Appliance Standards Awareness Project
Natural Resources Defense Council

October 8, 2021

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

RE: Docket Number EERE-2021-BT-STD-0018: Request for Information for Energy Conservation Standards for Commercial and Industrial Pumps

Dear Mr. Dommu:

This letter constitutes the comments of the Appliance Standards Awareness Project (ASAP) and the Natural Resources Defense Council (NRDC) on the request for information (RFI) for commercial and industrial pump standards. 86 Fed. Reg. 43430 (August 8, 2021). We appreciate the opportunity to provide input to the Department.

In the RFI, DOE seeks comment on expanding the scope of the energy conservation standards for pumps and on potential technology options. We encourage DOE to expand the scope of the standards to additional categories of clean water pumps and to consider variable-frequency drives (VFDs) as a technology option for both clean water pumps as well as for currently uncovered wastewater pumps. While DOE screened out VFDs in the last rulemaking due to the assumption that they would only provide significant savings in certain applications, strong evidence exists that VFDs can provide large savings even in constant flow or high static head applications. Finally, the RFI explains that DOE seeks data and information on the distribution of pump efficiencies and how that distribution may differ across ranges of flow and shaft input power for each equipment class. Our analysis shows that most pumps with efficiencies well above the minimum standards are small and/or low specific speed pumps. We therefore encourage DOE to consider how the standards can reflect the distribution of efficiencies as there appears to be a significant opportunity for energy savings from improved efficiency standards for smaller pumps and/or pumps with low specific speeds.

We encourage DOE to expand the scope of the standards to cover additional pump types currently used in clean water applications. As DOE describes in the RFI, the current standards for commercial and industrial pumps cover five categories of clean water pumps.[1] However, there are additional categories of pumps used in clean water applications that are not currently covered by the standards that in some cases may have significant end use overlap with covered pump classes. This means that non-covered pumps may be serving as an alternative to covered pumps. Expanding the scope of the standards to these additional pump types will ensure a level playing field for pump manufacturers and achieve

[1] 82 Fed. Reg. 36923.

additional energy savings. As stated in our comments on the April 2021 test procedures RFI for pumps,[2] we encourage DOE to consider the following additional categories of clean water pumps: double suction pumps, multi-stage end-suction pumps, vertical turbine pumps, and 1,200 rpm pumps.

We encourage DOE to evaluate VFDs as a technology option. DOE's analysis from the previous rulemaking stated that varying the speed of a pump using a VFD has the potential to reduce pump energy consumption significantly. Absent speed control, an operator will typically run the pump at full speed and throttle the system until the required flow condition is met.[3] However, when a throttle valve is used to control flow in lieu of speed control, the unneeded pump pressure is lost to friction. Nonetheless, VFDs were screened out based on the assumption that they would only provide significant savings in variable flow situations with low static head and thus were not universally applicable as a technology option. However, strong evidence exists that VFDs can provide significant savings even in constant flow or high static head applications.

Most pumps are oversized, which means that the addition of a VFD can provide significant energy savings even in constant load applications by "right-sizing" the pump to the actual system requirements. In oversizing scenarios, the system is often throttled to reduce flow. Based on the nearly 5000 bare pumps in the DOE certification database, on average a pump uses only 10% less power at 75% of its best efficiency point (BEP) flow; this is analogous to throttling the flow by 25% and only getting a 10% reduction in power requirements. In contrast, due to the cubic relationship between speed and power, reducing the speed of the pump to provide a 25% reduction in flow would reduce power by more than 50%.[4] Even a 10% reduction in speed can translate to a reduction in power of almost 30%. VFDs are also a great option to "future proof" a pump, as even a properly designed (i.e., not oversized) constant load pump optimized for current process conditions may become inefficient as process requirements change over the 10-25 year expected pump lifetime.

Indeed, a recent NEEA analysis showed large energy savings with VFDs for both constant and variable load applications.[5] This analysis determined load profiles for 132 pumps across numerous applications using operational data and pump curve information. The study found that about half of the pumps were used in variable load applications, and energy savings of 43% could be achieved in these applications by utilizing VFDs. Critically, even pumps used in constant load applications had estimated energy savings with VFDs of 23%. The only application where a VFD did not yield savings in constant load applications was municipal water treatment, though the sample was only a single pump. We understand that operators at these facilities often install pumps in pairs, with a constant speed pump that handles the base load and a variable speed pump that handles the fluctuating load. This results in no observable power savings from the addition of a VFD to the constant load pump. However, new variable speed pressure boost skids that operate multiple variable speed pumps dynamically can deliver savings up to 40% over traditional constant-variable speed pump skids.[6] VFDs can therefore offer large energy savings even in applications such as pressure boosting that have historically relied on a constant speed pump.

