ENERGY STAR® Clothes Dryer Version 2.0 Specification Discussion Guide November 2023

1. Overview

The U.S. Environmental Protection Agency (EPA) is pleased to share with stakeholders the ENERGY STAR Version 2.0 Clothes Dryer Discussion Guide. We invite stakeholder input to inform development of this revised specification. Please submit comments on the discussion questions below, as well as data, to: appliances@energystar.gov by **Thursday, December 14, 2023**.

EPA will host a webinar on Tuesday, November 21, 2023 from 1 – 3 PM Eastern Time to seek input from stakeholders on the topics below. Please register to attend the webinar here.

2. Background

The time is ripe for a revision of the ENERGY STAR Clothes Dryer Specification. Since EPA last partnered with stakeholders to finalize the first Clothes Dryer Specification in 2015, the clothes dryer market has evolved significantly with technological advances driving efficiency gains. These efficiency gains are reflected in the ENERGY STAR dataset, enabling utility incentives at significantly higher levels of efficiency, with a healthy selection of models that meet these levels.

Per the ENERGY STAR Guiding Principles, EPA also works towards ensuring that consumers have a positive experience and association with ENERGY STAR certified products, ensuring performance isn't traded off in pursuit of greater efficiency. For clothes dryers in particular, and in follow up to EPA's May 19, 2020, memo, EPA is seeking to use this Discussion Guide to gain a better understanding of the user experience with laundry in regard to cycles and settings, and drying performance and how this impacts their experience with their ENERGY STAR dryer.

Because stakeholder engagement is key to the success of the ENERGY STAR program, EPA has drafted this Discussion Guide to seek early insights and feedback on this planned revision. EPA looks forward to working with all stakeholders to revise the ENERGY STAR Clothes Dryer Specification.

3. Scope

In the Version 1 specification, EPA includes all products that meet the definition of a Clothes Dryer, except for:

(1) Commercial Clothes Dryers

(2) Water-Cooled Ventless Clothes Dryers

(3) Combination All-in-One Washer-Dryers

(4) Residential Clothes Washers with an Optional Dry Cycle

Combination all-in-one washer-dryers are eligible for certification under the ENERGY STAR Clothes Washer Specification. Combination all-in-one washer-dryers do need to meet all the ENERGY STAR clothes dryer criteria for certification. EPA has received requests that combination all-in-one washer-dryers be included under the ENERGY STAR clothes dryer specification. These recent suggestions were made for clarification to State and utility rebate programs, in particular those focused on heat pump dryers. EPA is considering these requests.

Regarding commercial clothes dryers, EPA received stakeholder requests for inclusion of this product type to complement the ENERGY STAR coverage of commercial clothes washers. Stakeholders provided feedback that efficient commercial clothes dryers are necessary for multifamily applications where energy efficiency is a key focus for builders and developers. Commercial clothes dryers have not been included in the scope of the ENERGY STAR Dryer Specification to date because a test procedure for measuring energy use has not yet been established.

Discussion Question

1. EPA is exploring expanding coverage to include commercial clothes dryers. EPA is interested in hearing stakeholder feedback. What is the availability of electric commercial clothes dryers, including heat pump or hybrid heat pump models, specifically those that are applicable for multifamily and laundromat purposes? See Section 8.C for testing information for commercial dryers and requests for data.

