U.S. Energy Efficiency Potential

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ABSTRACT

About every five years, EPRI estimates the potential U.S. energy savings available in Energy Efficiency (EE) programs promoting adoption of cost-effective efficient technologies. The study aims to provide a technically sound estimate of the potential for electricity savings, taking into account technical, economic, and market constraints, to inform electric utilities, policymakers, regulators, and other stakeholders in their decision-making. This paper presents the results from EPRI's most recent study, which shows that EE has the potential to reduce growth in electricity use by 31% through 2045, incorporating the latest available data on end-use equipment performance, costs, and grid costs. This paper summarizes the EPRI approach used in the study, including the latest updates to account for federal policy changes and to consider the emissions avoided through energy efficiency. A scenario is included that illustrates the potential impact of federal incentives for efficiency. Although not enacted, the scenario uses the U.S. Inflation Reduction Act (IRA) of 2022 as an example of potential policy impacts on the market to inform program goals and design.

Introduction

The latest U.S. Energy Efficiency Potential Through 2045 study (EPRI 2025) summarized in this paper updates EPRI's modeling and study (EPRI 2019) to account for new government regulations, avoided costs, and technology options. To illustrate the impact that federal incentives targeting the adoption energy efficient equipment, a scenario analysis was included incorporating the U.S. Inflation Reduction Act (IRA) of 2022 (White House 2022) into the economic screening. While incentives were sunset beginning in 2025, the analysis includes a scenario using the IRA incentives to illustrate additional potential savings when the upfront cost of investment in efficiency is reduced. Avoided emissions are estimated based on the modeled cost-effective efficiency measures, using emissions data from the National Renewable Energy Lab's (NREL) Cambium datasets (NREL 2024). This paper summarizes the high-level estimates of potential U.S. electricity savings available between 2022 and 2045 through programs that encourage the adoption of energy-efficient technologies.

Modeling Energy Efficiency

The study followed the analysis approach outlined in EPRI's Energy Efficiency Planning Guidebook (EPRI 2008), consistent with the National Action Plan for Energy Efficiency (NAPEE) Guide for conducting Energy Efficiency Potential Studies (Loiter and Mosenthal 2007). EPRI's approach estimates three levels of efficiency potential across 14 U.S. regions and multiple end-uses in the residential, commercial, and industrial sectors. Achievable potential is derived by applying adoption factors to economic potential to reflect market, customer, and programmatic constraints. A stock turnover model is used in the residential and commercial sectors to estimate equipment replacement over time, assuming that new equipment replaces existing stock at the end of its useful life rather than prematurely. In the industrial sector, where detailed stock data is limited, energy savings are applied at the process level within each manufacturing segment to estimate the economic potential. In all cases, new equipment is modeled as a like-for-like replacement with no fuel switching from gas to electric. Avoided emissions associated with cost-effective efficiency measures are estimated separately and are not monetized or included in economic screening. The three levels of potential estimated are described as follows.

Technical potential represents achievable savings if all end uses adopted the most efficient available technologies as equipment turns over, without regard to cost or market barriers.

Economic potential represents the subset of technical potential that passes the Total Resource Cost (TRC) test, based on incremental measure costs and avoided system costs, without consideration of market barriers. TRC calculations follow standard practice as defined in the California Standard Practice Manual (CPUC 2001).

Achievable potential represents the portion of economic potential expected to be realized given customer adoption behavior and market barriers, with adoption rates informed primarily by customer cost-effectiveness.

Key Assumptions

The study incorporated current codes and standards, updated costs and impacts of technology options included in each of the measure categories, and an update to use the U.S. DOE Energy Information Administration's (EIA) Annual Energy Outlook 2023 (AEO2023) baseline. In addition to the latest utility cost and equipment data, two major enhancements were included. The incentives offered in the Inflation Reduction Act (IRA) are included in the economics in the AEO2023 Reference Case modeling, and the impacts are reflected in the Reference Case energy use forecast. A subset of IRA incentives is considered in a scenario to illustrate the impacts of federal incentives on potential cost-effective energy savings. The AEO 2023 is the primary data source for baseline data (EIA 2023a), a 30-year projection of U.S. energy consumption across sectors, end-uses/processes, and fuel types. EPRI uses AEO's Reference Case as representing a "best guess under nominal conditions, which presumes no new policy or laws over the modeled time horizon," meaning only considering current laws and regulations and does not attempt to project future policy changes. The AEO2023 Reference Case includes the impacts of several IRA tax credits: home EE improvements (major end-use equipment), residential clean energy investments, and new energy-efficient homes (EIA 2023b). AEO2023 equipment efficiency, costs, and usage data (EIA 2023c) was used to augment measure data derived from EPRI's subject matter expertise. EIA's 2020 Residential Energy Consumption Survey (EIA 2023d) and the 2018 Commercial Building Energy Consumption Survey (EIA 2022) also inform end-use level stock turnover models, e.g., equipment age, unit energy consumption. AEO2023 industrial energy use is broken out by industry and process at the 3-digit NAICS code for each Census region using 2018 Manufacturing Energy Consumption Survey (EIA 2021) data.

It is worth noting that the AEO2023 has limited representation of certain types of business and end uses like data centers, which are included in the "other" buildings category. Notably, AEO2023 does not reflect the rapid growth in energy use from large data centers since 2024. Due to the rapidly changing data center landscape, this study lacks sufficient detail to thoroughly treat data center energy efficiency, which remains an opportunity for follow-up efforts.

Energy Efficiency Measures

Commercial and residential end use categories and equipment options considered in the study are summarized in Table 1. The technology choices available in the model include high-efficiency appliances and equipment for each end use, many of which have numerous efficiency levels, devices, controls, maintenance actions, and enabling technologies. Commercial and residential analyses include *secondary* measures in a few end-use categories, for instance the addition of an attic fan, that saves space conditioning energy separately from a high-efficiency system. Secondary measure options are included for residential water heating (e.g., faucet aerators, pipe insulation) and both commercial and residential space heating and cooling (e.g., system maintenance, duct repair, insulation, fans, ceiling fans, windows). The model does not consider behavioral EE measures such as enhanced usage reporting or gamification.

Table 1. Categories of residential and commercial efficiency measures considered

Space heating and cooling equipment	Commercial and residential air-source heat pumps; Commercial building chillers; Room air conditioners in homes
Water heating	Heat pump water heaters and electric resistance water heaters
Appliances	Refrigeration, freezers, dishwashers, clothes washers, dryers, ranges, ovens
Interior lighting	General-service LED and linear fluorescent; High-output LED, linear fluorescent, and HID lighting in commercial spaces
Consumer and office electronics	Televisions and personal computers (PCs) in residential homes; PCs, monitors, servers, and copiers / printers in commercial spaces

U.S. Geographic Divisions

The study disaggregates energy consumption and savings for 14 U.S. divisions, the 10 Census divisions with the four largest states broken out (California, Texas, Florida, New York), noting that that Mountain division is broken into North and South due to climate differences.

