

Technical Notes: EPA ENERGY STAR Benefits Methodology¹

ENERGY STAR® is the government-backed symbol for energy efficiency, providing simple, credible, and unbiased information that consumers and businesses rely on to make well-informed decisions. In accordance with our mission, EPA is committed to documenting quantifiable program results and using well-established methods to estimate the benefits of its programs. The specific approach varies by program strategy, sector, availability of data, and market characteristics.

The benefits metrics provided on energystar.gov are based on ENERGY STAR program data unless otherwise noted, references are provided below. They are based on 2020 calendar year data unless otherwise noted. Multi-year cumulative savings and GHG emission reductions are based upon a total of all program years back to 1993, unless otherwise noted.

Emission Factors

EPA calculates ENERGY STAR's emission reductions by applying pollutant emission factors to net annual electricity and fossil fuel savings attributable to the program. For electricity, EPA uses national marginal pollutant emission factors to estimate reduced emissions from power plants that run less due to reduced demand. These factors are derived using EPA's [Avoided Emissions and Generation Tool \(AVERT\)](#). Emission factors applied to direct fossil fuel savings are derived from on-site fuel combustion emissions using EPA's [GHG Emission Factors Hub](#). Contributions to criteria pollutant (SO₂, NO_x, and PM_{2.5}) emission reductions reflect avoided electricity use only, and do not include any contributions to criteria pollutants avoided through direct fuel use. Contributions to criteria pollutants are measured in short tons while greenhouse gas emissions are measured in metric tonnes. All quantified emission reductions are estimates, and we acknowledge that some of the estimated reductions may not be realized due to other dynamics affecting behavior of generating units on the grid and may not account for overlapping impacts of regulatory programs.

Net Cost Savings

Net energy cost savings for the ENERGY STAR program are estimated in present value terms, subtracting incremental investment costs from gross bill savings. The Gross Domestic Product (GDP) Implicit Price Deflator Index is used to convert nominal dollars to constant current analysis year dollars. EPA's calculations assume sector-specific, national average prices, including electricity and fossil fuel prices published by the Energy Information Administration (EIA). The analysis for all programs assumes each measure is financed over its specified lifetime. The calculation uses a private sector real discount rate of 7% as the interest rate for financing investments in new measures. 7% is used because the majority of EPA partners are in the private sector.

The methods for estimating energy savings from each of the ENERGY STAR programs are described below.

ENERGY STAR Certified Products Analysis

- Sales of products attributed to the ENERGY STAR program are based on shipments of products to the US and are defined as those that are above and beyond efficient product purchases that would have been occurred without ENERGY STAR actions. These sales are estimated by:
 - Collecting annual shipment data on ENERGY STAR certified products from participating product manufacturers, provided to EPA as a condition of partnership, and comparing these data to industry reports on total annual product shipments. EPA screens for data quality to ensure an accurate reflection of ENERGY STAR sales.
 - Establishing reference case baselines for annual product sales for each product category without ENERGY STAR, based on percent of models that meet the ENERGY STAR

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requirements when they are initially set, as well as an analysis of the market barriers for each product related to the benefit/cost ratio.

- ENERGY STAR products with a lower benefit/cost ratio face higher market barriers, and it is assumed those products are more likely to be purchased due to the ENERGY STAR label and less likely to be prevalent in a reference case baseline than products with a higher benefit/cost ratio.
- Annual energy savings are calculated using standardized values for the difference in annual energy use between a product that meets the ENERGY STAR requirements and a product that is not ENERGY STAR certified. For these values, EPA:
 - Assumes that ENERGY STAR certified products just meet the ENERGY STAR minimum savings thresholds, even though there are some products that exceed those levels.
 - Assumes non-ENERGY STAR products meets minimum efficiency standards where standards exist. If standards do not exist, assumes the average energy use of available products within a category that do not meet the ENERGY STAR criteria prior to the introduction of an ENERGY STAR specification. EPA updates the baseline assumptions for products based on changes in ENERGY STAR requirements, as well as federal efficiency standards.
 - Uses primary data from third parties, such as product metering on power use information, where additional information is necessary to estimate energy savings.
 - Uses product-specific lifetimes that vary from 4 to 25 years.
 - Subtracts the savings associated with products used in ENERGY STAR Certified New Homes to avoid double counting savings.
 - Accounts for interactive effects from HVAC products and windows by assuming that consumers would apply the most cost-effective measure first. For example, ENERGY STAR attributes savings from windows decrease when they are applied to homes that have already installed efficient HVAC equipment.
- Annual and lifetime net energy cost savings is the present value of energy bill savings minus the present value of any incremental cost of purchasing an ENERGY STAR certified product above a standard model over the product lifetimes discussed above.
 - Total incremental cost is calculated by multiplying the number of units purchased in a given year by the incremental unit cost of a particular product. Incremental unit costs are collected via periodic market research.

ENERGY STAR Certified New Homes Analysis

- On a quarterly basis, independent oversight organizations called Home Certification Organizations (HCO) submit data to EPA on the number of homes that have been certified to meet ENERGY STAR program requirements. This reporting is a condition of approval to be an HCO for ENERGY STAR. EPA reviews the submitted data and resolves any data irregularities.
- When accounting for homes certified, EPA acknowledges that some new homes that were already intended to be built at above-code performance levels may become ENERGY STAR certified even though certification was not a primary driver. At the same time, other homes may be built with efficiency measures that resulted from the influence of the ENERGY STAR program, even though these homes themselves are not certified. For example, a builder who becomes accustomed to air-sealing homes because of the ENERGY STAR program may incorporate this efficiency measure across all homes. In the latter cases, EPA is not claiming credit for these measures, because the homes are not certified.

