



Response to Comments on the Draft 1 Specification Revision

Version 7 ENERGY STAR® for Windows, Doors, and Skylights

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B. General Comments on the Version 7 Draft 1 Proposal

I. Overall Version 7 Proposal

EPA received comments from over 40 organizations and individuals for the Version 7 Draft 1 proposal. Many of the commenters strongly supported the proposal and appreciated the additional in-depth and robust analysis performed to consider the new criteria levels. These commenters supported the proposal based on the current high market share of the program, the abundant availability of better-performing products in the marketplace, the increased resiliency against extreme weather events, and the significant energy savings from energy use reductions consumers would enjoy from higher performing windows. Conversely, several commenters expressed general concern that the proposal advanced the criteria too aggressively and raised some technical questions about the analysis, including the version of EnergyPlus, the assumptions feeding into the cost model, outdated population and weather data, and the use of the CPD, which are covered in greater detail in the following sections.

C. Energy Analysis

I. Baseline

EPA received comments asking for further explanation of the baseline of 0.35 U-factor and 0.30 SHGC used for the energy savings and payback analysis. Commenters suggested that the Version 6.0 criteria should have been used for this analysis. Specific comments included the following:

- Several commenters suggested that the baseline be changed from the “market baseline” of 0.35 U-factor 0.30 SHGC or even “code baseline” of 0.30 U-factor 0.30 SHGC to using Version 6.0 as the baseline for each zone.
- One commenter questioned the baselines used based upon the data presented in the product cost data package as only 8 products had a U-factor above 0.30, five of which were from the same manufacturer.
- Several commenters questioned the baseline given that the market share for ENERGY STAR windows is estimated to be in the 80-90% range.

EPA Response:

EPA thanks stakeholders for their comments on the baseline window performance levels used for the Version 7.0 analysis. EPA determined the market baseline by analyzing the distribution of certified options in the NFRC CPD, reviewing DOE field studies, and conducting mystery shopping of installers, retailers, and distributors. The reasoning behind these choices was explained in the Criteria Analysis Report (CAR). When conducting the mystery shopping, EPA attempted to collect a sample of product lines and performance tiers that represented advancements in energy performance using various technologies in order to identify incremental costs between these tiers rather than the worst-performing products or the entire

range of performance. The more stringent “code” baseline was used in the North because of progressive building codes in several of the Northern states. EPA appreciates that other baselines could have been used for this analysis. However, the baselines chosen are reasonable and show the analysis from two different perspectives. Although the current market share of ENERGY STAR sales is high, the installed base of older windows is much larger. Version 6.0 was not used as a baseline since consumers are very unlikely to replace a Version 6.0 ENERGY STAR window installed in the last few years with a Version 7.0 window.

II. EnergyPlus

EPA received comments identifying an issue with the version of EnergyPlus used for the energy savings and payback analysis. Additionally, commenters asked for more information on the inputs into the model, such as HVAC equipment, equipment efficiencies, and foundation types. Specific comments included the following:

- Several commenters were concerned that the version of EnergyPlus used for the energy modeling included a known error that was fixed in more recent versions.
- Two commenters asked for further details about HVAC and foundation types used in energy modeling.
- One commenter asked EPA to provide the foundation and heating system data for evaluation by industry.
- One commenter asked EPA to consider varying equipment efficiencies in its analysis. The assumed equipment was a minimum efficiency (80 AFUE) furnace; however, EPA did not research the baseline efficiency of a new furnace in different regions or assess how different efficiencies would impact its conclusions.

EPA Response:

EPA thanks the stakeholders for the feedback on the use of EnergyPlus for the Version 7.0 analysis. EPA appreciates all who brought attention to significant updates made in more recent versions of the modeling software. In the early stages of this analysis, EnergyPlus V8.9 was the common version in use. To address the concerns raised, EPA and LBNL elected to rerun the initial analysis and expand it to address lower SHGCs using EnergyPlus V9.5. The results can be found in the data package files released with this document and in the summary tables in [Appendix section III](#).

Before rerunning the model, LBNL and D+R reviewed the approach to update and revise several aspects of the analysis to address suggestions from stakeholders and feedback from Pacific Northwest National Lab (PNNL) modeling experts, including:

- Downloading the IECC 2006 files from the “Complete Set” of residential prototype buildings. The version used was available on September 1, 2021. The files for EnergyPlus

version 9.5 included various changes related to duct leakage. The model can be found here: <https://www.energycodes.gov/prototype-building-models>

- The downloaded files have one model per climate zone and reference the weather file for the representative city in the zone. A model for each of the 132 cities in the analysis was created and the local weather file was referenced for that city. The "Site location, Sizing Period Design Day, and Site Water Mains Temperature" were modified in the IDF file based on the .stat and .ddy files for the specific city.
- Updated population data based on the 2020 Census was used for weighting.
- County-level assignments were checked and a few counties were reassigned to new population centers (See [Appendix section IX](#) and the response to comments on Population Data below)

The results of the EnergyPlus 9.5 analysis showed very similar results in the North and North-Central Zones and improved results in the South-Central and Southern Zones. Based on these results, EPA has opted not to change the prescriptive values for windows. Adjustments to the Equivalent Energy Performance values (Tradeoffs) are addressed later in this document.

It should be noted that LBNL included summaries of the assumed HVAC and foundation types in the Draft 1 Version 7.0 webinar presentation. However, to address the request for more information, additional information on the HVAC and foundation types can be found in [Appendix section V](#) and [Appendix section VI](#) of this document, respectively. There are numerous variables that can impact energy modeling, including HVAC equipment efficiencies and other household characteristics. Attempting to account for the wide variety of scenarios encountered in the real world would not necessarily make EPA's analysis more accurate; in fact, including more variables would slow down the already burdensome analysis and could obscure or skew the impact of window performance on energy use. EPA and LBNL used a standard-efficiency furnace for the analysis to represent a mixture of older homes with poorer efficiency systems and new or updated homes with more modern systems. This simplifying assumption was used as a proxy for systems that can range widely in performance and, therefore, be reasonably representative of the existing housing stock.

III. Population Data

EPA received several comments regarding historical population data and how the populations were assigned to the TMY cities used for energy savings and payback analysis. Specific comments included the following:

- Several commenters were concerned about the use of outdated population data to determine the weightings of cities.
- Several commenters expressed concern about the aggregation of certain populations to particular cities, which would affect the weighting of a particular city within an ENERGY STAR zone. The commenters specifically mentioned International Falls and Duluth, MN.

EPA Response:

EPA appreciates the feedback from the stakeholders in identifying the incorporation of outdated population data in the energy analysis. The outdated population data was inadvertently used from early stages of the analysis. EPA has updated the population data to reflect the most recent 2020 census. Additionally, the assignment of population to the 132 TMY cities used in this analysis was also reviewed. Several counties and the associated populations were re-assigned to different cities. A summary of these adjustments are shown in [Appendix section IX](#). Re-assigning counties within a zone had only a limited impact on the overall results. For example, county populations were re-assigned to Duluth, Kansas City, and San Antonio from International Falls, Wichita, and Houston, respectively, with limited impact on results because these pairs of cities are in the same state and ENERGY STAR zone.

IV. IECC Zone 5

EPA received many comments discussing IECC zone 5 and its inclusion in the ENERGY STAR Northern climate zone. One of the comments which supported this decision was the following:

- One commenter stated that window performance is very different in zone 4 and zone 5 based on the energy savings analysis data package. Zone 5 should continue to be included in the Northern ENERGY STAR zone. If zone 5 is moved to North-Central with weaker U-factor requirements and a cap on SHGC that would harm energy savings in this zone.

EPA also received several comments asserting that IECC zone 5 be included in the ENERGY STAR North-Central zone. Specific comments included the following:

- Several commenters asserted that the IECC climate zone 5 should be moved into the North-Central ENERGY STAR climate zone as opposed to the Northern climate zone because the climate conditions are similar to those of zone 4.
- One commenter asked about the effect on paybacks on moving zone 5 into the ENERGY STAR North-Central zone.
- One commenter asserted that keeping zone 5 in the Northern zone distorts the data because 75% of the population in the Northern zone is in zone 5.
- One commenter asked for an in-depth explanation as to why the EPA has decided to keep zone 5 in the Northern zone.
- One commenter referred to the IECC code that has the same Cooling Degree Day (CDD) thermal criteria (< 6,300; CDD50F) for zones 4 and 5 while zones 6-8 do not have CDD criteria. In addition, the Heating Degree Day (HDD) thermal criteria for zone 4 is between 3,600-5,400 (HDD65F) and is 5,400-7,200 for zone 5, while zones 6-8 span a much higher range from 7,200-12,000.

EPA Response:

EPA thanks the stakeholders for their comments on the assignment of IECC zones within the ENERGY STAR climate zones. As previously mentioned, the entire energy modeling data set was rerun with updated EnergyPlus modeling software (Version 9.5). There continues to be an increase in energy savings with an increase in SHGC in zone 5, just as with the other more Northern IECC zones. Further, keeping zone 5 in the ENERGY STAR Northern Zone will deliver more energy savings and cost savings for consumers. The fact that zone 5 has a large population will mean that the higher-level performance requirement will deliver higher energy savings and comfort to more people. The mentioned IECC zone definitions are relevant in defining the zone boundaries. Those definitions (CDD and HDD) help group together regions by similar climates but do not explain the energy performance trends of the proposed criteria. Therefore, the EPA intends to keep zone 5 in the Northern climate zone for the Version 7.0 criteria.