Baseline Forecast

The AEO2023 Reference forecast is used as a base, with total 2022 U.S. electricity use of 3,886 TWh, equivalent to 11.7 MWh per capita and 197 Wh per dollar of 2022 gross domestic product (GDP) (EIA 2023a). To estimate potential efficiency program savings, the study begins by estimating an adjusted baseline that excludes the impacts of current efficiency programs reflected in AEO. To construct an "adjusted baseline," commercial and residential program impacts in the AEO2023 were "added back" to the Reference Case. EPRI's models then calculates savings relative to that adjusted baseline to avoid double-counting efficiency built into AEO forecasts. The industrial baseline is not adjusted due to the limited end-use detail.
The adjustment assumes that states continue to increase programmatic energy savings as the average 2012 to 2022 annual savings growth based on American Council on Energy Efficiency Economy (ACEEE) state scorecard data provided to EPRI.[1] EPRI's achievable potential estimate is used as an upper bound on programmatic energy savings over the study period. Savings estimates are applied to the Adjusted Baseline instead of the AEO2023 Reference to avoid

[1] Average of 2012 through 2022 from 2022 State Energy Efficiency Scorecard data, representing the customer-funded incremental electric savings as a percent of state retail sales. Data provided by ACEEE, 2022.

double counting programmatic savings. The energy savings that may be attributed to existing programs in the shaded area between the AEO Reference and EPRI's Adjusted Baseline, shown in Figure 1.

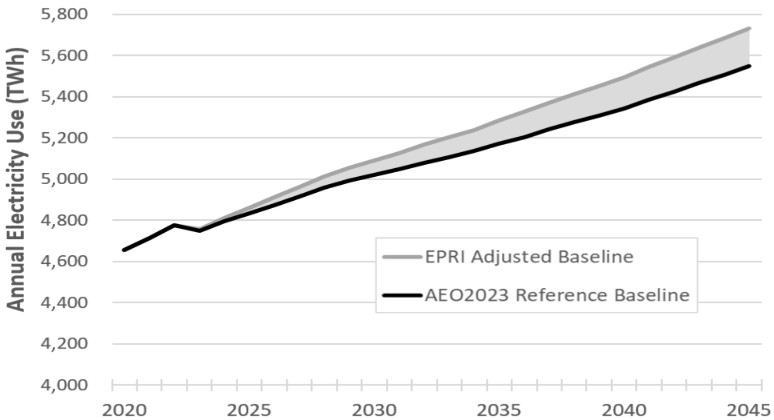

Figure 1. Estimated impact of efficiency embedded in the AEO2023 Reference Case

U.S. electricity consumption is distributed fairly evenly across the residential, commercial, and industrial sectors, which make up 39%, 35%, and 26% of total electricity respectively, with little growth from 2007 to 2022 at a compound annual growth rate (CAGR) of 0.2%, due to shifts in the economy, energy prices, technology innovation. The Reference Case forecasts steady growth in electricity use from 2022 to 2045, growing 0.74% annually over this period. Average growth in GDP between 2022 and 2050 is forecast to be 1.9%, more than three times the rate of projected electricity growth, which implies a decline in the electricity intensity of the U.S. economy per GDP. By 2050 electricity use in the AEO2023 Reference Case is projected to increase to 5,549 TWh annually, 16% higher than in 2022.

Avoided Energy and Capacity Costs

Avoided costs represent the value of electric system resources that are no longer needed when energy efficiency reduces demand. These avoided costs fall into two categories: 1) avoided energy costs, the reduction in fuel and operating costs from generating less electricity (measured in $/kWh); 2) avoided capacity costs, the reduction in investment needed to meet peak demand for generation, transmission, and distribution infrastructure (measured in $/kW-yr). Efficiency measures provide value by reducing both the amount of electricity consumed over the year (energy savings) and, in some cases, the highest levels of demand placed on the system (capacity savings). Avoided energy and capacity cost forecasts are used to calculate the overall benefits of commercial and residential efficiency measures compared to a baseline option. All costs are in real dollars, with avoided costs initially estimated at the point of generation ("source"). These values are then adjusted to reflect costs at the customer meter by applying line loss factors and reserve margins. This accounts for the fact that reducing 1 kWh of customer consumption avoids more than 1 kWh of generation due to transmission and distribution losses, and may also reduce the need for additional reserve capacity. Capacity costs differ by season (summer and winter), due to differences in customer outage costs, while avoided energy costs are calculated as load shape-weighted annual averages. The avoided capacity costs are applied to system coincident demand savings and avoided energy costs are applied to annual energy savings. All costs are in real dollars and are assumed to grow at an annual escalation of 1.2% accounting for escalation outside of inflation, and these escalated costs are used to find the total avoided costs over the life of a measure. The marginal cost of generation capacity used in this study is $72.94/kW-yr at the source (2016 dollars), split 50% summer and 50% winter (i.e., 50% attributed to summer and 50% to winter demand)[2] The avoided transmission capacity cost used in this study is $30/kW-yr at the source (2010 dollars), split 50/50 summer and winter to estimate avoided summer and winter coincident demand cost reductions separately, equivalent to $34.32 in 2016 dollars[3]. Finally, the avoided cost of distribution capacity is $125/kW-yr for California (SCE 2017) and $65/kW-yr elsewhere (2016 dollars) (Brattle 2018), split 50/50 between summer and winter. Resulting hourly marginal generation costs (dollars per kilowatt-hour) are applied to end-use level load shapes, and the total end-use energy is used to calculate the end-use-specific average avoided cost for energy savings in each year. These trends result in declining average avoided energy costs in many regions over time, primarily due to increasing penetration of low-marginal-cost renewable generation. As avoided energy costs decrease, fewer efficiency measures pass economic screening under the TRC test, since the monetary value of energy savings is reduced.

U.S. Energy Efficiency Potential

Resulting energy savings are shown in Table 2. The Adjusted Baseline represents an adjustment to the Reference Case without inclusion of new program impacts. The economic potential assumes equipment is replaced with the most efficient option passing the TRC test at the end of existing stock's useful life. The achievable case reduces the economic potential to represent adoption barriers, primarily customer cost-effectiveness. The results suggest that efficiency programs could realistically reduce the 0.65% CAGR of U.S. electricity consumption between 2022 to 2045 to 0.45% CAGR, a 31% growth reduction. Compared to the AEO2023 Reference Case, up to 11.0% of U.S. electricity consumption in 2045 could be mitigated through deployment of cost-effective technologies. Table 3 shows estimated annual 2035 and 2045 savings relative to the two baselines and forecasts of annual U.S. consumption through 2040 are illustrated in Figure 3.

