November 2, 2020

REPORT #E20-412

Air Cleaner Specification and Baseline Assessment Review

Prepared For NEEA:
Meghan Bean, Sr. Project Manager, MRE

Prepared by:
Joe Van Clock, Associate
Noah Lieb, Associate

Apex Analytics
2500 30th Street, Suite 207
Boulder, CO 80301

Northwest Energy Efficiency Alliance
PHONE
503-688-5400
EMAIL
info@neea.org

To:	Meghan Bean, NEEA
From:	Joe Van Clock and Noah Lieb, Apex Analytics
Subject:	Air Cleaner Specification and Baseline Assessment Review
Date:	October 7, 2020

This memo presents findings from Apex Analytics' review of NEEA's role in the ENERGY STAR® Version 2.0 (V2.0) specification update and assesses NEEA's baseline assumptions for room air cleaners (air cleaners) based on those findings.

Background

NEEA included air cleaners in its Retail Products Portfolio (RPP) initiative beginning in 2014. From the beginning of NEEA's involvement in the market, RPP data suggested that the market share of ENERGY STAR air cleaners in the Northwest was high, particularly among higher-capacity air cleaners. In addition, NEEA identified certain measurement and compliance issues that limited the ability of the ENERGY STAR label to differentiate between efficient and inefficient products.[1] As a result, NEEA pursued measurement and compliance and specification revision strategies for air cleaners through the RPP initiative. NEEA began engaging with EPA related to the air cleaner ENERGY STAR specification as early as 2015. NEEA discontinued midstream incentives for air cleaners in 2019.

In October 2018, the U.S. Environmental Protection Agency (EPA) began the revision process for the air cleaners ENERGY STAR specification. NEEA and its partners were involved throughout the specification revision process, submitting comments on the Discussion Guide (December 2018),[2] the Draft 1 Specification (April 2019),[3] and the Connected Criteria proposal (July 2019).[4] EPA published the final V2.0 specification in October 2019. The specification was originally set to take effect on July 17, 2020, but in April 2020, EPA pushed the effective date back to October 17, 2020 due to supply chain disruptions related to the COVID-19 pandemic.

[1] While the ENERGY STAR label is designed to differentiate efficient products, its effectiveness in doing so is diminished when market share grows to a level at which consumers have few non-ENERGY STAR choices or when efficiency criteria and measurement procedures do not accurately reflect typical device usage and energy consumption.

[2] Available at: https://www.energystar.gov/sites/default/files/NEEA%2C%20NEEP%2C%20PG%26E%2C%20and%20SMUD%20Comments.pdf

[3] Available at: https://www.energystar.gov/sites/default/files/ESRPP%20Comments_0.pdf

[4] Available at: https://www.energystar.gov/sites/default/files/NEEA%20PGE%20Comments.pdf

Research Objectives

This memo addresses the following research objectives:

- Assess the influence of NEEA and its partners on the ENERGY STAR V2.0 room air cleaners specification update.
- Determine whether that influence supports NEEA's baseline assumptions for room air cleaners and recommend alternative assumptions where appropriate.

Approach

The Apex team conducted two research activities to address these research objectives:

- **Stakeholder comments and specification document review:** Apex reviewed the public comments NEEA submitted as part of the ENERGY STAR specification revision process, as well as public comments other stakeholders submitted, EPA comment response documents, and other publicly available documents related to the specification revision. A detailed tracking of each of the recommendations NEEA made in public comments is included in the Appendix to this memo. The Apex team also reviewed emails that NEEA staff provided related to the specification revision process.
- **Stakeholder interviews:** Apex conducted four interviews with a total of six individuals involved in the specification revision process. Respondents included EPA ENERGY STAR staff, staff of NEEA partner organizations (Pacific Gas & Electric and Consolidated Edison), and staff of NEEA's contractor, Energy Solutions. These interviews occurred between July 31 and August 14, 2020.

