Appliance Standards Awareness Project
American Council for an Energy-Efficiency Economy
California Energy Commission
Natural Resources Defense Council

June 22, 2020

Mr. Jeremy Dommu
U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Building Technologies Office, EE–5B
1000 Independence Avenue SW
Washington, DC 20585–0121

RE: Energy Conservation Standards for Electric Motors; Request for Information (Docket number EERE-2020-BT-STD-0007)

Dear Mr. Dommu:

This letter provides comments from the Appliance Standards Awareness Project, American Council for an Energy-Efficiency Economy, California Energy Commission and Natural Resources Defense Council in response to the Request for Information related to electric motor standards. 85 Federal Register 30878 (May 21, 2020). We appreciate the opportunity to provide input.

Very large energy savings are possible from improved motor standards. Given significant changes to the motor market since DOE published the 2014 final rule, DOE must conduct a full analysis to determine whether higher standards are economically justified. In addition, DOE may be able to achieve even larger savings by expanding the scope of DOE's motor standards to address advanced motor technologies, additional types of induction motors and low horsepower motors that are not currently regulated. Even if DOE does not expand its regulatory scope to include standards for additional motor types, DOE must account for the substitution of unregulated motors for regulated motors in its analysis of increased standards. Finally, DOE should amend its motor test procedures to better reflect energy use under a representative average use cycle.

Improved motor standards could provide very large savings.

DOE presents information in the RFI showing that products with efficiency performance significantly exceeding current standards are available.[1] Motors at the levels shown as the "maximum available" in

[1] 85 Fed Reg 30885, Table II.4

the RFI increase nominal full load efficiency by 0.5 to 3.5 percentage points compared to current standards. Motor losses represent the energy used by a motor to convert electrical energy to mechanical energy, or in other words, the energy consumed (dissipated as heat) by the motor. The maximum levels available identified by DOE would reduce motor losses by 15% for the highest sales volume motors covered by DOE standards. These levels are equivalent to "IE4" or "Super-premium" efficiency levels, which the International Electrotechnical Commission (IEC) generally designed to reduce losses by at least 15%.[2] (Appendix A provides a table of equivalent motor efficiency terms.)

The "maximum available" levels shown in the RFI are the same as the "maximum technologically feasible" (or "max tech") levels evaluated in the 2014 final rule (TSL 4). DOE found that standards based on those levels would provide very large energy savings relative to the levels adopted in the 2014 rule (TSL 2). The final rule reported that standards at TSL 4 would save an additional 6.7 quads of energy on a full fuel cycle basis compared to the levels adopted. DOE also evaluated a set of efficiency levels in between the level adopted and the max tech levels and found that that level (TSL 3) would have saved 3.8 quads more than the level adopted.[3]

DOE must conduct a full, updated economic analysis that reflects the current motor market.

The market for motors, including regulated electric motors, has changed significantly since publication of the 2014 final rule. New DOE standards effective in 2016 nearly doubled the U.S. sales volume of motors meeting or exceeding TSL 2.[4] Many other countries and the European Union also have adopted equivalent efficiency levels, further increasing the production scale for compliant motors.[5] In late 2019, the European Union became the first to adopt IE4 or "super-premium" efficiency levels. Effective in 2023, all new electric motors sold in the EU in the 75 to 200 kW range will have to meet this higher efficiency level. (The EU standards are also more expansive than US standards since they extend IE3 up to 1000 kW.)[6]

The range of efficiency performance available above the minimally compliant products has also increased. In 2014, DOE reported that the "max tech" levels were not then commercially available.[7] DOE relied on modeling for its evaluation of TSL 4 efficiency levels. Now, as described in the RFI, TSL 4 motors are commercially available. Manufacturers have invested heavily in new product lines with efficiency above TSL 2, some of which are based on induction motor technology and others that are based on advanced motor technologies. Washington State University's Emerging Technologies database reports

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[2] de Almeida, Anibal T. "Super-Premium Electric Motors" presentation for Motors Academy Webinar Course. University of Coimbra, Portugal. November 2017 available at https://www.slideshare.net/sustenergy/superpremium-electric-motors

[3] 79 Fed. Reg. 30995, Table V.13

[4] ASAP calculation based on DOE total shipments estimates (Table 9.2.1) and baseline market share estimates in 2014 TSD (Table 10.2.3).

[5] These include Brazil, Canada, Japan, Korea, Mexico, Saudi Arabia, Singapore, Taiwan and the United Kingdom. "Global MEPS Guide for Low Voltage Motors." WEG. May 2020. https://static.weg.net/medias/downloadcenter/h68/h3c/WEG-global-meps-guide-for-low-voltage-motors-50060049-brochure-english-web.pdf

[6] "Commission Regulation (EU) 2019/1781. Official Journal of the European Union. October 25, 2019. The EU currently requires that motors meet IE3 or meet IE2 and be sold with a variable speed drive. The IE2 compliance option sunsets in 2021.