Table 2. Forecast of annual U.S. electricity consumption for key years

	AEO2023 Reference Case	Adjusted Baseline	w/ Achievable Potential	w/ Economic Potential	w/ Technical Potential
2025	4,833 TWh	4,860 TWh	4,773 TWh	4,715 TWh	4,676 TWh
2035	5,171 TWh	5,284 TWh	4,964 TWh	4,704 TWh	4,566 TWh
2045	5,549 TWh	5,733 TWh	5,294 TWh	4,940 TWh	4,733 TWh
CAGR 2022–2045	0.65%	0.80%	0.45%	0.15%	-0.04%

Table 3. Potential annual U.S. terawatt-hour (TWh) savings, with percent savings in parentheses

Savings Relative to AEO2023 Reference Case			
2025	60 TWh (1.2%)	118 TWh (2.4%)	157 TWh (3.3%)
2035	207 TWh (4.0%)	467 TWh (9.0%)	605 TWh (11.7%)
2045	256 TWh (4.6%)	609 TWh (11.0%)	817 TWh (14.7%)

[2] Avoided generation capacity cost of 72.94 $/kW-yr for 2016 based on independent power producer (IPP) cost to install an LM100PA Simple Cycle Combustion turbine.
[3] Conversion factor of 1.144 to convert 2010 dollars to 2016 dollars, https://data.bls.gov/cgi-bin/cpicalc.pl?cost1=30&year1=201001&year2=201801

Savings Relative to Adjusted Baseline Forecast			
2025	87 TWh (1.8%)	145 TWh (3.0%)	184 TWh (3.8%)
2035	320 TWh (6.1%)	580 TWh (11.0%)	718 TWh (13.6%)
2045	439 TWh (7.7%)	793 TWh (13.8%)	1,000 TWh (17.4%)

Compared to EIA's AEO2023 Reference Case, up to 11.0% of the annual electricity consumption in the U.S. in 2045 could be reduced by deployment of cost-effective technologies. Figure 2 shows the four forecasts of annual electricity consumption through 2045. Figure 3 shows the 10 measures with the highest achievable potential in 2045 across all three sectors.

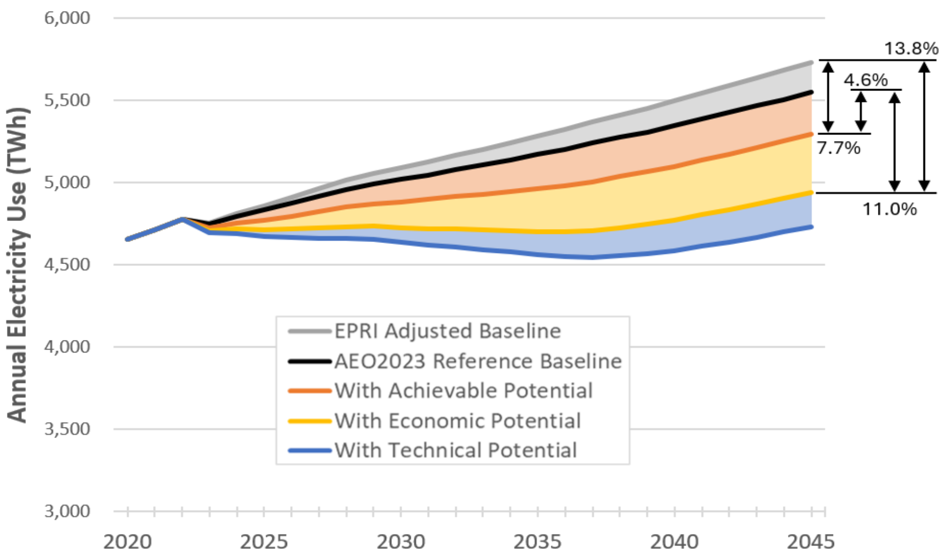

Figure 2. Forecast of U.S. energy efficiency potential

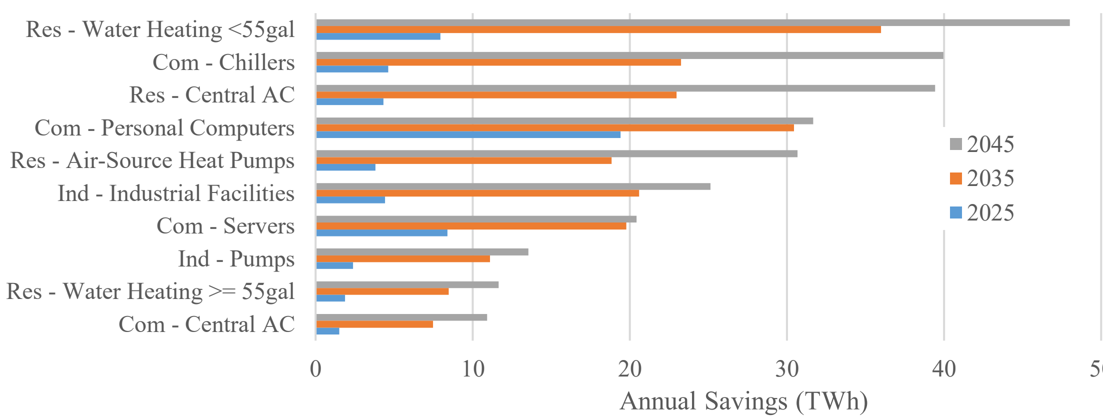

Figure 3. Top 10 Measures with highest achievable potential in 2045

Regional Results

Table 4 compares the Baseline energy consumption in 2022 and 2045, with compound annual growth, compared to the 2045 Achievable Potential for each of the four census regions (Northeast, Midwest, South, and West).

Table 4. Baseline energy use and 2045 achievable potential by U.S. Census region

U.S. Region	2022 Baseline	2045 Baseline	CAGR	2045 Achievable Savings
Northeast	610 TWh	718 TWh	0.71%	55.7 TWh
Midwest	1,075 TWh	1,260 TWh	0.70%	80.2 TWh
South	2,209 TWh	2,654 TWh	0.80%	220 TWh
West	883 TWh	1,100 TWh	0.96%	82.5 TWh

Electricity consumption is highest in the South region, which has the highest potential savings of the four regions, in terms of total savings and as a percentage of baseline. Electricity consumption is lowest in the Northeast region, which is projected to grow at a rate of 0.7% on average per year. The achievable potential of the Northeast is also the lowest of the four regions. The West is the second smallest in terms of energy consumption but is second largest in terms of Achievable Potential and has the highest annual growth rate (0.96%). The Midwest is the second largest region in terms of baseline energy use but has the lowest growth rate (0.70%). Figure 4 illustrates how the savings in each sector compares to the division's baseline consumption. Although absolute savings vary among divisions, savings as a percentage of the division's baseline range from 6% (in the West North Central division) to 11% (Florida).