Specification Review Findings

Apex assessed three potential areas of NEEA's influence on the ENERGY STAR specification for air cleaners: influence on the specification's timing, influence on its stringency, and influence on energy consumption measurement.

Specification Timing

The current ENERGY STAR air cleaners specification (Version 1.2) took effect in 2011, and represented only minor changes to the test procedure relative to the original air cleaners specification, which took effect in 2004. EPA staff reported that, while they had reviewed the specification since the previous version, they had not identified notable increases in efficiency or shifts in technology that would suggest an opportunity for an update. Prior to the launch of the V2.0 specification revision process, EPA's ENERGY STAR Unit Shipment Data Reports indicated that the market share of ENERGY STAR air cleaners had been gradually increasing but remained relatively low, growing from 16% in 2012 to 39% by 2017. One interviewed RPP team member further noted that revisions to mandatory efficiency standards often trigger ENERGY STAR specification updates for other products, but air cleaners are not subject to federal standards.

NEEA was engaged with EPA on air cleaners prior to the launch of the V2.0 specification revision. NEEA and other program administrators involved in the ENERGY STAR RPP (ESRPP)

effort began communicating with EPA ENERGY STAR staff about air cleaners in 2015.[5] These initial discussions sought to determine the cause of a large discrepancy between the market share of ENERGY STAR air cleaners reported in the annual ENERGY STAR Unit Shipment Data reports, which showed a 39% market share in 2017, and ESRPP sales data, which suggested a market share of 93%.

Emails shared with the Apex team and ENERGY STAR documents suggest this engagement helped call EPA's attention to the potential for an air cleaners specification update. EPA staff requested ESRPP data so they could better understand the difference between the Unit Shipment Data and the ESRPP findings. As part of these requests, one EPA staff member involved in the national ESRPP coordination effort noted in a 2016 email that, with ESRPP data on air cleaners, "EPA may be able to accelerate a spec transition." Later emails indicate that ENERGY STAR product labeling staff were skeptical that ESRPP data were representative of the market.

Despite this skepticism, early documents related to the specification revision process reference the high ENERGY STAR air cleaner market share in ESRPP data. These documents include a slide from a briefing EPA staff gave to the Director of the ENERGY STAR Product Labeling Branch in May 2018 on the discussion guide for the upcoming air cleaner specification update, which would be released in October. Under the heading "major drivers," the slide notes the discrepancy between the market share of ENERGY STAR air cleaners in ESRPP data and the market share reported in the ENERGY STAR Unit Shipment Data report. EPA's discussion guide also noted the high ENERGY STAR market share in ESRPP data.[6]

In response to stakeholders' comments on the discussion guide, EPA staff concluded that they would "evaluate the ENERGY STAR market penetration consistent with the ENERGY STAR Guiding Principles and based on the Unit Shipment Data, which provides a national estimate for shipments at all retailers." Nonetheless, EPA moved forward with the specification revision process. Apex's assessment of this result is that NEEA and other ESRPP program sponsors' early engagement with EPA helped call attention to efficiency advances in the air cleaner market. These advances in efficiency were sufficient to justify the specification revision, even if EPA did not ultimately accept the ESRPP market share as representative of the market.

EPA staff coordinated closely with NEEA and its ESRPP partners leading up to the launch of the V2.0 air cleaners specification revision. EPA staff reached out to NEEA seeking ESRPP data and any other market data NEEA could share in February 2018. NEEA communicated with EPA staff and contractors to answer questions about ESRPP data through the spring of 2018. As discussed further below, documents suggest these data helped EPA justify increasing the stringency of the specification. For example, in addition to the discrepancy in market shares, the briefing slide referenced above stated that ESRPP sponsors had been providing incentives for air cleaners that were 30% and 50% more efficient than the V1.2

[5] ESRPP is an EPA-facilitated, national effort that seeks to increase the program's leverage with retailers by coordinating offerings across program administrators.

