Appliance Standards Awareness Project
American Council for an Energy-Efficient Economy
Consumer Federation of America
Natural Resources Defense Council

January 27, 2022

Mr. Bryan Berringer
U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Building Technologies Office, EE-2J
1000 Independence Avenue SW
Washington, DC 20585

RE: Docket Number EERE-2017-BT-STD-0014/RIN 1904-AD98: Energy Conservation Standards for Residential Clothes Washers

Dear Mr. Berringer:

This letter constitutes the comments of the Appliance Standards Awareness Project (ASAP), American Council for an Energy-Efficient Economy (ACEEE), Consumer Federation of America (CFA), and the Natural Resources Defense Council (NRDC) on the preliminary technical support document (PTSD) for residential clothes washers. 86 Fed. Reg. 53886 (September 29, 2021). We appreciate the opportunity to provide input to the Department.

DOE's preliminary analysis shows that amended efficiency standards for residential clothes washers could net nearly 3 quads of energy savings and would be cost-effective for purchasers. We support DOE's overall approach to this rulemaking analysis but believe there are several issues that should be addressed. First, we encourage DOE to investigate the correlation between capacity and efficiency for the new proposed energy and water usage metrics. Second, we believe that DOE is underestimating both water heating and drying energy usage. Third, we encourage DOE to analyze higher efficiency levels (ELs) for the top-loading, compact product class. Finally, we encourage DOE to more rigorously model market shifts under standards implementations. Below we provide our comments on these and other issues.

We support DOE's approach to selecting ELs based on the proposed new energy and water usage metrics. DOE developed a model to predict a washer's energy efficiency ratio (EER) and water efficiency ratio (WER) values based on both testing performed under the existing Appendix J2 and a washer's physical and operational characteristics.[1] DOE used this model along with EPCA[2] and market cluster approaches to develop the ELs for the preliminary analysis. We support refining this approach and conducting additional testing using the new proposed Appendix J test procedure, but believe this approach is valid for determining ELs for this rulemaking.

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[1]EERE-2017-BT-STD-0014-0030, PTSD, pp. 5-7, 8. www.regulations.gov/document/EERE-2017-BT-STD-0014-0030
[2]The Energy Policy and Conservation Act (EPCA) specifies measuring energy/water usage for a representative sample of products when DOE determines that an amended test procedure will alter measured efficiency.

We encourage DOE to investigate the correlation between washer capacity and measured efficiency. We support the proposed change in the September 2021 test procedure NOPR to make the water and energy usage metrics based on lbs. of clothes washed rather than capacity, which will help mitigate the current bias towards large-capacity washers. However, DOE's preliminary testing presented in the PTSD suggests that for at least top-loading standard washers, large-capacity washers still achieve higher efficiency ratings. While the model-predicted and tested EERs are not tabulated in the PTSD as a function of capacity, Figure 1 plots rated IMEF (left) and linear-fit estimated EERs[3] (right) versus capacity for the 30 top-loading washers in DOE's test sample.[4] While the correlation between capacity and efficiency is slightly less pronounced for EER than for IMEF, it persists based on this preliminary analysis. We thus encourage DOE to investigate whether this results from: 1) larger machines being inherently more efficient, 2) larger machines employing additional technology options that improve efficiency, or 3) some remaining inherent bias towards larger capacity machines. To the extent that larger machines can achieve higher EER and/or WER ratings, DOE should consider requiring higher efficiency levels for larger capacity washers. For example, DOE could consider standards that are a function of capacity.