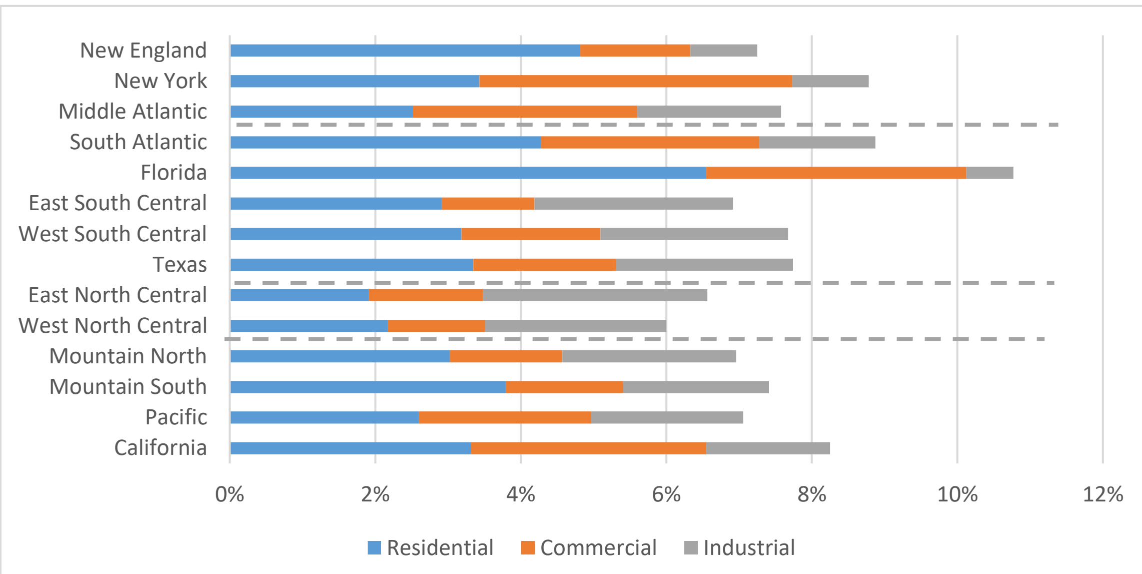

Figure 4. 2045 achievable potential by sector for each division

Sensitivity analysis: Federal Energy Efficiency Incentives under the IRA. Utility and state energy efficiency incentives are not included directly in the TRC for economic screening, as such incentives are both a cost to the program administrator and a benefit to the participant, netting to zero from a total resource perspective. In contrast, federal tax incentives enacted under the IRA were treated as exogenous to utility programs and are included in the TRC screening, since they reduce customer upfront costs without imposing costs to the program administrator.

The IRA, enacted in August 2022 (White House 2022), established a suite of residential energy efficiency and electrification tax credits (shown in Table 5) including credits for high-efficiency heat pumps, heat pump water heaters, central air conditioners, building envelope improvements, and home energy audits. These incentives were structured primarily as personal income tax credits, reducing effective installed costs only for households with sufficient tax liability.

Subsequent legislation—the One Big Beautiful Bill Act (OBBB) of 2025, enacted in July 2025—eliminated or accelerated the sunset of most residential energy efficiency tax credits originally established under the IRA, with the majority of incentives terminating for equipment placed in service after December 31, 2025. As a result, the incentives considered here represent a time-limited policy environment rather than an ongoing market condition.

To illustrate the potential impact of federal incentives on cost-effective energy efficiency, this study includes a policy sensitivity scenario in which applicable residential IRA incentives are incorporated into the economic screening of eligible measures. Commercial-sector incentives were not included due to the greater complexity of commercial tax provisions and building characteristics. The IRA scenario is evaluated relative to the primary modeling case, which excludes federal incentives.

Table 5. IRA incentives offered for residential measures

Measure	IRA Incentive
Windows	$600
Doors	$500
Insulation & air sealing	$1,200
Home energy audit	$150
Air conditioner	$600
Heat pump	$2,000
Heat pump water heater (HPWH)	$2,000

Note that this model considers air conditioners, heat pumps, and water heaters as primary measures, i.e. their installation directly reduces energy consumption. All the other measures incentivized by IRA are considered as secondary measures, impacting the energy use of home heating and cooling equipment.
Table 6 shows the impact of IRA incentives on potential savings in the residential sector, comparing the Economic Potential (EP) and Achievable Potential (AP) under the IRA scenario to the primary modeling scenario (without IRA), including AP, EP, and Technical Potential (TP).

Table 6. Additional potential savings with IRA incentives, percentage savings in parentheses

	2025	2035	2045
Added Achievable Potential	2.9 TWh (11.0%)	11.2 TWh (9.2%)	7.9 TWh (4.2%)
Added Economic Potential	4.4 TWh (10.4%)	15.9 TWh (8.0%)	7.2 TWh (2.3%)

Figure 5 illustrates the impact of federal incentives over time on the primary measures that are incentivized.

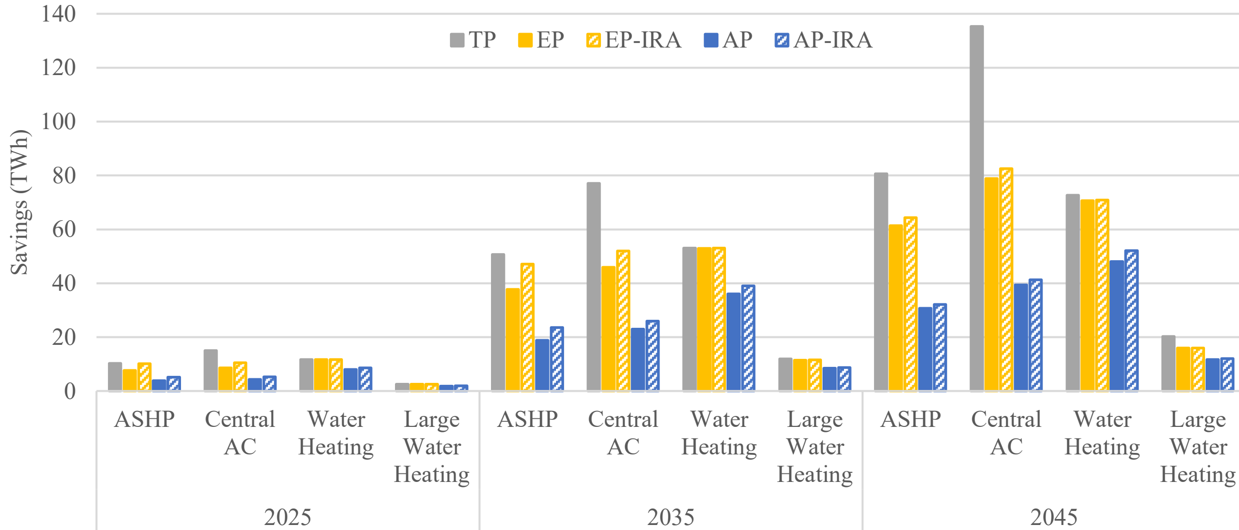

Figure 5. Impact of IRA on residential end-use potential savings

Results indicate that federal incentives modestly expanded the set of residential measures that passed the TRC test, particularly for air-source heat pumps, heat pump water heaters, and central air conditioning. The incremental impact is greatest in earlier years and diminishes over time as baseline efficiencies improve and remaining opportunities are increasingly constrained by adoption factors rather than cost-effectiveness alone. Because the incentives were short-lived and have since been eliminated, results should be interpreted as illustrative rather than as a projection of sustained policy effects.

