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

May 2, 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-2020-BT-STD-0007: Energy Conservation Standards for Electric Motors

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 electric motors standards. 87 Fed. Reg. 11650 (March 2, 2022). We appreciate the opportunity to provide input to the Department.

The December 2021 test procedure notice of proposed rulemaking (NOPR) for electric motors proposed a significant scope expansion to include seven categories of unregulated motors. We support DOE's efforts to analyze potential standards for these unregulated motor types. DOE presented detailed analysis in the PTSD only for currently-covered induction motors as well as currently-unregulated small non-small-electric-motor electric motors (SNEMs), air-over (AO) medium electric motors, and AO-SNEMs. This preliminary analysis showed that about 13 quads of full-fuel-cycle energy savings are available and generally cost effective for SNEMs and AO motors. For the next stage of the rulemaking, we encourage DOE to fully analyze potential standards for the additional motor categories targeted for scope expansion: synchronous motors, inverter-only motors, motors greater than 500 hp, and submersible motors.[1]

Furthermore, there are several topics discussed in the PTSD that warrant further consideration. First, we urge DOE to analyze synchronous motors jointly with currently-covered induction motors, AO motors, and SNEMs. Second, we encourage DOE to both clarify and potentially refine baseline efficiency levels for AO motors. Third, while we encourage DOE to analyze inverter-only motors jointly with currently-covered motors, we are concerned that inverter-only motors are at a disadvantage when efficiency is evaluated only at full load. Finally, we encourage DOE to further investigate repair and replacement assumptions in the cost analysis, particularly for currently-covered motors, and to use the repair cost alternative scenario in the main analysis. These and other issues are discussed in more detail below.

[1]EERE-2020-BT-STD-0007-0010, pp. 2-8, 9, 10. www.regulations.gov/document/EERE-2020-BT-STD-0007-0010

We urge DOE to analyze synchronous motors jointly with currently-covered motors as well as AO motors and SNEMs. In the PTSD, DOE estimates that up to 6 quads of energy savings could be achieved due to synchronous motor substitutions if higher standards were adopted for currently-covered NEMA Design A or B electric motors. While DOE's estimates of the percentage of purchasers choosing synchronous motors in lieu of currently covered motors at higher ELs may be conservative,[2] these results highlight the potential energy savings opportunities facilitated by market shifts to synchronous motors. DOE states in the PTSD that they plan to analyze synchronous motors jointly with induction motors of similar output power, speed range, and torque/speed characteristics.[3] We support DOE analyzing synchronous motors jointly with currently-covered motors, and we encourage the Department to also analyze synchronous motors jointly with relevant SNEM and AO motors.

Synchronous motors include the most efficient motor types on the market and can exceed the efficiencies of both single- and variable-speed AC induction motors, particularly in partial and/or variable load applications. For DOE's preliminary synchronous motor energy usage analysis, DOE multiplied efficiency level 0 (EL0) annual energy consumption by the ratio of full-load EL0 efficiency to full-load synchronous motor efficiency, while estimating additional energy savings associated with speed control in synchronous motors.[4] DOE further stated in the PTSD that the Department may consider analyzing synchronous motor energy use over a variety of operating cycles including part-load in a future proposal.[5] We encourage DOE to fully analyze synchronous motor efficiency and energy usage as part of the current rulemaking. We expect that a full DOE analysis, including real-world part-load profile estimates applied to both currently-covered and synchronous motors, will show even greater savings from synchronous motor substitutions versus the approach for the preliminary analysis.

We believe the potential life-cycle cost (LCC) savings associated with synchronous motor substitutions should be directly accounted for when evaluating potential amended standards for electric motors. For example, DOE should combine the relevant synchronous motor substitution purchasers with currently-covered motor purchasers when evaluating the cost-effectiveness of a given EL. As discussed above, DOE's preliminary analysis for synchronous motor substitutions showed large energy savings for customers purchasing synchronous motors rather than currently-covered motors. However, as currently constructed, we understand that DOE's analysis essentially excludes this subset of customers in the downstream analysis when evaluating the cost-effectiveness of a given EL. We believe including these customers would provide a more realistic comparison of average cost savings as a function of EL.