V. Northern Zone “Islands”

EPA updated the ENERGY STAR climate zone map to align with the IECC 2021 climate zone updates. In doing so, several high elevation areas were identified as Northern zone “islands” within the North-Central climate zone. EPA received comments to change the proposed map to include these areas in the North-Central climate zone. Specific comments included the following:

- Several commenters agreed with the approach of aligning the energy zones with IECC/ASHRAE but recommended removing the Northern zone “islands” in high elevation areas of CA and NC back into the North-Central Zone.
- Several commenters asserted that the islands would create product distribution challenges.

EPA Response:

EPA appreciates the feedback regarding the Northern zone “islands” (isolated counties) in the Draft 1 version of the ENERGY STAR [climate zone map](#). EPA will change the proposed map to include these Northern zone high elevation islands back to the North-Central climate zone. In addition, EPA found a few islands between North-Central and South-Central locations and made those adjustments in the [Draft 2 climate zone map](#). EPA has provided a list of zone adjustments by county in [Appendix section X](#).

VI. TMY3 Weather Data

EPA received comments concerning the use of TMY3 weather data in the energy savings and payback analysis because of concerns about its accuracy. Specific comments included the following:

- One commenter was critical of the use of TMY3 weather data in the energy modeling, claiming it is 30 years old.
- One commenter claimed the inclusion of Class 2 weather stations is troubling because of issues with insolation.

EPA Response:

EPA thanks the stakeholders for feedback on the use of TMY3 weather data in the energy modeling. The use of this data was recommended under the expert advice of LBNL researchers because it is still considered the standard for energy modeling analysis. According to NREL documentation, most of the TMY3 data was collected from 1991-2005, but a few locations include data from 1976-2005. It is not clear which locations have the earlier data. There is no newer TMY3 data available, and there is no TMY4 data. [Appendix section VIII](#) summarizes the cities used for the analysis that are classified as TMY3 Class II sites. One city, Houghton, MI, used for the analysis used TMY2 data. This location was included to help improve geographic distribution analysis. Compared to TMY3 Class I data, Class II does have somewhat higher uncertainty. However, only about 20% of the sites chosen were Class II sites, and the improved confidence in results from utilizing more locations outweighed the small additional uncertainty from the Class II data. EPA also reviewed and consulted with LBNL experts on the concern about insolation (solar radiation) from Class II data raised by commenters. EPA was advised that the experts were not aware of any issue specifically related to insolation significantly impacting Class II data.

VII. Site vs. Source Energy

EPA received several comments discussing site versus source energy of the energy savings analysis. The commenters asserted that source energy would be a more appropriate metric for comparison for energy savings because of the different energy sources used for heating versus cooling energy that is impacted by window performance.

EPA Response:

EPA thanks the stakeholders for raising the issue on the use of site energy versus source energy for the analysis. The policy of the ENERGY STAR program is to use site energy for its program analyses. However, given the complexity of energy tradeoffs for windows between heating and cooling energy from different energy sources, the EPA has applied a source energy factor (1.05 for natural gas and 2.8 for grid electricity) to the energy analysis results to consider the effects.¹

¹ "Portfolio Manager Technical Reference: Source Energy" ENERGY STAR Portfolio Manager. October 2020.

Table 1 summarizes the total site versus total source energy savings for the proposed tradeoffs and also breaks this out between electrical and gas energy savings for each.

Table 1. Comparison of Site versus Source Energy Savings over Market Baseline for Proposed Tradeoffs

Energy Star Zone	U-factor	SHGC	Total Site Energy Savings (GJ)	Site Electricity Energy Savings (GJ)	Site Gas Energy Savings (GJ)	Total Source Energy Savings (GJ)	Source Electricity Energy Savings (GJ)	Source Gas Energy Savings (GJ)
Northern Prescriptive	0.22	0.30	9.3	0.4	8.8	10.5	1.2	9.3
Northern Tradeoffs	0.23	0.35	10.1	-0.2	10.3	10.3	-0.5	10.8
	0.24	0.35	9.3	-0.2	9.5	9.5	-0.6	10.0
	0.25	0.40	10.1	-0.9	11.0	9.1	-2.5	11.6
	0.26	0.40	9.4	-0.9	10.4	8.3	-2.6	10.9

Analyzing source energy savings for the Northern Zone tradeoffs confirms that these tradeoffs reduce total source energy thanks to significant heating energy savings; however, source energy savings are slightly lower for the tradeoffs due to higher energy losses for electric cooling energy. While source energy savings are not exactly “equivalent,” savings for gas heating increase with the tradeoffs, which some consumers may value more heavily than cooling. EPA plans to advise consumers of the potential for cooling energy losses when selecting high gain windows and provide guidance on how cooling energy can be reduced with common window attachments or other solutions.

VIII. Modeling Calculations

EPA received several comments asking for clarification of some calculations and the approach used as compared to model energy code standards. The specific comments include the following:

- Two commenters asked for further explanation on how heating, cooling, and fan site energies were combined when determining total energy.
- Two commenters suggested that EPA look into the methodology employed by PNNL in their energy codes determinations because the transparency and reproducibility are industry standard. The PNNL method uses a rolling baseline which commenters suggested EPA could adopt.

EPA Response:

EPA thanks the stakeholders for the questions about the calculations and approach used for the windows energy analysis. The EnergyPlus software used for the analysis calculates the heating, cooling, and fan site energy for each modeled location. These energy values were combined to determine the total site energy for the home modeled in each city. ENERGY STAR is a national energy efficiency program and typically uses a single national price for electrical energy costs and gas energy costs. EPA went a step further in this analysis to determine a weighted average energy price for electricity and gas for each climate zone. LBNL used standard assumptions based on 2015 Residential Energy Consumption Survey (RECS) data for the energy modeling.² EPA has released a large amount of data, provided detailed explanations of the analysis approach, and had multiple document releases to stakeholders to be transparent throughout this process.

D. Cost-Effectiveness/Payback

A cost data characterization is provided in [Appendix VII](#).

I. Representative Frame Material and Operator Type for Windows

EPA received several comments concerning the cost analysis relying primarily on vinyl double-hung windows.

EPA Response:

EPA thanks the stakeholders for their providing their concerns on the use of vinyl-frame, double-hung windows for the cost-effectiveness analysis. When considering cost-effectiveness, the EPA is trying to answer the question of whether it is possible for a consumer to find an ENERGY STAR certified product that produces cost-effective savings. As explained in the CAR, vinyl-framed windows make up by far the largest share of sales (70+%). No other frame material breaks even 15% of sales. Vinyl is also typically the lower-cost frame material option. In addition, single and double-hung operator types are known to be the most common and worse thermally performing option since there is an extra piece of frame crossing the center of the product. Therefore, EPA focused its analysis on the most common, lowest cost, and worse performing products – single and double-hung products - as it did successfully for the Version 6 analysis.

II. Cost Model

EPA received several comments concerning the cost model used in the payback analysis and the assumption to ignore installation costs. The specific comments included the following:

² <https://www.eia.gov/consumption/residential/data/2015/>

- Several commenters questioned the cost model suggesting that low-cost products were used and that average or mid-range costs should be used instead. This would make the paybacks significantly longer.
- One commenter claimed that the incremental costs are significantly understated and requests a reasonable explanation for how these were determined.
- One commenter disagreed that installation costs can be ignored in the cost model, assuming they would be the same between a non-ENERGY STAR and ENERGY STAR window. Triple pane windows often incur higher installation costs.

EPA Response:

EPA thanks the stakeholders for the feedback regarding the cost model. In the market, consumers can find products at a wide range of cost premiums and performance levels. EPA's analysis found little correlation between price and performance level. EPA found expensive products that had a poor thermal performance level and lower-cost products that had a high-thermal performance level.

EPA's focus was on finding simple, common, low-cost products to identify the actual incremental costs of technologies that improve the thermal performance of the window. Following the ENERGY STAR programmatic approach, EPA did not attempt to identify an average cost because that would include markups that are not related to performance improvements.

EPA also compared the incremental costs to component costs ensuring that those costs were covered with some markup included. EPA provided all cost data collected and charts in the CAR and webinar detailing exactly how the incremental costs were determined. See Figure 11. "Cost Premium for Adding Room-Side Low-e Within a Product Line" and Figure 12. "Cost Premium for Adding Triple-Pane within a Product Line" in the CAR or Slides 18 and 19 from the Draft 1 Webinar. Finally, EPA is not requiring triple-pane windows to meet its proposed criteria. Manufacturers and installers have multiple options to meet the criteria, including high-performance double-pane products, thin triples, or using trade-offs which would allow the use of double-pane products. If a company chooses triple-pane as an option to meet the criteria, current manufacturers and installers of triple-pane products indicate that no-cost or low-cost adjustments can be made during installation to address any additional weight issues that may occur.

III. Appropriate Payback Period

EPA received several comments discussing the time period that constitutes a reasonable payback period for consumers asserting that a shorter payback is required. The specific comments include the following:

- Several commenters have asserted that a payback period of over ten years is not reasonable.
- One commenter claimed that lower paybacks are justified to avoid technology lock-in as new, innovative technologies are introduced into the market.

EPA Response:

EPA appreciates the feedback on acceptable payback periods. EPA addressed this issue in the CAR, citing three studies that show the average homeowner stays in their home for 13 years. All of the payback periods under the proposed criteria, with the exception of the Northern zone when considering the code baseline. Jurisdictions that have adopted the latest IECC building codes often also have access to utility incentives that can reduce the upfront costs and help reduce the payback period. EPA also asserts that the cost of upgraded windows can be partially recouped in the sale of the home since a window improvement adds value to the home. When accounting for this added value, consumers will recoup the value of their investment within seven years.