- To account for the energy savings resulting from the operation of ENERGY STAR certified homes across a range of climates, sizes, and fuel types, EPA estimates a composite energy consumption of a standard (i.e., code-minimum) home constructed in each of seven climate zones, taking into account regional construction characteristics (e.g., foundation type, typical fuel use profile) and configuring the home to the applicable model energy code. EPA then applies ENERGY STAR requirements to each modeled home to determine an estimated composite energy consumption of ENERGY STAR homes in each climate zone. These calculated energy consumptions are used to calculate savings.
- Gross energy bill savings are calculated using the composite energy consumption estimates, national average energy prices for the residential sector, and an assumed 30-year average lifetime of a home. Net energy cost savings are calculated by subtracting the present value of the incremental cost of purchasing an ENERGY STAR certified home from the present value of gross energy bill savings.
- The incremental cost for each home configuration is calculated by first subtracting the cost of each configuration of ENERGY STAR certified home from that of the corresponding standard home. Then, these incremental costs are used to calculate a composite estimate of incremental upgrade cost per home using the same weighting factors as applied in energy savings calculation. The incremental cost calculation includes the cost of the energy efficiency features for each ENERGY STAR certified home, both the mandatory measures required by the program and measures that are not mandatory but are commonly used to meet the ENERGY STAR HERS Index target required by the program.
- A detailed description of the ENERGY STAR Certified Homes cost analysis by specification version can be found below:

[ENERGY STAR Certified Homes Version 3 Cost and Savings Estimates](#)

[ENERGY STAR Certified Homes Version 3.1 Cost and Savings Estimates](#)

ENERGY STAR Commercial Buildings and Industrial Plants Analysis

EPA develops commercial buildings and industrial plants (C&I) impact evaluations using econometric modeling. The research design is outlined in a series of peer reviewed articles.² Generally, the methodology attributes certain aggregate national energy savings in the commercial and industrial sector to the ENERGY STAR program, controlling for the impact of other federal and non-federal energy efficiency programs.

To calculate the national impacts of ENERGY STAR for commercial buildings and industrial plants, EPA uses historical energy consumption data for relevant fuel types from the U.S. Energy Information Administration, and other publicly available data, to estimate the differential effects of voluntary energy efficiency programs on electricity, natural gas, and other fuels (for the industrial modeling) consumption. A quasi-experimental research design is formed by designating state treatment and control groups and then using the control group energy consumption behavior to simulate counterfactual energy consumption for the treatment group. Being comprehensive in scope, the impact estimates incorporate other notable secondary effects, including spillover and market transformation savings.

Cumulative annual energy savings for the current year, defined as the accomplishments from current year activities as well as from previous year program activities, are derived after controlling for effects from other measures such as energy savings from the installation of new equipment, including ENERGY STAR products. This avoids double counting between the programs. In addition, the analysis excludes estimations of the energy savings impacts from demand side management programs, federal, state, and third-party public benefits energy efficiency programs, state building codes and appliance standards programs, and related energy efficiency and renewable energy programs.

² See Horowitz 2001, 2004, 2007, 2011, 2014, and Horowitz and Bertoldi 2015.

Net energy cost savings are calculated using present value of energy bill savings minus the present value of any incremental costs. Special aspects of each sector-specific analysis are provided below.

Specific Aspects of the ENERGY STAR Commercial Buildings Analysis

- The commercial building analysis specifies electricity and natural gas savings.
- Per EIA estimates showing that commercial customers require a payback for energy efficiency investments of no more than three years³, it is assumed that, on average, incremental investment in the commercial sector would be no more than 1/3 of the additional annual bill savings in a given year. Thus, the estimated investment is calculated by multiplying the increase in energy savings compared to the previous analysis year by three.

Specific Aspects of the ENERGY STAR Industrial Analysis

- The industrial analysis specifies electricity, natural gas, coal, and petroleum savings.
- Incremental cost is the amount of capital invested or committed to investment in ENERGY STAR industry measures in a given year. The cost is calculated using a 1.5-year payback period and is based on similar assumptions and reporting used to calculate the 3-year payback in the commercial sector methodology.⁴

ENERGY STAR Program Investment and Effectiveness

Benefits results and calculated investment costs are used along with program budget data to calculate comparative program benefits like emission reductions and net cost savings relative to EPA's investment in the ENERGY STAR program itself. Similar calculations are used to estimate private investment leveraged by EPA's investment in ENERGY STAR. All results are across the lifetime of the program since 1993. All cost savings, investment, and budget data are levelized to current year dollars.

ENERGY STAR Public Health Benefits

[EPA's Public Health Benefits per kWh \(BPK\) values](#) are used to estimate ENERGY STAR's monetary public health benefits due to reductions in ambient fine particulate matter (PM_{2.5}). National energy savings are apportioned to different BPK/AVERT regions based upon the region's proportional energy savings as reflected in the ACEEE's State Energy Scorecard. The analysis uses values based on BPK's "EE at peak" definition. The BPK table of values provides a low and high estimate of health benefits based on varying health sensitivity scenarios, so the results are reported as a range.

³ DOE's Energy Information Administration has estimated that approximately 84 percent of all commercial customers require a payback for energy efficiency investments of no more than 3 years. Because the overwhelming majority of commercial customers require paybacks of less than 3 years, it was assumed that, on average, incremental investment in the commercial sector would be no more than 1/3 of the additional annual bill savings in a given year. See EIA 2007a.

⁴ See EIA 2007b.

Sources

These sources are either explicitly cited above or otherwise inform the analysis.

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