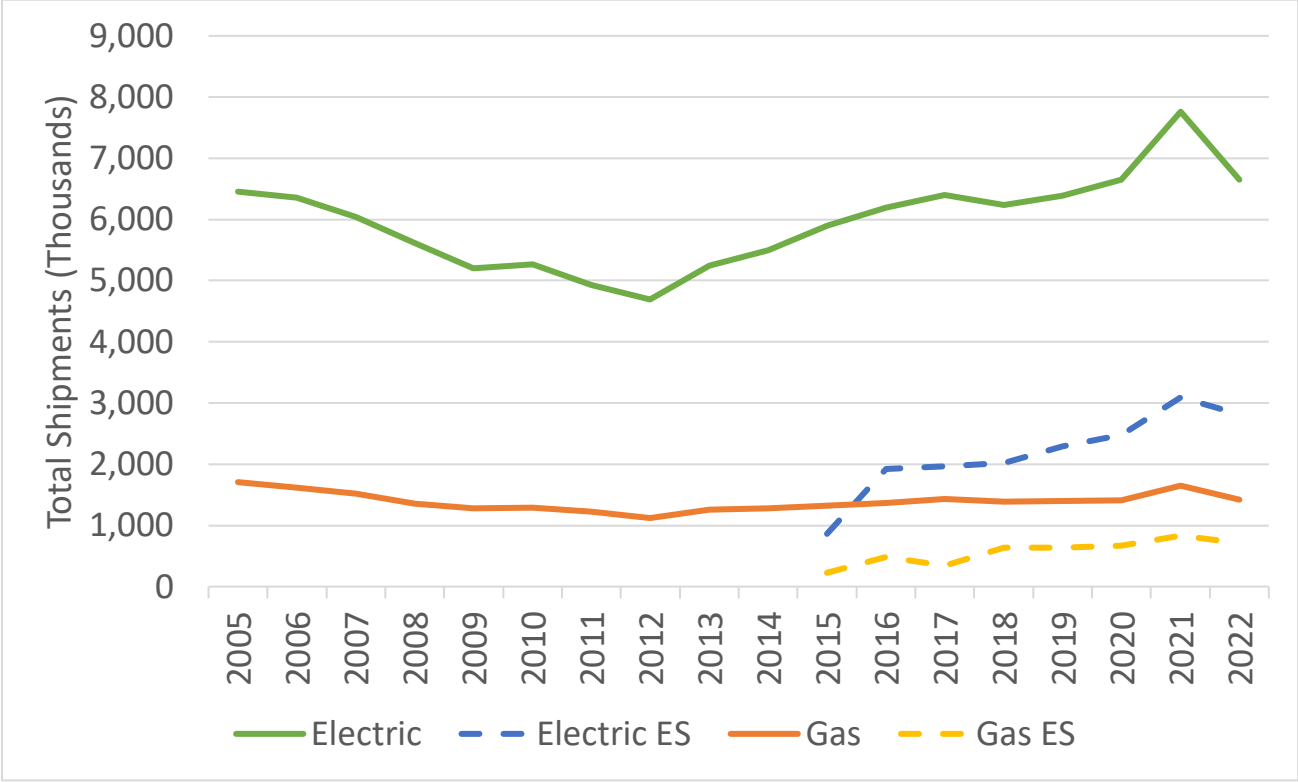
4. Market Assessment

EPA reviewed the clothes dryer market to determine what has changed since the Version 1.1 Specification took effect in 2015. Specifically, EPA reviewed ENERGY STAR market penetration and industry product availability data, DOE's certified product database, and websites for the manufacturers and retailers. Additionally, EPA met with key stakeholders to inform this market analysis.

A. Clothes Dryer Shipments

Figure 1 shows clothes dryer shipments are around 7 million a year and in general have been increasing year over year the last decade.

Figure 1: ENERGY STAR and Total Shipments for Gas and Electric Clothes Dryers – Historic



B. Growing ENERGY STAR Market Penetration

The ENERGY STAR Unit Shipment Data Summary Report shows that market penetration of ENERGY STAR certified clothes dryers has been steadily growing in recent years reaching 46% for electric and 56% for gas in 2022.

Further supporting the increase in efficiency of dryers in recent years, data shared by ENERGY STAR Retail Products Platform (RPP) partners shows significant increases in sales of high efficiency dryers. The RPP is a collaborative midstream initiative of ENERGY STAR, energy efficiency program sponsors, retailer partners, and other key stakeholders that is facilitated by EPA. RPP offers a gateway for energy efficiency programs to

capture energy savings for specific product types at a significantly lower cost than current programs incur. Clothes dryers are one of the product categories included in the RPP program, and RPP utilities offer incentives for selling more efficient clothes dryers. RPP currently incents at ENERGY STAR for its basic tier and ENERGY STAR Most Efficient for its advanced tier. The number of RPP dryer incentives are on pace to double each of the last four years. We expect the growth of high efficiency dryers to accelerate with the introduction of rebates for heat pump dryers in the High-Efficiency Electric Home Rebate Act (HEEHRA) of the Inflation Reduction Act.

Discussion Question

2. EPA welcomes stakeholder data, industry trends, and other information that may provide additional insight into the clothes dryer market.

