2024 Buildings Technology Baseline: Dataset Documentation

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1 Guidehouse
2 National Renewable Energy Laboratory
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List of Acronyms

AC	air conditioning
ATB	Annual Technology Baseline
B-TB	Buildings Technology Baseline
BEopt	Building Energy Optimization Tool
BTO	Building Technologies Office
CSV	comma-separated value file
DOE	U.S. Department of Energy
EERE	Office of Energy Efficiency and Renewable Energy
EIA	U.S. Energy Information Administration
EIA Buildings Data Report	*Updated Buildings Sector Appliance and Equipment Costs and Efficiencies*
GEB Data Report	*Grid-Interactive Efficient Building Technology Cost, Performance, and Lifetime Characteristics*
LBNL	Lawrence Berkeley National Laboratory
NREL	National Renewable Energy Laboratory
NREMDB	National Residential Efficiency Measures Database
R&D	research and development
UEF	universal energy factor

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Introduction

The purpose of the Buildings Technology Baseline (B-TB) dataset is to provide a curated and regularly updated dataset of current and projected performance, retail, and installed price data for all major building energy technologies.[1] The dataset has been compiled using existing building technology datasets, as well as newly collected data from online retailers, distributors, and manufacturers. This initial version does not have an "annual" moniker, although the intent is that this will join the Annual Technology Baseline (ATB) collection of datasets and be updated each year. The data are provided in the form of regression coefficients and intercepts for each technology to calculate low, mid, and high (10th, 50th, and 90th percentile, respectively) retail price estimates and labor multipliers/add-ons to estimate new construction and retrofit total installed project costs. These price values are provided (in 2023$) for projected years (2023–2050) and for each projection scenario (Reference, Intermediate, and Advanced). The dataset contains a list of all 312 technologies and measures; the main categories of these technologies and measures are listed in Table 1. The dataset also includes typical and high (maximum) values for each technology's performance metric(s) (e.g., capacity, volume, efficiency), retail price, and installation cost.

Table 1. Major Residential and Commercial Technology Categories in the B-TB Dataset

Major Technology/ Measure Category	Number of Residential Technologies/Measures Included in the Buildings Technology Baseline (B-TB)	Number of Commercial Technologies/Measures Included in the B-TB
Space Heating	5	7
Space Cooling	4	10
Heating & Cooling	8	11
Ventilation	1	2
Lighting	31	29
Water Heating	11	8
Refrigeration	7	12
Appliances	15	5
Opaque Envelope	86	3
Windows	5	5
Controls	29	6
Energy Storage	2	5
Electrical Upgrades	3	0
Generation	1	0
Pool Pump	1	0

[1] Moore, N., Wilson, E., Butrico, M., Langevin, J., & Ciraulo, R. (2024). 2024 Buildings Technology Baseline. [Data set]. Open Energy Data Initiative (OEDI). National Renewable Energy Lab - NREL. https://data.openei.org/submissions/8342

Use of the Buildings Technology Baseline (B-TB) Dataset

Motivation and Use Cases

Prior to this effort, there was not a curated and regularly updated dataset of current and projected performance, retail, and installed price data for all major building energy technologies. Such datasets have been developed for other technology sectors and are widely used. For example, the U.S. Department of Energy's (DOE's) Office of Energy Efficiency and Renewable Energy (EERE) Office of Strategic Analysis has funded an ATB data product for the electricity sector since 2015 to address data collection, consistency, and verification challenges within the electricity generation sector. The Electricity ATB now has more than 100,000 users[2] and forms the backbone of EERE's annual Electricity Standard Scenarios that are widely used by researchers, decisionmakers, project developers, and grid planners. An ATB for the transportation sector was first released in 2020.

In 2021, the EERE Office of Strategic Analysis funded a scoping study for a "demand-side" ATB covering the buildings and industrial sectors. The scoping study surveyed 50 potential users of a demand-side ATB and found a strong value proposition for such a data product that provides credible and internally consistent projections of the costs and performance of buildings and industrial sector technologies. Major use cases identified by the survey include market potential studies, utility-integrated resource plans, and the development and evaluation of ratepayer-funded efficiency and demand response programs. Respondents value a centralized data resource managed by a reputable neutral party.

Another prominent use case is for building energy modeling that is widely used by architects, engineers, and consultants to evaluate the energy performance of potential new building designs and renovations. Although the use of actual cost estimates from local contractors and cost estimators is always preferable, the B-TB can be useful for early-stage designs and in situations where actual cost data are not available.

Specific Use Cases

Internal Building Technologies Office (BTO) and EERE analysis and planning:

- Building technology pathway analyses require an up-to-date understanding of installation costs and cost-effectiveness of key building technologies.
- Projections of technology costs into the future are a key input to scenario analyses that BTO and EERE use to prioritize research and development (R&D) funding. If building technologies are not well represented in these analyses, DOE funding may not

[2] Mercer, E. 2024. "Plug Into Newly Released 2024 US Electricity Sector Data." National Renewable Energy Laboratory (NREL). Accessed May 2025. www.nrel.gov/news/program/2024/plug-into-newly-released-2024-us-electricity-sector-data.html.

appropriately prioritize building technologies activities as they relate to DOE leadership goals.