[7] 79 Fed. Reg. 30969

IE4 induction motor product lines available from WEG, ABB, TECO and Siemens.[8] Manufacturers market these products as a potential low total cost option. For example, WEG's marketing brochure states, "High Efficiency and Low cost of Ownership throughout the entire motor lifetime have been the basis for the W22 development."[9] Siemens markets their IE4 product line as providing "Higher energy savings, lower operating costs and security for the future," and as a "simple retrofit," adding that, "You can upgrade from IE3 to IE4 just as simply as from IE1 to IE4—without having to adapt the mechanical design of the machine."[10] ABB also markets a line of synchronous reluctance motors as compliant with IE4 levels and as drop-in replacements for induction motors.[11] Nidec has chosen synchronous reluctance designs as the basis for a line of super premium/IE4 compliant motors.[12] Given the extensive changes in the motor market since the 2014 final rule, DOE must conduct a full analysis to determine if improved standards are warranted.

DOE should expand the scope of electric motor standards to additional motor types.

As DOE has previously described, the Department has broad authority to regulate motors not already subject to minimum standards, including advanced motors,[13] additional types of induction motors,[14] and low horsepower motors.[15] We urge DOE to expand the scope of coverage to include motors in each of these categories.

Advanced motors

DOE described many types of advanced motors in its 2017 test procedure Request for Information along with test procedures for these motor types.[16] Advanced motors include synchronous reluctance motors, line-start permanent magnet motors, electronically commutated motors, switched reluctance and written-pole motors. DOE's 2014 Motor Handbook states that advanced motors "can achieve efficiency levels that are significantly higher than premium efficiency induction motors"[17] and describes advanced motors that can provide the same or better service as induction motors for many applications. Advanced motors can provide improved full-load efficiency and improved efficiency over a range of partial load operating points.

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[8] "Super-Premium (IE4) Induction Motors." Emerging Technologies, Washington State University Energy Program, last accessed on 6/15/20 at http://e3tnw.org/ItemDetail.aspx?id=638

[9] WEG "Super Premium Efficiency (IE4) Induction Motors" at https://www.thermalsolutionsoftexas.com/pdfs/motors/super-premium-efficiency-motors.pdf Last accessed on 6/12/20

[10] "Innovative IE4 Motors to Give You a Competitive Lead." Siemens. 2014. Last accessed 6/15/20 at https://www.rekvisitt.no/content/files/Datablad/siemens-katalog-ie4-motorer.pdf

[11] ABB brochure at https://library.e.abb.com/public/1deacbd313d443268fd50804b6abbe16/EN_IE4_SynRM_brochure_3AUA0000132610_RevG.pdf last accessed on 6/12/20

[12] "Developing the Successors to Premium Efficiency IE3 Motors—IE4 and IE5 Class Motors" Nidec Corporation. At https://www.nidec.com/en/technology/casestudy/ie345/ last accessed on 6/10/20

[13] 78 Fed. Reg. 73608

[14] 78 Fed. Reg. 73602; 79 Fed. Reg. 30945

[15] 82 Federal Register 35470

[16] 82 Fed. Reg. 35468

[17] "Premium Efficiency Motors Selection and Application Guide: A Handbook for Industry." Advanced Manufacturing Office, Department of Energy. 2014. p. 7-2.

Since DOE published the Motor Handbook in 2014, manufacturers have prioritized their investments in advanced motors and the technology has continued to improve. ABB markets its line of IE4 compliant synchronous reluctance motors as "Perfect for Retrofits," stating, "The SynRM package is a perfect solution for motor retrofits. The IE4 SynRM is the same size as an IE2 induction motor, eliminating the need for mechanical modifications. The increased efficiency will, on the other hand, reduce the payback time of the investment." IE5 motors reduce losses by another 15% relative to IE4 products and can be met by existing designs.[18] WEG advertises a line of permanent magnet motors as "IE5 Ultra Premium" motors.[19]

Additional induction motors

DOE should expand scope to include air over motors and submersible motors. Air over motors and submersible motors have large annual shipments since they are used in two of the most common motor applications, fans and pumps. We expect that extending coverage to these motor types would potentially achieve very large energy savings. Both motor types generally have the same basic motor construction as currently regulated induction motors except that they are cooled differently. They have been left out of DOE's regulatory scope due to the lack of a complete test procedure for these products.[20]

In 2017, NEMA published a test procedure for air over motors.[21] The publication "Modern Pumping Today" reported in 2017 that, "most submersible motor pump manufacturers are developing or have released premium efficient motors for their pumps and are looking at ways to introduce higher hydraulic efficiency offerings to the industry."[22] In other words, manufacturers have already developed products meeting current DOE motor standards even though submersible motors are not now regulated. DOE should amend the DOE test procedure for motors to include air over and submersible motors and establish minimum standards equivalent to other induction motors.