[6] The discussion guide is the first document EPA publishes in launching an ENERGY STAR specficiation revision. It describes the justification for the revision and the key issues EPA plans to consider in revising the specification.

ENERGY STAR specification, and that a "good selection" of products were available at those levels.

Specification Stringency

A key aspect of the written comments NEEA submitted as part of the specification revision process related to ensuring that the revised specification would be stringent enough to effectively differentiate efficient products. Specifically, NEEA recommended that EPA:

- Bin products by capacity (Clean Air Delivery Rate (CADR)) and set the specification energy consumption level as a continuous equation that is a function of capacity.
- Ensure that efficiency-level specifications for all air cleaner capacities are at least as stringent as the previous (V1.2) specification.
- Adopt a standby power draw requirement of one Watt or less and consider certain functionalities as potential adders (allowances for increased power draw to support specific features).[7]

The Association of Home Appliance Manufacturers (AHAM), a trade association of manufacturers, and air cleaner manufacturers opposed each of these requirements. EPA presented an analysis in the Discussion Guide showing a trend of increasing average efficiency (CADR/W) among ENERGY STAR models since the launch of the V1.0 specification in 2004. This increase in efficiency could support a more stringent specification. AHAM and manufacturers questioned EPA's analysis, arguing that the data EPA was using did not represent a trend toward greater efficiency. In addition, AHAM and manufacturers argued that setting too stringent specifications would limit the availability of ENERGY STAR products in certain capacity bins. Finally, AHAM and manufacturers argued that increasing the stringency of standby power requirements could "impede innovation" in the area of connected products.

Despite these objections, EPA incorporated each of NEEA's recommendations listed above into the final specification. The final specification bins products by CADR. The final specification also adopts a baseline standby power requirement of one watt, as NEEA recommended, with an adder for wi-fi connectivity. While the final specification does not define efficiency levels as a continuous equation, on-mode efficiency requirements for all levels are more stringent than the previous specification (Table 1).

[7] The functionalities NEEA's comments listed as potential adders include a variety of indicator and accent lights, heating capabilities, and connected functionality.

Table 1: On Mode Efficiency Requirements

Capacity Bin (CADR)	On Mode Efficiency Requirement (Smoke CADR/W)		
	V1.2	V2.0	% Increase
30≤ CADR <100	1.8*	1.9	6%
100≤ CADR <150		2.4	33%
CADR ≥150		2.9	61%

** The V1.2 specification defined efficiency requirements using dust CADR. Apex converted to smoke CADR using the trend line equation NEEA included in its V2.0 Draft 1 Comments: [Smoke CADR/W] =0.99 X [Dust CADR/W] – 0.16*

Interviewed EPA staff confirmed that NEEA's involvement in the specification revision process helped to overcome manufacturers' objections to more stringent energy efficiency levels. In particular, EPA staff reported that NEEA and its partner organizations provided data, including web-scraped data, that offered a more complete view of the air cleaner market and helped to demonstrate that a more stringent specification was justified. According to an EPA staff member, "NEEA was able to fill this huge gap of what was going on in the marketplace, and since we knew what was out there…we were able to hold the line." EPA staff further noted that being able to provide an informed response to a manufacturer that had vocally opposed more stringent efficiency levels improved the tone of their dialog with that manufacturer.

Energy Consumption Measurement

NEEA recommended a variety of updates to the ENERGY STAR specification that would enable more effective tracking of the air cleaner market and assessment of air cleaner efficiency. EPA ultimately adopted NEEA's recommendations that:

- The specification's definition of air cleaners should explicitly exclude products like absorbent air fresheners, passive filters, and ozone generators, and the ENERGY STAR Unit Shipment Data collection form should list this definition.
- EPA should establish optional connected and/or load management criteria and include a reporting field to identify products with network connection capabilities.