Manufacturer, utility, state, and local decision-making:

- DOE products such as ComStock and ResStock datasets, dashboards, and reports are designed to help decision makers more accurately evaluate the impact that building technologies, programs, and policies could have on people's lives, including the impacts of technology costs, energy costs, and job opportunities both in the near term and decades into the future.
- Manufacturers can benefit from understanding the potential market for their current and potential new products, such as with cost-effectiveness analyses using ComStock, ResStock, or other tools.
- Community energy planners often do not have the resources or expertise to collect cost data themselves and can benefit greatly from cost and cost-effectiveness data being readily available as part of these decision-making resources.
- Similarly, state regulators and ratepayer advocates often do not have the resources or staff expertise to collect cost data and can benefit greatly from cost and cost-effectiveness data being readily available as part of these decision-making resources.
- By making data publicly available, DOE can save decision makers precious resources and facilitate faster and more accurate decision-making.

Building owner, designer, contractor, and homeowner decision-making:

- Building energy modeling is widely used by architects, engineers, and consultants to evaluate the energy performance of potential new building designs and renovations. While using actual cost data from local contractors and cost estimators is always preferrable, the B-TB can be useful in tools such as OpenStudio and Revit for early-stage design and in situations where actual cost data are not yet available.
- Large building portfolio owners, such as partners in DOE's Better Buildings Initiative can benefit from a better understanding of building technology costs and cost-effectiveness.
- BTO supports residential program, contractor, and homeowner decision-making through tools such as the Home Energy Score, Building Energy Optimization Tool (BEopt™),[3] Weatherization Assistant, and private-sector software. To recommend cost-effective solutions, these tools require up-to-date cost data.

Buildings Sector Scenarios

The data can also be used for building stock analysis, such as the DOE ComStock,[4] ResStock,[5] and Scout[6] tools, which provide energy and cost savings estimates for building technologies. Just as the Electricity ATB underpins the Electricity Standard Scenarios,[7] the B-TB is a key

[3] NREL. 2025. BEopt: Building Energy Optimization Tool. Accessed Feb. 2025. www2.nrel.gov/buildings/beopt.
[4] NREL. ComStock. Accessed May 2025. comstock.nrel.gov/.
[5] NREL. ResStock. Accessed May 2025. resstock.nrel.gov/
[6] DOE. Scout. Accessed May 2025. www.energy.gov/eere/buildings/scout.
[7] NREL. 2025. Standard Scenarios. Accessed May 2025. www.nrel.gov/analysis/standard-scenarios.html.

component of the Buildings Sector Scenarios[8] project that combines the use of Scout, ComStock, and ResStock to develop and publish regularly updated standardized future scenarios for the U.S. buildings sector. The Buildings Sector Scenarios aim to have sufficient geographic and temporal resolution to support federal, state, community, and utility decision-making and technical assistance.

As a key component of the Buildings Sector Scenarios, the B-TB will also facilitate more consistent cross-sectoral analysis—such as DOE-funded and external load forecasting and capacity expansion modeling of bulk power and electrical distribution systems. The B-TB and Buildings Sector Scenarios are designed to help decision makers more accurately evaluate the impact that building technologies, programs, and policies could have on people's lives, including the distributional impacts of technology costs, energy costs, pollutants, and job opportunities both in the near term and decades into the future.

Dataset Format

The dataset is provided as a flat machine-readable comma-separated value (CSV) file to be used as modeling inputs. Users can calculate the estimated total installation cost (for both retrofits and new construction) of a technology or measure for a given year and projection scenario using the coefficients, intercepts, multipliers, and add-ons from the file combined with known characteristics (e.g., capacity, efficiency, square footage) of the technology or measure in question. The dataset also provides typical (most common on the market) and high (current maximum technical limit) values for performance metrics and a range of the expected lifetime of the technology or measure.

[8] Lawrence Berkeley National Laboratory (LBNL) and NREL. 2024. "Buildings Standard Scenarios (B-SS)." 2024 Project Peer Review. Accessed May 2025. www.energy.gov/sites/default/files/2024-11/bto-peer-2024-35571_35570-building-standard-scenarios-langevin.pdf.

Sources

The dataset leverages existing building technology data sources, including the 2024 National Residential Efficiency Measures Database (NREMDB),[9] 2023 U.S. Energy Information Administration (EIA) *Updated Buildings Sector Appliance and Equipment Costs and Efficiencies* report ("EIA Buildings Data Report"),[10] DOE Appliance Standard Technical Support Documents,[11] DOE Lighting Market Model,[12] 2023 RSMeans database,[13] and 2020 *Grid-Interactive Efficient Building Technology Cost, Performance, and Lifetime Characteristics* report ("GEB Data Report"),[14] as well as new data from online retailers, stakeholder interviews, and contractor databases in 2023 and 2024.

Each technology in the B-TB has a list of key sources used for data collection, which is listed in the "Data Sources by Technology" section of the B-TB spreadsheet.

More information about each dataset is given in the following sections.

National Residential Efficiency Measures Database

The NREMDB has been used in residential building energy modeling software, such as BEopt and ResStock, since around 2012. Cost data for almost all technology categories were updated in 2024. The NREMDB provides regression coefficients and intercepts for different components to calculate low, mid, and high (10th, 50th, and 90th percentile, respectively) material price estimates and labor multipliers or add-ons to estimate residential new construction and retrofit project costs. The dataset provides a list of envelope and non-envelope components (e.g., windows, water heaters) and any associated classes within those components (e.g., electric instantaneous). The NREMDB was built out primarily using publicly available retail price data and RSMeans Construction cost data. These regressions from the NREMDB were reformatted and used in the B-TB as the Reference scenario (see the Projections and Scenarios section for a description of the Reference scenario). For technologies in the NREMDB, the B-TB uses the price regression data directly for the 2024 data points.