We encourage DOE to both clarify and potentially refine baseline efficiency levels for AO motors. Many AO motors are similar in construction to currently-covered AC induction motors and differ only by their inability to self-cool (e.g., no self-contained cooling fan). The PTSD states that the baseline efficiency levels of the air-over versions of motors currently in scope were the same as the currently-covered non-air-over versions;[6] however, Table 5.3.6 shows the current baseline standard levels for the currently-covered motors as EL1 for the air-over variants. The assumption that baseline air-over motors are less efficient than the current standards for covered motors is supported by the 2015 ASRAC term

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[2]DOE considered a payback period of two years or less for select applications less than 100 hp; non-energy-related benefits of synchronous motors (improved control, higher starting torque, size, etc.) were not considered.
[3]EERE-2020-BT-STD-0007-0010, pp. 2-20, 21. www.regulations.gov/document/EERE-2020-BT-STD-0007-0010
[4]EERE-2020-BT-STD-0007-0010, pp. 2-75, 76. www.regulations.gov/document/EERE-2020-BT-STD-0007-0010
[5]EERE-2020-BT-STD-0007-0010, p. 2-24. www.regulations.gov/document/EERE-2020-BT-STD-0007-0010
[6]EERE-2020-BT-STD-0007-0010, p. 5-7. www.regulations.gov/document/EERE-2020-BT-STD-0007-0010

sheet for fans and blowers, which included default air-over motor efficiencies less than those shown in the PTSD.[7] We suspect that the lack of coverage for AO motors means that there are available models that may be considerably less efficient than equivalent non-AO motors.

Furthermore, appropriate baseline efficiency levels for AO motors will depend heavily on the final AO motor test procedure. DOE tested five SNEMs with and without the fan using the proposed NOPR test procedure to determine the difference in efficiency between AO and non-AO motors. Removing the motor fan resulted in baseline efficiencies several percent higher for the AO-SNEMs. However, as noted in our comments to the test procedure NOPR,[8] DOE's specification of a single target test temperature of 75 °C for all AO motors may not be representative. For example, it is plausible that one or more of the AO motors DOE tested may run at higher temperatures in the field, which would result in lower real-world efficiency. Artificially cooling a hotter running motor beyond realistic operating temperatures could result in AO motor efficiency ratings that are not representative both in comparison to other AO motors and the equivalent non-AO motors. We thus encourage DOE to further analyze appropriate baseline efficiency levels for AO motors.

While we encourage DOE to analyze inverter-only motors jointly with currently-covered motors, we are concerned that inverter-only motors are disadvantaged when assessed only at full-load efficiency. In the PTSD, DOE states that inverter-only induction electric motors do not have a unique performance-related feature or utility that justifies a separate class from non-inverter and inverter-capable motors.[9] While we agree, we are concerned that inverter-only motors may be at an unfair disadvantage relative to single-speed induction motors when efficiencies are evaluated only at full load. The December 2021 electric motors test procedure NOPR proposes to continue to evaluate electric motor efficiency only at full load.[10] As DOE notes in the PTSD, evaluating efficiency at full load does not capture the energy savings of motors with variable-speed drives wherein savings materialize primarily during part-load operation.[11] In other words, inverter-only AC motors may not have a higher full-load efficiency than a comparable single-speed motor but they may save energy by reducing motor speed and resulting input power at partial loads. Since efficiency is evaluated only at full load, inverter-only motors would be at a disadvantage since the input losses associated with the inverter would be included in the efficiency calculation, but the potential energy savings resulting from its speed control capabilities would not be captured. Thus, we encourage DOE to consider how best to address this potential issue wherein inverter-only motors may appear less efficient than comparable single-speed motors.

We encourage DOE to further investigate repair and replacement assumptions and to use the repair cost alternative scenario in the main analysis. In general, higher efficiency levels are associated with lower operating costs resulting from energy savings. However, DOE's preliminary analysis for several representative units (RUs) of currently-covered motors shows that lifetime operating costs *increase* at higher ELs. We understand that this is due to the projected repair costs of these higher-efficiency motors completely offsetting the projected energy savings. For example, RU3, a 75 hp NEMA Design B motor, has lifetime operating costs at EL2, EL3, and EL4 that exceed those at EL0.[12] We thus encourage

[7]EERE-2013-BT-STD-0006-0179, p. 18, www.regulations.gov/document/EERE-2013-BT-STD-0006-0179
For example, a 4-pole, 5 hp motor baseline efficiency in the ASRAC term sheet is 81.5% vs. 87.5% in the PTSD.
[8]EERE-2020-BT-TP-0011-0027, pp. 2-3, www.regulations.gov/comment/EERE-2020-BT-TP-0011-0027
[9]EERE-2020-BT-STD-0007-0010, p. 2-21. www.regulations.gov/document/EERE-2020-BT-STD-0007-0010
[10]86 Fed. Reg. 71743, 71744.
[11]EERE-2020-BT-STD-0007-0010, p. 2-24. www.regulations.gov/document/EERE-2020-BT-STD-0007-0010
[12]EERE-2020-BT-STD-0007-0010, p. 8-45. www.regulations.gov/document/EERE-2020-BT-STD-0007-0010

DOE to further investigate motor repair and replacement assumptions and costs to ensure that operating costs at higher ELs are not overestimated.

