

## **ENERGY STAR® Windows, Doors, and Skylights Response to Comments (Part 1)**

The U.S. Environmental Protection Agency (EPA) received many comments in response to the Discussion Guide that was issued in September 2019. EPA's research and analysis related to a potential Version 7.0 criteria revision are ongoing; however, in the interest of transparency and stakeholder participation, EPA will be responding to these comments in two parts:

1. This Response to Comments document (Part 1) addresses the methodology and data sources that EPA will be using for its analyses. Specifically, this document answers questions and provides additional background data related to the following:
  - a) Energy savings analyses conducted by national laboratories
  - b) ENERGY STAR market share
  - c) Component cost research
2. EPA plans to respond to the remaining comments in a second Response to Comments document (Part 2) when the Criteria Analysis Report is released in late 2020 (estimated).

### [National Laboratory Energy Savings Analysis](#)

EPA received several comments related to the energy modeling analyses that are being conducted by two national laboratories:

- Several commenters expressed support for the use of the new EnergyPlus™, a whole building energy simulation tool developed by Lawrence Berkeley National Laboratory (LBNL) and the National Renewable Energy Laboratory (NREL).
- One commenter described EnergyPlus as becoming the standard for commercial building design professionals and building science, but noted that it is not commonly used by residential designers and contractors.
- Two commenters expressed support for efforts to address concerns about previous analytical methods, including those used in the development of Version 6.0.
- Several commenters also requested that EPA make its assumptions, data, and models available to the public with sufficient time to allow for stakeholders' review, input, and, if necessary, refinement prior to EPA reaching any conclusions based on such a model.
- Several commenters suggested additional modeling details that they wish to be considered, including:
  - Following the building modeling assumptions and approach used in the latest International Energy Conservation Code (IECC) model code determinations;
  - Ensuring that data inputs on housing stock and construction, residential energy consumption, climate, and so forth are the most up-to-date available;
  - Considering newer weather cycles, noting that American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 169, using weather data from more recent times, rearranges the climate boundaries and has already been accepted into the 2021 IECC;
  - Aggregating energy savings regionally, weighted by county-level existing houses;

- Addressing whether calibration will be used, and if so, what it adds to the viability of the program criteria;
- Incorporating regional gas and electric prices into the cost-effectiveness analysis;
- Including heating, ventilation, and air conditioning fan energy; and
- Including both equal and asymmetrical distributions of window orientation in the analysis.

**EPA Response:**

EPA strives to use the best available energy modeling expertise, standardized methodology, and up-to-date input data. To accomplish this goal, EPA has solicited the expertise of LBNL and NREL to perform the energy modeling for this effort.

EPA understands that stakeholders have an interest in the assumptions, input data, and models that will be used to perform the analysis. At this time, the analyses are ongoing, and certain inputs may change. EPA will provide complete information about all inputs and assumptions in the Criteria Analysis Report. Commenters will be provided with sufficient time to review these inputs and provide comments on the analysis, as with any ENERGY STAR specification proposal.

Regarding the modeling details:

- Both national laboratories are using updated versions of the EnergyPlus modeling software to perform the analysis. Specifically, LBNL is using EnergyPlus Version 8.9, and NREL is using EnergyPlus Version 9.2.
- LBNL is using the 2006 U.S. Department of Energy Pacific Northwest National Laboratory (PNNL) IECC Residential Prototype Building Model for single-family homes. The version from 2006 was specifically chosen because this struck a balance between older existing homes typical for replacement windows and new construction homes. NREL has compiled its own data on regional housing stock characteristics through a program called ResStock, which it will use for its analysis.
- Both laboratories are using 2009 Residential Energy Consumption Survey (RECS) data, 2010 U.S. Census data, and updated market share data from Ducker Worldwide. The 2015 RECS data cannot be used as it does not contain detailed regional information.
- Both laboratories are using Typical Meteorological Year 3 (TMY3) weather data, which is updated from the last specification revision. Other options, such as NASA’s Modern-Era Retrospective analysis for Research and Applications (MERRA) Climate Forecasting Models, have numerous differences with TMY3 measured weather data, and experts have not yet addressed the discrepancies.
- Energy savings will be calculated by LBNL using 130 cities geographically distributed across the United States. The NREL ResStock model will use 216 cities geographically distributed across the contiguous United States. Each city used the model that is associated with a TMY3 weather data record. The cities from both data sets represent more than 85 percent of the U.S. population. EPA will use a population-weighted average to roll-up city savings into estimates for Census regions, IECC climates zones, and ENERGY STAR climate zones.
- LBNL had used a calibration of RECS data in previous analyses, but did not include any calibration for this ENERGY STAR analysis. The NREL ResStock model was calibrated to 2009 RECS household annual energy use data for electricity and natural gas, including breakdowns by various home characteristics, to verify that the aggregated or average household results were not obscuring discrepancies among subgroups of homes.