NEEA sought to clarify the definition of air cleaners because one hypothesis regarding the cause of the discrepancies between the market share estimates from ESRPP sales data and the ENERGY STAR Unit Shipment Data reports was that the Unit Shipment Data may have included products like air fresheners or filter replacements. Including these products, which are not eligible for ENERGY STAR certification, in the denominator of the market share calculation could artificially lower the estimated market share.

Manufacturer recommendations related to product definitions were mixed. AHAM and some manufacturers argued for a broad definition of air cleaners that included products that emit ozone. EPA ultimately excluded products that generate more than 50 parts per billion of ozone in the specification. The definition does not explicitly exclude absorbent air fresheners or passive filters, but it specifies that all covered products, except ion generators, must operate with a motor and fan, which absorbent air fresheners or passive filters do not have.

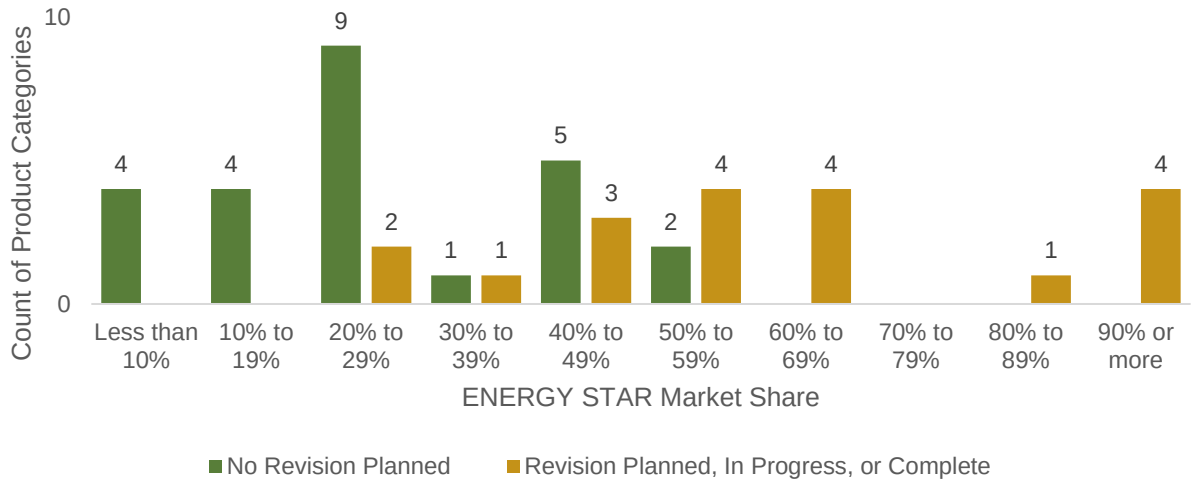
Manufacturers did not react strongly to the suggestion of establishing connected criteria, although one opposed reducing fan speed in response to demand response events as this could negatively impact filtration. EPA initially opted not to develop connected functionality, but reversed that decision based on stakeholder feedback. The final specification includes simplified criteria for connected functionality, similar to the criteria for other products but without addressing demand response capabilities.

Baseline Assessment

NEEA initially planed to report 100% of above-baseline savings related to the air cleaner specification revision as Net Market Effects for 10 years. In doing so, NEEA assumed that, without its intervention, EPA would not have revised the air cleaner specification until at least 2030.

This review strongly suggests that NEEA and its ESRPP partners accelerated the air cleaners specification update. However, EPA likely would have revised the specification prior to 2030 without NEEA's intervention. A review of all the product categories listed in the 2019 ENERGY STAR Unit Shipment Data Report suggests that EPA typically launches a specification revision before a product reaches 60% market share. The report indicated that a specification revision was either recently completed or in progress for every product category with an ENERGY STAR market share greater than 60% (Figure 1**Error! Reference source not found.**).