IV. Product Costs

EPA received several comments concerned about the product costs. Some asserted that the criteria would ultimately lower costs, while others stated that increased costs for manufacturers and consumers would be required to improve the performance levels of windows to meet the proposed Version 7.0 criteria. The specific comments included the following:

- Several commenters asserted that the proposed criteria would ultimately reduce the cost of higher-performing windows.
- Several commenters suggested that the proposed criteria would drive increased product costs for consumers, which are beyond what the consumer would realize in cost savings from the increased energy performance.
- One commenter stated that the cost analysis does not account for challenges in the supply chain currently and provides the example that Krypton has increased in cost by 400%.

EPA Response:

EPA appreciates the feedback on product costs. EPA acknowledges that products meeting the proposed criteria, especially some premium product lines, are more expensive; however, EPA's analysis found multiple high-performance products available for sale at cost-effective prices. The fact that common technology improvements are available and cost-effective today suggests that more manufacturers will be able to offer better-performing products at reasonable prices in the future. EPA acknowledges the current supply chain constraints for

some components but also understands that such constraints are likely temporary, and that Version 7 implementation is at least a year away.

V. Energy Bills

EPA received comments asking that the dollar savings be reported in terms of monthly as opposed to annual energy savings because this would be more relevant to consumers.

EPA Response:

EPA thanks the stakeholders for the feedback on reporting monthly energy savings values to consumers. EPA uses total annual savings values because monthly energy savings vary widely by season. Using annual savings provides a comparable result that consumers can understand.

VI. Fuel Prices

EPA received comments requesting that local, seasonal fuel prices be used for the payback analysis as opposed to the regional energy prices determined by ENERGY STAR climate zones.

EPA Response:

The EPA thanks the stakeholders for their feedback about fuel pricing in the cost savings analysis. ENERGY STAR is a national program. Fuel and electricity prices vary widely between local jurisdictions, and it is impossible to accurately predict how they will change in the future. EPA used EIA energy pricing data^{3,4} and determined a population-weighted average price per ENERGY STAR climate zone. By averaging prices in this way, ENERGY STAR standardizes the price input and focuses more broadly on the question of whether consumers will save energy. Utility programs and product suppliers may also provide more localized cost savings estimates, which include local rebates and incentives. EPA plans to provide some local savings data once the proposed criteria are finalized but before the criteria is implemented.

E. Product Availability

I. Market Share

EPA received several comments about the market share of ENERGY STAR windows, doors, and skylights. Some commenters expressed concern over the high market share, while others asserted that high market share is good for the program. The specific comments included the following:

- Several commenters stated the high market share shows that ENERGY STAR is failing to differentiate higher-performing products in the market. This allows poorer-performing products to get the benefits of ENERGY STAR certification.

³ "Electric Power Monthly with Data for January 2019" EIA, 2019.

⁴ "Natural Gas Monthly with Data for November 2019" EIA, 2019.

- One commenter commended the high market share of ENERGY STAR products as it results in more efficient windows in the market. The commenter also suggested the proposed criteria would lower availability and reduce demand for ENERGY STAR products which would damage the program.

EPA Response:

EPA thanks the stakeholders for their comments on the market share of ENERGY STAR products. Market share is one of several factors that EPA considers when deciding to undergo a criteria revision. EPA recognizes that the current Version 6.0 criteria remained high even after advancing the criteria. As stated in the CAR, a persistently high market share for ENERGY STAR certified products generally suggests that the current specification represents a widely achievable level of performance in the market. Furthermore, the high market share indicates a criteria revision may identify better performing energy-efficient products that deliver cost-effective savings to consumers. There is little indication that the proposed criteria will cause a product availability issue as over 50% of manufacturers currently have certified product lines that achieve the proposed criteria. Rather, EPA believes the revision will drive innovation, lower costs, and increase the availability of high-performing products on the market. EPA has not set a specific target market share for this revision.

II. Market Share Projection

EPA received several comments stating that the proposed specification will lead to fewer sales of energy-efficient windows and lower national energy savings overall. The commenters contend that consumers that may have purchased an ENERGY STAR window at the current Version 6.0 criteria will forego energy efficiency because the proposed criteria are too stringent, leading them to purchase less efficient, code-compliant products. One commenter believes that consumer adoption would drop significantly in the Northern zone because the glazing options that consumers prefer may not be able to meet the proposed criteria. The commenters encouraged EPA to project a lower market share for the proposed criteria and consider whether an efficiency increase on a smaller number of products sold will outweigh the lost opportunity.

EPA Response:

EPA thanks the stakeholders for bringing up their concerns regarding a drop in market share for ENERGY STAR products due to the proposed criteria. EPA analyzed the number of partners with certified products at the proposed Version 7.0 levels, and over half of the partners have certified product lines that meet these criteria. It is difficult to project how the market will respond to the new criteria. Historically, however, market share remained high after the last criteria revision.

III. Market Share Methodology

Several commenters questioned the accuracy of the market share figures calculated in the Ducker report, noting that the data is based on a survey of approximately 40 manufacturers – only 25 percent of program partners, and most manufacturers cannot accurately report the performance of products sold by geographic region. The commenters suggest that market share is lower, especially in the Northern Zone. In addition, EPA received several comments asking for further information regarding the methodology employed by the Ducker Report used to determine the market share of ENERGY STAR products. The specific comments included the following:

- Two commenters questioned the market share reported in the Ducker Report given a small sample size, data limitations, and the inability of manufacturers to provide accurate sales data of specific U-Factor/SHGC criteria in different climate zones.
- One commenter asked for greater insight into how the Ducker Report data is collected.

EPA Response:

EPA thanks stakeholders for their interest in understanding and improving the methodology for determining market share for ENERGY STAR products. The windows program has historically relied on the third-party analysis from Ducker instead of requiring windows partners to provide data directly to EPA as is the standard approach for other product categories. EPA uses this

third party to report on market share because industry made an agreement with DOE to use this specific organization to collect data instead of submitting sales data directly to the government. In addition to sales data collection, the analysis is based on surveys and follow-up interviews with manufacturers and over 100 distributors. EPA acknowledges that the report does not include data from all manufacturer partners and may not be a perfect representation of the market. However, this report does provide a consistent reference point to track changes in observed market share over time and is one of the only datasets available with a historical record. EPA and many stakeholders do believe that the Ducker report provides a reasonable and comparable representation of the marketplace. EPA encourages partners to reach out directly to EPA if they would like the ENERGY STAR program to change the data collection approach for all partners and require submission of sales data directly to EPA.

IV. Triple Pane Windows

EPA received comments about the limited availability of triple pane products and the burden to manufacturers that the proposed criteria would place on manufacturers in providing these product offerings. The specific comments included the following:

- One commenter asserted that triple pane products are less reliable because they are prone to seal failures. In addition, the typical payback for a triple pane product would be 20 years when replacing a double pane product and may require additional custom installation costs because of the increased weight of the product.
- One commenter implored ENERGY STAR to consider that the production capacity of triple pane windows is insufficient, and the proposed specification levels will burden suppliers.

EPA Response:

EPA appreciates the feedback on the availability of triple pane products. The analysis performed for this criteria revision found reasonable paybacks at the performance levels proposed for both high-performance triple and double pane products. EPA does not require a specific technology such as triple panes for the criteria. EPA found that some manufacturers can meet the proposed levels with a double pane product. The tradeoffs in the Northern zone provide further flexibility with performance levels that do not require triple panes. EPA generally does not consider installation costs for these products because they are assumed to be the same. Anecdotally, EPA has heard arguments on both sides of this question. Some companies state that heavier triple pane windows require more labor to install; however, other companies that frequently install triple-pane windows have adjusted their installation practices and claim that there is no differential in the installation costs.

V. NFRC Certified Products Directory (CPD)

EPA received several comments concerning the use of the NFRC CPD as representative of the windows market. The commenters assert that the CPD does not directly correlate to what is offered in the market or products that are sold in significant quantities.

EPA Response:

EPA appreciates the additional feedback on the analysis using the NFRC CPD. EPA has addressed this concern on multiple occasions during the Version 7.0 specification revision. EPA first proposed this approach in the Window Technology Pathways Methodology White Paper in 2017, and stakeholders provided feedback at the time. EPA also addressed this subject in the CAR released with Draft 1 of the Version 7.0 criteria. The NFRC CPD is the most granular data set available for this analysis. EPA acknowledges that it does not represent sales volume or the best-selling products. However, it does represent the typical technologies used at various performance levels. Manufacturers have been unwilling to share sales data with the EPA and may not have granular sales data by performance levels. Please see the white paper and CAR for further details.

VI. Trade Deficit

EPA received comments about the limited availability of high-performing windows in the USA compared to other markets such as Canada and Europe. The commenters supported the criteria because it would increase the availability of these products in the USA market.

- One commenter suggested EPA consider how many higher performing windows are being imported from Canada and Europe because of limited supply in the USA.
- One commenter supported advancing the criteria because markets such as Canada and Europe have greater availability of higher-performing windows, which are not available in the USA because of less stringent codes.

EPA Response:

EPA thanks the commenters for bringing attention to product availability in different markets with more progressive codes. EPA agrees that better-performing, lower-cost windows made in the USA would be beneficial for U.S. manufacturers and consumers. An analysis of trade data for windows shows that the U.S. was a net importer of vinyl and wood windows and doors by - \$258.7 million in 2019.^{5,6} The Version 7.0 criteria could drive innovation and increase the availability of U.S.-made high-performance windows in the market.