EIA Buildings Data Report

The 2023 EIA Buildings Data Report provides data on retail and installation costs and efficiency levels for residential and commercial building equipment for the years 2012 to 2050. Changes to minimum energy efficiency standards and costs are captured within this report through consultation with subject matter experts. These data are used in the EIA National Energy

[9] NREL. 2025. National Residential Efficiency Measures Database. Accessed Feb. 28, 2025. remdb.nrel.gov/.
[10] EIA. 2023. *Updated Buildings Sector Appliance and Equipment Costs and Efficiencies*. www.eia.gov/analysis/studies/buildings/equipcosts/pdf/full.pdf.
[11] Various DOE Appliance Standard Technical Support Documents accessed through https://www.regulations.gov/
[12] Yamada, M., J. Penning, S. Schober, K. Lee, and C. Elliott. 2019. *Energy Savings Forecast of Solid-State Lighting in General Illumination Applications*. Washington, D.C.: U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. DOE/EERE 2001. www.energy.gov/sites/default/files/2020/02/f72/2019_ssl-energy-savings-forecast.pdf.
[13] RSMeans. 2025. RSMeans Online. Accessed Feb. 28, 2025. www.rsmeansonline.com/.
[14] Nubbe, V., K. Lee, A. Valdez, E. Barbour, and J. Langevin. 2021. *Grid-Interactive Efficient Building Technology Cost, Performance, and Lifetime Characteristics*. Berkeley, CA: LBNL. LBNL-2001375. escholarship.org/uc/item/44t4c2v6.

Modeling System for EIA Annual Energy Outlook products. They are also used in the DOE Scout model. The data are provided for typical (average) products, high (highest efficiency available), current standard levels, and ENERGY STAR® levels when available. The costs and performance are projected with two scenarios: a Reference scenario and an Advanced scenario. The B-TB used the typical and high characteristics of the technologies and measures in the EIA Buildings Data Report to inform them of the typical and high characteristics of its own technologies and measures. Where typical characteristics did not exist in the EIA Buildings Data Report, they were calculated based on the median values of the data collected. Additionally, for some technologies (i.e., most commercial technologies in the EIA Buildings Data Report), the B-TB used the price data collected for the EIA Buildings Data Report to build retail price regressions, typical price points, and projected prices and performance for the three scenarios to 2050. In addition, for most technologies in the EIA Buildings Data Report, the Reference and Advanced scenario projections in the EIA Buildings Data Report were used to develop the projections of price and performance for the Advanced scenario in the B-TB.

DOE Lighting Market Model

The LED lighting performance and price data for the B-TB were collected from a preexisting Guidehouse database and model. These data were gathered in 2020 from various online retailers. The DOE Lighting Market Model was developed in 2018 for the DOE Solid-State Lighting Program and is used to predict solid-state lighting efficacy, lifetime, and price changes over time (for more information on the model, see the DOE *Energy Savings Forecast of Solid-State Lighting in General Illumination Applications* report).[15] For the B-TB, the 2020 pricing data were inflated to 2023 using the Producer Price Index for Electric Lighting Equipment Manufacturing to convert between 2020 and 2023 dollars. Lighting performance and price projections for the B-TB were made using the DOE Lighting Market Model.

GEB Data Report

The GEB Data Report provides information on current and projected performance, cost, and lifetime characteristics for residential and commercial building technologies and equipment with the potential to provide grid services. For each technology, characteristics are provided for a typical case and a connected or grid-interactive case for years 2020–2050. For many technologies from the GEB Data Report, the B-TB used the information in the GEB Data Report to create retail price regressions, projected prices and performance levels, and typical and high-performance characterization. In some cases, new data were collected to supplement existing price data.

Commercial Building Cost Data Newly Collected for the B-TB

For products considered within scope of the B-TB but not contained in the NREMDB, EIA Buildings Data Report, or GEB Data Report, new data—primarily for commercial building technologies—were collected to develop the B-TB retail price regressions and typical price points for all projected years and scenarios. Some technologies were contained in EIA, which provides high-level point value pricing. In these instances, more data were collected via RSMeans, manufacturer interviews, or other literature reviews. When there were not well-

[15] Yamada, M., et al. 2019. *Energy Savings Forecast of Solid-State Lighting in General Illumination Applications*. DOE. DOE/EERE 2001. www.energy.gov/sites/default/files/2020/02/f72/2019_ssl-energy-savings-forecast.pdf.

documented data beyond the EIA estimates, point values were used to produce a low, mid, and high price range. These new data were collected from publicly available retail price data published by retailers, cost data published in online reports and case studies, and interviews with key manufacturers, vendors, building developers, construction managers, contractors, and subject matter experts. When available, projections for each scenario are based on historical trends, available market research reports, and insights from researchers and subject matter experts.

Description of Dataset

Identifiers

As shown in Table 2, the “Identifiers” portion of the dataset shows the row number, B-TB version year, end use category, fuel type, most granular NREMDB technology/measure, most granular EIA/Scout technology/measure, component, technology/measure, display name, and output units. The B-TB version year shows the version of the B-TB the row is referencing. The “Output Units” column describes what the units of final output of the regression will be (e.g., 2023$ or 2023$/sq. ft.).