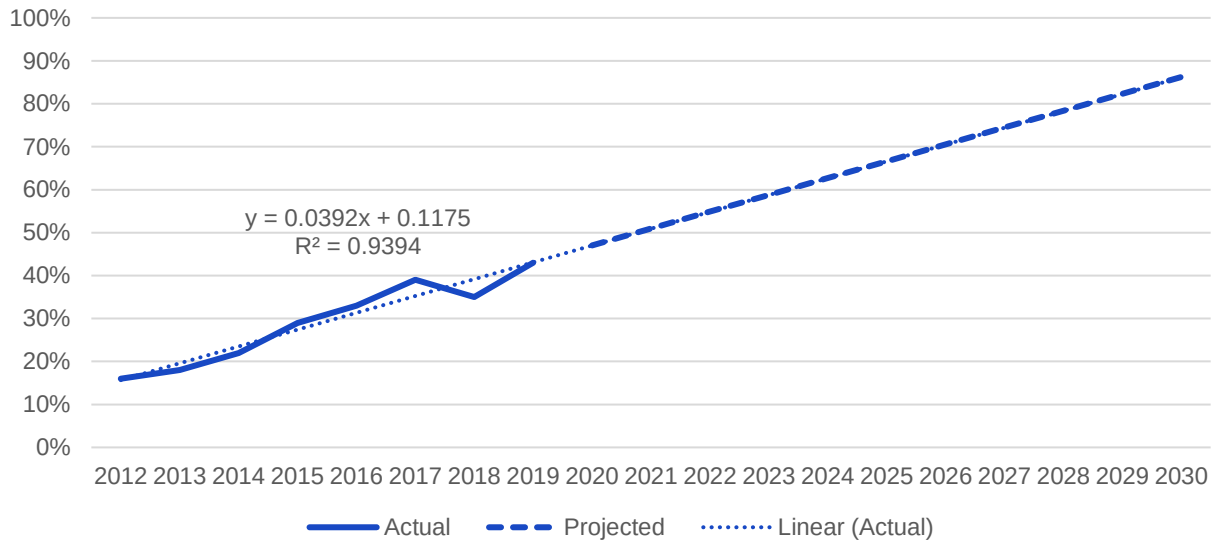
Figure 1: Distribution of Product Categories by Market Share and Revision Status in 2019 Unit Shipment Data Report



Unit Shipment Data Reports indicated that air cleaner ENERGY STAR market share was trending upward between 2012 and 2019. This growth was generally linear, with average annual increases of approximately 4% per year (Figure 2). Assuming that growth continued in a linear way, Unit Shipment Data would show an ENERGY STAR market share of 86% in

2030.[8] Market share would exceed 60% for the first time in 2024. Assuming, this would lead EPA to initiate a specification revision, consistent with the findings in Figure 1, our assessment is that 2025 may be a more appropriate year than 2030 in which to assume a revised specification would take effect absent NEEA's intervention.

Figure 2: Projected ENERGY STAR V1.2 Market Share Based on Unit Shipment Data



Two assumptions underly our assessment that a new specification would take effect in 2025:

- *EPA would not update the air cleaners ENERGY STAR specification until market share reached 60%.* As Figure 1**Error! Reference source not found.** shows, several product categories undergoing specification revisions have market shares below 60%. Nonetheless, Apex believes it is reasonable to anticipate that ENERGY STAR market share could be relatively high before EPA initiated a specification revision for air cleaners absent NEEA's intervention. As one interview respondent pointed out, air cleaners are not subject to federal standard updates, which often trigger ENERGY STAR specification revisions for other products.
- *EPA's decision to update the air cleaners specification would be based on ENERGY STAR Unit Shipment Data.* ESRPP data showed a notably higher ENERGY STAR market share than the Unit Shipment Data reports, potentially justifying a specification update sooner. However, in a baseline scenario, NEEA and its partner organizations would not be involved in the revision process, and EPA would not have access to ESRPP data. Further, even with access to ESRPP data, EPA determined that it would base

[8] Apex recognizes that a variety of factors may impact market share growth, causing it to change in non-linear ways. For example, the COVID-19 pandemic and west coast wildfires are likely to increase demand for air cleaners, and there could be a shift in market share as buying patterns change and new consumers enter the market. However, absent data to indicate how these changes might impact market share and what the timing of those impacts might be, we continue to assume linear growth.

specification update decisions on the Unit Shipment Data, which it viewed as more complete.