⁵ <https://oec.world/en/profile/hs92/windows-french-windows-frames-of-wood>

⁶ <https://oec.world/en/profile/hs92/plastic-doors-and-windows-and-frames-thereof>

VII. New Window Technologies

EPA received a comment about the limited commercial availability of new window technologies such as thin triple pane, vacuum glazing, and aerogels. The commenter asserts that the limited availability of these technologies will force manufacturers to use Krypton gas fills to meet the proposed criteria.

EPA Response:

EPA thanks the stakeholders for their insight into the availability of various window technologies to meet the proposed Northern zone criteria. EPA has presented its pathway analysis methodology in the CAR and used it to identify the common technologies used in the marketplace today to meet various performance thresholds. The proposed criteria do not specifically require triple-pane windows or krypton gas fills. There are also various technology pathways to meet the criteria, particularly in the Northern zone with the equivalent energy tradeoffs.

F. Window Criteria

Several stakeholders provided alternative criteria for EPA to consider. EPA has responded to suggestions for these alternative proposals in the appropriate sections of this document according to the subject matter. See [Appendix I](#) for all alternative proposals for each ENERGY STAR zone.

I. Northern Zone Criteria

EPA received a wide range of suggestions for the Northern Zone criteria. Some wanted EPA to consider more stringent criteria, some supported the proposal, and some expressed concern over the proposed levels. The specific comments include the following:

- Several commenters expressed support for the proposed criteria. The criteria will differentiate better-performing products for consumers and deliver additional energy savings.
- One commenter proposed a U-factor of 0.20 or better to keep up with the market and incentivize manufacturers to innovate.
- Several commenters suggested that the proposed U-factor of 0.22 in the Northern zone is too stringent. It is a larger increase than previous iterations of the criteria revisions and will often require a more expensive, triple-pane product.
- The proposed criteria will disadvantage aluminum-clad wood windows.
- The proposed criteria require room-side low-e coatings, which can lead to increased condensation and comfort issues.

EPA Response:

EPA thanks the stakeholders for their comments on the Northern zone criteria. The updated energy analysis performed for this criteria revision in EnergyPlus version 9.5 shows significant, cost-effective energy savings at the proposed level of 0.22 U-factor. EPA is aware that some products and frame types that have a lower thermal performance will have difficulty meeting

the proposed criteria in the Northern zone; however, the proposal also includes tradeoffs in the Northern zone that allow options and flexibility in how the criteria is met. EPA has reviewed studies on room-side low-e coatings and discussed the technology with glass manufacturers. The technology does slightly lower the inside surface temperature of the glass but should not create significant condensation issues or comfort issues for typical residential windows at the proposed criteria levels.

II. Northern Zone Tradeoffs

EPA received many comments about the equivalent energy savings tradeoffs in the Northern zone. Some commenters supported the tradeoffs because they provide flexibility to the manufacturers in meeting the criteria in the North, while other commenters were concerned about the varying dollar savings between the tradeoffs and potential comfort issues associated with high solar gain products. The specific comments included the following:

- Several commenters supported the SHGC tradeoffs because it provides flexibility for the manufacturers while reducing heat use in the winter which supports the goals of reduced fossil fuel use, de-carbonization, and electrification.
- Many commenters suggested removing the equivalent energy performance tradeoff criteria in the Northern zone. It was suggested that the tradeoffs are not equivalent cost savings which would be more relevant to consumers, the tradeoffs add additional complexity, and the high SHGC values could impact comfort.
- One commenter pointed out that the cost savings is over 30% different from some of the proposed tradeoffs.
- One commenter suggested the higher SHGC windows will increase the cooling costs during the summer months.
- One commenter suggested limiting the tradeoffs so that lower-cost alternatives are not promoted, which have room-side condensation issues.
- One commenter asserted that thermal comfort issues be considered more seriously in the proposal and be considered for the whole year, both in the winter and summer months.
- One commenter suggested that the consumers will not understand the equivalency, especially if it is not based upon cost savings rather than energy savings.
- The tradeoffs conflict with the 2021 IECC codes which has a maximum SHGC of 0.40 in zone 5.

EPA Response:

EPA appreciates the feedback on the energy equivalent tradeoffs in the Northern zone. EPA has successfully allowed tradeoffs in previous criteria revisions which have not led to confusion in the market. A similar approach is also used in other countries such as Canada. The tradeoffs allow flexibility to manufacturers in meeting the proposed criteria and allow consumers to use high-gain products when appropriate in their homes. The tradeoffs are based upon energy

savings equivalency and not energy cost savings equivalency. Additionally, although higher U-factor, high-gain products may have lower energy savings, they may also be less expensive than lower U-factor alternatives leading to a shorter payback period. EPA plans to update its buying guidance to include information on considerations when buying high-gain products.

Based on feedback from stakeholders and updated analysis, EPA has revised its proposal for Northern Zone tradeoffs. The revised proposal allows products with an SHGC ≥ 0.35 to be certified with a U-factor equal to 0.23 or 0.24 and products with an SHGC ≥ 0.40 to be certified with a U-factor equal to 0.25 or 0.26. This revision allows for more options and ensures that ENERGY STAR remains aligned with 2021 IECC codes for IECC zone 5.

III. Minimum SHGC in Northern Zone

EPA received several comments both supporting and expressing concern about the minimum SHGC criteria proposed for the Northern zone. The specific comments included the following:

- One commenter supported the minimum SHGC in the Northern zone because it prevents low SHGC products that are inappropriate for this zone from using the ENERGY STAR label.
- Several commenters suggested removing the minimum SHGC of 0.17 in the Northern zone claiming there is no technical justification for this requirement and will also make it more complicated to meet proposed criteria by limiting grids and other options in some cases. The commenters asked for further justification for this minimum, with market research regarding visual transmittance supporting the assertion that VT values less than 40% are unacceptably dark.
- One commenter suggested further energy savings analysis for SHGC values below 0.17 to confirm if the proposed minimum is justified.

EPA Response:

EPA thanks the commenters for highlighting concerns around the minimum SHGC proposed in the Northern zone. To help clarify this issue and provide additional justification, EPA has evaluated lower SHGC (down to 0.13) performance in the Northern zone in the updated energy analysis. The results show that lower SHGC products consistently save less energy in the Northern zone, as shown in [Figure 1](#). The proposed minimum SHGC is intended to ensure that ENERGY STAR delivers energy savings to consumers by limiting these lower-performing products.

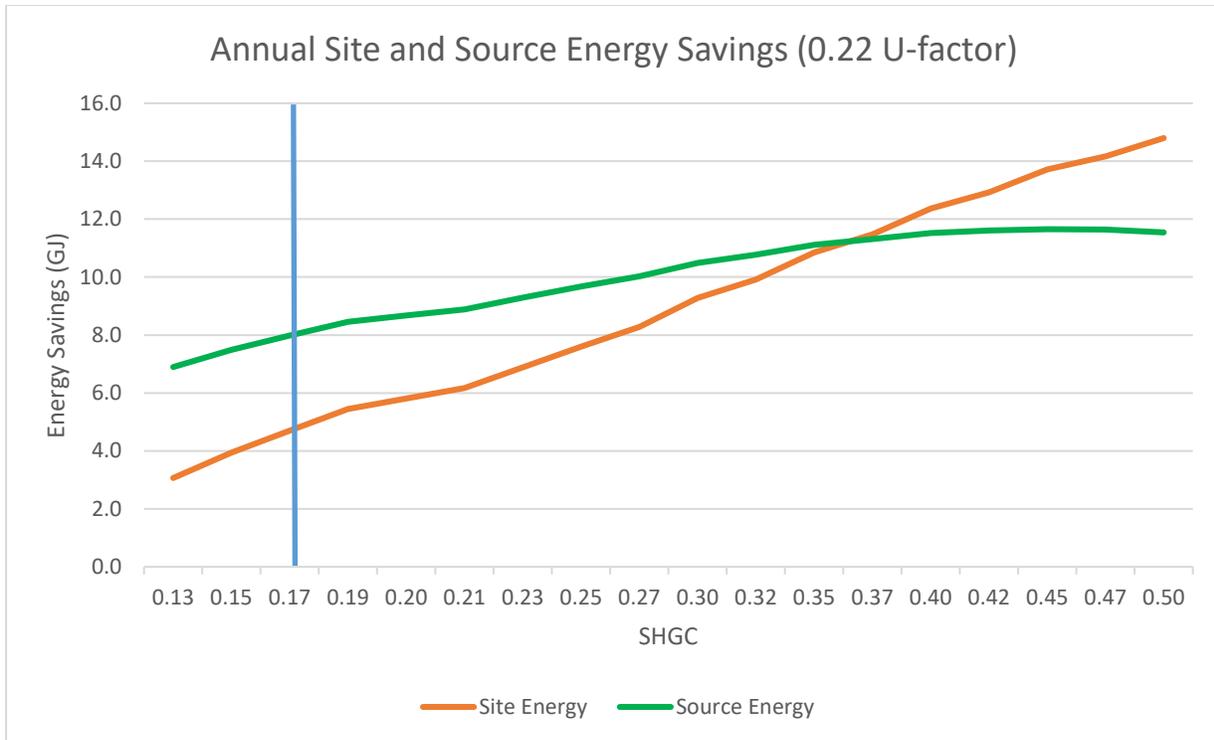


Figure 1. Annual Site Energy Savings at the prescriptive U-factor requirement of 0.22 across varying SHGC levels. The blue vertical line indicates the proposed minimum SHGC of 0.17 in the Northern ENERGY STAR climate zone.