The “Most Granular NREMDB Tech/Measure” and “Most Granular EIA/Scout Tech/Measure” columns allow users to map the technologies and measures in the dataset to the technologies in the NREMDB and 2023 EIA Buildings Data Report, respectively. In some cases, the NREMDB technology or measure is more descriptive (most granular); in others, the EIA technology or measure is more granular. For most technologies, the B-TB technology or measure matches the most granular technology or measure. This helps map across EIA, NREMDB, and Scout to show how the technologies are labeled in each of the datasets. When available, the data collected from the NREMDB were used for the price regression analysis data for 2023, and the typical and high-performance characteristics were used from the EIA Buildings Data Report for 2023–2050.

Table 2. Identifiers Example Row

ID	tb_ year	End Use Category	Fuel Type	Most Granular NREMDB Tech/ Measure	Most Granular EIA/Scout Tech/ Measure	Component	Technology/ Measure	Display Name	Output Units
52	2023	Appliance	Electricity	Clothes Washer – Front Load	Residential Clothes Washers (Front-Loading)	Clothes Washer	Front Load	Clothes Washer – Front Load	2023 $

Retail Price Regression

The “Retail Price Regression” sections of the file show the “Coefficient – Low,” “Coefficient – Mid,” and “Coefficient – High” values that correspond to the low, mid, and high quantile regression coefficients (representing the 10th, 50th, and 90th percentile), respectively, that are multiplied against the chosen performance metric values. Each component is fitted via quantile regression to one or two applicable performance metrics depending on the technology. For example, the standard electric clothes dryer technology has size in cubic feet as its only performance metric, whereas the electric storage water heater technology has two performance metrics: universal energy factor (UEF) (unitless) and volume in gallons. Technologies and measures’ performance metrics were chosen based on market research on pricing factors and customer needs. Some components, such as thermostats, have no performance metrics, as there are no measurable performance metrics associated with the product. Other technologies do have performance metrics but do not have a regression analysis because of a lack of available data.

The retail price regressions are meant to capture the national average and are not specific to a particular region (e.g., excluding variations in sales tax).

These sections also contain the high and typical values for each performance metric. The typical values represent the most common level of a given performance metric available on the market and are derived from either a shipment-weighted average of the available performance metric data or the median of the available performance metric data that were collected. The high values generally represent the maximum performance metric value available for the technology on the market.

The “Retail Price Regression” sections of the dataset also contain the name and units of each performance metric, the lower and upper bounds of the regression, and the intercepts associated with the low, mid, and high quantile regression equations. The bounds of the regression are the minimum and maximum values of a given performance metric that were used to create that regression. Table 3, Table 4, and Table 5 show an example of the data provided for the retail price regression for a technology with two performance metrics.

Table 3. Retail Price Regression, Performance Metric 1 Example Row

Coefficient – Low	Coefficient – Mid	Coefficient – High	Metric	Unit	Lower Bound	Typical	High	Upper Bound
−4.53	47.56	−53.47	Volume	ft^3	1	4.5	5	6

Table 4. Retail Price Regression, Performance Metric 2 Example Row

Coefficient – Low	Coefficient – Mid	Coefficient – High	Metric	Unit	Lower Bound	Typical	High	Upper Bound
1.71	0.77	10.66	Annual energy consumption	kWh/yr	50	71	158	158

Table 5. Retail Price Regression, Intercepts Example Row

Int – Low	Int – Mid	Int – High
550.16	718.52	510.30

Calculations Beyond Bounded Values

The lower and upper bounds in the file correspond to the maximum and minimum values for the performance metrics that were used to create the regressions. If a user wants to calculate the price of a technology that has one or both of the performance metric values outside of the listed range, the user should only use the “Coefficient – Mid” and “Int – Mid” values to estimate prices, as there are instances where the 10th and 90th percentile values are unrealistic beyond the upper and lower bounds due to convergence or divergence of the lines beyond the data limits.

Labor and Installed Costs

The installed cost of the technology or measure includes the retail cost and labor cost for installation, as well as any additional upgrades, construction, and removal costs that are needed. Installation labor and removal costs were estimated using a combination of RSMeans data, DOE Appliance and Equipment Standards Program data, and other contractor estimating tools. The total installed cost is calculated in one of two ways depending on the technology or measure. The first method uses an installation multiplier to derive the total installed cost based on the retail price. Installation multipliers are used for technologies that have installation costs that scale with the increasing material or equipment price. The labor multipliers are separated out by installation context: new construction or retrofit. Retrofit contexts include costs for removal or other demolition of existing components, which could include rewiring, upgraded electric panels, and/or a new 240-volt outlet. After getting the estimated retail price from calculating the retail price regression using the coefficients, intercepts, and chosen performance metric input values, the multiplier is used to calculate the total installed cost or cost per square foot. The retail price must be calculated first to use the labor cost multipliers. See Example 1 in the Price Calculation Example section and Table 6.

The second method to calculate the total installed cost is by using adders rather than multipliers. Labor for some of the components does not scale with increasing material or equipment price and has a constant installation cost (e.g., certain types of insulation upgrades). The values are added to the material price regression results to produce the total installed cost or cost per square foot. See Example 2 in the Price Calculation Example section and Table 7. Some technologies use multipliers and others use adders because certain technology labor costs scale with retail price, whereas others do not. Some installed costs for certain technologies scale with the retail price and other performance metrics, like capacity or efficiency, while other products have fixed labor costs. For example, as the capacity and retail price of a water heater increases, the cost of installing it also increases. In the instance of batt insulation, the labor costs do not increase as you increase the R-value and retail price because it takes a similar amount of time to install R-20 insulation as it does R-40.

