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Extended Motor Products Pump and Circulator Baseline Assumptions Review

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From:	Joe Van Clock and Noah Lieb, Apex Analytics
Subject:	XMP Baseline Review Findings
Date:	November 9, 2021

This memo presents Apex Analytics' assessment of key assumptions underlying NEEA's naturally occurring baselines for commercial and industrial (C&I) pumps and circulators in the Northwest. It reviews and provides recommendations for NEEA's baseline assumptions for the naturally occurring average energy rating (ER) for C&I pumps and NEEA's assumptions for the naturally occurring market share of efficient hydronic heating and domestic hot water recirculating pumps.

C&I Pumps

Assumption 1: NEEA's intervention in the market led to increased uptake of pumps that exceed the efficiency levels adopted in the 2020 federal standard in the years leading up to the standard's adoption.

NEEA's current assumptions for naturally occurring average pump ER prior to the standard taking effect are listed in Table 1.

Table 1: Pre-2020 Naturally Occurring Average ER Assumptions

Year	Naturally Occurring Average ER	
	Constant Speed Pumps	Variable Speed Pumps
2016	5.6	47.63
2017	6.1	47.95
2018	6.6	48.28
2019	7.1	48.60

Rationale

NEEA began intervening in the C&I pumps market in 2013. NEEA's initial market interventions supported efforts to develop an efficiency labeling process for pumps. These efforts sought to both drive uptake of efficient pumps in the market and support a DOE rulemaking to establish pump efficiency standards that launched at the same time. NEEA, other efficiency organizations, and other industry groups worked with the Hydraulic Institute to develop test procedures (in 2016), a lab certification process (in 2017), the Pump Energy Rating (ER) label, and an online database of pumps that had received the label that pump specifiers could use to compare the efficiency of different pump options (established in 2017-2018, database fully populated in 2019-2020).

Assessing savings resulting from adoption of the federal standard, which took effect in 2020, is outside the scope of this review. However, NEEA would like to estimate savings

from increased uptake of pumps exceeding the adopted standard resulting from its efforts, including uptake that occurred before the standard took effect. As a result, NEEA's naturally occurring baseline estimate for above-standard pumps begins in 2013, prior to the standard taking effect.

Findings

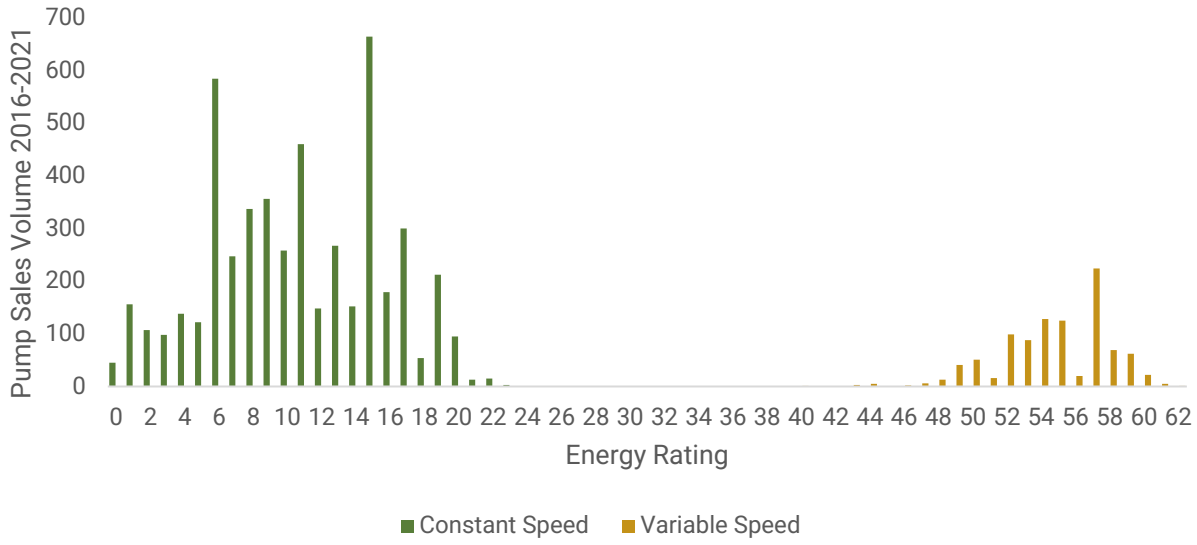
Apex's review focused on three aspects of NEEA's baseline estimates:

- NEEA's use of average ER as a baseline metric rather than an alternative, such as efficient market share,
- NEEA's assumptions regarding the effect of the 2020 federal standard on average ER, and
- NEEA estimated baseline values.