IV. North-Central Zone Criteria

EPA received comments proposing less stringent criteria in the North-Central zone. One commenter suggested the 0.24 U-factor is too low to be achieved with double pane and room side low-E in most products. The commenter claimed that it would be reasonable to require triple pane products as far south as Virginia.

EPA Response:

EPA thanks the stakeholders for feedback on the criteria in the North-Central zone. EPA’s analysis of the CPD demonstrates that there are many double-pane products available at the proposed U-factor levels for the North-Central zone. The technology pathways analysis presented in the CAR shows that there are various technology components that can be used to achieve the proposed levels that include double-pane, triple-pane, low-E coatings, improved frames, gas fills, improved spacers, etc. The criteria do not require a specific technology such as a triple pane.

V. South-Central and Southern Zone Criteria

EPA received comments expressing concern about the maximum SHGC criteria in the South-Central and Southern zones because it may adversely impact certain product types. The specific comments included the following:

- Several commenters suggested that the SHGC requirement be 0.24 or remain at the current 0.25 level for the South-Central and Southern climate zones. The proposed SHGC of 0.23 in both zones would disproportionately affect the use of fixed windows and/or contemporary, low sightline windows. De-incentivizing fixed windows which have low air-infiltration rates would decrease energy performance.
- Several commenters pointed out that other codes such as Title 24 in CA allow weighted averaging and additional performance path options, which are not available for ENERGY STAR and are prescriptive on a unit basis.

EPA Response:

EPA thanks the stakeholders for their feedback on the criteria in the South-Central and Southern zones. EPA performed additional analysis to look at product counts for fixed operator type windows at lower SHGC levels to check product availability. The fixed operator type product would likely have slightly higher SHGCs than other operator types making it more difficult to meet the criteria. [Table 2](#) shows that there are many certified fixed window product lines available at and below the proposed maximum SHGC level of 0.23.

In addition, ENERGY STAR includes an air leakage requirement to ensure a minimum level of performance.

Table 2. Counts of Certified Total Products, Product Lines, and Unique Manufacturers at lower SHGC for Fixed-Windows

SHGC Bins	Total Products	Unique Product Lines	Unique Manufacturers
< 0.145	295,989	419	55
0.145–0.154	60,040	448	60
0.155–0.164	62,273	494	66
0.165–0.174	87,320	540	79
0.175–0.184	105,636	593	88
0.185–0.194	153,019	652	99
0.195–0.204	154,111	702	113
0.205–0.214	165,648	757	123
0.215–0.224	156,696	757	124
0.225–0.234	142,108	758	129
0.235–0.244	142,018	753	127
0.245–0.254	141,193	730	125
0.255+	1,783,519	850	142

Proposed Requirement
≤0.23 SHGC

G. Door Criteria

See [Appendix IV](#) for updated energy savings analysis for doors.

I. Aligning Sliding Door Criteria with Windows Criteria

EPA received many comments opposed to aligning the sliding door criteria with the window criteria. The concerns ranged from the significant change in the criteria for doors under this approach to the constructional differences between doors and windows. The specific comments included the following:

- Several commenters did not agree with aligning the sliding door criteria with the window criteria. Doors are heavier and require different constructional components and reinforcement compared to windows. Requiring a triple pane for sliding doors in the Northern zone would make an already heavy product even heavier and more difficult to ship and install.
- One commenter was also concerned that splitting up the sliding and swinging door criteria could cause general confusion for consumers and cause installation of lower-performing swinging doors that are more easily able to meet ENERGY STAR certification criteria compared to a better-performing sliding door that does not.
- One commenter believed the sliding and swinging door criteria should remain aligned as in V6 but supports the criteria proposed for swinging doors.

EPA Response:

EPA thanks the commenters for bringing up this issue. After some consideration, review of input from commenters, and review of the performance distribution of the products, EPA has decided to revise both the sliding glass door criteria and greater-than half-lite door criteria. The sliding glass door criteria will move back to the swinging door criteria. Both products will have a new U-factor criterion of less than or equal to 0.25. The sliding glass door criteria will adopt the proposed greater than half-lite SHGC criteria. This will align the sliding patio door and swinging-door products and make it easier for sliding glass doors to achieve the criteria.

H. Skylight Criteria

See [Appendix II](#) for all alternative proposals for each ENERGY STAR zone.

I. SHGC

EPA received comments on the proposed SHGC criteria stating that the criteria should be revised incrementally and should be set to preserve the visual transmittance at a level acceptable to consumers.

EPA Response:

EPA thanks the stakeholders for their comments regarding the SHGC criteria for skylights. EPA's analysis of CPD skylight product performance distribution in the CAR showed many products available at the proposed levels and a range of visual transmittance levels as well. EPA is not aware of any analysis on consumer preference of visual transmittance levels for skylights.

II. U-Factor and Energy Savings

EPA received comments asking for further justification for the revision to the skylight criteria because of a lack of energy savings and cost analysis for this product category. The specific comments included the following:

- One commenter did not support the proposed skylight criteria because it was not adequately justified, and the energy model was not configured to model skylight energy.
- One commenter suggested that combining the zones and improving the criteria is too aggressive. The commenter points to the exclusion of skylights from the Most Efficient program due to lack of cost-effectiveness.
- One commenter stated that the analysis for skylights presented in the discussion guide is inconclusive. The mention of the impact on the performance of mounting types has no discussion about what improvements need to be made to curb-mounted skylights or the impact this would have on affordability or cost-effectiveness. Additionally, EPA points to the Canadian ENERGY STAR U-factor requirement of 0.40, but the commenter claims this has little relevance to the Northern zone in the USA because it is a different market with a single criterion for more extreme cold climate conditions.

EPA Response:

EPA thanks the stakeholders for their comments on the energy savings potential for skylights. EPA was considering sun-setting the criteria for skylights; however, CPD analysis showed product lines available at lower U-factors without the need for more costly components such as triple panes. As mentioned in the CAR, EPA did attempt to conduct some energy analysis detailed in the 2019 Discussion Guide but found inconsistent results. Based on an analysis of certified product distribution, EPA found a significant number of products that can currently meet the proposed criteria and based its proposed criteria on those selections. Manufacturers can choose to make changes to their products (such as curb mounted options) if they want to expand their ENERGY STAR product offerings, but that is their choice. EPA mentions the Canadian ENERGY STAR criteria for skylights only because it is much more stringent than the U.S. proposed criteria for the Northern zone, and those products sold in Canada would easily meet the U.S. criteria.

III. Tubular Daylighting Devices

EPA received a comment requesting criteria that is specific to Tubular Daylighting Devices (TDDs) product types.

EPA Response:

EPA appreciates the feedback on Tubular Daylighting Devices (TDDs). TDDs have a similar function of providing daylight into a space through the ceiling and, therefore, EPA proposes that TDDs remain under the same criteria as skylights. EPA did confirm that there are certified TDD product lines in the CPD that can meet the proposed criteria.

I. Implementation Timeline

I. Effective Date

EPA received comments requesting a significant grace period before implementation of the Version 7.0 criteria to allow for the re-design of product lines where necessary and recent supply chain issues. The specific comments included the following:

- Several commenters have suggested that the effective date for the Version 7.0 criteria be delayed for several years (January 1, 2024, or 2025). If the current criteria proposals are implemented, manufacturers would need a longer time horizon to make design changes to product offerings and deal with supply chain issues resulting from the COVID-19 pandemic.
- One commenter suggested that industry would need at least 24 months after the adoption of the proposed criteria to relieve the burden on equipment manufacturers that are already challenged.

EPA Response:

EPA thanks stakeholders for their feedback on the implementation timeline for Version 7.0. EPA acknowledges the present supply chain constraints; however, it is unclear how long these constraints will remain. EPA currently plans to provide one (1) year transition period to the Version 7.0 after finalizing the criteria.

II. Version 8

EPA received comments asking about future criteria revisions and the timeline on which they could occur. The commenters suggested a shorter revision period than the current update from the Version 6.0 implementation to the proposed Version 7.0 criteria.

EPA Response:

EPA thanks the stakeholders for their comments on future criteria revisions. EPA is currently focused on finalizing Version 7.0. It will take time to implement the new criteria and see its

effects on the market. After Version 7.0 implementation, EPA will monitor the market and use its standard revision process when it considers another criteria revision.

J. Miscellaneous

I. Alternative Program

EPA received a comment suggesting an alternative ENERGY STAR labeling program in which triple pane products are labeled separately from other product types. The commenter suggested that this would incentivize manufacturers to produce more of these product types and improve costs.

EPA Response:

EPA thanks the stakeholder for their comments regarding alternative approaches to the program and labeling. EPA already has a Most Efficient recognition for high-performance windows and patio doors and has no plans for additional performance tiers. EPA has demonstrated that various technical and component pathways exist to meet the proposed criteria. The ENERGY STAR program's broad goal is to promote energy-saving products to consumers and not focus on a particular technology. A triple-pane product does not inherently mean it is a high-performing product in terms of its thermal performance. There are indications the market is shifting towards increased installations of high-performance products, and the ENERGY STAR program hopes that the new criteria will encourage manufacturers to increase the performance of their product offerings of both double- and triple-pane products.

II. Energy Codes

EPA received several comments regarding ENERGY STAR's guiding principle to be a voluntary, above-code program. The specific comments included the following:

- Two commenters referenced ENERGY STAR's guiding principle to be better than current energy codes and pointed out that the current V6 criteria are already more stringent than the 2021 IECC code.
- Several commenters suggested that ENERGY STAR reassert that it is an above-code, voluntary program so that local code jurisdictions do not align their criteria with ENERGY STAR.

