Appliance Standards Awareness Project
American Council for an Energy-Efficient Economy
Natural Resources Defense Council
New York State Energy Research and Development Authority

April 11, 2022

Mr. Jeremy Dommu
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-2021-BT-STD-0011: Energy Conservation Standards for Ceiling Fans

Dear Mr. Dommu:

This letter constitutes the comments of the Appliance Standards Awareness Project (ASAP), American Council for an Energy-Efficient Economy (ACEEE), Natural Resources Defense Council (NRDC), and the New York State Energy Research and Development Authority (NYSERDA) on the preliminary technical support document (PTSD) for ceiling fan standards. 87 Fed. Reg. 7758 (February 10, 2022). We appreciate the opportunity to provide input to the Department.

DOE's preliminary analysis in the PTSD suggests that amended efficiency standards for ceiling fans could net 3.5 quads of full-fuel-cycle energy savings and would be cost-effective for purchasers. These energy and cost savings can be achieved primarily by switching from AC induction motors to efficient DC motors in standard and hugger ceiling fans. The ENERGY STAR specification already effectively requires the use of DC motors, and the market penetration of ENERGY STAR-certified ceiling fans doubled from 2019 to 2020.[1] Overall, we generally support DOE's approach for the preliminary analysis, including the approach for estimating manufacturing costs, but believe there are several issues that should be addressed. First, we encourage DOE to reevaluate the warranty factor applied to DC motors. Next, we encourage DOE to evaluate a max-tech level consistent with the most efficient ceiling fans on the market. Finally, we encourage DOE to evaluate potential standards for belt-driven ceiling fans. These issues and other topics are discussed in further detail below.

We support DOE's approach for estimating the manufacturing costs of ceiling fans. DOE's teardown-based model was developed such that a fan's design specifications are input into the model which generates a manufacturer production cost (MPC) estimate for each fan evaluated in the engineering analysis.[2] Using the ENERGY STAR database, the CEC Modernized Appliance Efficiency Database System, and manufacturer literature, DOE identified the characteristics of ceiling fans at each efficiency level (EL) and then relied on product teardowns to generate estimated component costs and overall MPCs for

[1]www.energystar.gov/partner_resources/products_partner_resources/brand_owner_resources/unit_shipment_data/archives
[2]EERE-2021-BT-STD-0011-0015, p. 5-17. www.regulations.gov/document/EERE-2021-BT-STD-0011-0015.

each representative unit at each EL; nine inputs into the teardown model were utilized.[3] We support the use of this teardown approach as a robust method of estimating ceiling fan MPCs.

Concerns were raised at the DOE public meeting about the Department's estimated MPCs. Industry representatives postulated that DOE may have overestimated the baseline (EL0) MPC and underestimated the MPC increase associated with changing from an AC to DC motor at EL3 and EL4.[4] However, we are not aware of any information showing that DOE's estimated MPC increase from EL0 to EL4 has been underestimated. As DOE's consultant noted at the DOE public meeting,[5] ceiling fans on the market utilizing DC motors include other premium features that increase cost beyond the DC motor substitution. DOE's MPC estimates based on the teardown model appropriately reflect only the cost associated with features that increase energy efficiency (e.g., changing from an AC to a DC motor) and would not include these optional features.

While we generally support DOE's manufacturing cost model, we encourage DOE to re-consider the 8% warranty factor applied to DC motors. The warranty factor is an adjustment factored into the MPCs meant to represent the costs associated with in-warranty repairs. For comparison, DOE assumes a warranty factor of only 1.2% for ceiling fans using AC motors. While we acknowledge statements made by industry representatives regarding why failure rates for DC motors are higher than for AC motors in ceiling fans, we do not believe a 7-fold higher warranty rate for DC motors is warranted. For example, Aeratron offers a 30-year warranty for the DC motors in their ceiling fans,[6] which suggests a high degree of confidence in their reliability. Further, DOE's analysis for the 2014 furnace fan rulemaking showed only a small projected difference in failure rate between AC and DC motors.[7] Thus, we are concerned that DOE's applied warranty factors may be artificially inflating the projected MPCs for ceiling fans using efficient DC motors. We therefore encourage DOE to reevaluate the warranty factor for DC motors.