Cost of Potential Savings

This study employs a net present value framework to evaluate the economics of energy efficiency investments from multiple perspectives, including participants, utilities, and society. This framework enables comparison of energy efficiency resources with conventional supply-side alternatives The levelized cost of energy (LCOE) is used to compare energy efficiency measures with supply-side resources by expressing lifetime costs on a per-unit energy basis. LCOE captures installed costs, operating costs, and the time value of money, and is used here as a screening metric rather than a system planning tool. While LCOE does not fully capture capacity, dispatchability, or reliability value, it provides a transparent and consistent basis for comparing efficiency measures across end uses and sectors.

Residential levelized costs in Figure 6 vary from $0.01/kWh for screw-in lighting up to $0.34/kWh for clothes dryers. Commercial levelized costs in Figure 8 vary from about -$0.02/kWh for screw-in lighting up to approximately $0.52/kWh for heat pumps. (The incremental costs for some lighting replacement technologies are negative, i.e., the more efficient technology costs less than the baseline technology, therefore the levelized costs are less than zero.) Industrial levelized costs in Figure 9 vary from approximately $0.07/kWh to $0.12/kWh for industrial facilities. The width of each end use segment represents the annualized economic potential savings at the corresponding LCOE.

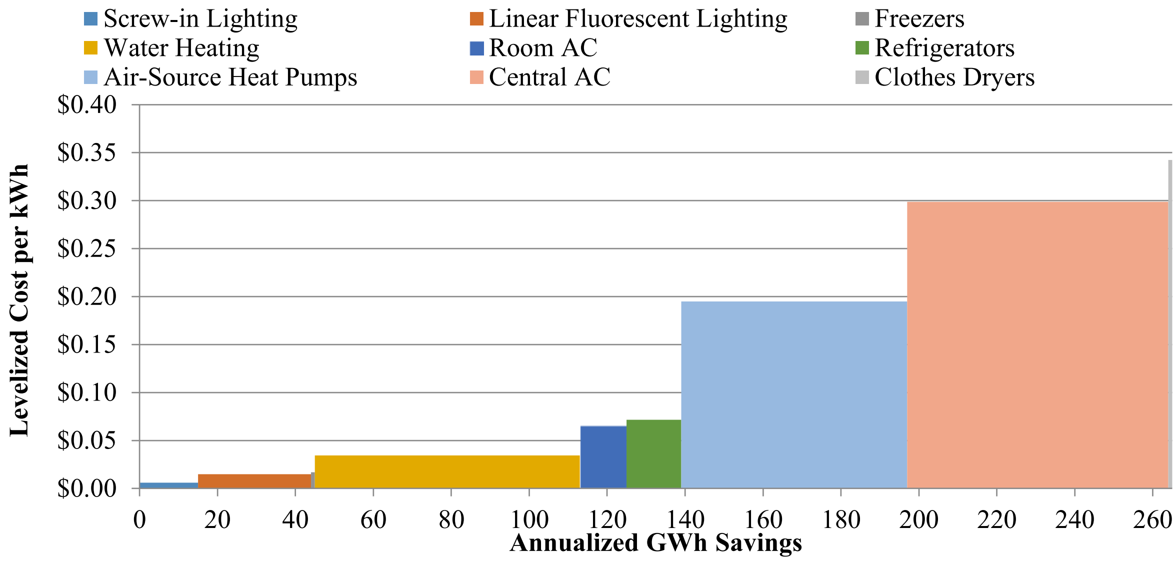

Figure 6. Residential energy efficiency supply curve, based on economic potential