EPA Response:

EPA appreciates the feedback regarding ENERGY STAR's role in the market. Energy codes are only one of the factors EPA considers when deciding to make a criteria revision. EPA is aware of proposals for the IECC 2024 code which propose to use of Version 6.0 as the basis for window performance criteria. Energy codes are progressing, and the criteria for the ENERGY STAR Windows, Doors, and Skylights program is intended to identify better performing, cost-effective

products in the market, which may encourage greater innovation and better-performing lower-cost products for consumers. EPA does not have any direct influence over local code decisions, nor does it encourage the adoption of current ENERGY STAR criteria for building codes.

III. Most Efficient

EPA received a comment concerning the ENERGY STAR Most Efficient program and its relevance under the Version 7.0 proposal because the criteria is similar.

EPA Response:

EPA thanks the commenter for pointing out the similarities in the proposed Version 7.0 criteria and the Version 6.0 Most Efficient criteria. EPA will re-evaluate the Most Efficient criteria in 2022 and may make adjustments at that time.

IV. Window Attachments

EPA received comments about the lack of consideration for window attachments such as blinds/shades in the energy analysis that will reduce the impact of high gain windows in the Northern climate zones.

EPA Response:

EPA thanks the commenter for concern regarding window attachments and their effect on the energy performance of a window. EPA acknowledges that windows attachments will affect the energy performance of a window. EPA plans to update buying guidance that will emphasize how consumers can take advantage of the high gain feature of a window by adjusting any window attachments.

V. Dynamic Glazing

EPA received comments regarding accommodations for products with dynamic glazing in the Version 7.0 criteria. The specific comments included the following:

- One commenter stressed the importance of dynamic glazing and accounting for this product type in V7 with a mid-cycle change with special accommodations for this product type.
- One commenter also pointed out that Blinds Between Glass (BBG) and Grilles Between Glass (GBG) are not compatible with current thin triple technology because the airspace of the IGU is not wide enough with the extra glazing layer. The proposed criteria would make these types of products less competitive and attractive to consumers.

EPA Response:

EPA thanks the commenters for the feedback in this product category. EPA understands that blinds between glass and other dynamic glazing options may provide a net benefit to energy

performance, but without certified performance ranges, it is difficult to calculate energy savings and establish criteria for these product types. EPA will wait until performance range data becomes available before considering a possible criteria revision to accommodate BBG products. Manufacturers can add external grills if thin triples do not accommodate that product option. Thin triples are not a requirement for the proposed criteria, and manufacturers have several options to meet the criteria.

VI. Revision Approach

EPA received several comments concerned about the significant change (23% in some cases) in criteria for some of the ENERGY STAR zones, which are greater than incremental revisions seen in past revision cycles.

EPA Response:

EPA appreciates the feedback on the change in the criteria for this proposal. Although the proposal is more aggressive than previous revision cycles, the analysis for this proposal is greatly expanded and more in-depth than the previous analysis. The expanded effort gives EPA more confidence that cost-effective technologies are available today in currently sold products that will produce large national energy savings.

VII. Embodied Carbon

EPA received comments to consider the increase in embodied carbon of window products that employ triple pane technology, which may be required to meet the proposed criteria in the Northern zone.

EPA Response:

EPA thanks the commenters for their concern over the additional embodied carbon of employing a third pane of glass in a window. However, it is EPA policy that the ENERGY STAR program focuses on carbon impact from the “use phase” of products and not on other lifecycle aspects. According to an analysis published by the National Glass Association (NGA), the embodied energy/carbon for adding a third lite to a window is paid back within a year or less through the energy savings resulting from the increased thermal performance of the window.⁷ EPA welcomes stakeholders to provide their analysis of this issue in the Draft 2 response to comments.

VIII. Installation

EPA received a comment bringing attention to the quality of the window installation process, claiming that it will impact the overall thermal performance of the window regardless of the

⁷ Culp, Tom. “Triple Glazing and Embodied Energy: Yes, the Juice is Worth the Squeeze.” Glass Magazine Weekly, January 18, 2022. <https://www.glass.org/triple-glazing-and-embodied-energy-yes-juice-worth-squeeze>.

performance criteria of the window. The commenter claimed that improper installation can reduce the performance of an R-5 window to an R-2 performance level.

EPA Response:

EPA thanks the commenter for their insight into the impact of poor installation procedures on the thermal performance of the window. EPA agrees that proper installation is important to ensure that consumers get the rated performance from their fenestration products. To help address this issue, EPA included in Version 6 requirements that certain elements be included in installation instructions to help ensure products are installed correctly. EPA has not received any studies or detailed analysis showing a difference in performance based on an alternative approach from existing installation standards. If detailed analysis on better performing alternative installation procedures were provided, EPA would review and consider possible adjustments to installation requirements.

IX. North American Fenestration Standards (NAFS)

EPA received one comment suggesting that NAFS AAMA/WDMA/CSA 101/I.S.2/A440 be required under the Version 7.0 criteria as it is for the Most Efficient program.

EPA Response:

EPA thanks the stakeholder for their recommendation. This issue was addressed in the Discussion Guide Response to Comments. To reiterate, EPA already requires air leakage as part of the current window, door, and skylight criteria, which is the part of the NAFS certification that impacts the energy performance of the product. When considering the next ENERGY STAR Most Efficient requirements, EPA will consider whether it wants to consider continuing requiring NAFS for the Most Efficient recognition.

X. ENERGY STAR Climate Map

EPA received one comment suggesting that the ENERGY STAR program sunset the climate zone map in lieu of more localized market signals which they suggest would have greater market transformation potential.

EPA Response:

EPA thanks the stakeholder for the suggestion to use local market message instead of the current IECC-based climate zone map. EPA disagrees with this suggestion. The 4-zone climate map allows the program to link to established, code-based zone analysis efforts that help set regionalized product performance standards. Setting local program standards would likely lead to confusion and unnecessary complexity for distributors, retailers, and consumers. EPA plans to continue the use of the map and the label because it helps consumers, builders, contractors, and code officials clearly determine whether a product meets the criteria for their zone. EPA provided savings values for about 90 US cities after Version 6 was completed and plans to expand the effort and do the same for Version 7. These values can be used by local programs, utilities, distributors, and retailers to help sell ENERGY STAR products in local markets.

XI. High-Altitude and Impact Resistant Products

EPA received one comment suggesting that the Version 7.0 criteria include allowances for high-altitude and impact-resistant products.

EPA Response:

EPA thanks the stakeholder for their comment on the high-altitude and impact-resistant product types. This issue was addressed in the Discussion Guide Response to Comments on Page 17. EPA has not changed its response.

K. Appendix

I. Alternative Proposals Window

EPA received alternative proposals for the criteria for each ENERGY STAR climate zone and the Northern zone tradeoffs, which are summarized in the tables below.

ENERGY STAR Zone Proposals	Alternative Proposals U-Factor	Alternative Proposals SHGC	Current Proposal U-Factor	Current Proposal SHGC
Northern 1	≤ 0.20	Any (remove minimum)	≤ 0.22	≥ 0.17
Northern 2	≤ 0.23	Any (remove minimum)	≤ 0.22	≥ 0.17
Northern 3	≤ 0.25	Any (remove minimum)	≤ 0.22	≥ 0.17
Northern 4	≤ 0.26	Any (remove minimum)	≤ 0.22	≥ 0.17
North-Central 1	≤ 0.25	N/A	≤ 0.24	≤ 0.40
North-Central 2	≤ 0.27	N/A	≤ 0.24	≤ 0.40
South-Central 1	N/A	≤ 0.24	≤ 0.28	≤ 0.23
South-Central 2	N/A	≤ 0.25	≤ 0.28	≤ 0.23
Southern 1	N/A	≤ 0.24	≤ 0.32	≤ 0.23
Southern 2	N/A	≤ 0.25	≤ 0.32	≤ 0.23

Tradeoff Proposals	Alternative Proposals U-Factor	Alternative Proposals SHGC	Current Proposal U-Factor	Current Proposal SHGC
Northern Tradeoffs 1	= 0.24	≥ 0.35	= 0.23	≥ 0.35
	= 0.25	≥ 0.40	= 0.24	≥ 0.40
	= 0.26	≥ 0.45	= 0.25	≥ 0.45
	= 0.27	≥ 0.50	= 0.26	≥ 0.50

II. Alternative Proposals Skylights

EPA received alternative proposals for the skylight criteria to set a less stringent U-factor in the Northern zone and general concerns over VT with the proposed SHGC level in the other zones. This is summarized in the table below.