We encourage DOE to evaluate higher max-tech levels that are consistent with the most efficient ceiling fans currently on the market. There are ceiling fans currently available with efficiencies, in CFM/W, more than double those of DOE's maximum technologically feasible (max-tech) ELs for standard and hugger fans. These models can deliver airflows equal to or greater than that assumed in DOE's analysis at a fraction of the input power assumed at DOE's max-tech level (EL4). For example, a 52" 1055 Desert Sun ceiling fan delivers high-speed airflow[8] greater than that assumed in DOE's analysis while requiring only 18.8 W of input power at high-speed for the standard fan configuration per the ENERGY STAR ceiling fan database;[9] this input power at high-speed is almost 50% less than DOE's max-tech level at EL4, 35.7 W. The resulting CFM/W of 345, per ENERGY STAR, is more than double DOE's max-tech level of 152 CFM/W for 52" standard fans. This model has a conventional base design and blade appearance, and its blades are only 9" from the ceiling. We understand that higher efficiency ceiling fans generally leverage a combination of higher efficiency DC motors and more advanced aerodynamic design, while the max-tech levels for standard and hugger ceiling fans assume only the use of standard

[3]Fan size, number of fan heads, mounting type, number of blades, blade material, blade type, blade shape, blade dimensions/weight, motor type, and control type.
[4]EERE-2021-BT-STD-0011-0021, pp. 48-51, 79-86. www.regulations.gov/document/EERE-2021-BT-STD-0011-0021
[5]EERE-2021-BT-STD-0011-0021, p. 46. www.regulations.gov/document/EERE-2021-BT-STD-0011-0021
[6]shopus.aeratron.io/pages/product-warranty
[7]EERE-2010-BT-STD-0011-0111, p. 8-E-6. www.regulations.gov/document/EERE-2010-BT-STD-0011-0111
[8]It is unclear whether the reported airflow (5135 CFM) is for the standard or hugger configuration, but it exceeds the DOE assumption in either case. www.rplighting.com/wp-content/uploads/2019/10/1055_DC_Specsheet.pdf
[9]www.energystar.gov/productfinder/product/certified-ceiling-fans/details/2345986

DC motors with common blade designs. Thus, DOE should incorporate higher efficiency DC motors and improved aerodynamic design into additional ELs representing new max-tech levels (e.g., new EL5 levels) that are more consistent with the higher efficiencies available on the market.

We encourage DOE to evaluate potential standards for belt-driven ceiling fans. The PTSD states that DOE is planning to evaluate energy conservation standards for high-speed belt-driven (HSBD) and large-diameter belt-driven (LDBD) ceiling fans but that the Department did not have sufficient data to establish a baseline EL or higher ELs for the preliminary analysis.[10] While we encourage DOE to gather information specific to belt-driven ceiling fans, in lieu of new information we suggest that DOE consider standards for LDBD ceiling fans based on the efficiency levels identified for conventional LDCFs. Moreover, we understand that the general utility and airflow generated by LDBD fans are comparable to LDCFs so LDBD fans may not warrant a separate product class.

We encourage DOE to cover VSD ceiling fans that are not included in the low-speed small diameter (LSSD) category in the ongoing fans and blowers rulemaking. While VSD ceiling fans were analyzed in the PTSD, finalization of the December 2021 test procedure proposed rulemaking would mean that VSDs not included in the LSSD category would be excluded from the scope of this rulemaking. As discussed in the PTSD, the physical characteristics of these high speed VSD ceiling fans are more similar to air circulating fan heads (ACFHs) with diameter-to-maximum operating speed ratio less than 0.06. At the DOE public meeting, DOE's consultant mentioned that VSD fans would likely move from the ceiling fan definition and be considered ACFHs.[11] We support including relevant VSD fans as ACFHs as part of the fans and blowers rulemaking.

As presented, the average life-cycle cost (LCC) savings in the PTSD are somewhat misleading. We understand that the reported average LCC savings 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 the highest evaluated EL. For example, the reported average LCC savings, shown in Table 1 (middle column), suggest that the LCC savings for hugger fans are highest at EL1. However, the average LCC savings relative to the baseline efficiency level (EL0) are 5-fold higher at EL4 ($69) versus EL1 ($13), as shown in Table 1 (right column).[12] We believe this distinction is important in the context of selecting potential new standard levels for ceiling fans.

Table 1: Reported average LCC Savings for hugger fans relative to the base case efficiency distribution, from Table 8.6.6, and relative to EL0, from Table 8.6.5.[13]

Efficiency Level	Reported Average LCC Savings	Average LCC Savings relative to EL0
1	$24	$13
2	$14	$20
3	$23	$69
4	$23	$69

[10]EERE-2021-BT-STD-0011-0015, p. 2-38. www.regulations.gov/document/EERE-2021-BT-STD-0011-0015
[11]EERE-2021-BT-STD-0011-0021, p. 27. www.regulations.gov/document/EERE-2021-BT-STD-0011-0021
[12]Average LCC savings relative to EL0 were calculated by subtracting the LCC at each EL from the EL0 LCC.
[13]EERE-2021-BT-STD-0011-0015, p. 8-33. www.regulations.gov/document/EERE-2021-BT-STD-0011-0015

Thank you for considering these comments.

Sincerely,

Jeremy Dunklin, PhD
Technical Advocacy Associate
Appliance Standards Awareness Project

Amber Wood
Director, Buildings Program
American Council for an Energy-Efficient Economy

Joe Vukovich
Energy Efficiency Advocate
Natural Resources Defense Council

Chris Corcoran
Team Lead – Codes, Products, & Standards
New York State Energy Research and Development Authority (NYSERDA)