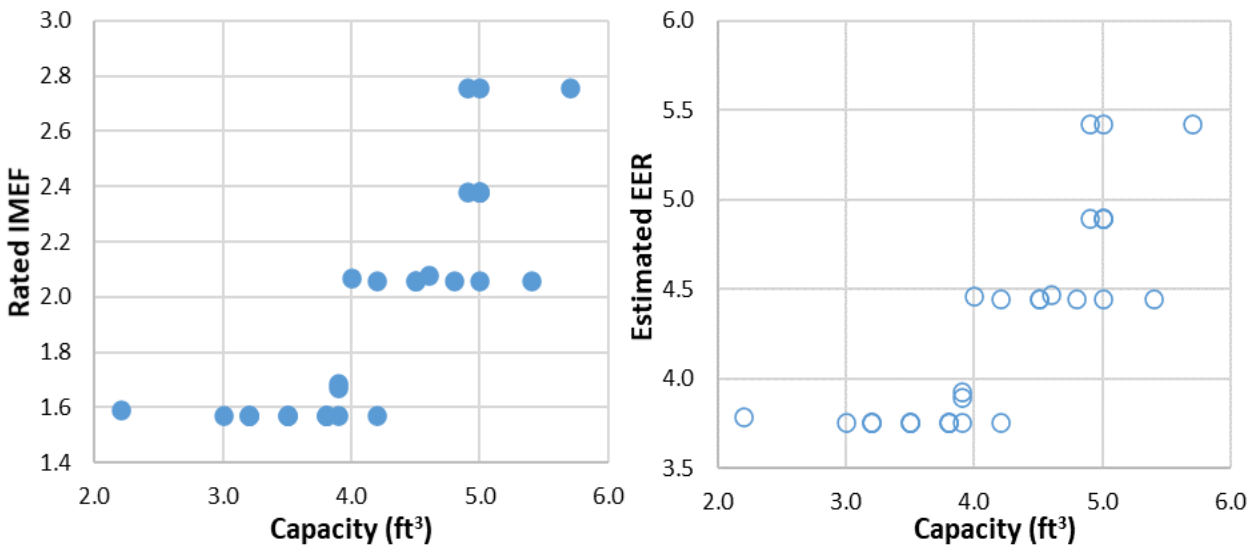

Figure 1: Rated IMEF (left) and estimated EER (right) versus capacity for top-loading standard washers.

We believe DOE's assumptions regarding water heater efficiencies are underestimating water heating energy usage. In the preliminary analysis, the calculation of hot water energy use assumes water heater efficiencies of 100% for electric water heaters and 78% for gas water heaters.[5] However, we believe that these estimates are likely significantly overstating the efficiencies of water heaters in the field. Based on shipment data from the last water heater rulemaking and current models in the Compliance Certification database, we estimate that shipment-weighted efficiencies for new water heaters are

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[3]Estimated EERs were calculated using the rated IMEFs and the linear fit equation given in Figure 5.3.2. PTSD, p. 5-12. www.regulations.gov/document/EERE-2017-BT-STD-0014-0030

[4]PTSD, Table 5.5.3, p. 5-23. www.regulations.gov/document/EERE-2017-BT-STD-0014-0030

[5]PTSD, p. 7-1. www.regulations.gov/document/EERE-2017-BT-STD-0014-0030

about 92% for electric water heaters and 64% for gas water heaters.[6] Moreover, the average efficiencies of the stock of water heaters in the field are likely lower than those of new shipments. We therefore suggest that DOE estimate the average water heater efficiencies for the overall stock of water heaters in the field for the assumed compliance year for amended residential washer standards. Hot water energy usage is the second largest component of overall energy usage and varies significantly by EL. For example, a baseline top-loading, standard washer's water heating energy usage per cycle, 0.47 kWh, is more than double that of EL4 (0.22 kWh). Thus, we believe more realistic estimates of water heater efficiencies will demonstrate that higher ELs are even more cost-effective.

Both DOE's recent analysis for clothes dryers and real-world data suggests that drying energy usage in the clothes washers analysis is being significantly underestimated. DOE's analysis in the residential washers PTSD suggests that drying energy usage represents 75-83% of total energy usage.[7] Thus, changes in drying energy estimates can have a significant impact on the overall energy savings and economic analysis. ***Crucially, clothes dryer active-mode energy use, based on DOE's 2021 dryers analysis, is 67 and 93% greater than the estimated drying energy usage in the washers PTSD for standard top-loading and front-loading washers, respectively.[8]*** Further, the dryer analysis estimates agree much more closely with real-world data.

According to the recent April 2021 preliminary analysis for consumer clothes dryer standards,[9] the average standard electric clothes dryer has a CEF rating of 3.06.[10] Based on this dryer standards analysis, a CEF rating of 3.04 (i.e., nearly identical to the market average estimate of 3.06), corresponds to an average annual energy usage of 712 kWh.[11] While this value includes standby power, DOE discusses in the dryer analysis that standby powers were only 0.11-1.16 W for the models examined, or about 1-10 kWh/yr.[12] Thus, DOE's dryer analysis suggests a typical dryer consumes upwards of 700 kWh/yr in active mode. In contrast, the preliminary analysis for washers suggests an average drying energy of only 419 and 362 kWh/yr for top-loading and front-loading standard washers, respectively.[13] Importantly, these estimates are lower than even the maximum technologically feasible level for dryers based on the dryer analysis (CEF = 4.30, 511 kWh/yr). Further, the dryer analysis agrees much more closely with real-world dryer energy usage estimates from 2015 RECS data (776 kWh/yr)[14] and a 2014 NEEA study (915 kWh/yr).[15] Higher, more realistic drying energy usage estimates should further improve the cost-