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[2] https://www.regulations.gov/comment/EERE-2020-BT-TP-0032-0018
[3] EERE-2011-BT-STD-0031-0039, p. 3-30,33. https://www.regulations.gov/document/EERE-2011-BT-STD-0031-0039.
[4] Pumping System Tip Sheet #7, 2006, DOE and Hydraulic Institute.
https://www.energy.gov/sites/prod/files/2014/05/f16/trim_replace_impellers7.pdf
[5] E20-313, Power Drive Systems: Energy Savings and Non-Energy Benefits in Constant & Variable Load Applications.
[6] Ross, B. (2019). Pumping Systems - Low Hanging Fruit in Savings Energy. Armstrong Ltd.

Moreover, the recent NEEA analysis demonstrated significant energy savings in applications with large static head components. The average static head of the pumps used in open loop applications was 22-35%, depending on the application, for the energy savings discussed above. Further, results of a sensitivity analysis showed that a 50% increase in static head, to 33-52.5%, still resulted in energy savings of 23% and 40% for constant and variable pump loads, respectively. In addition, a 2010 case study estimated that power consumption could be reduced significantly by using a VFD, rather than throttling flow, in a system with 80% static head.[7] Taken together, these results suggest that VFDs have utility even in high static head applications.

Furthermore, in addition to the potential energy savings from the addition of a VFD, there are also important non-energy benefits of VFDs like lowered maintenance costs and improved process control.[8] Lowering speed, rather than throttling flow and increasing head, reduces wear and tear on pump components, thus reducing maintenance requirements. VFDs also provide finer process control that can be optimized to precise design specifications. For example, finer control and consistency of a pump-driven process that takes place before or after a production step can significantly enhance the quality of the end product.

In summary, VFDs can provide large energy savings in a wide range of applications, including in constant flow and high static head applications, and we therefore encourage DOE to evaluate VFDs as a technology option.

We encourage DOE to evaluate potential standards for wastewater pumps based on the addition of VFDs. Wastewater pumps represent a significant amount of energy consumption nationwide, but are not currently covered by DOE pump standards. Since wastewater flows vary significantly over time, flows are often re-directed or throttled. Thus, as with clean water pumps, large energy savings of up to 50% can be achieved by adding VFDs to wastewater pumps.[9] Standards for wastewater pumps based on the addition of a VFD may therefore represent a significant energy savings opportunity.

We encourage DOE to consider ways that the standards or the PEI calculations could reflect the observed greater range of efficiencies at low hp levels and specific speeds. Figure 1 shows PEI for bare pumps in the DOE certification database[10] for three pump classes (ESCC, ESFM, and IL) as a function of pump specific speed (left) and pump input hp at the BEP load point (right). While PEI is calculated with the intention of normalizing pumps with different sizes and specific speeds, it is apparent that the majority of pumps with PEIs less than 0.9 are less than 50 hp and/or have specific speeds of less than 2000. (This trend is evident for each of the three individual classes [ESCC, ESFM, and IL] plotted in Figure 1, but is not observed for the RS-V and VT-S pump classes.) Thus, DOE should consider revising the standards or the calculation of a minimally compliant pump for at least the ESCC, ESFM, and IL classes to better reflect how efficiency varies with specific speed and/or hp. For example, DOE could consider establishing hp and/or specific speed bins for each of the pump classes. A 2021 Lawrence Berkeley

[7] G.V. Martins, E.v.H Lima. Improving Reliability In A High Static Head System Through VFD Application. (2010).
[8] E20-313, Power Drive Systems: Energy Savings and Non-Energy Benefits in Constant & Variable Load Applications.
[9] Electricity Use and Management in the Municipal Water Supply and Wastewater Industries, EPRI and Water Research Foundation, 2013. https://www.epri.com/research/products/000000003002001433.
[10] https://www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A

National Laboratory (LBNL) report estimated that about 90% of pumps are less than 50 hp and are responsible for about 1/3 of total pump energy usage.[11] This suggests a significant energy savings opportunity from improved standards for smaller pumps as many models in the DOE database consume 10-30% less energy than pumps just meeting the current standards. Furthermore, hp and/or specific speed groupings could allow DOE to evaluate VFDs within these different groupings individually.