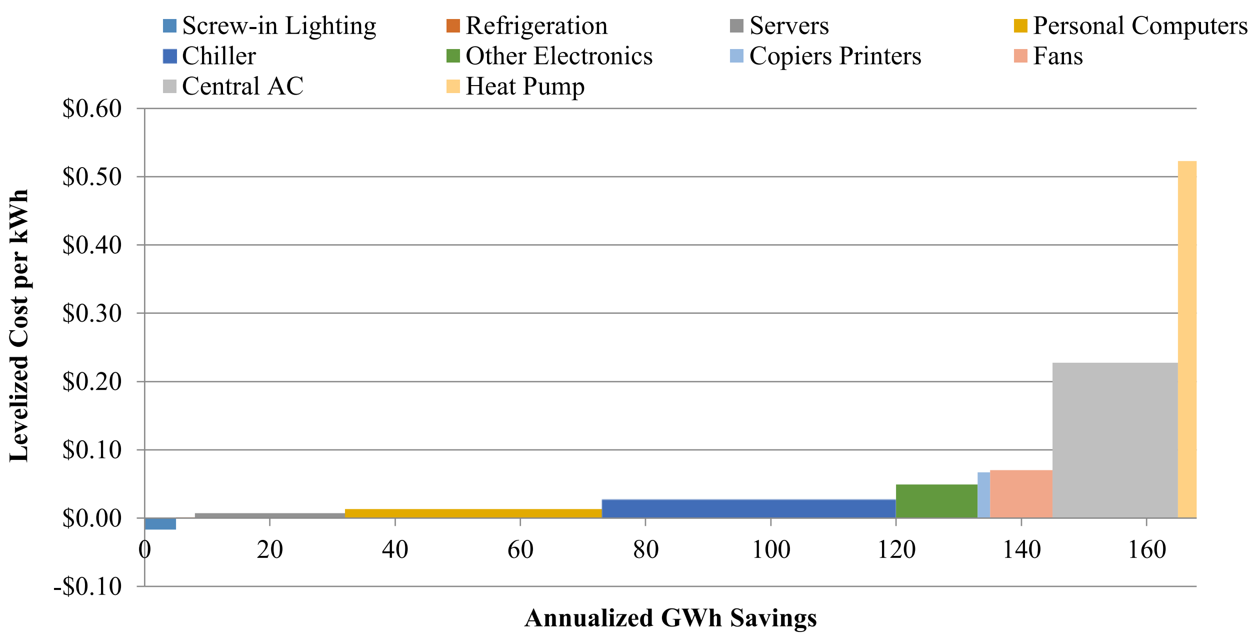

Figure 7. Commercial energy efficiency supply curve, based on economic potential

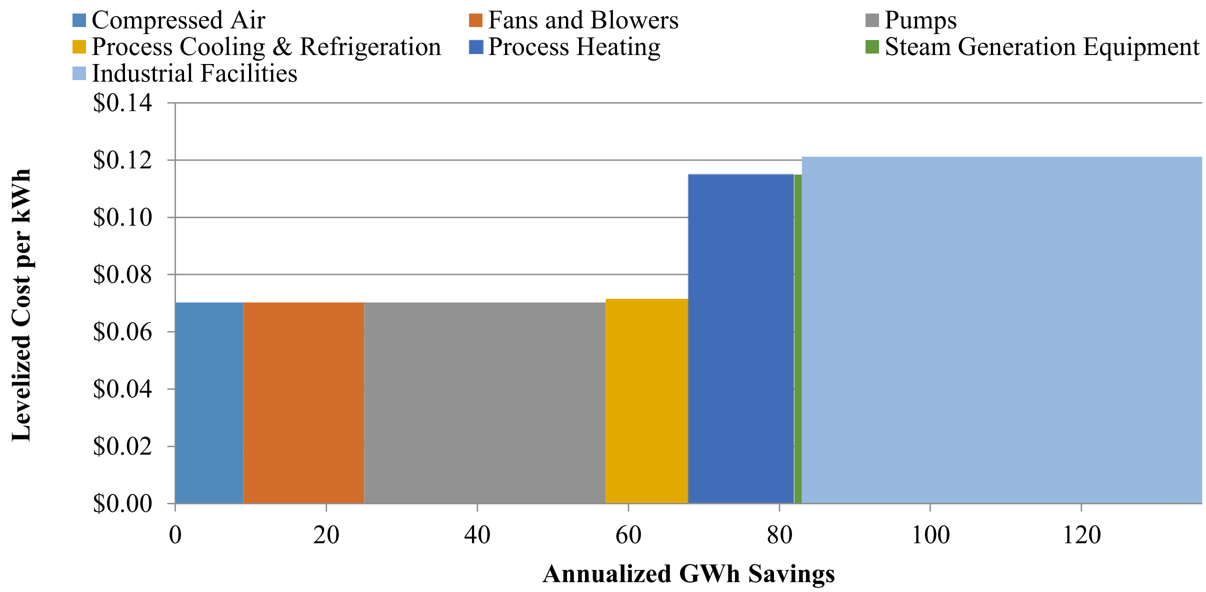

Figure 8. Industrial energy efficiency supply curve, based on economic potential

Total cost of economic potential. Table 7 shows incremental costs for installing cost-effective efficient technologies along with the assumed program administration costs. For this study the program administration costs were assumed to be 20% of the incremental costs of measures. Capturing the economic potential over the forecast period is estimated to cost about $146 Billion in incremental capital costs and $29 Billion in program administration costs.

Table 7. Economic potential incremental and program administration costs, millions of dollars

		2025	2035	2045
Incremental capital costs	Residential	$38,404	$54,811	$69,620
	Commercial	$34,052	$37,915	$41,530
	Industrial	$18,190	$34,867	$35,084
	Total	**$90,647**	**$127,593**	**$146,234**
Program administration costs	Residential	$7,681	$10,962	$13,924
	Commercial	$6,810	$7,583	$8,306
	Industrial	$3,638	$6,973	$7,017
	Total	**$18,129**	**$25,519**	**$29,247**

Emissions Impacts

To model emissions savings from energy efficiency, data from the National Renewable Energy Lab's (NREL) Cambium datasets is used (NREL n.d.). Cambium is an annually updated tool NREL developed to support long-term decision making in the energy sector. The tool includes a variety of modeled hourly emission, cost, and operational data through 2050 for 8 scenarios (NREL 2024). Cambium's hourly long-run marginal emissions rates (LRMER) in kgCO2e/MWh at the point of end-use from the mid-case scenario were used in this study. LRMER are used rather than short-run rates to include forecasted changes in grid assets in response to marginal changes in net electricity, better capturing the dynamics of the system over many years. The mid-case scenario is defined as: "central estimates for inputs such as technology costs, fuel prices, and demand growth. No nascent technologies. Electric sector policies as they existed in September 2023." (NREL 2024) Note that "policies as they existed in 2023" include incentives from the IRA, aside from clean hydrogen production credits which had not been finalized at the time. The mid-case scenario is selected to align the emissions data with data coming from AEO.

Figure 9 shows the average annual emissions through 2050 for each region treated in this EE potential model. As shown, most regions—especially the Mid-Atlantic, East North Central, East South Central, West South Central, and South Atlantic—are modeled to experience a significant decrease in emissions by 2030. After 2030, the rate of change in marginal emissions decreases in most regions and many see an increase in marginal emissions after 2045. These marginal emissions rates are used to estimate the emissions that could be avoided by the adoption of cost-effective efficient technologies, with regional hourly emissions applied to measures that passed economic screening (i.e., TRC above 1.0). In each geographic division, avoided emissions are calculated for each end use (e.g., space conditioning, water heating) using underlying hourly load shapes. These results show how energy efficiency can be an asset for decreasing regional carbon footprints and reaching emissions reductions goals. The results also characterize the avoided emissions through existing programs, using the EPRI calculated adjusted baseline that adds back in savings from programs already in place.

