensors and devices overtook the number of people on planet Earth. Over the last five years, the stock of connected appliances, sensors and devices has grown by roughly 33% annually, reaching around 9 billion in 2021. Smart meters, sensors and other IoT (Internet of Things) devices were expected (as of mid-2021) to hit 7.5 billion devices. For connected lighting, the number was 800 million; for audio, 200 million; appliances, 100 million; space conditioning, also 100 million; water heating at 40 million; street lighting at 33 million and cooking at 30 million connected devices.[1]

Grid-interactive efficient buildings (GEBs) are energy efficient buildings with smart technologies characterized by the active use of distributed energy resources (DERs) to optimize energy use for occupant needs, preferences, grid services, and cost reductions in a continuous and integrated way. In doing so, GEBs can play a key role in promoting greater resilience, environmental performance, affordability, and reliability throughout the U.S. electric power system.

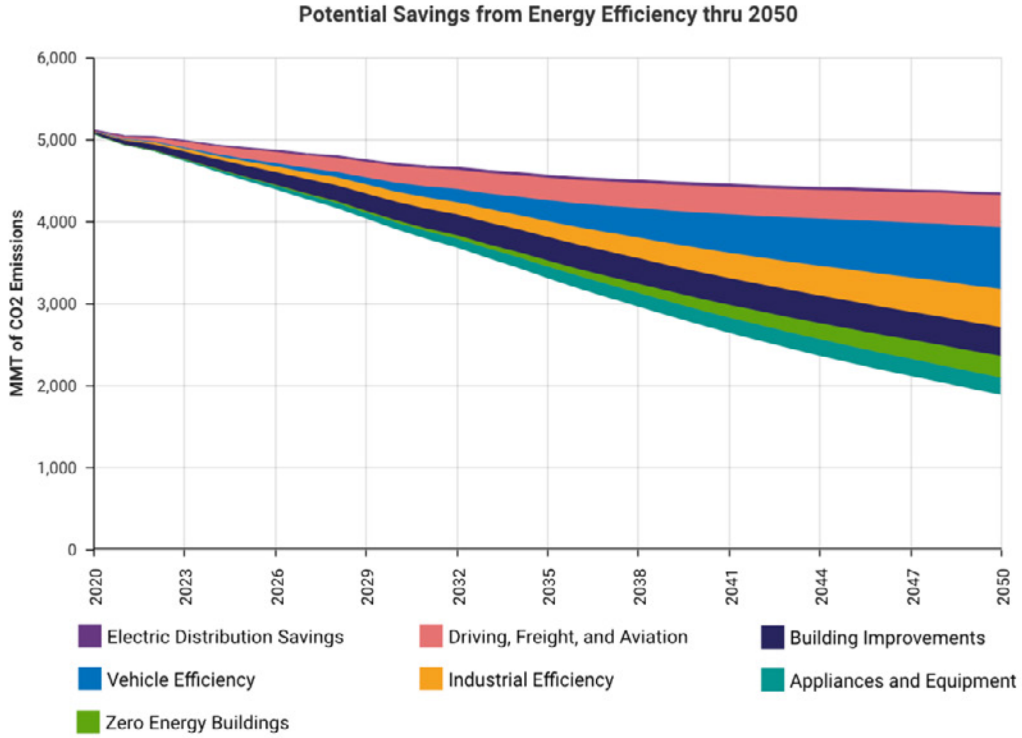
Over the course of the next two decades, national adoption of GEBs could be worth between $100 to $200 billion in U.S. electric power system cost savings. By shifting and reducing the timing of electricity consumption, GEBs could decrease CO_2 emissions by 80 million tons per year by 2030, or 6% of total power sector CO_2 emissions. To put that in perspective, that is more than the annual emissions of 50 medium-sized coal plants, or 17 million cars.[2]

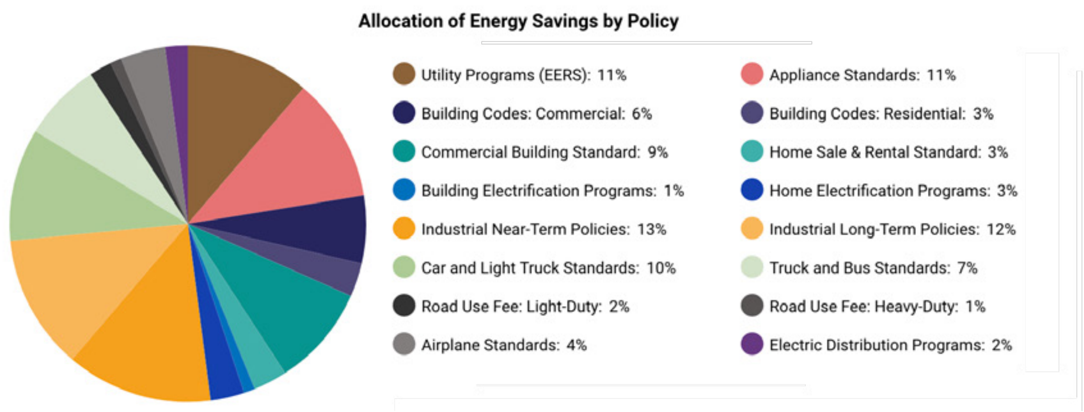
1 IEA (2021), Executive summary – Energy Efficiency 2021 – Analysis