Use of Average ER as Baseline Metric

Distributors participating in the XMP program provide NEEA with data on all of their pump sales, including both qualified and non-qualified models. This sales data suggests that the ERs of both constant speed and variable speed pumps sold follow a relatively normal distribution (Figure 1). As a result, the average ERs NEEA uses to estimate its baseline can provide a reasonable representation of the pumps on the market.[1]

Figure 1: Distribution of C&I Pump Sales by Energy Rating, 2016-2021



[1] An average value would be less representative of the market if, for example, the distribution of models was bimodal, with some models concentrated among lower ER values and other models concentrated among higher ER values. In that case, an overall average might provide a value in between the two modes that represented few actual pumps.

Effect of Federal Standard

A new federal standard for pumps would result in an increase in average ER as manufacturers remove non-compliant pumps from the market and replace them with more efficient models.[2] This change would largely occur between 2016, when the standard was finalized, and 2020, when the standard took effect. NEEA's baseline reflects this increase with the average ER rising most steeply between 2016 and 2020.

DOE assembled a dataset of pump performance data to conduct technical analysis in support of its recent rulemaking. Apex analyzed this dataset to assess NEEA's baseline assumptions around increases in the average ER resulting from the federal standard. We compared the average ER of the full pump dataset to the average ER of the dataset excluding models that did not comply with the standard. The difference between these two averages represents the change in average ER that would result if manufacturers simply removed non-compliant models from the market. As manufacturers likely replaced at least some of their non-compliant models with compliant versions that have higher ERs, the calculated difference represents a minimum increase in average ER likely to result from the standards.

Table 2 summarizes the results of this analysis. NEEA's baseline assumes a somewhat lower relative increase in average ER than the DOE data would suggest. However, NEEA's baseline assumes higher average ERs in both 2016 and 2020 than the DOE dataset would suggest.[3] NEEA's baseline includes a larger absolute increase in Average ER (2 points) than the minimum implied in the DOE data (1.5 points).

Table 2: Minimum Increase in Average ER Likely to Result from Federal Standard

Estimate Source	Pre-Standard Average ER	Post-Standard Average ER	% Increase
DOE Dataset, Assuming Standards Result Only in Removal of Non-Compliant Models*	3.8	5.3	39%
NEEA Baseline Assumption	5.6	7.6	36%

* Averages weighted by pump-class sales volumes listed in XMP sales data.

Estimated Baseline ER Values

Apex analyzed the Hydraulic Institute's ER database and NEEA's XMP sales data to assess whether NEEA's naturally occurring average ER assumptions are reasonable. Distributors participating in XMP provide NEEA with historical sales data for a period prior to the start of their participation in the program. These pre-participation sales data serve as a baseline for sales to some extent, in that one would expect sales of efficient pumps to increase once distributors become eligible for incentives on those products and make changes to their stocking and recommendations to take advantage of those incentives. The pre-participation data does not account for the program's broader influence, however; it does not capture