As discussed, certain retrofit technologies sometimes require additional installation costs, such as electrical panel upgrades. Because these additional costs are only needed in some situations, technology subcategories are added as separate rows that represent the situation where that specific technology would require additional installation measures. For example, there are rows for the “air-source heat pump” technology and “air-source heat pump with new circuit” technology subcategory. The two technologies have the exact same retail price coefficients and intercepts, but the technology subcategory with new circuit has increased installation cost adders to reflect the additional cost of adding a new circuit.

Table 6. Installation Multiplier Example Row

New Construction	Retrofit
1.20	1.38

Table 7. Installation Adder Example Row

New Construction	Retrofit
$3,450	$4,040

Projections and Scenarios

The file provides retail price regression and installation cost data for each component from the base year of 2023 through the projected year 2050 at three different scenarios: Reference, Intermediate, and Advanced. The projection example row is shown in Table 8. Projections in the Reference scenario are considered a business-as-usual scenario, meaning that all policies and programs enacted as of September 30, 2024, will remain in place, but no new policies affecting the price or efficiency of components will be enacted, including appliance standards, R&D funding, and incentives. In the Reference scenario, technologies follow the current trajectory for price and efficiency for new and emerging technologies in the market, while technologies that have an established market generally remain constant. Technological improvements were accounted for in the Reference scenario. The Advanced scenario illustrates the impact of increased innovation and breakthroughs for building technologies. Newer technologies, have significant development opportunities and show higher potential for energy efficiency or cost improvements. When available, projections and assumptions from the Advanced scenario of the EIA Buildings Report are applied to the B-TB data for relevant technologies. When the projections from the EIA Buildings Report are not available, interviews with internal and external subject matter experts as well as broader literature reviews are used to determine the projections out to 2050 for the different cases. The Intermediate scenario is the midpoint between the Reference and Advanced scenarios. Key assumptions for each scenario are provided in the "Notes" column of the "Additional Data" section.

These projections do not include any assumptions on larger economic changes, including inflation/deflation, economic growth/decline, population growth/decline, labor markets, and wages. The projections and different scenarios do not consider specific incentives or rebates in the cost estimates. Incentives and rebates are used as an indicator to understand market trends but are not used to calculate price discounts in the outputs. Lastly, the projections and different scenarios do not account for changes to minimum energy efficiency standards made after September 30, 2024, which generally reduce the overall price for the technologies. Though the EIA Buildings Report includes estimates for the minimum energy efficiency standards, estimates are not guaranteed to be equivalent to the actual changes in minimum energy efficiency.

Table 8. Projection Example Row

Year	Scenario
2040	Advanced

The accompanying data tables and charts provide visuals for each technology's projections for 2023–2050. Figure 1 shows an example of the projected typical and high-efficiency values in Combined Energy Efficiency Ratio (CEER) for residential room air conditioning (AC) for each projection scenario. Figure 2 shows the projected retail prices and new construction/retrofit installed cost for residential room AC for a current 2023 typical technology (CEER 12, 10,000-Btu/h capacity) for each projection scenario.