C. Heat Pump and Hybrid Heat Pump

EPA is aware of growing sales for dryers with heat pump technology. Further, EPA expects accelerated sales when the Inflation Reduction Act rebates for heat pump dryers are available. EPA is interested in hearing stakeholder thoughts on and plans for the likely growth in dryers with heat pump technology. EPA anticipates that products that rely on heat pump technology will deliver myriad benefit to the market. For example, EPA expects that heat pumps will deliver savings across all dryer cycles and dryer loads. Further, EPA anticipates that the Agency's concerns raised in the May 2020 memo regarding models being switched out of the tested mode due to degraded performance could be resolved with hybrid or full heat pumps.

Discussion Questions/Data Request

3. How will the market for dryers with heat pump technology change when the Inflation Reduction Act's High Efficiency Electric Home Rebates are available?

4. Are there plans for additional standard-sized models with heat pump technology? Manufacturers may submit information confidentially with EPA. See the Request for Feedback section of this Discussion Guide for more details on submitting information to EPA.

5. EPA requests test data for dryers with heat pump technology for the normal and other cycles in a range of load sizes (3 lbs., 8.45 lbs, and 12 lbs) and different test load materials (i.e., 100% cotton). Data shared with EPA should include, but not be limited to, the model number, test load weight, test load material, calculated CEF, FMC, and cycle time.

6. For hybrid heat pump models, what is the energy use, cycle time, and performance difference when the heater is on in different heater cycle durations in "hybrid" mode versus in full heat pump mode?

7. EPA requests any use data that provides insight into how consumers operate their hybrid heat pumps.

8. What can the ENERGY STAR program do to further educate the market about heat pump and hybrid heat pump dryers for consumers?

i. Combination All-in-One Washer/Dryers with Heat Pump Technology

EPA is aware of new combination all-in-one washer/dryer models with heat pump technology that are available in the market or will be soon. If there are distinctions to the answers for any of the questions in this Discussion Guide regarding these models compared to other dryers, please note the distinction in the comments. If stakeholders wish to share information confidentially, see the Request for Feedback section of this Discussion Guide for more details on submitting information to EPA.

5. ENERGY STAR Efficiency Criteria and Qualified Product List (QPL) Efficiency Assessment

To assess appropriate efficiency criteria for Version 2.0, EPA evaluated the current ENERGY STAR Qualified Product List, along with other market data. The Combined Energy Factor (CEF) is the metric referenced by the ENERGY STAR specification to determine the product's energy efficiency and is measured in terms of test load weight (lbs) per kilowatt hours (kWh)[1]. The larger the CEF, the more efficient the dryer is at removing moisture from the test load. The current ENERGY STAR energy efficiency criteria are in Table 1.

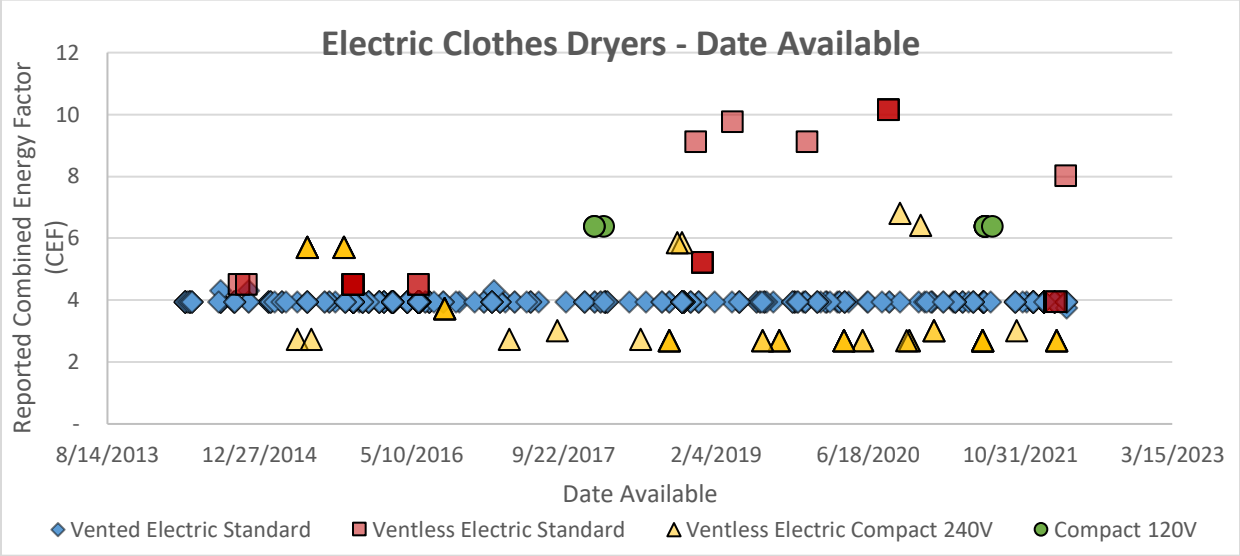
Table 1 : ENERGY STAR Version 1.1 Minimum CEF Levels