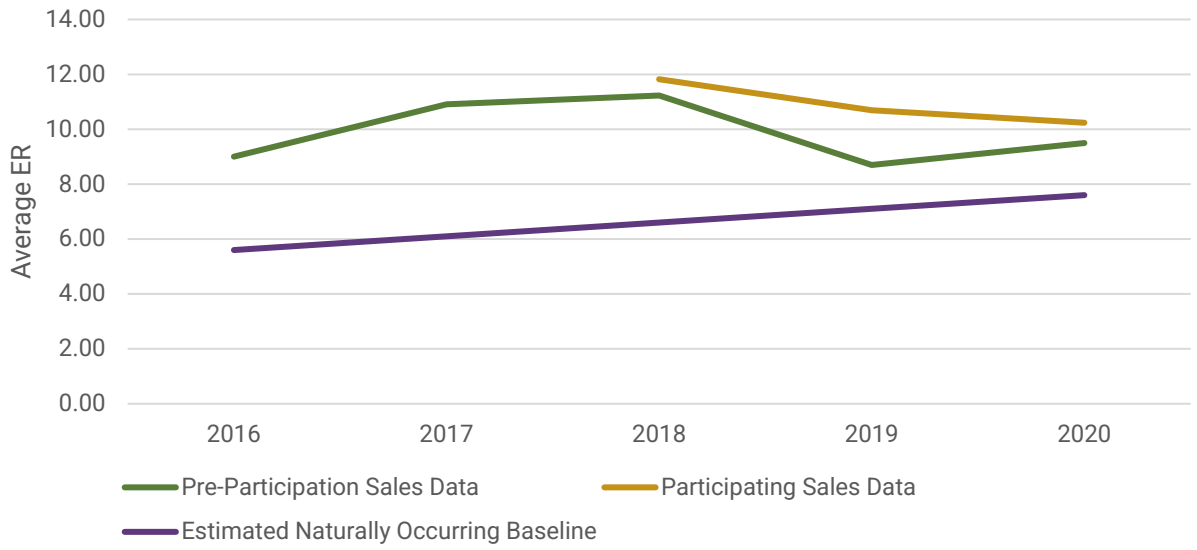
[2] NEEA is assessing its influence on the adoption of the federal standard for pumps through a separate process, so this assessment considers increases due to standard adoption part of the baseline.

[3] These differences likely reflect differing datasets used to estimate 2020 baselines. Apex did not assess the relative benefits and drawbacks of the DOE dataset and the dataset on which NEEA based its estimates.

any shift toward efficient pumps driven by the increased visibility of efficiency that the ER label and database provide.

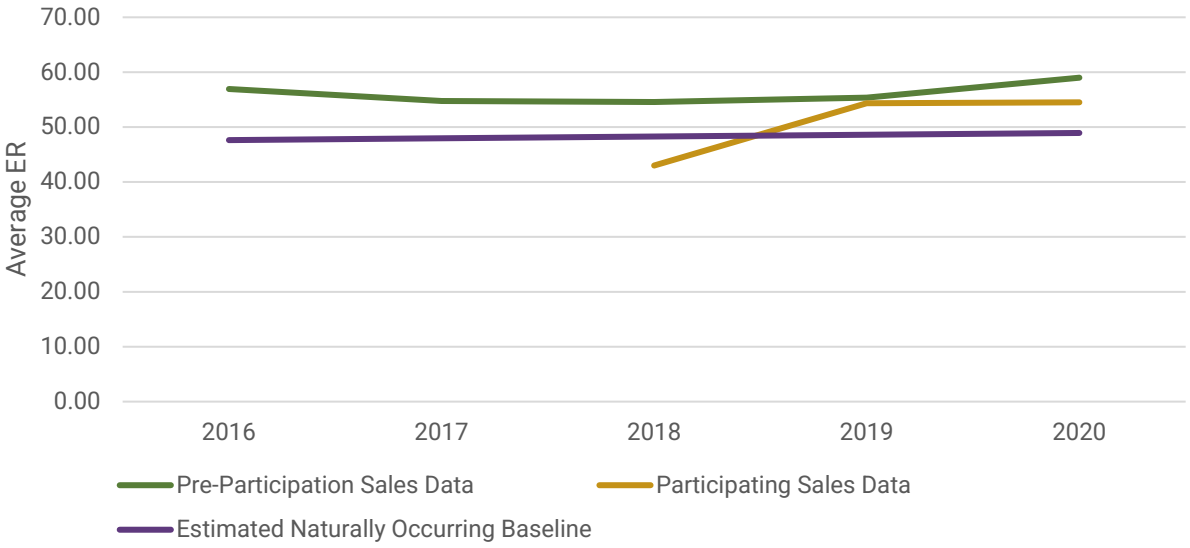
As Figure 2 illustrates, the pre-participation sales data that XMP distributors submitted (green line) provides a higher baseline than NEEA's estimated naturally occurring baseline for constant speed C&I pumps (purple line). The period from 2018 to 2020 has both pre-participation data from distributors entering the program in 2019, 2020, and 2021 and participating sales data from distributors who entered the program in 2018. Average ERs from both the historical and participating sales data decrease between 2018 and 2020, potentially reflecting distributors' and manufacturers' efforts to clear their inventories of non-compliant pumps before the federal standard took effect.