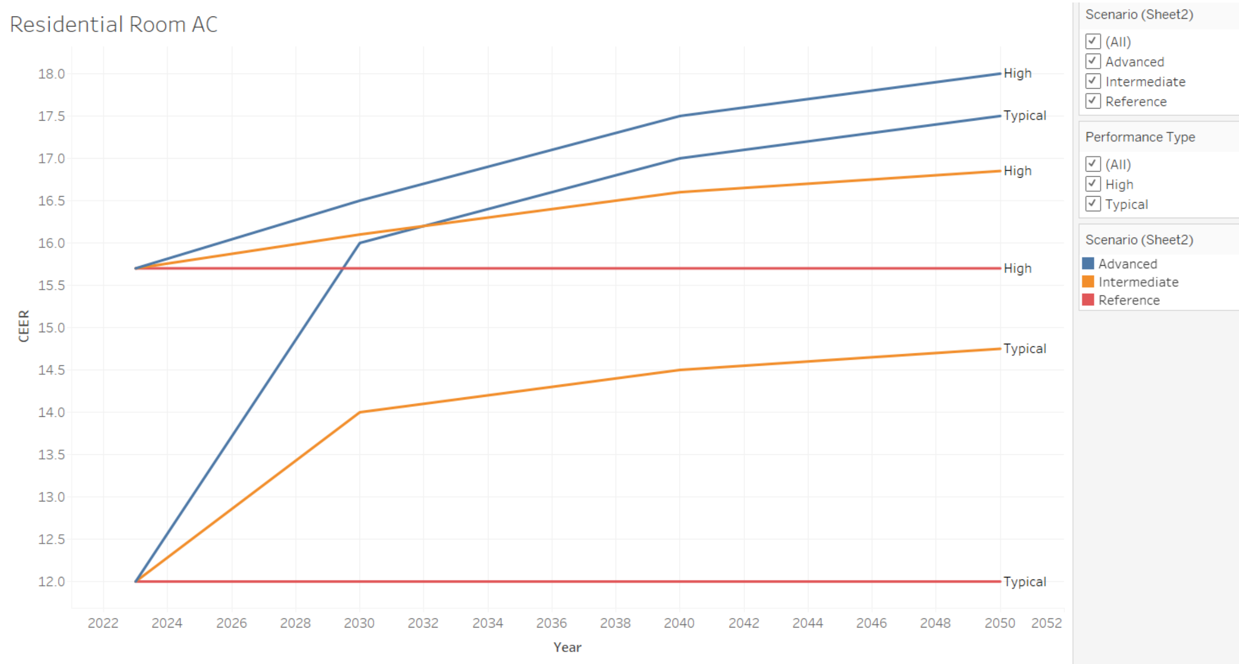

Figure 1. Efficiency Value Projections Example

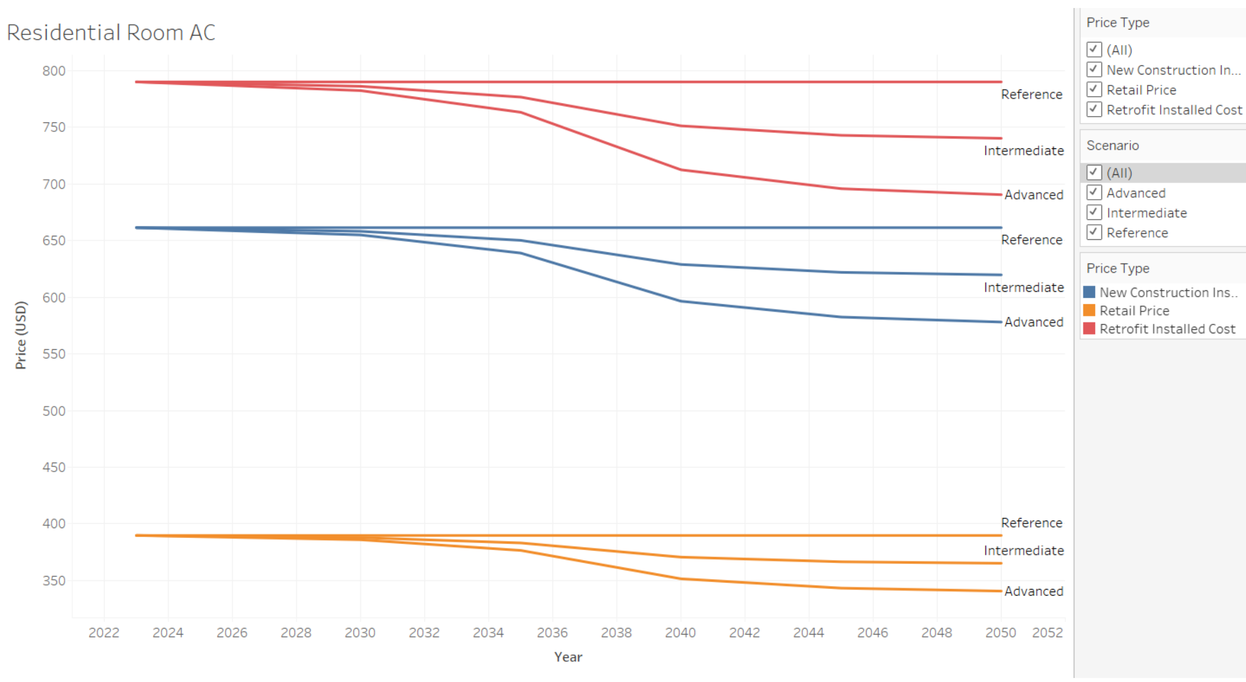

Figure 2. Price Value Projections Example

Additional Data

The last section of the file contains additional data not directly used within the calculation of each component and product class. These include the expected average lifetime (in years) of the component, cost variation considerations, a list of data sources used in the analysis for each component (using a numbering format), and a qualitative confidence rating of the data.

For cost variation considerations, the following implications may have additional impacts on pricing for each component, which are not considered in the retail price regression. The relevant considerations for each technology, if available, are provided in the cost variation column.

- Prevailing local wages
- Drive time
- Access
- Presence/condition/type of existing insulation
- Existing construction and materials
- Moisture issues present
- Condition of existing flue
- Need for condensate line/drain
- Need to bring in combustion air
- Condition of existing electrical system
- Presence of hazardous materials
- Nature/size of leaks
- Extent of preparation.

Each regression includes a set of additional data columns that provide information on the average lifetime of the equipment, cost variation considerations, number of different sources used to collect the data, sample size, median R^2 value (where applicable), average age of the data, and additional notes. Note that certain technologies, such as insulation, have a lifetime of 999 years, which is meant to allow the building simulator to define an analysis range. Insulation and other technologies typically last until the end of life for buildings.

Table 9. Additional Data Example Row

Lifetime (Years)	Cost Variation Considerations	Source Diversity	Sample Size	R^2	Data Age	Notes
21.0	Prevailing local wages, drive time, local code requirements, access …	7	76	0.89	2017	Cost of roof curb adapters is included

B-TB Database Update Methodology

To ensure that the B-TB database contains accurate price information for all relevant technologies, it is recommended to update the database regularly. This methodology includes the procedure of updating the B-TB database, a general schedule for updating the database, and potential steps to support the update of the NREMDB. The significance of relevant market trends and the timing of updates to key data sources for the technologies were used to develop this methodology.