Product Type*	CEF_{BASE} (lbs/kWh)
Vented Gas	3.48
Ventless or Vented Electric, Standard (4.4 cu-ft or greater capacity)	3.93
Ventless or Vented Electric, Compact (120V) (less than 4.4 cu-ft capacity)	3.80
Vented Electric, Compact (240V) (less than 4.4 cu-ft capacity)	3.45
Ventless Electric, Compact (240 V) (less than 4.4 cu-ft capacity)	2.68

* Those products meeting the definition of a Clothes Dryer with Supplementary Drying System - The primary dryer must meet the appropriate CEF to certify for ENERGY STAR as if it were a stand-alone product.

EPA reviewed the performance data of ENERGY STAR certified products, and specifically, how product efficiency improved since the Version 1.0 Specification was published in 2014. Figure 2 shows more models in recent years with greater efficiency providing an opportunity to increase the stringency of the ENERGY STAR criteria**.**

Figure 2: ENERGY STAR QPL Efficiency of Products Available on the Market from 2014 to Present



6. Product Technology and Characteristics Assessment

A. Technology Assessment

EPA investigated product advancements to understand what improvements have been made to clothes dryers since the Version 1 Specification.

[1] CEF is measured in accordance with the DOE test procedure at 10 CFR 430, Subpart B, Appendix D2

i. **Technological Advancements**

Based on research and recent conversations with stakeholders, EPA learned about the following efficiency advancements made over the past decade:

Sensors – allow for the dryer to manage the drying process and prevents overdrying.

More advanced automatic termination control – a more advanced microprocessor controller terminates the drying cycle earlier to minimize overdrying, while still achieving the required final moisture content (FMC).

Modulating (2-stage) heat – by replacing the conventional single electric resistance heater with two smaller-sized electric resistance heaters mounted in series in the heating duct, which are controlled by feedback from temperature and moisture sensors, allows the dryer to be operated at a lower power level at the beginning of the cycle.

Inlet air preheat – an air-to-air heat exchanger (with added ducting) could recover exhaust heat energy and preheat inlet air. Moisture sensors and variable-speed blowers would be required to adjust airflow rates and allow for more accurate control of the drying cycle and prevent condensation.

Heat pump, hybrid heat pump technology – provides a significant increase in energy efficiency.

Use of lower GWP refrigerants – A selection of ENERGY STAR dryers are making use of R-290 and achieving high levels of energy efficiency.