Figure 2: Average ER of Constant Speed Pumps, 2016-2020



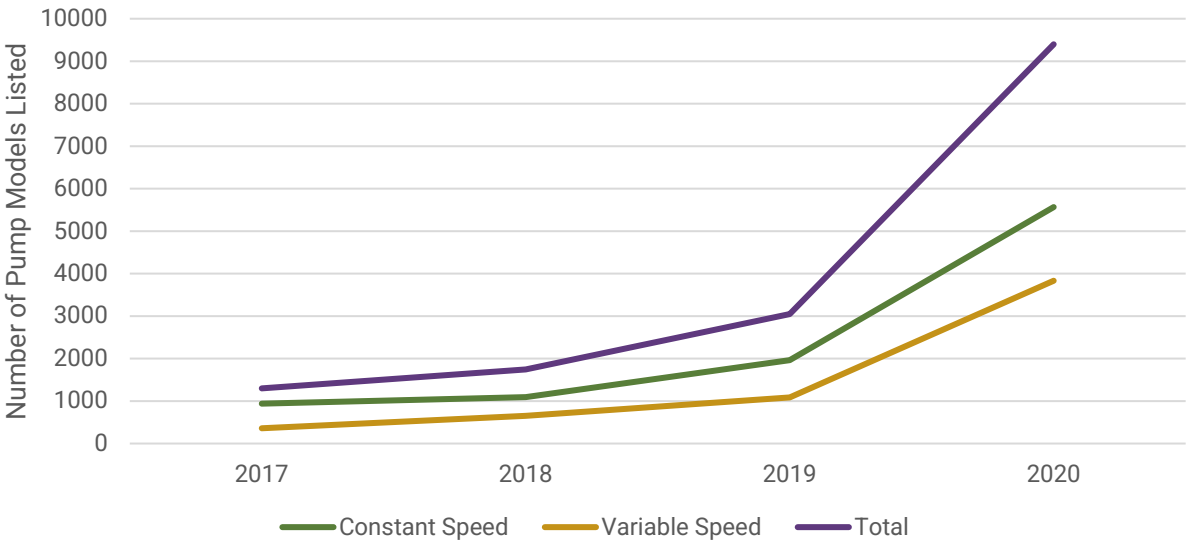
As with constant speed pumps, the average ER of variable speed pumps in the pre-participation sales data (green line) is somewhat higher than NEEA's estimated naturally occurring baseline average ER (purple line; Figure 3). Counterintuitively, the average ER of participating sales is below the average of pre-participation sales data, and even below the estimated naturally occurring baseline in 2018. This likely reflects differences in average ER between distributors who joined the program earlier and those who joined later, rather than any broader market trend.