2 LBL (2021), A National Roadmap for Grid-Interactive Efficient Buildings

59 Energy Efficiency Can Cut Energy Use and Greenhouse Gas Emissions in Half

Energy efficiency can reduce greenhouse gas emissions by 50% by 2050





Source: ACEEE (2019), Halfway There: Energy Efficiency Can Cut Energy Use and Greenhouse Gas Emissions in Half by 2050

Through an analysis of the potential of 11 different energy efficiency opportunities, ACEEE estimates that energy efficiency could reduce projected U.S. energy consumption and projected greenhouse gas emissions by about 50% by 2050 (and even greater carbon dioxide reductions, as shown in the line graph). ACEEE also finds that almost all the savings could be achieved through government policies and programs (pie chart). The policies and programs can provide more than $700 billion worth of savings in 2050.[3]

3 ACEEE (2019), Halfway There: Energy Efficiency Can Cut Energy Use and Greenhouse Gas Emissions in Half by 2050

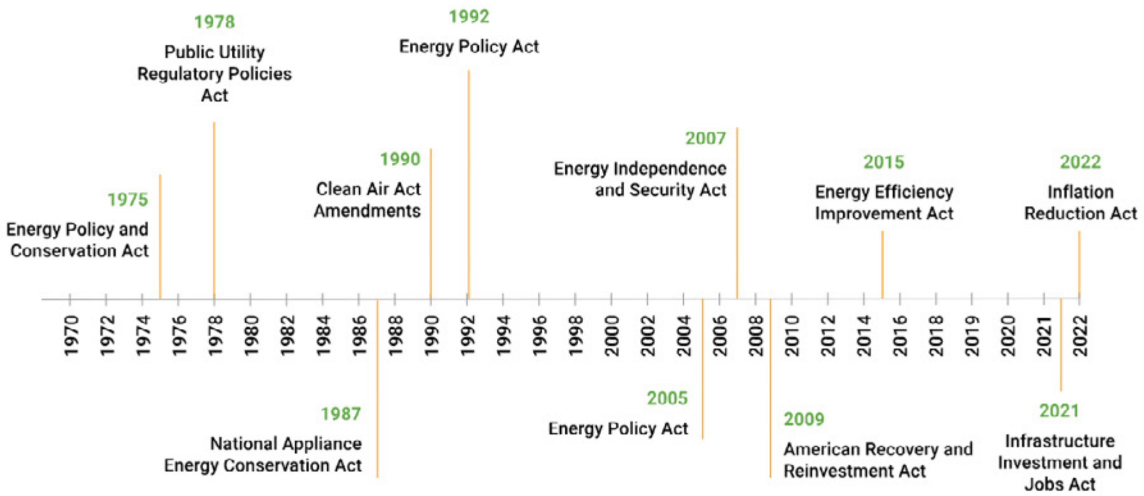
Conclusions

Key Policy Opportunities

Energy efficiency is a diverse, ubiquitous, and versatile tool that often presents a clear and cost-effective investment decision. However, its diversity often leads to challenges in its implementation, and today's energy efficiency investments – while significant – still fall well below their potential.

Consistent, well-designed policies are critical to ensure that markets drive energy efficiency forward across all sectors. Currently, we are reaping the benefits of decades of commitment to energy efficiency; however, accelerating energy efficiency requires a proactive and evolving strategy.

Primary Energy Efficiency Policies, 1970-2022



The U.S. policymaker has an extensive toolkit to promote energy efficiency across national, state, and local levels. Like the distributed nature of energy efficiency, there is also not one "single bullet" policy to incentivize it; instead, the "silver buckshot" method has proven highly effective.