We also encourage DOE to use the alternative scenario, wherein a motor is only assumed to be repaired if that motor's projected lifetime is greater than half of the average motor lifetime. This alternative approach is similar to that used in the analysis for motor replacements in the 2016 Direct Final Rule for dedicated-purpose pool pumps.[13] We believe that using this alternative approach will result in LCCs that are more reflective of real-world repair/replacement decisions. For example, RU2 highlights the strong effect that repair/replacement assumptions have on the overall LCC analysis. RU2 is a 30 hp NEMA Design B motor that represents both 21-50 hp motors and 6-20 hp motors. When representing 6-20 hp motors, each EL evaluated for RU2 is cost-effective; the EL1 and EL2 average LCCs are $130 and $218 lower, respectively, than the average EL0 LCC based on Table 8.5.3.[14] In contrast, when representing 21-50 hp motors, this same representative 30 hp motor has an average LCC that is lower than the baseline average LCC only at EL1 (by only $2). The difference is attributable at least in part to the assumption that motors above 20 hp are repaired while motors less than 20 hp are replaced. This assumption results in significantly higher lifetime operating cost savings at higher ELs for RU2 when representing 6-20 hp motors in comparison to when representing 21-50 hp motors.[15] In other words, the added repair costs for RU2 when representing 21-50 hp motors largely offset the projected energy savings from a more efficient motor.

Using the alternative scenario, wherein a motor is only assumed to be repaired if that motor's projected lifetime is greater than half of the average motor lifetime, largely aligns the results for RU2 when representing both motor size ranges. With the repair assumptions in the main analysis, the average lifetime of the RU2 motor representing 21-50 hp motors is only 1.2 years greater than when representing 6-20 hp motors. In other words, DOE's main analysis appears to assume a repair that would not be cost-effective for the 30 hp RU2 motor when representing 21-50 hp motors. The alternative approach would reduce instances were a non-cost-effective repair was assumed in the overall cost analysis. Using the alternative approach for RU2 representing 21-50 hp motors, the EL1 and EL2 average LCCs are $89 and $128 lower, respectively, than the LCC at EL0 based on Table 8B.1.2; these alternative repair results are more consistent with RU2 when representing 6-20 hp motors (i.e., the replacement assumption). While the discussion herein focused on RUs representing currently-covered 20-100 hp motors, we encourage DOE to use the alternative scenario for all relevant motors moving forward (e.g., 100-500+ hp induction motors, large AO motors, etc.).

We encourage DOE to clarify how motor slip was incorporated into the energy use analysis. In DOE's analysis, the Department considered the impact of potential increases in motor speed on energy use. An increase in motor efficiency is sometimes accompanied by a reduction in motor slip, which can result in a higher motor operating speed. DOE incorporated the effect of reduced motor slip into their analysis, based primarily on a European motor study,[16] by assuming that 20 percent of consumers with fan,

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[13]EERE-2015-BT-STD-0008-0105, p. 8-25. www.regulations.gov/document/EERE-2015-BT-STD-0008-0105
[14]EERE-2020-BT-STD-0007-0010, p. 8-43. www.regulations.gov/document/EERE-2020-BT-STD-0007-0010
[15]For example, per table 8.5.5, the difference in lifetime operating costs between EL0 & EL1 for RU2 are $165 and $38 for 6-20 hp and 21-50 hp motors, respectively.
[16]De Almeida et al. EuP Lot 30: Electric Motors and Drives, p. 12. www.eup-network.de/fileadmin/user_upload/EuP-LOT-30-Task-7-Jun-2014.pdf

pump, and air compressor applications would be negatively impacted by higher operating speeds. However, it is unclear exactly how this statement translates into the analysis.

We support DOE's inclusion of electric motors within covered equipment. While improvements in energy efficiency for motor-using products subject to energy conservation standards (i.e., covered equipment) may require more efficient motors, there is still value in regulating the motors separately. As DOE discusses in the PTSD, different motor efficiency levels may be cost-effective for different covered products, and the presence of electric motors in covered equipment does not preclude the possibility of cost-effective energy standards for electric motors.[17] Furthermore, absent standards for motors that are used in covered equipment, consumers may get stuck with inefficient replacement motors. Finally, we understand that motors used in covered equipment are often purchased by the OEM from a motor manufacturer. Thus, exempting motors used in covered equipment would likely create enforcement challenges since it would be difficult to determine a given motor's end use application.

Thank you for considering these comments.

Sincerely,

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[17] EERE-2020-BT-STD-0007-0010, p.2-13. www.regulations.gov/document/EERE-2020-BT-STD-0007-0010