Discussion Questions

9. What other technological advancements in dryers have been made that bring about improved efficiency?

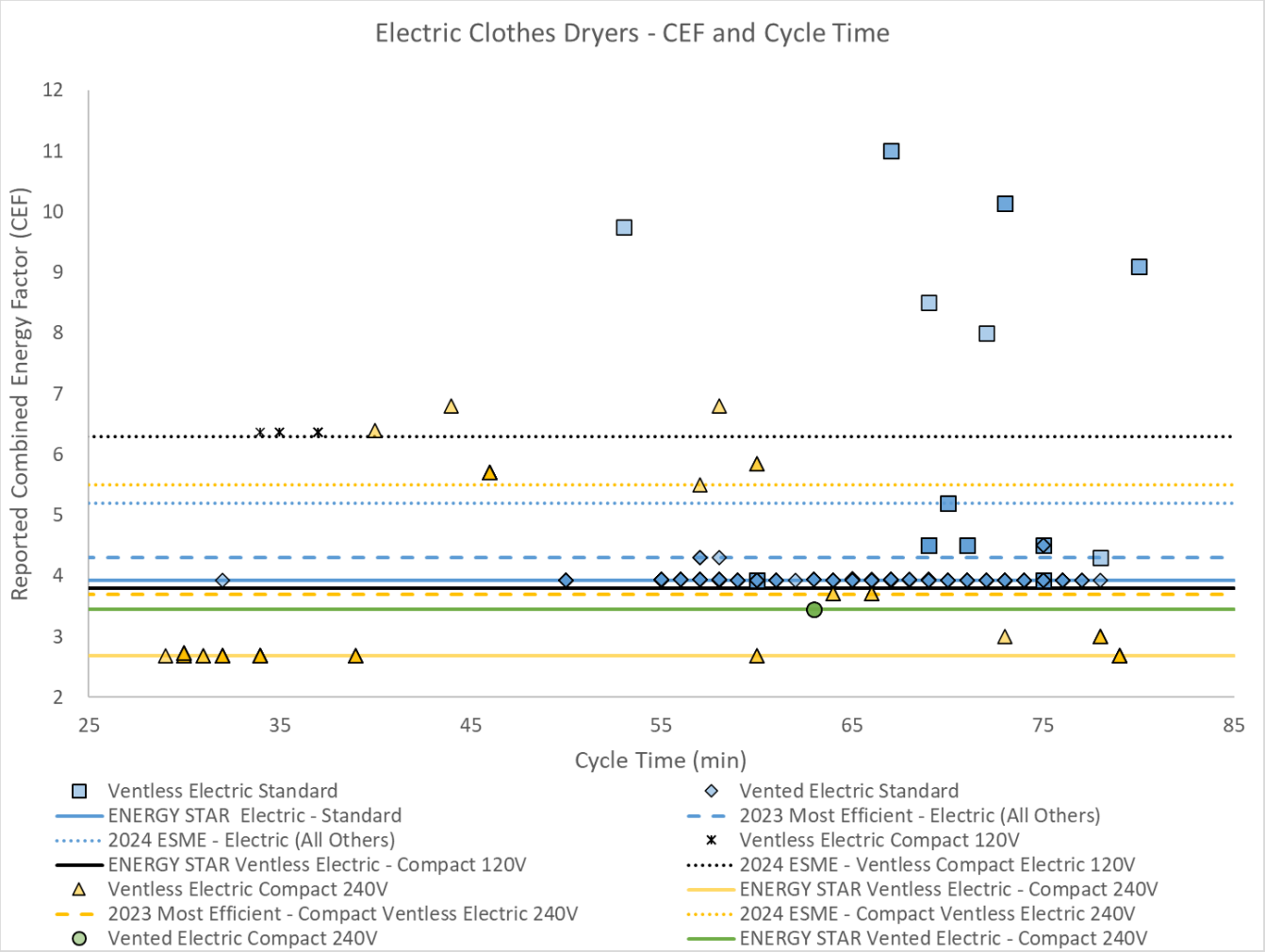
10. How prevalent are these advancements in standard-sized dryers and at what price points?

B. Product Characteristics Impacting Efficiency and Performance

i. **Cycle Time**

EPA reviewed cycle time for ENERGY STAR dryers. Figure 3 shows ENERGY STAR electric dryers have a cycle time that ranges between 29 and 80 minutes. Most of the standard-size dryers have cycle times between 50 and 80 minutes. The current ENERGY STAR specification requires the cycle time to be 80 minutes or less.

Figure 3: ENERGY STAR QPL Models – CEF and Cycle Time



EPA has heard stakeholder feedback that the most common consumer complaint is cycle time. It is EPA's understanding that many consumers prefer to do multiple loads of laundry at once, one right after another, and therefore, would prefer dryer cycle times to approximately match washer cycle times. Additionally, EPA has heard feedback that longer cycle times mean consumers are unable to do as many loads of laundry in a day.

Discussion Questions

11. What are the average cycle times for clothes washers that are operating with standard-sized dryers?

12. What cycle durations for washers and dryers do consumers find acceptable?

ii. **Paired Laundry**

EPA understands that combination all-in-one washer-dryers, laundry centers and paired washers and dryers – which are washers and dryers designed to be sold together and operated together in a consumer's home – may have energy efficiency and cycle time benefits. For simplicity in this section, EPA will refer to combination all-in-one washer-dryers, laundry centers, and paired washer and dryer models as paired laundry. EPA is aware different clothes washer models will have different remaining moisture content (RMC) levels for a load, which will mean paired dryers will start with different initial moisture content levels, depending on the paired washer. EPA has observed washer models with a wide range of RMCs and recognizes the positive impact lower RMCs could have on the paired dryer's energy efficiency and cycle time.

