

## TECHNICAL NOTES: METHODOLOGY FOR MEASURING RESULTS<sup>1</sup>

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 will vary by program strategy, sector, availability of data, and market characteristics.

The metrics provided in our website are based on ENERGY STAR program data unless otherwise noted and references are provided below. Annual program metrics are based on 2017 calendar year data unless otherwise noted. A key exception is energy savings, net energy cost savings, and emissions reductions, which are based on 2016 calendar year data. Multi-year cumulative savings and emissions reductions are based upon all program years through 2016, unless otherwise noted.

EPA calculates ENERGY STAR's emissions reductions by applying pollutant emissions factors, as applicable, to net annual electricity and fossil fuel savings attributable to the program. For electricity, a national marginal pollutant emissions factor is assumed that estimates reduced emissions from power plants that run less due to energy efficiency. These factors are derived from EPA's [Avoided Emissions and Generation Tool \(AVERT\)](#), and are available on the [AVERT website](#). Emissions factors applied to direct fossil fuel savings are based on on-site fuel combustion. Contributions to criteria pollutant 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. Contributions to greenhouse gas emissions are measured in metric tons. 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 the overlapping impacts of regulatory programs.

The net energy cost savings for the ENERGY STAR program are estimated in present value terms, and subtracts incremental investment costs from gross bill savings. The GDP Implicit Price Deflator Index is used to convert nominal dollars to constant current reporting year dollars. EPA's calculations assume sector-specific, national-average prices, including electricity and fossil fuel prices published by the Energy Information Administration (EIA). A private sector real discount rate is used as the interest rate for financing purchases of new technologies and practices since the majority of EPA partners making the investments 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**

- Sales of products due to the ENERGY STAR program are determined as those above and beyond business as usual (BAU) purchases of these products. These sales are estimated by:
  - Collecting annual sales 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 sales. EPA screens the data and investigates and resolves issues when market penetration is not as expected.
  - Establishing BAU baselines for annual product sales for each product category based on the benefit/cost ratio for the product and a characterization of the market barriers for the product.

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<sup>1</sup> Published April 2018.

- Annual energy savings are calculated using established values for the difference in annual energy use between a single ENERGY STAR product and a typically purchased product. For these values, EPA:
  - Assumes that ENERGY STAR certified products just meet the ENERGY STAR thresholds, even though there are some products that exceed those levels.
  - Assumes the typically purchased product meets minimum efficiency standards where standards exist. If standards do not exist, assumes the average energy use of available products within a category prior to the introduction of an ENERGY STAR specification. EPA reviewed the baseline assumptions for key products in 2014.
  - Supports primary data collection, such as product metering to collect power use information, where additional information is necessary to estimate energy savings.
  - Uses product-specific lifetimes that vary from 4 to 20 years.
  - Subtracts out 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. As a result, savings from windows have decreased since they are applied to homes that have already installed efficient HVAC equipment.
  
- 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. Incremental cost equals the incremental unit cost multiplied by the number of units purchased. Incremental unit costs are collected via annual market research.

### **ENERGY STAR Certified New Homes**

- On a quarterly basis, third-party Home Energy Rating Providers, accredited by the Residential Energy Services Network (RESNET), 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 a Provider's partnership with the ENERGY STAR program. 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 calculated the 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 applied ENERGY STAR requirements to each modeled home to determine the estimated annual energy savings achieved (for both electricity and natural gas) as compared to the standard home. This approach avoids double counting of energy savings from building energy codes.

Then, these calculated energy consumptions were combined into a composite estimate of energy consumption.