Figure 3: Average ER of Variable Speed Pumps, 2016-2020



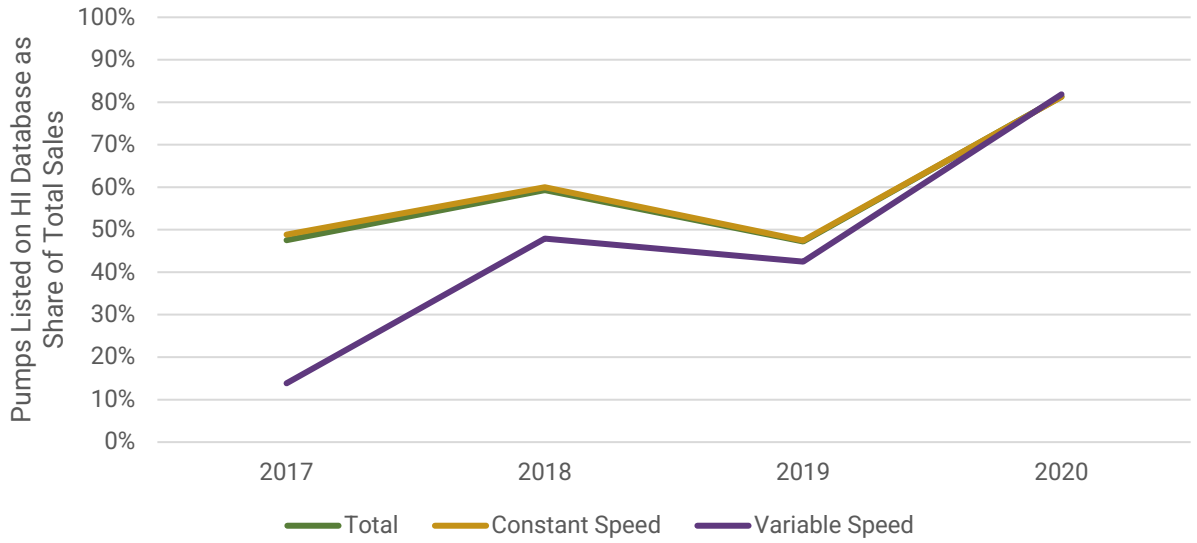
Apex assessed additions to the Hydraulic Institute's ER database over time, and the share of sales attributed to listed models to understand the timing of the database's potential effect on the pump market. As Figure 4 shows, the number of models included in the database increased gradually from 2017 to 2019, before accelerating in 2020. More than two-thirds (68%) of the models listed in a database export dated November 2020 had been added in 2020. The database included no radially split, multi-stage, vertical in-line casing (RSV) or submersible turbine (ST) pumps prior to 2019.

Figure 4: Number of Pump Models Listed on ER Database by Year



Despite the gradual growth in the number of listed pumps prior to 2020, XMP data indicate that the pumps listed in the database accounted for a substantial share of sales. As early as 2017, nearly half (48%) of the pumps participating distributors sold were listed on the ER database at the time of sale, although fewer variable speed pumps were listed (Figure 5).

Figure 5: Share of Participating Distributor Pump Sales from Pumps Listed on ER Database When Sold



Assessment

NEEA's C&I pump baseline estimates for the 2016-2020 period appear reasonable, based on the data Apex reviewed. This period largely represents the time between when the federal standard was finalized and when it took effect. NEEA's naturally occurring baseline estimates anticipate an increase in average ER over this period that exceeds (in absolute terms) the minimum increase we would expect to see from the removal of non-compliant models from the market.

NEEA's naturally occurring baseline estimates are lower than the market shares indicated in the pre-participation sales data. It is reasonable for NEEA's naturally occurring baseline estimates to be lower as the pre-participation sales data could still reflect NEEA's influence through its efforts to establish the ER label and online pump efficiency database. The distributors participating in the XMP program may also prioritize efficiency more than those not participating in the program, leading to a higher average ER among XMP distributors relative to the market as a whole.

- **Recommendation 1:** NEEA should assess whether the difference between the pre-participation sales data and NEEA's estimated baseline is reasonable given the expected influence of the ER label and database and any bias in average ER of participating distributors relative to the market as a whole. This assessment would likely draw on expert opinion, although it could also be informed by primary data collection with market actors if the opportunity arises.

NEEA's naturally occurring baseline estimates do not account for the dip in average ER for constant speed pumps observed in 2019 and 2020. Assuming this dip in average ER reflects efforts to clear non-compliant inventory, it is likely to be temporary and thus less critical for the baseline estimates to address.

We note that there appears to be limited rationale for NEEA to report savings prior to the establishment of the ER database and the launch of the program's midstream incentives. NEEA's activities leading up to the establishment of the database laid important groundwork for the adoption of the federal standard and the establishment of the ER database. However, those earlier activities are unlikely to have significantly impacted the efficiency of pumps sold in the Northwest at the time. Establishment of a test procedure and lab certification process are unlikely to have an immediate impact on the availability or uptake of efficient pumps.