Notably, a dryer paired with a washer that has a lower RMC. EPA seeks feedback from stakeholders to understand what these savings and benefits may be.

Discussion Question

13. How could EPA recognize the potential energy efficiency and cycle time benefits of paired laundry models in the Version 2.0 dryer specification? EPA welcomes feedback on ideas to recognize these benefits and help product meet the 80-minute maximum test cycle time limit criteria e.g., a time credit for the dryer's cycle time that is a function of the paired washer's RMC[2], additional testing of the dryer with a test load at starting RMC that is equal to the paired washer's RMC, or other ideas stakeholders suggest.

14. For the purposes of this question, EPA is not referencing washers and dryers that can share information with each other, only washers and dryers designed to operate as a pair in a consumer's home. What is the energy efficiency and cycle time benefits for dryers that are part of a pair versus dryers that are not part of a pair?

iii. **Smart/AI Laundry**

EPA is aware there are washers and dryers on the market that can share information between the two products to give recommendations to consumers for an appropriate dry cycle based on the information gathered by the washer and the completed wash cycle.

Discussion Questions

15. How different is the energy use for a dryer that can share and react to information from the washer compared to the energy use of the same dryer without this information using the energy test load or a real-world load?

16. What are the typical adjustments to the cycle and settings for dryers with this capability? How often are the cycle and/of settings changed away from the cycle and settings used in the energy test?

17. What is the typical net energy savings for laundry pairs that are able to share and react to information from each other?

7. Cycle and Settings Selections

EPA has heard from stakeholders and seen Residential Energy Consumption Survey (RECS)[3] data that suggest that users will select the normal cycle for typical, everyday loads, which is the basis for testing clothes dryers. EPA has also received feedback that some users switch out of the normal cycle when it consistently fails to meet their expectations (i.e., load does not fully dry, or there are wet spots) and may switch to a more energy intensive cycle or manually select a timed cycle.

EPA is seeking feedback to understand typical user cycle selections – including cycle type, temperature setting, dryness setting, and other optional or default cycle settings such as an "eco" setting – and if users do not use the normal cycle, what other cycles/settings users may select and what the drivers are for selecting those other cycles/settings.

Discussion Questions

18. EPA has heard feedback that in some instances these "eco" or energy saving settings/cycles, which are typically used for the purposes of ENERGY STAR certification, are in some instances leading to less than satisfactory results in drying loads or cycle times, causing users to switch to

[2] The time credit could be applied to the "cycle time" field in the QPL or applied in a new field, cycle time when used with paired washer model. The exact field name would need further review.

[3] https://www.eia.gov/consumption/residential/data/2020/

another cycle or switch off the “eco” or energy saving setting. What cycles and settings are users selecting? How frequently are consumers using an “eco” or energy savings setting/cycle?

19. If users are selecting other cycles and settings, what are the reasons for doing so? What are the impacts on energy use, cycle time, and consumer satisfaction?

20. Does cycle selection drive energy use for dryers with heat pump technology like it does for conventional dryers?

8. Network-Connected Functionality and Updates

A. Network-Connected

EPA is aware there are network-connected clothes dryers on the market that allow consumers to interact with the product by using a mobile device or a computer through an app. EPA seeks feedback at understanding how connected functionality in dryers has evolved over the years.

Discussion Questions

21. What is the prevalence of network-connected clothes dryers?

22. What percentage of consumers connect their clothes dryers to a network?

23. For consumers who connect their dryer to a network, what are the drivers for doing so?

24. For consumers with a dryer capable of connecting to a network but have not connected it to a network, what are the reasons for not connecting to a network?

B. Demand Response/Load Shift

As Demand Response (DR) load shift programs have evolved, EPA has concluded that utilities and aggregators are not currently addressing clothes dryers through active demand response involving real-time communication, nor are they likely to. Yet, when dryers are running, their energy draw is substantial. Two potential ways to address when dryers are used without real time signaling with a utility or aggregator are (a) connecting to a smart home system (b) managing use around set time-varying energy prices. Integration into smart home systems provides consumer amenity, and therefore may move forward whether or not it provides load flexibility.