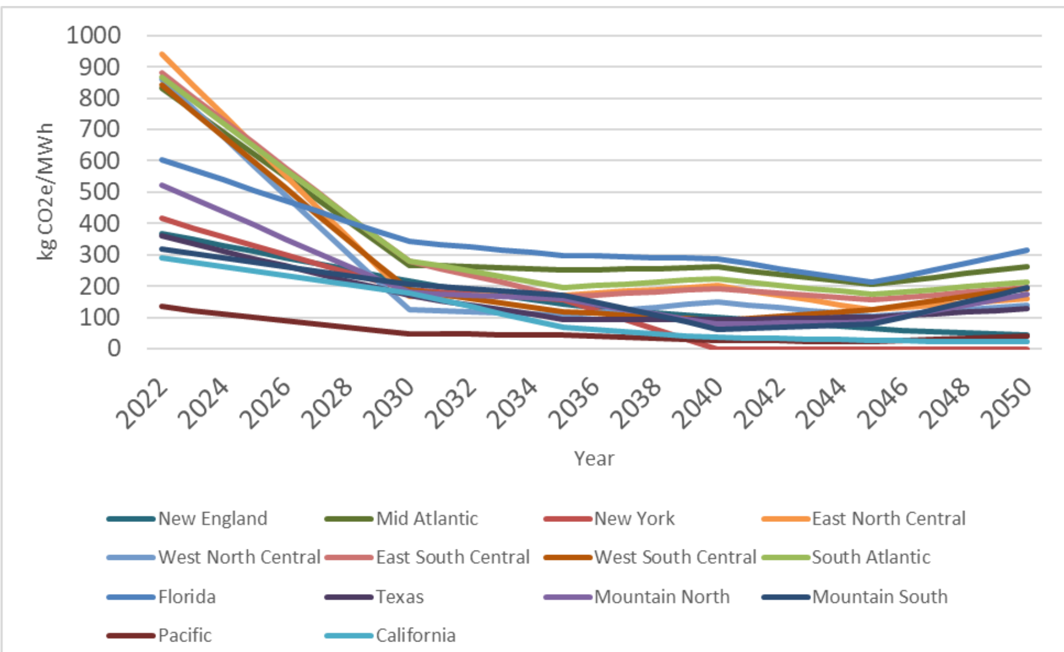

Figure 9. Average annual emissions rate by division

Hourly, long-run marginal emissions rates (LRMER) in kgCO2e/MWh at the point of end-use from the mid-case scenario (NREL 2024)were used to calculate avoided emissions based on the savings calculated in the EE potential model. In each geographic division, avoided emissions are calculated for each end use (e.g., space conditioning, water heating) using the hourly load shape of each passing measure multiplied by the region's LRMER.

Avoided emissions are not considered in the TRC and therefore do not impact the cost-effective savings estimated in the model. Figure 10 shows the forecast avoided emissions in megatonne (million metric tons) CO_2 equivalent through 2045. As shown, the avoided emissions profiles follow the trends of the LRMER metric. The steepest increase in annual avoided emissions leads up to 2030 with a slight decrease in annual avoided emissions after 2040 as LRMERs in certain areas approach 0 kgCO2e/MWh. The annual avoided emissions reach their peak in 2040.

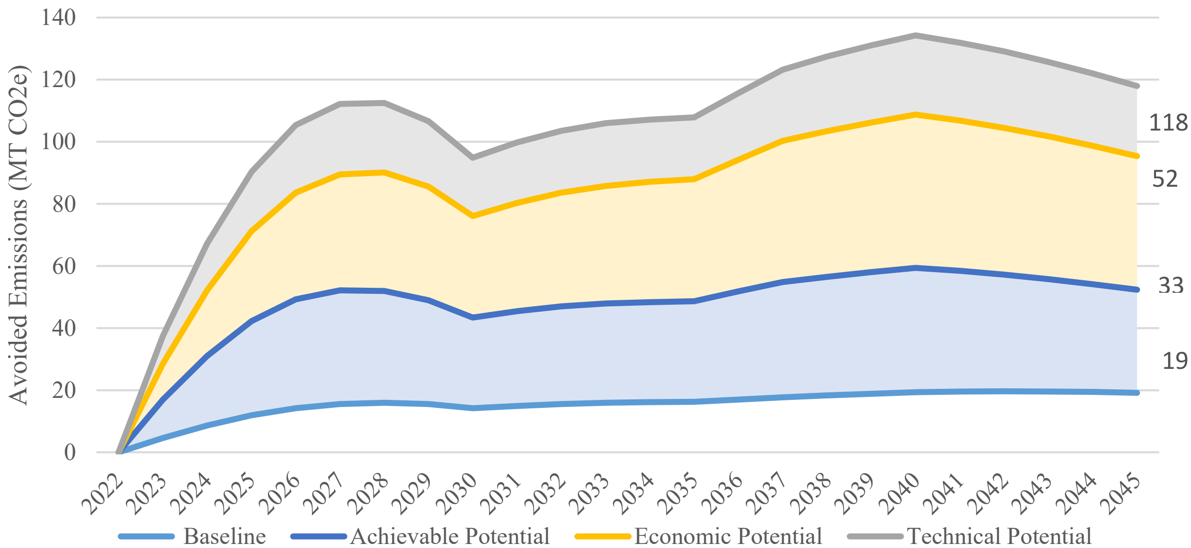

Figure 10. Forecast of U.S. avoided emissions

Figure 11 shows achievable avoided emissions by region, in 2045 the divisions with the largest achievable avoided emissions lie in the South and the Midwest. Many divisions in the West and Northeast near zero avoided annual emissions as policy drives the generation mix to be carbon free – resulting in no emissions to be avoided. In New York, where 100% emission free power is required by 2040 shows no avoided emissions after 2040.

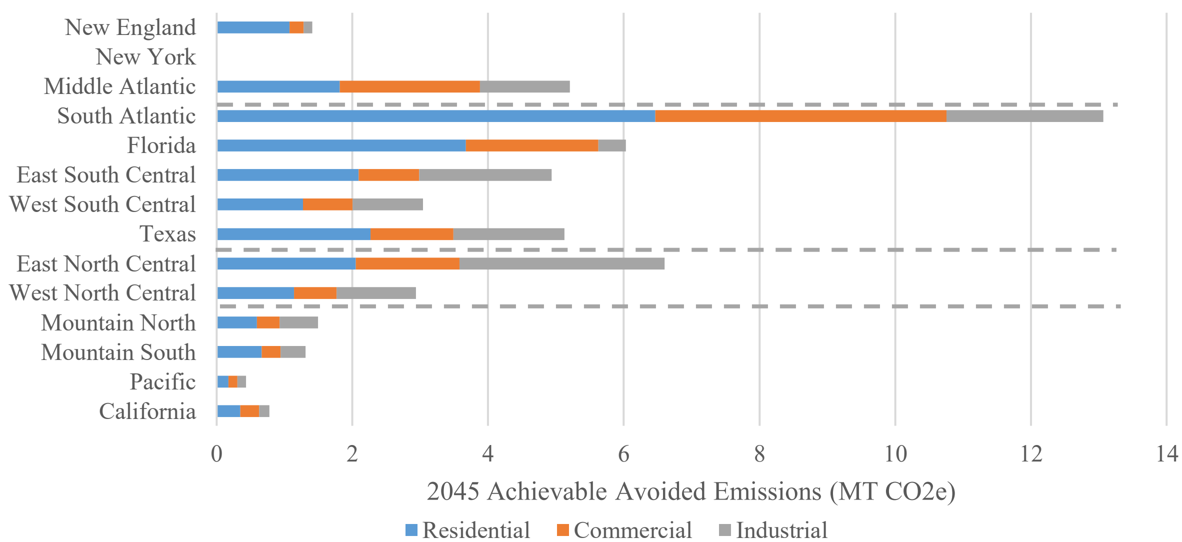

Figure 11. Achievable avoided emissions by sector and region, in 2045

State-Level Achievable Potential

To disaggregate division data to the state level, EIA's published data for 2022 state-level electricity sales by class (EIA 2023e) were used. EPRI's estimates of potential savings include new programmatic savings, establishing an adjusted baseline with programmatic savings growth added back into the AEO2023 Reference Case. The state-level baseline energy use reflects estimated use net of programmatic growth. Every state has a large amount of potential electricity savings that can be utilized as a cost-effective energy resource. This potential grows over time as equipment reaches the end of its useful life and is replaced by a cost-effective, efficient replacement. State achievable potential in 2045 ranges from less than 1 TWh in small states (AK, DC, ME, RI, NH, VT) to 53.5 TWh in Texas, reflective of state loads and the types of electric services. The achievable potential savings range from 5.6% in North Dakota to 11% in Florida in 2045 as a share of state sales. Because the EPRI division-level results were used to determine state-level potential, there is a strong similarity by region in percent savings.