- **Recommendation 2:** NEEA should not begin reporting savings for XMP prior to 2019, when the midstream incentive offering launched. While the Hydraulic Institute's ER database launched in 2017, bringing another opportunity for program influence, it was likely not sufficiently populated in its first year to allow pump specifiers and end-users to compare the efficiency of models they were considering. While participating distributors reported substantial sales of listed pumps in 2017, these distributors, which were the first to join the program, may not be representative of the larger market. Two factors indicate that the database was incomplete prior to 2020: It did not include any RSV or ST pumps prior to 2019, and two-thirds of the pump models listed at the end of 2020 were added to the database that year.

Assumption 2: Average pump ER will increase steadily from 2020 to 2024 and more slowly from 2025 to 2029 before plateauing in 2030. Constant speed pumps may see an additional increase in 2034 when NEEA estimates a new federal standard is possible.

NEEA's current assumptions for the naturally occurring average pump ER from 2020 through 2034 are listed in Table 3.

Table 3: 2020-2034 Naturally Occurring Average Pump ER Assumptions

Year	Naturally Occurring Average ER	
	Constant Speed Pumps	Variable Speed Pumps
2020	7.6	48.93
2021	7.9	49.18
2022	8.1	49.43
2023	8.4	49.68
2024	8.6	49.93
2025	8.9	50.18
2026	8.9	50.18
2027	8.9	50.18
2028	8.9	50.18
2029	8.9	50.18
2030	8.9	50.18
2031	8.9	50.18
2032	8.9	50.18
2033	8.9	50.18
2034	9.3	50.18

Rationale

NEEA bases these estimated rates of change in average ER on an analysis of average pump efficiency between the models included in the dataset DOE used in its market analysis for the pump efficiency standard, which dates to 2012, and the Hydraulic Institute's current database of pump ERs. NEEA's estimate that pump efficiency will increase following adoption of the federal standard before slowing and eventually plateauing reflects experience with other products as manufacturers have updated product lines to comply with new standards and introduced more efficient offerings to differentiate themselves from competitors. NEEA assumes an updated federal standard in 2034 will have a smaller impact than adoption of the first standard in 2020.

NEEA anticipates that uptake of variable speed pumps will be driven by state building energy codes, which require them in new construction and major renovations, as well as building owners' desires to improve their building energy ratings in jurisdictions that require rating and disclosure. NEEA does not anticipate that an updated federal standard would increase variable speed pump efficiency requirements in a baseline case, without intervention from NEEA and other advocates.

Findings

DOE is required to review efficiency standards every six years. If DOE determines an update is warranted, it must publish a final rule two years later.[4] Under that schedule, DOE would need to review the C&I pumps standard by 2026, with a final rule published by 2028.[5] The rule typically takes effect between three and five years after it is finalized. The compliance date for the recent pump efficiency standard was four years after the final rule was published. Thus, under DOE's statutory schedule, an updated standard would likely take effect between 2031 and 2033.

Apex reviewed data from the Industrial Facilities Site Assessment (IFSA) and the Commercial Building Stock Assessment (CBSA) to identify the sectors with the greatest concentration of pumps and thus suggest any potential market indicators that might influence pump efficiency in those industries. IFSA data indicate that C&I pump use in the Northwest is most concentrated in the wood products industry, with four of the five industrial sectors with the highest pump energy consumption per employee related to the broader wood products sector.[6] CBSA suggests that a majority of the pumps in the commercial sector (55%) are in hospitals; lodging was the sector with the next highest concentration at 12%.[7]

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[4] https://appliance-standards.org/document/missed-doe-deadlines-mounting

[5] The Appliance Standards Awareness Project (ASAP) lists the due date for a C&I pumps standard update as 2024 based on a potential effective date of 2018. Our estimate is based on the actual effective date.

[6] These sectors were, ranked first, pulp, paper and paperboard mills (NAICS code 3221); ranked third, veneer, plywood, and engineered wood product manufacturing (NAICS code 3212); ranked fourth, sawmills and wood preservation (NAICS code 3211); and ranked fifth, other wood product manufacturing (NAICS code 3219). The only sector ranked in the top five other than wood products was primary metal manufacturing (NAICS code 331).

[7] Consistent with the scope of the XMP program, we limited our analysis of pups in CBSA to those between 1 and 200 horsepower.