- Both LBNL and NREL analyses will produce site energy data. Results can be converted into source energy data as needed. To calculate carbon dioxide emissions savings, this data would need to be converted to source energy.
- Since EnergyPlus is being used for both analyses, fan energy is included. The fan was sized for the PNNL IECC baseline.
- Both analyses assume an even distribution of glazing around the vertical surfaces of the house. EPA will conduct additional sensitivity analyses on other window distributions, such as predominantly East/West or North/South orientations, to consider energy as part of the Criteria Analysis Report.

## Market Share

The second major area of interest among commenters was market share data:

- Several commenters suggested that more detailed segmented market data are essential to understanding where the current ENERGY STAR saturation is highest, and where opportunities exist geographically to focus efforts on growing market share. Some commenters specifically suggested that EPA disaggregate ENERGY STAR market share by the following attributes:
  - *Product category (windows, doors, and skylights)*
  - *Climate zone and market segment*
  - *New construction versus remodeling/replacement applications*
  - *Hinged doors by slab glazing categories, as defined by the National Fenestration Rating Council (opaque, ¼ lite, ½ lite, and full lite)*
- Two commenters suggested that the market share for ENERGY STAR windows in the Northern Zone is substantially lower than the 84 percent figure presented in the Discussion Guide.
- Two commenters indicated that there are physical and economic barriers to increasing market share, citing that ENERGY STAR market share has stabilized at a high level and has not significantly increased for windows or doors in the past five years.
- Two commenters stated that an increase in the stringency of U-factors in Version 7.0 would lead to added costs, and this could discourage the purchase and use of ENERGY STAR windows, doors, and skylights.
- One commenter stated that if more than 80 percent of all windows sold are now ENERGY STAR certified, the ENERGY STAR label is less effective as a differentiator in the marketplace and does not give manufacturers a clear value proposition.
- One commenter noted that the ENERGY STAR market share for windows, doors, and skylights is much higher than the standard EPA goal of 25 percent for any given product category. The commenter further stated that the market share increased for all three product categories following the Version 6.0 criteria revision, and therefore, it is time to revisit the specification.
- Two commenters noted that ENERGY STAR certification is often a minimum expectation for consumers and “big box” retailers.

- Two commenters stated that building codes often require ENERGY STAR certification for fenestration products, so it would be expected that the percentage of certified products would remain high out of necessity.
- One commenter stated that the low market share and sales for triple-pane products, including those that meet ENERGY STAR Most Efficient criteria, indicate that there is little consumer interest in triple-pane performance due to the high cost and long payback.

**EPA Response:**

To address commenters' requests, EPA has provided excerpts from the DuckerFrontier 2019 ENERGY STAR Window & Door Tracking Program report (Ducker Report) in Appendix A of this document to allow interested parties to review market share data by product type and climate zone. The 2019 Ducker Report is copyrighted, and the national sales data in the report utilizes information from the Fenestration and Glazing Industry Alliance's (FGIA) U.S. Industry Market Studies, which is available through FGIA's online store.

**Component Cost Research**

In the Version 7.0 Discussion Guide, EPA proposed a three-part methodology for cost research, including component costs, manufacturer-provided costs, and costs provided by consumer-facing dealers and retailers.

- Two commenters indicated that EPA's proposed three-part methodology for estimating costs was acceptable, and stated that it would likely be more accurate than methodologies used in the past.
- Several commenters opposed the use of component costs because such costs are proprietary and not representative of the total cost of the assembly or the value to consumers.
- One commenter stated that component pricing varies among manufacturers because they buy different quantities in different regions.
- One commenter cautioned that component suppliers will want to keep their pricing confidential.
- One commenter stated that the changes required to implement performance improvements often extend beyond material costs, including substantial capital investment in equipment, redesign of window extrusions, retooling production lines, or the additional cost of labor. The commenter suggested that EPA should consider the total true cost to manufacturers of keeping their products ENERGY STAR certified.
- One commenter stated that the cost of the component upgrade will need to be adjusted to reflect retail/supplier mark-up, but it will be difficult to determine the appropriate adjustment.
- One commenter recommended that EPA evaluate component costs, because advances in window technology, including thin triple insulating glass units (IGUs) that can fit in current frame designs, may show that the incremental cost can be much lower than the conventional notion that a 0.01 decrease in U-value requires a \$1/ft<sup>2</sup> increase in product cost.