A specification revision occurring without NEEA's intervention likely would not be as stringent as the V2.0 specification, particularly for larger air cleaners. NEEA's input was influential in EPA's decision to bin products by CADR in setting on-mode efficiency requirements and ensuring those requirements were at least as stringent as the V1.2 specification for all efficiency bins. NEEA also provided input to support a more stringent standby power requirement. Manufacturers and AHAM opposed these changes, and, without NEEA's intervention, their arguments likely would have resulted in a less stringent specification.

For example, binning products by CADR likely allowed for a larger increase in efficiency requirements for the highest-capacity air cleaners than would be feasible with a uniform efficiency requirement like the one in the V1.2 specification. As a result, while a specification revision would likely occur without NEEA's intervention before 2030, its impact on baseline market share of efficient air cleaners would be less than the V2.0 specification that will take effect in October 2020.

Given these considerations, NEEA proposed reporting savings after 2025 for only the air cleaners in the largest CADR bin. We find this proposal to be reasonable. The V2.0 sepcification increased on-mode efficiency requirements by 61% for air cleaners in the largest CADR bin. An increase of that magnitude is unlikely in a baseline scenario in which NEEA is not involved in the specification revision.

Conclusions and Recommendations

Conclusion 1: EPA would likely initiate an air cleaner specification revision before 2030, even without NEEA's intervention. ENERGY STAR Unit Shipment Data reports suggest a trend of increasing ENERGY STAR market share for air cleaners. Assuming that trend continues, market share would reach a level likely to trigger a specification revision prior to 2030.

- **Recommendation 1: NEEA should revise its assumptions to report 100% of above-baseline savings related to the air cleaner specification revision as Net Market Effects for five years, rather than 10 years.** This assumes EPA would launch a specification revision in 2024, the first year Unit Shipment Data reported market share is expected to exceed 60%, and a new specification would take effect in 2025.

Conclusion 2: NEEA is justified in reporting a share of above-baseline savings after a naturally occurring specification revision, given its role in increasing the stringency of energy efficiency requirements in the V2.0 specification. NEEA and its ESRPP partners' involvement in the specification revision process, and the data they provided, supported EPA's decision to set efficiency requirements by CADR bin, increase the stringency of those requirements, and set more stringent standby mode requirements. While we cannot predict what efficiency requirements an ENERGY STAR specification revision completed without NEEA's input would adopt, it is unlikely they would reflect the increase of more than 60% that the V2.0 specification applied to air cleaners in the largest CADR bin. The 33% increase in efficiency that the middle CADR bin experienced is also likely larger than what EPA would

adopt over manufacturers' objections and without support from NEEA and its ESRPP Partners.

- **Recommendation 2: NEEA should proceed with its plan to report savings on the largest CADR bin after 2025.** The V2.0 specification increased efficiency requirements by more than 60% for air cleaners in the largest CADR bin. It is unlikely EPA would have made such a large increase, facing pushback from manufacturers, had NEEA and its ESRPP partners not been involved. NEEA should also consider whether to report all or partial savings from air cleaners in the middle CADR bin.