This diverse toolkit includes opportunities such as:

	Options for Action
Market-Based Mechanisms	Consider cost-effectiveness of assets through lifecycle assessments, including operation and maintenance, as well as the non-energy benefits Develop and improve financing tools for energy efficiency, including PACE and ESPCs Strengthen the accountability and market value of energy efficiency by strengthening existing voluntary market certification tools and labeling (e.g., ENERGY STAR®, LEED) and industry-wide energy efficiency voluntary agreements Establish market incentives for energy efficiency (e.g., tax incentives, rebate programs, or broader tools such as carbon pricing)
Set Policy Prioritizing Efficiency	Recognize and consider the benefits of energy efficiency beyond energy savings, including benefits to the broader economy, job growth, U.S. international competitiveness, public health, lower energy burdens, and climate and particulate emissions impacts Establish clear top-line prioritization of energy efficiency through energy efficiency strategies and planning Advance equitable outcomes by targeting energy efficiency to low- and moderate-income households and other underserved communities Support utility energy efficiency programs and concrete targets for energy efficiency, such as EERS
Regulatory Levers	Continually strengthen energy-efficient building codes and appliance/equipment standards (e.g., refrigeration, air conditioning, lighting), one of the most cost-effective ways to ensure cost-effective energy efficiency is built-in from the beginning Continually strengthen transportation fuel economy standards to drive innovation and energy efficiency gains in key sectors (examples: CAFE standards, marine and aviation fuel economy standards) Establish policies to correct market disincentives to energy efficiency, such as decoupling, LRAM
Technology & Data Enablers	Invest in rigorous research, development, and demonstration, to maintain a competitive pipeline of innovation Develop and maintain up-to-date and accurate public data, statistics, and analysis to enable effective tracking of energy efficiency trends and effectiveness Support market development of energy efficiency enablers such as AMI and other grid modernization technologies
Support System Approaches	Explore system-wide and time-dependent opportunities to enhance efficiency, leveraging fast-moving combinations of IoT, connectivity, and IT innovations to identify and pursue new levels of energy savings Explore opportunities to invest in energy efficiency and demand response as utility system resources, supported by decoupling and shareholder incentives Consider options to stimulate behaviors that support greater sector-wide energy-efficiency, such as programs and smart technologies to encourage demand response participation, and by increasing occupancy levels in transportation vehicles

Where We Go From Here

It is clear from the 59 indicators described above that energy efficiency has made its mark on the U.S. energy economy. It has had transformational impact in large part due to its pragmatism, cost-effectiveness, bipartisan support, and the ability to leverage small and beneficial advances over an immense scale.

Energy productivity has more than doubled since 1970, and industrial carbon intensity in particular has declined 70% since 1980. Energy efficiency investments have reduced today's energy expenditures by approximately $800 billion, and federal funding for energy efficiency programs has increased by 61% in the last decade, with North American energy efficiency investments still growing, with a projected 15% increase from 2015 to 2022.

But it has also done much more: created millions of jobs, reduced climate emissions, enhanced public health, improved comfort, and commercial productivity, and it continues to address the inequality in the financial burden of energy costs.

Energy efficiency programs have repeatedly shown to be highly cost-effective, marking energy efficiency as one of the most affordable resources for utilities. The policy environment is critical; from EERS and decoupling to federal, state, and local standards, each of these tools has been a critical enabler of energy efficiency deployment.

These investments are paying off, though there is still tremendous room to grow. The numbers of new residential and commercial zero-energy buildings are still a small fraction of the building stock in the United States. Only three states have adopted IECC's most recent residential energy code, with 10 states using the 2018 codes, and eight states having no state-wide energy codes at all. Meanwhile, we continue to see inequitable outcomes for low- and moderate- income, Black, and Indigenous households. In the U.S., roughly 34 million households had difficulty meeting their energy needs, and just over 30 million households had high energy burdens. Energy burdens for Black and Native American households are nearly double, and Hispanic households about 20% higher than White, non-Hispanic households. Internationally, the United States ranks 10th on ACEEE's international energy efficiency scorecard.

However, to move forward as a nation, strong and consistent support for the continued growth of energy efficiency is critical. We must raise our ambitions to support energy efficiency – advancing on tried-and-true policies that unlock private capital, drive innovation, and ensure energy efficiency is accessible for all.

But it also requires that we prepare for energy efficiency's future.
With the deployment and development of connected devices that allow for greater integration and automation of energy efficiency, new efficiency gains at higher levels of complexity are becoming increasingly possible, perhaps inevitable. But to take advantage of these evolving opportunities and align them to provide the U.S. with maximum benefit, we must consider energy efficiency as the foundation of our path forward and leverage its massive scale and versatility to prepare for tomorrow's challenges. But it also requires that we prepare for energy efficiency's future.