ENERGY STAR Zone	Alternative Proposals U-Factor	Alternative Proposals SHGC	Existing Proposal U-factor	Existing Proposal SHGC
Northern	≤ 0.48	N/A	≤ 0.45	Any
North-Central South-Central Southern	N/A	No proposed level; General concerns over VT	≤ 0.50	≤ 0.25

III. EnergyPlus Version 8.9 versus Version 9.5 Summary Tables

Proposed Criteria Version 8.9

Energy Star Zone	U-factor	SHGC	Savings (\$/yr)	Simple Payback (Yrs)	\$200 Incentive Payback (Yrs)	65% Recouped from Sale Payback (Yrs)
Northern (Market)	0.22	0.30	\$113.35	11.3	9.5	4.1
Northern (Code)	0.22	0.30	\$70.26	16.2	15.4	6.5
North/Central	0.24	0.30	\$80.75	8.5	6.1	3.1
South/Central	0.28	0.23	\$35.85	9.0	3.4	3.2
Southern	0.32	0.23	\$20.14	8.9	0.0	3.2

Proposed Criteria Version 9.5

Energy Star Zone	U-factor	SHGC	Savings (\$/yr)	Simple Payback (Yrs)	\$200 Incentive Payback (Yrs)	65% Recouped from Sale Payback (Yrs)
Northern (Market)	0.22	0.30	\$115.19	11.2	9.4	4.0
Northern (Code)	0.22	0.30	\$72.04	15.9	13.1	5.7
North/Central	0.24	0.30	\$83.07	8.3	5.9	3.0
South/Central	0.28	0.23	\$67.28	4.8	1.8	1.7
Southern	0.32	0.23	\$45.60	3.9	0.0	1.4

Proposed Tradeoff Criteria Version 8.9 (Market Baseline)

Energy Star Zone	U-factor	SHGC	Savings (\$/yr)	Simple Payback (Yrs)	\$200 Incentive Payback (Yrs)	65% Recouped from Sale Payback (Yrs)
Northern Tradeoffs	0.23	0.35	\$104.18	12.3	10.4	4.4
	0.24	0.40	\$99.71	6.9	4.9	2.5
	0.25	0.45	\$88.56	7.8	5.5	2.8
	0.26	0.50	\$76.69	9.0	6.4	3.2

Proposed Tradeoff Criteria Version 9.5 (Market Baseline)

Energy Star Zone	U-factor	SHGC	Savings (\$/yr)	Simple Payback (Yrs)	\$200 Incentive Payback (Yrs)	65% Recouped from Sale Payback (Yrs)
Northern Tradeoffs	0.23	0.35	\$108.32	11.9	10.0	4.3
	0.24	0.35	\$99.32	6.9	4.9	2.5
	0.25	0.40	\$89.87	7.7	5.5	2.8
	0.26	0.40	\$80.93	8.5	6.1	3.1

Proposed Tradeoff Criteria Version 8.9 (Code Baseline)

Energy Star Zone	U-factor	SHGC	Savings (\$/yr)	Simple Payback (Yrs)	\$200 Incentive Payback (Yrs)	65% Recouped from Sale Payback (Yrs)
Northern Tradeoffs	0.23	0.35	\$60.88	18.8	17.8	7.6
	0.24	0.40	\$56.41	9.7	8.7	4.4
	0.25	0.45	\$45.27	12.1	10.8	5.5
	0.26	0.50	\$33.39	16.4	14.7	7.4

Proposed Tradeoff Criteria Version 9.5 (Code Baseline)

Energy Star Zone	U-factor	SHGC	Savings (\$/yr)	Simple Payback (Yrs)	\$200 Incentive Payback (Yrs)	65% Recouped from Sale Payback (Yrs)
Northern Tradeoffs	0.23	0.35	\$65.17	17.5	14.5	6.3
	0.24	0.35	\$56.17	9.7	6.2	3.5
	0.25	0.40	\$46.72	11.7	7.4	4.2
	0.26	0.40	\$37.78	14.5	9.2	5.2

National Energy Savings for Windows at proposed criteria Version 8.9

	Unit Energy Savings (MMBtu)	2019 ES Shipments	Total Energy Savings (TBtu)
Northern Replacement/Remodel	0.40	11,084,395	4.42
New Construction	0.26	6,576,665	1.73
North/Central	0.26	9,370,708	2.45
South/Central	0.08	12,387,796	0.95
Southern	0.03	4,815,650	0.13
National Total (100% 2019 ES Shipments)			9.68
National Total (50% 2019 ES Shipments)			4.84
National Total (25% 2019 ES Shipments)			2.42

National Energy Savings for Windows at proposed criteria Version 9.5

	Unit Energy Savings (MMBtu)	2020 ES Shipments	Total Energy Savings (TBtu)
Northern Replacement/Remodel	0.37	10,946,811	4.04
Northern New Construction	0.23	6,639,088	1.52
North/Central	0.23	9,579,526	2.19
South/Central	0.08	12,488,986	1.05
Southern	0.05	4,877,119	0.25
National Total (100% 2020 ES Shipments)			9.06
National Total (50% 2020 ES Shipments)			4.53
National Total (25% 2020 ES Shipments)			2.27

IV. Version 9.5 Energy Savings Analysis for Doors

Door Baseline Assumptions

Door Category	U-Factor	SHGC
≤1/2-Lite	0.30	0.17
>1/2-Lite Northern and North-Central	0.35	0.30
>1/2-Lite Southern and South-Central	0.35	0.25

Energy and Cost Savings for Proposed ≤1/2-Lite Door Criteria

Climate Zone	Door Type	U-Factor	SHGC	Energy Savings (GJ)	Savings (\$/yr)
Northern	≤1/2-Lite	0.23	0.17	0.60	\$7.55
North-Central	≤1/2-Lite	0.23	0.17	0.45	\$6.50
South-Central	≤1/2-Lite	0.23	0.17	0.29	\$3.52
Southern	≤1/2-Lite	0.23	0.17	0.12	\$2.12

Energy and Cost Savings for Proposed >1/2-Lite Door Criteria

Climate Zone	Door Type	U-Factor	SHGC	Energy Savings (GJ)	Savings (\$/yr)
Northern	>1/2-Lite	0.25	0.30	0.83	\$10.33
North-Central	>1/2-Lite	0.25	0.30	0.61	\$8.88
South-Central	>1/2-Lite	0.25	0.23	0.38	\$6.05
Southern	>1/2-Lite	0.25	0.23	0.19	\$4.23

Analysis using EnergyPlus V9.5

Door Type	Unit Energy Savings (MMBtu)	2020 Shipments	Total Energy Savings (TBtu)
> ½ Lite	0.25	6,450,995*	1.63
≤ ½ Lite	0.18	3,045,083	0.56
National Total (100% 2020 ES Shipments)			2.19
National Total (50% 2020 ES Shipments)			1.10

*Includes Sliding Glass Patio Doors

V. HVAC Model Scenarios

RECS and Census data for HVAC heating sources used for EnergyPlus modeling. The heating source called “Others” was not included in the analysis since the type of heating was unknown (likely wood stoves or fireplaces in many cases). The distribution of the heating types with “others” was adjusted to a new distribution based on the four heating types without "Others." (New Data = original heating source data/ (sum of original data set without "others"))

Original RECS and Census data on heating sources

Division Number	Census Division	Electric Resistance	Gas Furnace	Oil Furnace	Heat Pump	Others	Sum without "others"
DIV1	New England	0.1296	0.8691	0.0001	0.0005	0.0007	0.9993
DIV2	Middle Atlantic	0.2270	0.7623	0.0001	0.0001	0.0106	0.9894
DIV3	East North Central	0.0058	0.9914	0.0000	0.0000	0.0027	0.9973
DIV4	West North Central	0.0156	0.9808	0.0000	0.0002	0.0035	0.9965
DIV5	South Atlantic	0.0022	0.7373	0.0002	0.0000	0.2604	0.7396
DIV6	East South Central	0.0125	0.7684	0.0000	0.0003	0.2187	0.7813
DIV7	West South Central	0.0020	0.9679	0.0001	0.0001	0.0299	0.9701
DIV8	Mountain North	0.0096	0.9888	0.0002	0.0001	0.0013	0.9987
DIV9	Mountain South	0.0052	0.9024	0.0003	0.0001	0.0920	0.9080
DIV10	Pacific	0.0056	0.9070	0.0006	0.0018	0.0850	0.9150

Adjusted REC and Census data on heating sources used for modeling

Division Number	Census Division	Electric Resistance	Gas Furnace	Oil Furnace	Heat Pump
DIV1	New England	0.1297	0.8698	0.0001	0.0005
DIV2	Middle Atlantic	0.2294	0.7704	0.0001	0.0001
DIV3	East North Central	0.0058	0.9942	0.0000	0.0000
DIV4	West North Central	0.0156	0.9842	0.0000	0.0002
DIV5	South Atlantic	0.0029	0.9968	0.0002	0.0000
DIV6	East South Central	0.0161	0.9835	0.0000	0.0004
DIV7	West South Central	0.0020	0.9978	0.0001	0.0001
DIV8	Mountain North	0.0096	0.9900	0.0002	0.0001
DIV9	Mountain South	0.0058	0.9938	0.0003	0.0001
DIV10	Pacific	0.0062	0.9913	0.0006	0.0019

VI. Foundation Model Scenarios

RECS and Census data for foundations used for EnergyPlus modeling. The foundation type called "Others" was not included in the analysis since the type of foundation was unknown. The distribution of the foundation types with "others" was adjusted to a new distribution based on the four foundation types without "Others." (New Data = original foundation type data/ (sum of original data set without "others"))

Original RECS and Census data on foundation types

Division Number	Census Division	Slab	Crawl Space	Others	Unheated Basement	Heated Basement	Sum without "others"
DIV1	New England	0.0263	0.0016	0.0044	0.4800	0.4900	0.9979
DIV2	Middle Atlantic	0.0582	0.0446	0.0007	0.3300	0.5700	1.0028
DIV3	East North Central	0.1611	0.0057	0.0004	0.0700	0.7700	1.0068
DIV4	West North Central	0.0519	0.0018	0.0012	0.0900	0.8600	1.0037
DIV5	South Atlantic	0.9147	0.0534	0.0007	0.0100	0.0200	0.9981
DIV6	East South Central	0.3475	0.5448	0.0006	0.0800	0.0300	1.0023
DIV7	West South Central	0.9995	0.0001	0.0004	0.0000	0.0000	0.9996
DIV8	Mountain North	0.4281	0.0394	0.0017	0.0300	0.5000	0.9975
DIV9	Mountain South	0.4281	0.0394	0.0017	0.5300	0.0000	0.9975
DIV10	Pacific	0.8377	0.1516	0.0086	0.0000	0.0000	0.9892