Assessment

NEEA's assumption that a new federal standard would take effect in 2034 may slightly overestimate the timing of the standard, given DOE's regulatory schedule. We note that, according to ASAP, as of March 2021 DOE was behind schedule on updates for 28 product standards. Thus, a delay in the update is possible. Nonetheless, it would likely be more defensible for NEEA to assume that the update will occur on schedule and adjust its assumed effective date to 2032.

- **Recommendation 3:** NEEA should update its baseline assumptions to have an updated C&I pumps standard take effect in 2032, which is more consistent with DOE's mandated review cycle.

Given the high concentration of C&I pumps in the wood products industry, it may be worthwhile for NEEA to monitor trends in that industry, as industry expansion is likely to result in an increased demand for pumps. Beyond changes in overall sales volume, the impact of expansion or contraction in the wood products industry on pump efficiency levels is not clear. IFSA did not provide sufficient data on pump types or efficiencies in use in different industries to determine how a change in demand in a sector like wood products is likely to impact average efficiency levels across the industry overall. This is a topic NEEA could explore in future data collection efforts with market actors.

Circulator Pumps

Assumption 3: Market share of efficient circulator pumps will increase gradually from a starting value of 12% in 2020 to 20% in 2027 before jumping to 30% in 2028 due to the adoption of a new federal standard.

Table 4 lists NEEA's current assumptions for the naturally occurring market share of efficient circulator pumps.

Table 4: 2020-2030 Circulator Pump Baseline Market Share Assumptions

Year	Efficient Circulator Pump Baseline Market Share
2020	12%
2021	13%
2022	14%
2023	15%
2024	17%
2025	18%
2026	19%
2027	20%
2028	30%
2029	30%
2030	30%

Rationale

NEEA's baseline analysis of circulator pumps is focused on market share of efficient circulators rather than average ER. The ER rating has a variety of drawbacks for circulator pumps that do not apply to C&I pumps:

- There is not a linear relationship between circulator pump ER and energy consumption as there is for clean water pumps.
- Circulator pump ER is more variable than clean water pump ER.
- The ER metric was not fully developed for circulator pumps at the time NEEA developed the baseline estimates reviewed in this memo. The Hydraulic Institute finalized an ER metric for circulator pumps in June of 2021.

While average ER may be a more complex metric for circulator pumps than clean water pumps, it is easier to draw clear distinctions between efficient technologies and inefficient technologies for circulator pumps than it is for other C&I pumps. NEEA staff also note that basing their baseline estimates on market share shifts simplifies savings calculations and makes it easier to communicate NEEA's market transformation progress to stakeholders.

NEEA assumes a beginning market share of 12% in 2020 for its circulator pump baseline, which NEEA anticipates will rise to 20% in 2027 due to consumers' general desire for energy savings and environmental benefits. NEEA anticipates a new federal standard for circulator pumps will take effect in 2028, which will drive market share to 30%, where it will plateau.

Findings

Beginning Market Share

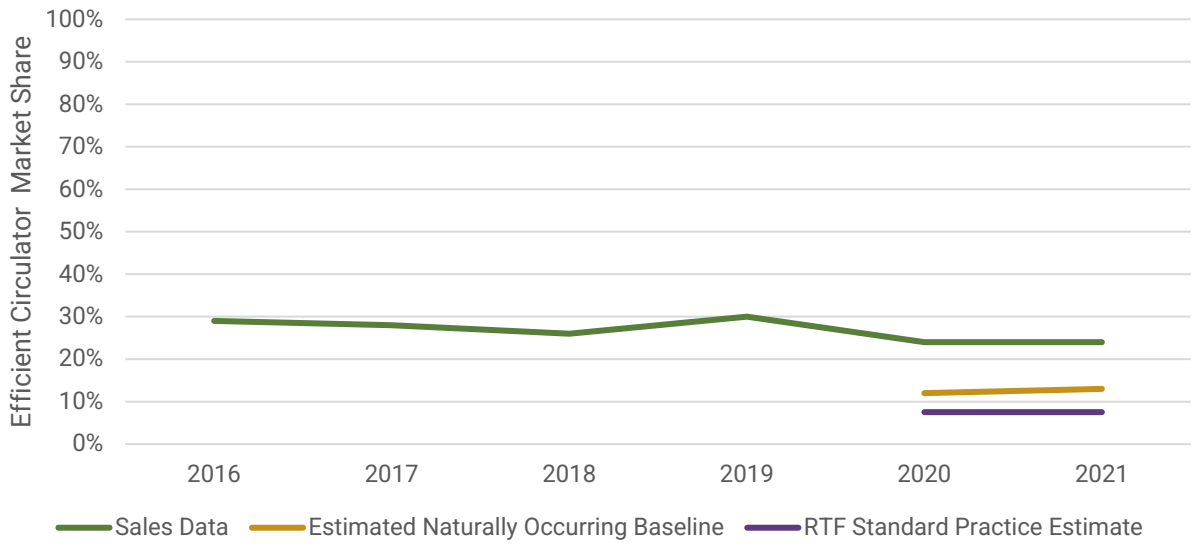
Few data sources are available to assess the market share of efficient circulators. NEEA assumes a beginning market share of 12%, citing assumptions in the Cadeo Group's savings assessment research. The rationale for assuming a 12% baseline in that research are not clear. The current RTF workbook's current practice analysis suggests a lower overall market share of 7.5%, citing DOE analysis but without a specific reference.[8,9] These estimates are broadly consistent with the experience of one pump distributor outside the Northwest, who reported that, in their experience, a reasonable estimate would be in the range of 10%.