EPA also received several comments about the costs provided by manufacturers, dealers, and retailers, which it will take under consideration as it conducts research. EPA will respond to those comments further in the Response to Comments document (Part 2).

**EPA Response:**

EPA recognizes the difficult issues raised by commenters and appreciates the feedback provided. Cost data for this product category are very difficult to gather and vary over a wide range. EPA is still in the process of collecting data from several different sources, as was discussed in the December 2014 presentation and the 2019 Discussion Guide.

EPA has gathered estimated component cost data focusing on technologies that can improve U-factors and lower solar heat gain coefficients. These are the costs to manufacturers, not consumers. To develop these estimated cost ranges, EPA collected cost data from various sources, including prices found on the internet, cost data from research reports, discussions with national laboratories, and discussions with industry stakeholders. EPA has combined these data sources into a summary list of estimated component cost ranges, and is now sharing this list with stakeholders and asking for feedback as to whether these cost ranges are reasonable. See appendices B and C.

These cost ranges will help EPA form a basis for evaluating cost increases and product mark-ups for technical improvements to window, door, and skylight products. In addition, understanding the component costs can help explain the incremental costs among different technologies, confirm price estimates from other sources, and estimate the costs for technology pathways that may currently have limited availability.

EPA acknowledges that component costs are only part of the manufacturer's cost and the price ultimately paid by the consumer. As one commenter noted, amortized capital costs, labor costs, and supply chain mark-ups are all important factors. As such, EPA plans to use data from all three sources (manufacturer list prices, retail and dealer prices, and component costs) to evaluate cost-effectiveness.

## Appendix A

### ENERGY STAR Residential Window, Doors, and Skylight Market Share

Market share data produced below is available in the DuckerFrontier ENERGY STAR Window & Door Tracking Program report, published November 2019.

#### Overall ENERGY STAR Market Share by Product Category and Year

Product Category	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Residential Windows	76%	81%	79%	77%	80%	83%	84%	83%	84%	85%
Hinged Entry Doors	70%	71%	73%	74%	76%	77%	79%	78%	80%	79%
All Patio Doors								81%	82%	83%
Skylights	70%	70%	68%	62%	60%	62%	65%	64%	68%	68%

#### 2018 ENERGY STAR Window Market Share by Climate Zone

Climate Zone	All Windows Sold	ES Windows Sold	ES Market Share
Northern Zone	20,450,130	18,357,727	90%
North Central Zone	11,032,300	8,818,744	80%
South Central Zone	14,339,940	12,456,637	87%
Southern Zone	6,333,630	4,526,003	71%

#### 2018 ENERGY STAR Replacement Window Market Share by Climate Zone

Climate Zone	All Windows Sold	ES Windows Sold	ES Market Share
Northern Zone	12,707,360	11,569,228	91%
North Central Zone	6,043,720	5,187,120	86%
South Central Zone	6,938,940	6,330,213	91%
Southern Zone	3,047,980	1,996,244	65%

#### 2018 ENERGY STAR New Construction Window Market Share by Climate Zone

Climate Zone	All Windows Sold	ES Windows Sold	ES Market Share
Northern Zone	7,875,510	6,788,499	86%
North Central Zone	4,481,120	3,631,625	81%
South Central Zone	6,972,240	6,126,424	88%
Southern Zone	4,089,130	2,529,759	62%

#### 2018 ENERGY STAR Skylight Market Share by Climate Zone

Climate Zone	All Skylights Sold	ES Skylights Sold	ES Market Share
Northern Zone	437,800	330,088	75%
North Central Zone	187,653	141,052	75%
South Central Zone	289,398	145,006	50%
Southern Zone	122,349	89,973	74%

**2018 ENERGY STAR Door Market Share by Glazing and Operation**

<b>Door Type</b>	<b>Total Doors Sold</b>	<b>ES Doors Sold</b>	<b>ES Market Share</b>
Sliding Patio Doors	2,921,500	2,416,010	83%
Hinged Patio Doors	876,100	727,385	83%
Entry Doors (non-Patio)	11,000,900	8,671,245	79%
Opaque	2,750,225	2,174,756	79%
< 1/2 Doorlite	3,587,250	2,825,121	79%
> 1/2 Doorlite	4,663,425	3,671,368	79%