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[6]We calculated average efficiencies by size class (>30 gal, 31-49 gal, and 50+ gal) for models (excluding tankless and heat pump water heaters) in the Compliance Certification Database (accessed November 11, 2021) found at: www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A*, then we calculated weighted-average efficiencies by shipment estimates by size class from the previous water heater standards analysis, p. 7-7, found at: www.regulations.gov/document/EERE-2006-STD-0129-0149

[7]PTSD, Tables 7.2.2 and 7.2.4, pp. 7-3, 4. www.regulations.gov/document/EERE-2017-BT-STD-0014-0030

[8]Based on the dryer PTSD (700 kWh/yr) and the washer PTSD, 419 (362) kWh/yr, for top(front)-loading washers.

[9]Dryer PTSD, pp. 7-13, 10-5. www.regulations.gov/document/EERE-2014-BT-STD-0058-0016

[10]Based on a weighted average of ELs in the no-new-standards case shown in Table 10.3.1 of the dryer PTSD.

[11]Dryer PTSD, Table 7.5.1, p. 7-13. www.regulations.gov/document/EERE-2014-BT-STD-0058-0016

[12]Dryer PTSD, p. 5-22. www.regulations.gov/document/EERE-2014-BT-STD-0058-0016

[13]Values were estimated by multiplying electric dryer energy use per cycle for each EL in Tables 8.3.3/8.3.5 by the number of cycles per year 233 (254) for top (front)-loading washers. A weighted average of the EL-specific annual dryer energy totals was calculated using the no-new-standards EL market shares in Tables 10.2.1/10.2.2.

[14]2015 RECS, Table CE5.3a. www.eia.gov/consumption/residential/data/2015/c&e/pdf/ce5.3a.pdf

[15]#E14-287, Dryer Field Study, 2014. neea.org/resources/rbsa-laundry-study

effectiveness of higher EL washers that reduce drying energy use. Thus, we encourage DOE to update their drying energy usage calculations to better align with the Department's dryers analysis and real-world energy usage.

One potential partial explanation for the apparent underestimation of drying energy usage in the washers analysis is the estimate for DEF, or the nominal energy required for a dryer to remove moisture from clothes. DOE's washers analysis assumed a DEF of 0.5 kWh per lb. of moisture removed from clothes.[16] Using weighted-average dryer efficiency ratings and parameters from the dryer test procedure,[17] we estimate a higher nominal DEF of about 0.6 kWh/lb.[18] A recent NEEA study suggests that even the clothes dryer test procedure can underestimate drying energy usage, particularly when a non-Energy Star rated top-loading washer is paired with a non-Energy Star electric dryer.[19] For comparison, the Northwest Regional Technical Forum's most recent estimate is 0.65 kWh/lb.[20] Overall, this suggests DOE should increase their estimated DEF above 0.5 kWh/lb. of moisture removed.

We encourage DOE to further analyze the top-loading, compact product class. According to the Department, no washers exceeding the baseline level were available on the market at the time of the analysis.[21] Thus, DOE did not evaluate any higher ELs for top-loading, compact washers. However, DOE's Compliance Certification Database has 8 models with IMEF ratings of 1.24 to 1.36,[22] while the minimum standard level is 1.15. Furthermore, the new proposed test procedure could change both the relative rankings and range of efficiency ratings for top-loading, compact models. We therefore encourage DOE to evaluate one or more higher ELs for top-loading, compact washers.

We encourage DOE to more thoroughly model market shifts under standards implementations. DOE's analysis predicts future market shifts (e.g., front-loading vs. top-loading) that would occur from adoption of various standard levels. In the preliminary analysis, DOE used a logistic regression model to capture the relationship between the market share of front-loading and top-loading washers, their prices, and their energy usage.[23] The model indicates that front-loading market share is negatively correlated with top-loading price and energy usage. Thus, the model predicts that front-loading market share will decrease if higher standards are implemented for both top- and front-loading washers. However, the estimated average price difference between front-loading and top-loading washers is

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[16]PTSD, p. 7-2. www.regulations.gov/document/EERE-2017-BT-STD-0014-0030

[17]86 Fed. Reg. 56643 (October 8, 2021).