It is recommended that the B-TB database be reviewed annually for minor updates and more extensive updates every 5 years. Low-priority technologies should be updated annually to account for inflation. Higher-priority technologies require a more involved process and should be updated every 5 years, as the EIA report is also updated every 5 years.

A recommended first step in updating the database is to review the graphs and machine-readable file to compare the current prices with the projected prices for the technologies. Obsolete technologies, such as products no longer available on the market, should be removed from the database to ensure that only relevant data are included. Whether a technology is relevant is determined based on market trends and product research at the time the database is updated. Once all irrelevant technologies have been removed, the remaining technologies could be prioritized according to overarching DOE priorities at BTO based on market trends and future projections. An advisory team of various technology subject matter experts could be formed to prioritize technologies and determine which technologies need price and performance projection updates. These meetings could also address any discrepancies in the projections for the technologies. Once the technologies are prioritized, they can be updated. The following is a suggested method for updating the price and performance data:

- For low-priority technologies, update prices using price indices (e.g., HVAC and Commercial Refrigeration Equipment).[16]
    - Retail costs: To scale to current-year dollars, use multipliers for specific industries to see how much inflation has increased for that industry. Apply the multiplier to the retail cost.
    - Labor costs: These costs need to be scaled and can be done in several ways. The following is a list of potential measures that can be used to scale labor costs:
        - Technical support document: If a product has an updated standard, review the technical support document for a labor analysis.
        - RSMeans: Review wage increases for the specific technicians performing the work and then recalculate the total labor cost.
- For high-priority technologies, gather updated pricing and performance (e.g., web scrape, manual data collection, interviews).
    - Use the source documentation, links, and descriptions to reevaluate the data.

[16] Federal Reserve Bank of St. Louis. 2025. "Producer Price Index by Industry: HVAC and Commercial Refrigeration Equipment." Last updated Feb. 13, 2025. fred.stlouisfed.org/series/PCU3334133341.

    - Rerun the regressions to generate new selling-price curves.
    - Update labor costs based on newly published standards and RSMeans data.
    - Check for updated EIA building analysis to use for technology projections.

In addition to the above updates, update the price based on regional differences, as costs vary by location. The following is a suggested method for accounting for regional price differences:

- Gather data for location factors to incorporate into the B-TB database.
- Add a multiplicative factor for the location factor in the technology database to update the price of the technology.

Because there are similarities in the data between the B-TB and NREMDB databases, contact the National Renewable Energy Laboratory (NREL) and discuss sharing updated data for both databases. Prior to meeting, the B-TB team should share an expected cadence for updates and the data sources included in the B-TB database.

Price Calculation Example

Example 1: Heat Pump Water Heater (Retrofit Installation adder)

Example for calculating the low, mid, and high retail price, along with the associated labor for replacing a typical gas water heater with a 60-gallon, 3.33-UEF heat pump storage water heater that does not require a panel upgrade. The numbers in red correspond to the different coefficients in the flat CSV file for the two performance metrics and the low, mid, and high regressions:

$$A \times 3.33 + B \times 36 + C = price$$

Where A is the UEF coefficient, B is the volume coefficient, and C is the intercept value (constant).

Low retail price: 376.15 × 3.33 UEF + 28.4 × 60 gal + -824.65 = $2,131.93

Mid retail price: 511.48 × 3.33 UEF + 26.2 × 60 gal + -973.30 = $2,301.93

High retail price: 840.78 × 3.33 UEF + 12.6 × 60 gal + -676.84 = $2,880.96

To produce the total installed cost, use the retrofit labor multiplier (if this was for new construction, the new construction multiplier would be used):

Low installed cost: $2,131.93 + 1,018.19 = $3,150.12

Mid installed cost: $2,301.93 + 1,018.19 = $3,320.12

High installed cost: $2,880.96 + 1,018.19 = $3,899.15

Therefore, the median material price is $2,301.93 and the labor cost is $1,018.19, for a total installed cost of $3,320.12. The installation costs here include labor and equipment costs for demolition, removal, and a new circuit.

Example 2: Crawlspace Wall Closed Cell Spray Foam Insulation (Retrofit Installation multiplier)

Example for calculating the low, mid, and high retail price, along with the associated labor for replacing (retrofitting) crawlspace wall insulation with an R-value of 20, using closed cell spray foam insulation. The numbers in red correspond to the different coefficients in the machine-readable CSV file for the performance metric and the low, mid, and high regressions:

$$A \times 20 + C = price$$

Where A is the R-value coefficient and C is the intercept value (constant).

Low material price: 0.21 × 20 R-value + 0.0 = $4.20/sq. ft.

Mid material price: 0.30 × 20 R-value + 0.03 = $6.03/sq. ft.

High material price: 0.62 × 20 R-value + 0.0 = $12.40/sq. ft.

To produce the total installed cost, use the retrofit labor multiplier:

Low installed cost: \$4.20/sq. ft. × 1.28 = \$5.38/sq. ft.

Mid installed cost: \$6.03/sq. ft. × 1.28 = \$7.72/sq. ft.

High installed cost: \$12.40/sq. ft. × 1.28 = \$15.87/sq. ft.

Therefore, the median material price is \$6.03 per square foot and the labor cost is \$1.69 per square foot, for a total installed cost of \$7.72 per square foot. *Note that in this example the labor cost is calculated by subtracting the material price from the installed cost*.