Discussion Questions

25. Do stakeholders agree with EPA’s assessment of dryer load shift/DR programs? Do utility or aggregator stakeholders have plans to directly address dryers in the future?

26. Are manufacturers including features in their dryers (beyond networking capability) to make them easier to integrate into smart home systems? This could include specific protocols, set up menus, etc.

27. Are there market forces that will make it more likely that future dryers will be able to manage time-varying energy prices? Are there technical developments that will make this easier? How would dryers be aware of the energy prices?

C. Firmware/Software Updates

It is EPA’s understanding that firmware and/or software updates may be pushed to connected clothes dryers. EPA seeks to understand what kinds of updates can be sent to dryers in consumer homes.

Discussion Questions

28. What firmware or software updates are stakeholders making available via network connection? Do these updates have an impact on the cycles, settings, and resulting energy use?

29. How are these updates described to the users?

9. Commercial Dryer Testing

As discussed above, EPA is considering expanding the scope of the ENERGY STAR specification to include commercial clothes dryers. Recognizing that commercial clothes dryers may differ from residential clothes dryers in several ways—for example, design, settings, cycles, and typical operating conditions—EPA expects that the development of a test method for commercial clothes dryers based on appendix D2 may be necessary to effectively determine their performance in a representative manner. A new test method for commercial clothes dryers would also provide the means of differentiating between products of varying efficiency and performance. EPA has identified several key areas of interest related to commercial clothes dryer use and operation to help inform the development of a test method.

Discussion Questions

30. **Average Use Cycle** – What is a representative number of cycles per year for a commercial clothes dryer? Does this differ based on the application (e.g., multi-family, laundromat)

31. **Drum Capacity Measurement** – Residential clothes dryers employ a water-based drum capacity measurement approach that could potentially be unwieldy or overly burdensome for commercial clothes dryers. If that is the case, are there other effective methods of determining drum capacity (e.g., CAD models)?

32. **Test Settings** – What are the typical setting selections (e.g., cycle, dryness, temperature) for commercial clothes dryers?

33. **Test Conditions** –

    DOE's Appendix D2 test procedure for residential clothes dryers requires that the dryer be pre-conditioned prior to the start of testing. For vented clothes dryers, this involves operating the dryer without a test load in the non-heat mode for 15 minutes or until the discharge air temperature is varying less than 1 °F for 10 minutes—whichever is longer—in the test installation location with the ambient conditions as specified by the test procedure. Would other starting test conditions be more representative of typical use of a commercial clothes dryer? For example, pre-conditioning the dryer using a heated cycle?

    DOE's Appendix D2 test procedure specifies a starting moisture content of 57.5% ±0.33% for the load. Would this starting moisture content be representative of real-would use of a commercial clothes dryer used in conjunction with a commercial clothes washer, or would a different starting moisture content be more representative?

34. **Test Load** – What is a representative test load weight for commercial clothes dryers? If there is no typical or representative test load weight, would a variable weight based on the drum capacity be reasonable? If so, what might be an appropriate way to identify an appropriate method of determining load weight?

10. Request for Feedback

EPA welcomes feedback from commenters on these issues and would welcome opportunities to collaborate with manufacturers in identifying key technologies, selecting key models for testing, and testing products. Stakeholders may share information confidentially with EPA. To do so, please send comments marked as confidential in addition to public comments if the stakeholder chooses to submit public comments. The information gathered through this Discussion Guide will inform the Version 2.0 and future ENERGY STAR specification revisions.

EPA requests feedback on these - and any other related issues or concerns - **by December 14, 2023**. Please send comments to appliances@energystar.gov. Registration for the Version 2.0 Clothes Dryers Discussion Guide webinar on **Tuesday, November 21, 2023, from 1 - 3 PM Eastern Time**, is available here.

For any questions about this Clothes Dryer Discussion guide, please contact Steve Leybourn, EPA at Leybourn.Stephen@epa.gov or (202) 934-2262 or reach out to appliances@energystar.gov. For test procedure questions, contact Carl Shapiro, DOE at carl.shapiro@ee.doe.gov.