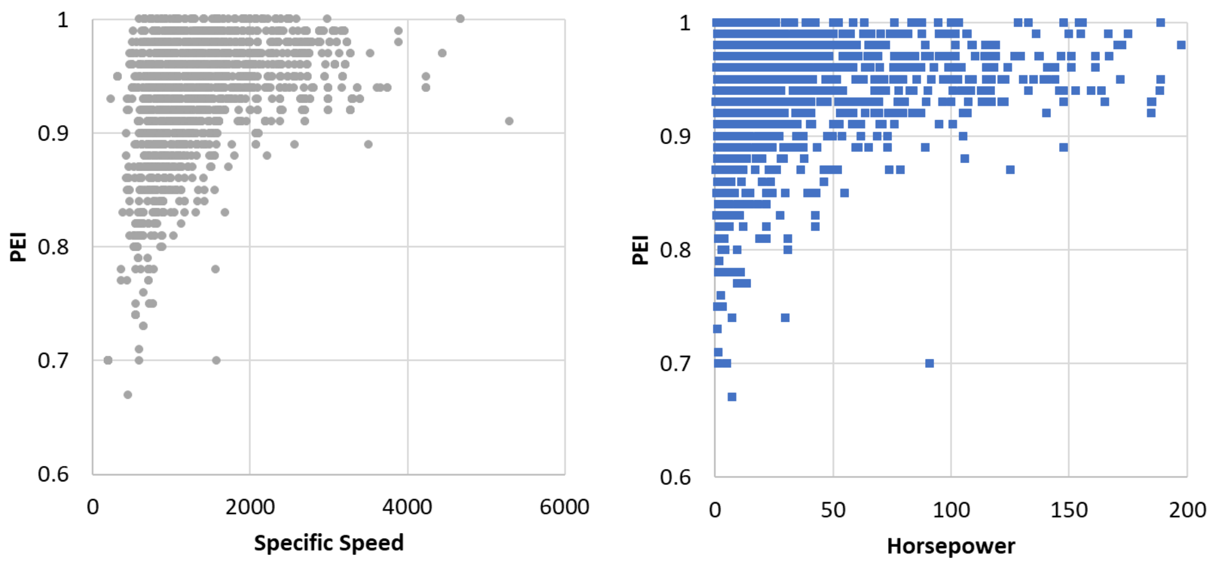

Figure 1: Certified bare pump PEIs as a function of pump specfic speed (left) and horsepower (right).[7]

We encourage DOE to investigate the effect of impeller trimming on real-world pump efficiencies. The analysis for the prior rulemaking estimated that 50% of pumps (except for the VT-S class) were trimmed at 15%.[12] This estimate was based on industry sources that suggested most pumps are trimmed 10-20%.[10] The DOE analysis used Affinity Laws relations, which state that reducing the impeller diameter via trimming will reduce the flow rate by an equal amount. The prior analysis thus did not assume any loss in pump efficiency associated with impeller trimming. However, Affinity Laws are valid only for impellor diameter trimmings of 5-15%.[13] As the impeller diameter decreases due to excessive trimming, added clearance between the impeller and the fixed pump casing increases internal flow recirculation, causes head loss, and lowers pumping efficiency. We encourage DOE to ensure that the upcoming analysis reflects actual power consumption in trimmed pumps, since the prior approach may have underestimated power consumption for pumps trimmed above 15%.

Thank you for considering these comments.

Sincerely,

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[11] P. Rao et al. U.S. Industrial and Commercial Motor System Market Assessment Report, 2021. https://eta.lbl.gov/publications/us-industrial-commercial-motor-system.

[12] EERE-2011-BT-STD-0031-0039, p. 10-11. https://www.regulations.gov/document/EERE-2011-BT-STD-0031-0039.

[13] Ludwig's Applied Process Design for Chemical and Petrochemical Plants, 2007, 4th ed.

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