Additional small motors

DOE's current "small electric motor" regulation is limited to just three types of small motors (capacitor start, capacitor run; capacitor-start, induction run; and polyphase) in a limited horsepower range. Several common motor types (e.g., shaded pole, permanent split capacitor, split phase) that have typical efficiency performance levels well below regulated small motors are not covered by any current motor standards. Other types (e.g., brushless permanent magnet motors) have superior performance and are also not covered by standards. In the 2017 test procedure RFI, DOE reported that, "single-phase, 2-digit

[18] de Almeida, Anibal T. "Super-Premium Electric Motors" presentation for Motors Academy Webinar Course. University of Coimbra, Portugal. November 2017 available at https://www.slideshare.net/sustenergy/superpremium-electric-motors

[19] See https://www.weg.net/catalog/weg/BE/en/Electric-Motors/Special-Application-Motors/Permanent-Magnet-Motors/Permanent-Magnet-Motors/W22-Magnet-IE5/W22-Magnet-IE5-Ultra-Premium/p/MKT_WMO_EU_3PHASE_LV_W22_MAGNET_IE5

[20] 79 Fed. Reg. 30945 citing to 78 Fed. Reg. 75975.

[21] "NEMA Motors and Generators Standard Adds New Efficiency Test for Air-Over Motors." https://www.nema.org/news/Pages/NEMA-Motors-and-Generators-Standard-Adds-New-Efficiency-Test-for-Air-Over-Motors.aspx last accessed on 6/13/20 and see discussion in 2017 test procedure RFI at 82 Fed. Reg. 35475.

[22] "Understanding Test Standards for Submersible Pumps" Modern Pumping Today. at https://modernpumpingtoday.com/understanding-test-standards-submersible-pumps/ last accessed 6/12/20

NEMA frame size motors that exceed 3 hp are available, along with single-phase motors inclusive of all frame sizes with up to 15 hp. DOE also found that polyphase 2-digit NEMA frame size motors, excluding those currently regulated at 10 CFR 431.25, exist up to 5 hp."[23]

Tens of millions of currently unregulated low horsepower motors are sold each year and minimum standards could potentially achieve very large savings. DOE should address the range of motor technologies used in across the range of horsepower outputs identified in the 2017 RFI.

DOE must account for substitution effects.

As noted above**,** manufacturers market advanced motors as replacements for induction motors. These motors can provide superior performance and may be smaller and lighter. They may also be less expensive then comparably efficient induction motors, especially as production volumes increase. Changes in relative purchase price resulting from potential new standards will cause some buyers to switch from induction motors to advanced motors. DOE generally accounts for market shifts from one product category to another due to standards. For example, in the furnace docket, DOE modeled the shift from gas furnaces to electric heating appliances (e.g., heat pumps) due to potential increases in installed furnace costs.[24] For general service incandescent lamps, DOE modeled the shift from incandescent lamps to LED lamps, finding that consumer benefits increased due to selection of products outside the scope of DOE's incandescent lamp regulation.[25] DOE should similarly model market shifts to advanced motors due to increased standards.

DOE should update the motors test procedure.

Motors typically operate at a range of loading conditions, but DOE's test procedure measures efficiency at just one load point (100%). We urge DOE to develop a test procedure that is more representative of motor energy use across the range of motor applications. We will provide more detailed comments in our response to the motor test procedure Request for Information (docket EERE-2020-BT-TP-0011).[26]

Thank you for considering these comments.

Sincerely,

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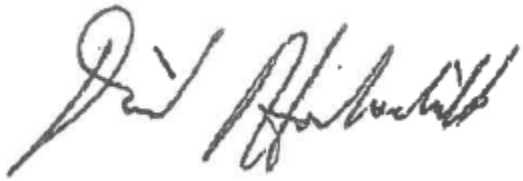
[23] 82 Fed. Reg. 35470
[24] 81 Fed. Reg. 65720, see especially 65791
[25] 84 Fed. Reg. 71626
[26] 85 Fed. Reg. 34111



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Appendix A

Motor efficiency level terminology

2014 Final Rule	NEMA*	IEC
TSL 2	Premium	IE3
TSL 3	None	None
TSL 4	Super-premium	IE4
None	Ultra-premium	IE5

* "Premium" is defined by NEMA; "Super-premium" and "Ultra-premium" are market terms not defined by NEMA.