[18]A typical electric standard dryer has a CEF = 3.06 lb./kWh or 0.33 kWh per lb. of clothes dried. The dryer test procedure (TP) bone-dry load is 8.45 lbs., which gives 2.76 kWh (0.33 kWh/lb. x 8.45 lbs.) per TP cycle. Further, Appendix D2 specifies a ~56% reduction in moisture content (MC). MC is the difference in bone-dry and wet weight divided by bone-dry weight. Bone-dry weight (8.45 lbs.) and target MC (~56%) are known, so solving for wet weight yields ~13.2 lbs. Thus, the moisture removed from the TP load is ~13.2 – 8.45 lbs. = ~4.7 lbs. Since it takes 2.76 kWh for a typical dryer to complete a TP cycle, we estimate 2.76 kWh/4.7 lbs. = ~0.6 kWh/lb. of moisture removed. Results using Appendix D1 (MC reduction ~54%) yield similar but slightly higher kWh/lb.

[19]#E22-325, Perfect Pairings? Testing the Energy Efficiency of Matched Washer-Dryer Sets, 2022. neea.org/resources/perfect-pairings-testing-the-energy-efficiency-of-matched-washer-dryer-sets?

[20]Regional Technical Forum, Residential Clothes Washers, 2021. "Residential Clothes Washers v7.1", rtf.nwcouncil.org/measure/clothes-washers-0

[21]PTSD, p. 5-5. www.regulations.gov/document/EERE-2017-BT-STD-0014-0030

[22]Compliance Certification Database, accessed on January 26, 2022. www.regulations.doe.gov/certification-data/CCMS-4-Clothes_Washers.html#q=Product_Group_s%3A%22Clothes%20Washers%22

[23]PTSD, pp. 9-9, 10. www.regulations.gov/document/EERE-2017-BT-STD-0014-0030

$323 at EL0 vs. only $186 at EL4.[24] Thus, it is plausible that increasing standards could move the market towards—rather than away from—front-loading washers. DOE should thus analyze how estimated first costs for each product class may be reflected in market share projections. Since front-loading washers are more efficient than top-loading washers, an accurate prediction of future market shares of each type is important for the overall energy savings and economic analysis.

DOE should clarify the hot water temperature rise estimate used in the hot water energy usage calculations. DOE's recent washer test procedure NOPR proposed to reduce the temperature rise from 75 °F to 65 °F.[25] However, Tables 7.2.1 to 7.2.4, based on the test procedure, specify a temperature rise of 75 °F. Further, Tables 7.3.1 to 7.3.4 appear to be using a hot water temperature rise of 67.5 °F based on 2015 RECS data.[26] Finally, Tables 8.3.2 to 8.3.5,[27] which we understand include the values that are used in the overall energy use and economic analysis, specify water heater energy usage per cycle based on a 75 °F temperature rise. Prior DOE analysis of household hot water temperatures, discussed in the 2014 test procedure final rule for water heaters, found that the average set point for water heaters was 124.2 °F.[28] Given this hot water supply temperature, we believe a value lower than 75 °F (e.g., 67.5 °F) will more accurately reflect hot water energy usage.

As presented, the average life-cycle cost (LCC) savings in the PTSD are somewhat misleading. We understand that the reported average LCC savings shown in the LCC and payback period analysis consider the base case efficiency distribution but exclude unaffected consumers. However, we believe these reported average LCC savings obscure the fact that regardless of what EL a consumer would purchase in the base case, their LCC savings are always greatest at EL4. For example, the reported average LCC savings, shown in Table 1 (middle column), suggest that the LCC savings for top-loading standard washers are highest at EL2. However, the average LCC savings relative to the baseline efficiency level (EL0) are highest at EL4 ($349) not EL2 ($265), as shown in Table 1 (right column).[29] We believe this distinction is important in the context of selecting potential new standard levels for residential washers.

Table 1: Average LCC Savings for top-loading standard washers relative to the base case efficiency distribution, from Table 8.5.3, and relative to EL0, from Table 8.5.2.

Efficiency Level	Reported Average LCC Savings[30]	Average LCC Savings relative to EL0[31]
1	$158	$160
2	$245	$265
3	$199	$316
4	$215	$349

[24]PTSD, pp. 8-36, 38. www.regulations.gov/document/EERE-2017-BT-STD-0014-0030
[25]86 Fed. Reg. 49149.
[26]PTSD, p. 7-5. www.regulations.gov/document/EERE-2017-BT-STD-0014-0030
[27]PTSD, pp. 8-15, 16. www.regulations.gov/document/EERE-2017-BT-STD-0014-0030
[28]79 Fed. Reg. 40554.
[29]Average LCC savings relative to EL0 were calculated by subtracting the LCC at each EL from the EL0 LCC.
[30]PTSD, p. 8-37. www.regulations.gov/document/EERE-2017-BT-STD-0014-0030
[31]PTSD, p. 8-36. www.regulations.gov/document/EERE-2017-BT-STD-0014-0030

Thank you for considering these comments.

Sincerely,

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