- Gross energy bill savings are calculated using the composite energy consumption estimate along with 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 was calculated by first subtracting the cost of each configuration of ENERGY STAR certified home from that of the corresponding baseline home. Then, these incremental costs were 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 cost analysis for Version 3 of the program can be found at: [http://www.energystar.gov/ia/partners/bldrs\\_lenders\\_raters/downloads/EstimatedCostandSavings.pdf?66e5-7f53](http://www.energystar.gov/ia/partners/bldrs_lenders_raters/downloads/EstimatedCostandSavings.pdf?66e5-7f53).
- A detailed description of the cost analysis for Version 3.1 of the program can be found at: [http://www.energystar.gov/ia/partners/downloads/ES\\_Version\\_3.1\\_Cost\\_Savings\\_Summary.pdf?bd8a-f009](http://www.energystar.gov/ia/partners/downloads/ES_Version_3.1_Cost_Savings_Summary.pdf?bd8a-f009).

### **ENERGY STAR Commercial Buildings**

- To calculate the national impacts of ENERGY STAR for Commercial Buildings, EPA uses historical energy consumption data from the U.S. Energy Information Administration, and other publicly available data, to estimate the differential effects of voluntary energy efficiency programs on electricity and natural gas consumption in states with the strongest commitments to voluntary energy efficiency programs. A quasi-experimental research design is formed by designating state treatment and control groups, as identified by aggregating states into groups based on multiple years of ACEEE's annual state scorecards, and then using the control group energy consumption behavior to simulate counterfactual energy consumption for the treatment group. The technical details of the impact estimation methodology, including the econometric models and statistical tests, are published in double-blind, peer-reviewed scientific journals.<sup>2</sup>
- Cumulative annual energy savings for the current year for ENERGY STAR for Commercial Buildings, defined as the accomplishments from current year activities as well as from previous year program activities, are derived after controlling for the uptake in new equipment, including ENERGY STAR products, in commercial buildings. In addition, ENERGY STAR for Commercial Buildings program accomplishments excludes estimations of the energy savings impacts from demand side management programs, state and third-party public benefits energy efficiency programs, state building codes and appliance standards programs, and related energy efficiency and renewable energy programs. Being

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<sup>2</sup> See Horowitz 2001, 2004, 2007 and 2011.

comprehensive in scope, ENERGY STAR for Commercial Buildings impact estimates incorporate other notable secondary effects, including spillover and market transformation savings.

- Net energy cost savings represent the present value of energy bill savings minus the present value of any incremental costs. Incremental cost is the amount of capital invested or committed to investment in ENERGY STAR for Commercial Buildings in a given year. Per EIA estimates showing that commercial customers require a payback for energy efficiency investments of no more than three years<sup>3</sup>, 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.

### **ENERGY STAR for Industry**

- To calculate the national impacts of ENERGY STAR for Industry, EPA uses historical energy consumption data from the U.S. Energy Information Administration, and other publicly available data, to develop panel econometric models that include up to all forty-eight of the continental states. Counterfactual panel data is created using a forecast of the evaluation year using the most recent ten years prior to the evaluation year to estimate panel econometric models of state industrial sector energy consumption, national electricity, natural gas, coal, and petroleum consumption. With this counterfactual, the impact of voluntary energy efficiency programs is calculated as the difference between forecasted and observed energy consumption. The technical details of the impact estimation methodology, including the econometric models and statistical tests, are published in double-blind, peer-reviewed scientific journals.<sup>4</sup>
- Cumulative annual energy savings for the current year for ENERGY STAR for Industry, defined as the accomplishments from current year activities as well as from previous year program activities, are derived after controlling for the uptake in new equipment, including ENERGY STAR products, in industrial facilities. In addition, ENERGY STAR for Industry program accomplishments excludes estimations of the energy savings impacts from demand side management programs, state and third-party public benefits energy efficiency programs, and related energy efficiency and renewable energy programs. Being comprehensive in scope, ENERGY STAR for Industry impact estimates incorporate other notable secondary effects, including spillover and market transformation savings.
- Net energy cost savings are calculated using a method similar to the Commercial program. The present value of any incremental costs are subtracted from the present value of gross energy bill savings. Incremental cost is the amount of capital invested or committed to investment in ENERGY STAR for Industry 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 program.<sup>5</sup>

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<sup>3</sup> 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.

<sup>4</sup> See Horowitz 2007, 2011 and 2014.

<sup>5</sup> See EIA 2007b.

## SOURCES

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

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