Appendix: Detailed Tracking of NEEA Comments on Air Cleaner V2.0 ENERGY STAR Specification Revision

Table 2: NEEA Comments and EPA Response

NEEA Comment	Other Commenter Suggestions	EPA Response/Action	NEEA Influence
Specification definition should explicitly exclude products like absorbent air fresheners, passive filters, and ozone generators.	Mixed: While 3M supported excluding photocatalyst or plasma products (which produce ozone), AHAM and Helen of Troy opposed excluding products that emit "harmful byproducts" (i.e. ozone), arguing there was no standard definition for "harmful byproducts" and air quality was outside of ENERGY STAR's scope.	Continued to exclude ozone generators and proposed to make consumer buying guidance available due to lack of tests for other byproducts. Did not explicitly exclude absorbent air fresheners or passive filters but clarified that all covered product types except ion generators operate with a motor and fan.	Moderate
The ENERGY STAR Unit Shipment Data collection form should include the product definition.	None	Committed to including the definition on the data collection form.	High
Include motor technology as a qualified product list field.	Manufacturers and AHAM oppose requiring DC motors for ENERGY STAR specification, arguing that while they are a growing technology and increase efficiency, they are not common in lower-priced models like those sold in home centers and mass-market retailers.	Did not require DC motors, committed instead to including educational materials on motor type on the consumer-focused ENERGY STAR air cleaners webpage. Did not list motor technology as a reporting requirement.	None

NEEA Comment	Other Commenter Suggestions	EPA Response/Action	NEEA Influence
Establish optional connected and/or optional load management criteria.	One manufacturer opposed reducing fan speed in response to demand response events, as this could have negative consequences for filtration. Others did not directly comment but noted that sensors and connected functionality are expensive and thus not included in most mainstream products.	Established simplified criteria for connected functionality, similar to those used for other products but without addressing demand response capabilities.	High
Include a reporting field to identify products with network connection capability when submitting for ENERGY STAR certification.	None	Included tracking of network capability as a field on the qualified products list.	High
Bin products by size and set the specification energy consumption level as a continuous equation that is a function of size. Following First Draft, suggested modification to proposed size bins.	One manufacturer opposed the use of CADR bins. Others did not directly comment but noted that larger units are more likely to include additional value-added features like advanced controls, air quality sensors, and DC motors, while smaller air cleaners are lower cost and often higher volume.	Binned products into capacity (CADR) categories and set criteria for each bin, although not as a continuous function. Accepted NEEA's suggestion to alter size bins.	High

NEEA Comment	Other Commenter Suggestions	EPA Response/Action	NEEA Influence
Ensure that efficiency level specifications for all sizes are at least as stringent as the ENERGY STAR V1.2 specification.	AHAM and one manufacturer argued that there is not a trend toward greater efficiency in air cleaners. AHAM argued that setting too stringent standards, particularly for small air cleaners, might limit ENERGY STAR availability among lower-priced products.	Agreed to ease stringency of requirements for lowest size bin, but all size bins remain more stringent than previous specification.	High
Consider the use cases for each filter type and set certification requirements to avoid inadvertently promoting a worse-performing filter; this may include establishing product classes based on filter type. In later comments, supported EPA's choice to base the specification on smoke CADR, which is most in line with consumer usage and most energy intensive to achieve.	Manufacturers and AHAM strongly supported shift from certification requirements based on dust CADR to requirements based on smoke CADR, argued this is the only particulate needed for testing.	Based specification solely on smoke CADR.	Low
Collect data on product noise levels and consider noise levels as well as efficiency in specification development.	Manufacturers and AHAM strongly opposed noise level requirements, arguing there was not sufficient data that noise levels are a problem for consumers and what level of noise is problematic. They also argued that the relationship between noise levels and efficiency is not clear.	Did not include noise level requirements in draft specification.	None

NEEA Comment	Other Commenter Suggestions	EPA Response/Action	NEEA Influence
Adopt a standby power draw requirement of 1 watt or less and consider listed functionalities as potential adders.	AHAM and one manufacturer argued that increasing standby mode power draw requirements could "impede innovation" around connected products.	Adopted a base partial on-mode (i.e. standby) power allowance of 1 watt with an adder for Wi-Fi capability.	High
Consider developing an ENERGY STAR Most Efficient tier.	None	Stated that 2020 focus will be on increasing market adoption of ENERGY STAR models. EPA will monitor market response and consider future adoption of a Most Efficient tier.	None