## Appendix B

### Residential Window Component Chart – Glass and Coatings

This table contains estimated cost ranges for base components and common thermal and solar gain performance-enhancing technologies. These are the estimated costs to manufacturers, not consumers. To develop these estimated cost ranges, EPA collected cost data from various sources, including prices found on the internet, cost data from research reports, discussions with national laboratories, and discussions with industry stakeholders (without revealing their specific product prices). EPA is sharing this list and asking for feedback as to whether these cost ranges are reasonable. EPA is not asking for specific prices, rather they are seeking confirmation or suggestions to adjust the estimated ranges to improve accuracy. These cost ranges will help EPA form a basis for evaluating cost increases and product mark-ups for technical improvements to window, door, and skylight products.

- The glass is assumed to be for residential insulated glazing unit (IGU) applications (not plate glass or curtain wall glass).
- All glass is assumed to be clear (no tint, no bronze, no reflective coating).
- Coating costs are assumed to be added to surface 2 of double-glazed IGU with 3mm clear glass base unless otherwise stated.

Component Item	Estimated Cost Range (\$/ft <sup>2</sup> )	Notes
Standard 2.5mm clear glass (single-strength annealed)	\$0.20–0.30	For residential IGU fabrication
Standard 3mm clear glass (double-strength annealed)	\$0.25–0.35	For residential IGU fabrication
Standard 3.2mm clear glass (tempered)	\$0.35–0.50 for stock products \$0.50–\$1.00 for special order	For residential IGU fabrication
Thin clear third layer of glass (1.6mm)	\$0.35–0.45	For a thin triple residential IGU fabrication
Single silver sputtered (coating only)	\$0.20–0.40	For surface 3 dual-glazed IGU
Double silver sputtered (coating only)	\$0.20–0.40	For surface 2 dual-glazed IGU
Triple silver sputtered (coating only)	\$0.35–0.75	For surface 2 dual-glazed IGU
Low-E high gain pyrolytic (coating only)	\$0.20–0.40	For surface 2 or 3 dual-glazed IGU
Fourth surface pyrolytic (coating only)	\$0.20–0.40	For fourth (or sixth) surface IGU
Fourth surface indium tin oxide (ITO) sputtered (coating only)	\$0.75–1.00	For fourth (or sixth) surface IGU

## Appendix C

### Residential Window Component Chart – Gases, Spacers, and Frames

Estimated cost ranges for base components and common thermal spacer and frame performance-enhancing technologies:

- Spacers are sold per linear foot.
- There are a variety of frame solutions. We are considering the cost of a 3'x5' foamed or enhanced vinyl frame and welcome additional feedback on the use of wood, fiberglass, or composite frames.

Component Item	Estimated Cost Range	Notes
Air	\$0	
Argon gas	\$0.05–0.20/ft <sup>2</sup>	Including overfill (injection fill or chamber fill)
Krypton gas	\$0.70–1.10/ft <sup>2</sup>	Including overfill
Standard aluminum spacer	\$0.10–0.15/ft	Box or U-shape
Standard tin-plated steel spacer	\$0.10–0.15/ft	U-shape
Warm edge spacer (stainless steel)	\$0.20–0.30/ft	Box or U-shape (range of options)
Foam spacer	\$0.25–0.35/ft	Silicone foam
High-performance spacer	\$0.30–0.40/ft	Top performer – Nonmetal spacer element
Total spacer cost with automation	\$0.35–0.50/ft	Automation costs more but has reduced labor costs.
Expanded polystyrene foam insert for frame	\$8–\$12/window	Cut foam, manually inserted
Spray foam into frame	\$8–\$12/window	Two-part foam (polyiso), manually inserted
Advanced vinyl frame with vinyl foam	≈ \$20/window	Foam added when frame is extruded; there is no labor cost.
Advanced vinyl frame (more chambers)	Additional cost by vinyl weight	Extrude more chambers when fabricating. Performance impact varies by design.
Vinyl commodity price	\$1.40–\$1.60/lb	
3'x5' – Vertical slider – 7/8" slot	18–20 lbs	Dual glaze
3'x5' – Vertical slider – 1-1/8" slot	19–22 lbs	Dual or triple glaze, PG50
3'x5' – Vertical slider – 1-3/8" slot	24–26 lbs	Triple glaze, PG80