The extent to which states utilize energy efficiency differs. A benchmark analysis calculates the percent of state-level achievable potential that is remaining after projecting the future performance of each state's programs using average historical savings growth. Since it is possible for state savings to exceed the EPRI identified savings, the adjustment made to each state's baseline is capped by the achievable potential savings estimates. Considering natural growth in efficiency programs at the state level, the remaining savings are estimated as shown in Figure 13. This metric serves as a benchmark of the extent to which states are positioned to utilize energy efficiency as a resource through existing programs, policies and action. States that have achieved historically high levels of annual energy savings (lighter shades) may be challenged to unlock additional savings year-over-year. Yet states that have lagged in capturing energy efficiency could unlock all of the energy efficiency identified here.

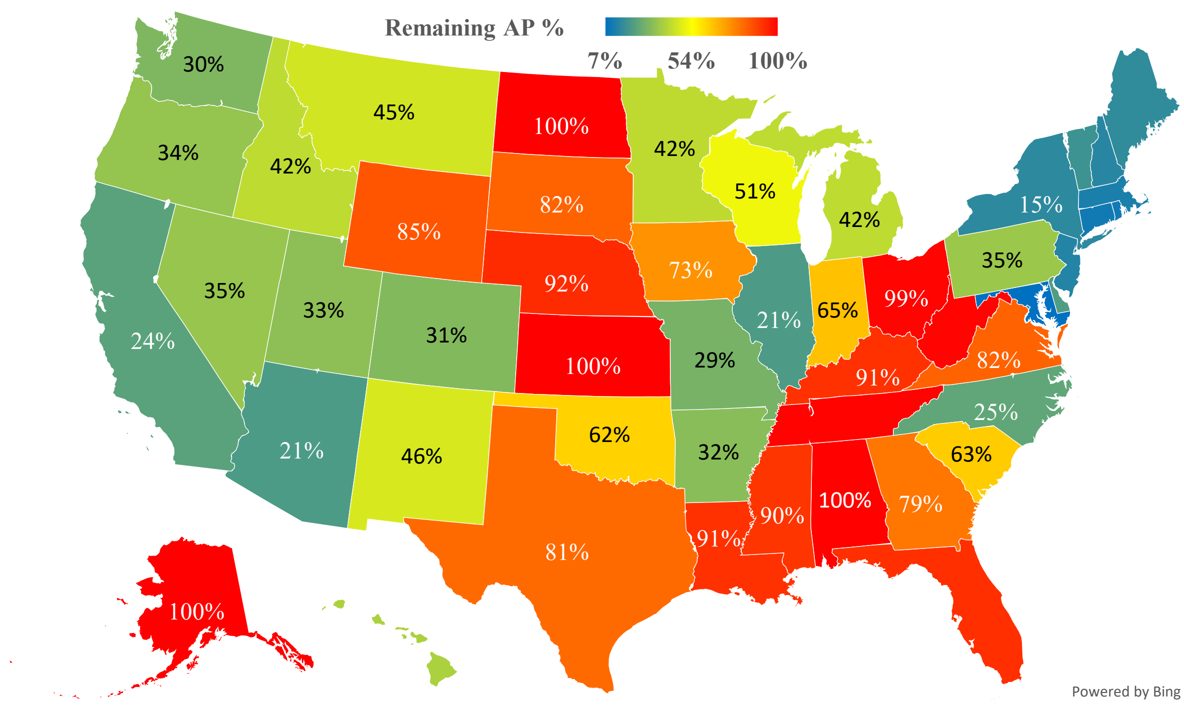

Figure 12. Remaining 2045 achievable potential based on extrapolated average historical state savings

Given the high annual energy savings that have been achieved year-over-year in some states, this benchmark analysis also highlights a limitation of the model. If states with historically high annual savings continue their progress, the compounded savings may exceed the achievable potential that is reported in this study. Additional savings may be available up to the economic potential, which represents the full scope of cost-effective savings. These higher levels of cost-effective savings may be attained by incorporating new technologies, reducing program administration costs, and finding innovative ways to enable efficiency savings. If policies mandate higher levels of savings than projected in this study, program administrators might implement new or additional efficiency measures to reduce costs and yield additional achievable potential savings, taking advantage of both technological innovation as well as other energy-saving approaches, such as behavioral savings which are not considered here. Further, as modeled, if real avoided costs increase over time due to changing supply, more energy efficiency becomes cost effective.

Conclusions and Opportunities

The Achievable Potential energy efficiency scenario estimated a 31% reduction in the projected annual growth rate of U.S. electricity consumption between 2022 and 2045, declining from 0.65% CAGR in the AEO2023 Reference Case to 0.45%. This compares with a 28% reduction in projected growth in the prior EPRI study, which found reduced CAGR 0.62% in AEO2018 Reference to 0.45% with Achievable Potential. The primary sources of difference between the previous results and these latest results can be attributed to two primary causes: Differences between the current and prior results are primarily driven by: 1) Lower projected avoided energy costs reduced the number of technologies that pass economic screening, and 2) Continued declines in unit energy consumption for key end uses, particularly lighting, which reduce baseline electricity demand. Despite these differences, energy efficiency continues to represent a significant and cost-effective resource for moderating long-term growth in electricity consumption. The results demonstrate that achievable efficiency savings remain substantial across all regions and sectors, even as baseline forecasts reflect improved equipment performance and slower demand growth.

Follow-On Efforts

Ongoing advancements in technology, codes and standards, and utility program design will continue to shape the scope and cost-effectiveness of future energy efficiency opportunities. Several technology trends are expected to play an increasingly important role in efficiency potential, e.g., advanced heat pumps, increased electrification, and greater interaction between end-uses and the electric grid. Continued refinement of input assumptions, including improved load shapes, updated technology cost and performance data, and enhanced understanding of customer adoption behavior will be important to accurately assess future efficiency potential.

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