Data Dictionary

Table 10. Data Dictionary

Column Name	Definition
Technology ID	Unique identifier for each technology or measure
B-TB Year	B-TB version year
Sector	Residential or commercial (non-residential)
End Use Category	End use category of the technology. (e.g., HVAC, refrigeration, lighting)
Component	The component associated with the technology or measure
Technology/Measure	The technology or measure name
Fuel Type	Fuel type associated with the technology or measure (e.g., gas, oil, electricity)
Display Name	The full displayed name, including the component, of the technology or measure
Regression Output Units	Output units for the price regression (i.e., 2023$ or 2023 $/sq. ft.)
Mapping to Most Granular NREMDB Tech/Measure Name	The most detailed NREMDB class associated with the technology
Mapping to Most Granular EIA/Scout Tech/Measure Name	The most detailed EIA class associated with the technology
Regression metric 1 - Coefficient-Low	Regression coefficient for metric 1, low estimate (typically 10th percentile)
Regression metric 1 - Coefficient-Mid	Regression coefficient for metric 1, middle estimate (typically 50th percentile)
Regression metric 1 - Coefficient-High	Regression coefficient for metric 1, high estimate (typically 90th percentile)
Regression metric 1 - Metric	Performance metric to characterize technology/measure (e.g., efficiency, capacity, size)
Regression metric 1 - Unit	Unit associated with the performance metric
Regression metric 1 - Lower Bound	The lowest value of the performance metric used in the retail price regression
Regression metric 1 - Typical	Typical value for the performance metric
Regression metric 1 - High	Highest value of the performance metric seen on the market
Regression metric 1 - Upper Bound	The highest value of the performance metric used in the retail price regression
Regression metric 2 - Coefficient-Low	Regression coefficient for metric 1, low estimate (typically 10th percentile)
Regression metric 2 - Coefficient-Mid	Regression coefficient for metric 1, middle estimate (typically 50th percentile)
Regression metric 2 - Coefficient-High	Regression coefficient for metric 1, high estimate (typically 90th percentile)

Column Name	Definition
Regression metric 2 – Metric	Performance metric to characterize technology/measure (e.g., efficiency, capacity, size)
Regression metric 2 – Unit	Unit associated with the performance metric
Regression metric 2 - Lower Bound	The lowest value of the performance metric used in the retail price regression
Regression metric 2 – Typical	Typical value for the performance metric
Regression metric 2 – High	Highest value of the performance metric seen on the market
Regression metric 2 - Upper Bound	The highest value of the performance metric used in the retail price regression
Regression Intercept - Low	Retail price regression intercept, low estimate (typically 10th percentile)
Regression Intercept - Mid	Retail price regression intercept, middle estimate (typically 50th percentile)
Regression Intercept - High	Retail price regression intercept, high estimate (typically 90th percentile)
Typical unit multiplier	For rows where the regression results in output units other than absolute dollars (2023$), this value is used to calculate typical prices in the subsequent columns (e.g., 900 ft^2)
Typical unit multiplier units name	Name of units for unit multiplier (e.g., Square feet)
Typical unit multiplier units abbreviation	Abbreviation for units of unit multiplier (e.g., ft2)
Typical Retail Price ($2023) - Low	The typical retail (i.e., without installation) price of the technology/measure using low estimates of coefficients and intercept.
Typical Retail Price ($2023) - Mid	The typical retail (i.e., without installation) price of the technology/measure using middle estimates of coefficients and intercept.
Typical Retail Price ($2023) - High	The typical retail (i.e., without installation) price of the technology/measure using high estimates of coefficients and intercept.
Installation Multiplier - New Construction	Installation cost multiplier for new construction. Typically includes installation labor as well as markup for overhead and profit.
Installation Multiplier - Retrofit	Installation cost multiplier for retrofits. Typically includes installation labor as well as markup for overhead and profit.
Installation Adder - New Construction	Installation cost adder for new construction. Typically includes installation labor as well as markup for overhead and profit.
Installation Adder - Retrofit	Installation cost adder for retrofits. Typically includes installation labor as well as markup for overhead and profit.
Typical New Construction Installed Cost ($2023) - Low	The typical cost to purchase and install the technology/measure in new construction using low estimates of coefficients and intercept.
Typical New Construction Installed Cost ($2023) - Mid	The typical cost to purchase and install the technology/measure in new construction using middle estimates of coefficients and intercept.
Typical New Construction Installed Cost ($2023) - High	The typical cost to purchase and install the technology/measure in new construction using high estimates of coefficients and intercept.

Column Name	Definition
Typical Retrofit Installed Cost ($2023) - Low	The typical cost to purchase and install the technology/measure as a retrofit using low estimates of coefficients and intercept.
Typical Retrofit Installed Cost ($2023) - Mid	The typical cost to purchase and install the technology/measure as a retrofit using middle estimates of coefficients and intercept.
Typical Retrofit Installed Cost ($2023) - High	The typical cost to purchase and install the technology/measure as a retrofit using high estimates of coefficients and intercept.
Projection Year	The year that the retail price data applies to
Projection Scenario	Projection scenario that the retail price data applies to
Lifetime	Expected average equipment lifetime
Cost Variation Considerations	List of factors that may lead to variation in the retail price and instillation cost of this technology/measure
Source Diversity	Number of different data sources used in regression
Sample Size	Number of data points used in the regression
R-squared value	Measure that assesses how well regression fits to the data
Data Age	Average year the data for the regressions is from
Notes	Brief note on additional information