Adjusted REC and Census data on foundation types used for modeling

Division Number	Census Division	Slab	Crawl Space	Unheated Basement	Heated Basement
DIV1	New England	0.0264	0.0016	0.4810	0.4910
DIV2	Middle Atlantic	0.0580	0.0445	0.3291	0.5684
DIV3	East North Central	0.1600	0.0057	0.0695	0.7648
DIV4	West North Central	0.0517	0.0018	0.0897	0.8569
DIV5	South Atlantic	0.9165	0.0535	0.0100	0.0200
DIV6	East South Central	0.3467	0.5436	0.0798	0.0299
DIV7	West South Central	0.9999	0.0001	0.0000	0.0000
DIV8	Mountain North	0.4292	0.0395	0.0301	0.5012
DIV9	Mountain South	0.4292	0.0395	0.5313	0.0000
DIV10	Pacific	0.8468	0.1532	0.0000	0.0000

VII. Cost Data Characterization

Note: EPA is limited on how much identifying information it can supply on cost data since some of the data was supplied under an agreement to keep sources anonymous. See the anonymized full data set in the Version 7 Draft 1 release. The Draft 1 data set represents all the cost data that EPA used to conduct its analysis.

- EPA collected cost data in a variety of ways. EPA first asked manufacturers to voluntarily supply cost data. Next, EPA was able to find some cost data from web research of retailers with follow-up calls or on-site visits to answer outstanding questions. EPA was also able to get some cost data from existing utility programs. Finally, EPA conducted mystery shopping from several distributors and retailers. These activities were mostly done by phone or email since the data collection was done during the COVID-19 pandemic.
- EPA collected cost data on 138 different window products from across the U.S. from a variety of manufacturers, dealers, and retailers. In addition to the following list, EPA acquired window cost data on 17 products from companies that manufacture and distribute nationally.

Census Region	# of Products
Midwest	33
Northeast	32
South	34
West	22

- The cost data came from 60 different product lines and 39 different manufacturers. This represents over 20% of all current ENERGY STAR partner manufacturers.
- Often cost data was collected on 2 or 3 products from the same line to directly compare the incremental cost differences between base products, room-side low-e versions, and triple panes versions of the same product. These groupings can be seen by reviewing the cost data set EPA provided in Draft 1.
- Of the cost data collected from the 39 product manufacturers, 19 of the companies were among the top 100 manufacturers by revenue, according to Window + Door Magazine June 2021.
- Breakdown of costs data by company size:

Revenue Category	% of Quotes
More than \$1 Billion	38%
\$500 Million-\$1 Billion	9%
\$100-\$500 Million	20%
\$15-\$100 Million	13%
Less than \$15 Million	1%

The cost data collected for the Version 7 criteria revision represents a larger, more robust, and more representative data set than was used for the Version 6 criteria.

VIII. Cities with TMY3 Class II data

Cities	TMY3 Class
Anchorage.Intl.AP.702730	2
Fairbanks.Intl.AP.702610	2
Kingman.AWOS.723700	2
Winslow.Muni.AP.723740	2
Redbluff.AP.725910	2
Sacramento.Metro.AP.724839	2
Colorado.Springs-Peterson.Field.724660	2
Eagle.County.Rgnl.AP.724675	2
Gunnison.County.AWOS.724677	2
Trinidad-Las.Animas.County.AP.724645	2
Goodland-Renner.Field.724650	2
Topeka-Phillip.Billard.Muni.AP.724560	2
Wichita.Muni.AP.724505	2
Baton.Rouge-Ryan.AP.722317	2
Monroe.Rgnl.AP.722486	2
Houghton.Field.727440	N/A; TMY2
Kirksville.Muni.AP.724455	2
Tupelo.Muni-C.D.Lemons.AP.723320	2
Manchester.Muni.AP.743945	2
Oklahoma.City-Will.Rogers.World.AP.723530	2
Redmond-Roberts.Field.726835	2
Amarillo.Intl.AP.723630	2
Fort.Worth-Alliance.AP.722594	2
Wichita.Falls.Muni.AP.723510	2
Saint.George.AWOS.724754	2
Vernal.AP.725705	2
Jackson.Hole.AP.725776	2

IX. TMY Cities with Population Reassignments

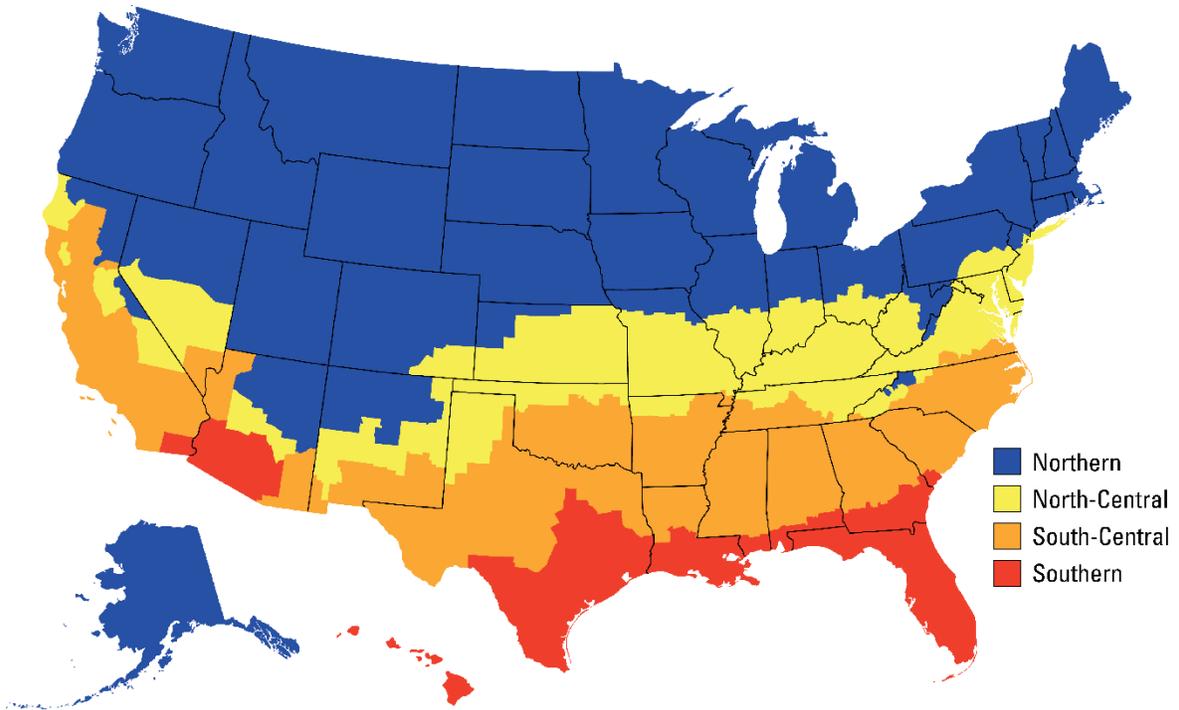
City ID	2020 Population	Population after Reassignments	% Change
Albuquerque.Intl.AP.723650	1395723	1519035	8.8%
Anchorage.Intl.AP.702730	538328	571275	6.1%
Baton.Rouge-Ryan.AP.722317	2691097	2937615	9.2%
Duluth.Intl.AP.727450	289790	522350	80.3%
Fort.Worth-Alliance.AP.722594	9047856	9257258	2.3%
Houston-Bush.Intercontinental.AP.722430	14275775	12248952	-14.2%
International.Falls.Intl.AP.727470	845456	514200	-39.2%
Jacksonville.Intl.AP.722060	7529335	6124939	-18.7%
Kansas.City.Muni.AP.724460	1433988	2041208	42.3%
Madison-Dane.County.Rgnl.AP.726410	5782597	5801716	0.3%
Minneapolis-St.Paul.Intl.AP.726580	4811151	4890728	1.7%
Oklahoma.City-Will.Rogers.World.AP.723530	4108520	4037436	-1.7%
Pierre.Muni.AP.726686	770451	784521	1.8%
San.Antonio.Intl.AP.722530	560868	2587691	361.4%
Shreveport.Rgnl.AP.722480	946497	699979	-26.0%
Tampa.Intl.AP.722110	5811007	7215403	24.2%
Wichita.Falls.Muni.AP.723510	564668	426350	-24.5%
Wichita.Muni.AP.724505	2186993	1579773	-27.8%
Winslow.Muni.AP.723740	652766	529454	-18.9%

X. County Reassignments to Address ENERGY STAR zone “islands”

County	Old ENERGY STAR Zone	New ENERGY STAR Zone
Danville, VA	North-Central	South-Central
Franklin, VA	North-Central	South-Central
Ashe, NC	Northern	North-Central
Alleghany, NC	Northern	North-Central
Wilkes, NC	Northern	North-Central
Watauga, NC	Northern	North-Central
Avery, NC	Northern	North-Central
Yancey, NC	Northern	North-Central
Lake, CA	North-Central	South-Central
Placer, CA	South-Central	North-Central
Alpine, CA	Northern	North-Central
Mono, CA	Northern	North-Central

XI. Climate Zone Map (Old and New)

1. Draft 1 Proposed Climate Zone Map – OLD



2. Draft 2 Proposed Climate Zone Map – NEW