NEEA's XMP sales data suggests a considerably higher market share of efficient circulators than any of these baseline estimates (Figure 6). This likely reflects differences between participating circulator distributors and the rest of the market. NEEA staff estimate that the program's sales data represents approximately 30% of the market. The participating distributors may focus more strongly on energy efficiency than others in the market and thus have a higher efficient market share.

[8] The RTF workbook lists baseline market share assumptions by pump type and horsepower. Apex used the distribution of sales by pump type and horsepower from NEEA's sales data to calculate a market share for the market as a whole.

[9] Regional Technical Forum. Circulator Pumps Workbook Version 2.3. September 27, 2021. Available at: https://nwcouncil.box.com/v/ComResCirculatorPumpsv2-3

Figure 6: Circulator Pump Baseline Market Share Estimates



Standard Adoption

NEEA assumes that the market share of efficient circulators will increase gradually until a new federal standard takes effect in 2028. DOE began the process of developing a standard in 2016 and held a series of meetings with a working group of stakeholders, and resumed the rulemaking process in May of 2021. While the rulemaking process to develop a standard is now active, there is no existing standard for circulator pumps, so the process for adopting a standard may take longer than standard renewals for other products. NEEA's baseline assumes a large, one-year jump in market share when the standard takes effect.

Assessment

The source of NEEA's beginning market share estimate of 12% is not clear, but limited data are available against which to assess that estimate. NEEA's sales data provide a market share estimate that is considerably higher than the estimated baseline. While this may reflect differences between participating distributors and non-participating distributors, NEEA should ensure it also accounts for those differences in its estimates of program effects (that is, avoid comparing participating distributor outcomes against a market baseline). It would also be worthwhile for NEEA to conduct additional research on broader circulator baseline market shares.

- **Recommendation 4:** NEEA should conduct additional research to:
  - Develop a more reliable estimate of starting baseline market share for circulator pumps.
  - Account for differences between participating distributors' market share of efficient circulators and that of the broader market in savings estimates.

NEEA's estimate of the timing of an updated federal standard is reasonable. While progress on the rulemaking has resumed, it remains its early stages, and with no existing standard to build on, the process of developing a final rule could take a number of years. Given these

timing considerations and a likely sell-through period, 2028 is a reasonable estimate for the effective date of a new standard.

Distributing the 10% increase in market share assumed between 2027 and 2028 over the period from the year NEEA assumes the standard will be finalized (likely 2024 or 2025) to its effective date in 2028 could provide a more reasonable estimate of naturally occurring market share trends. As with C&I pumps, the market will likely adapt to the standard in the three-to-five-year period between the time the final rule is released and the standards' effective date.

- **Recommendation 5:** NEEA should assume a steeper year-over-year increase in market share of efficient circulators in the years between when NEEA assumes a standard will be finalized and its assumed effective date, rather than a large, one-year increase.