

Memorandum

To: Joan Wang, Bonneville Power Administration
From: Jonah Hessels, Nate Baker, Elizabeth Daykin, Sarah Widder, Cadeo Group
Date: March 24, 2022
Subject: Industrial Pump, Fan, and Adjustable Speed Drive Sales Data Collection Summary Memo

Executive Summary

In 2021, Bonneville contracted with Cadeo (the team) to collect sales data from industrial pump and fan manufacturers and distributors in the Pacific Northwest (NW, or “region”). The team sought to characterize sales of industrial standalone pumps and fans larger than one horsepower in the NW and understand the level of adjustable speed drive (ASD) adoption on these equipment types. The sales data was intended to inform inputs in the team’s upcoming ASD market model. This ASD market model will calculate the change in energy consumption of standalone industrial pumps and fans in the NW. The model will also calculate Momentum Savings from the addition of ASDs to these systems. The team set out to collect sales data in this market because there are limited regional data sources on the industrial sector as a whole and, specifically, on the pump and fan market.¹ In addition to sales data collection, the team conducted secondary data research to inform their understanding of the fan and pump market size and major players in the supply chain. This team was the first in the region to attempt to collect comprehensive sales information from pump and fan market actors in the industrial sector.

What is an ASD?

ASD stands for “Adjustable Speed Drive”. This memo uses the term ASD to describe any electronic controls that allow a motor to rotate at different speeds, controlling the equipment load via changes in rotational speed.

The team adapted best practices used to collect data from residential and commercial market actors to accommodate this industrial data collection project. In the end, the research team struggled to collect the quantity and quality of data desired but gained significant insight into how market actors serving the industrial sector manage their sales data. Moreover, the secondary data research augmented the team’s existing market intelligence about pumps, fans and ASDs. This memo documents the lessons learned from this project and shares recommendations for future industrial data collection efforts, specifically for ASDs as well as fans and pumps.

¹ NEEA recently published market research on commercial and industrial standalone fans and reported that “there is a lack of full category data that could hinder the ability to understand the market”. https://neea.org/resources/commercial-industrial-stand-alone-fans-market-research?utm_source=MRE+Report&utm_medium=Campaigner&utm_campaign=C%26l+Fans+Research

Research Questions

The scope of this project was two-fold. First, the team aimed to collect shipments data from pump and fan **manufacturers** that are representative of total shipments of industrial pump and fan equipment to the region. This data allows for characterization of total motor horsepower (HP) sold by variables required for the ASD market model (such as state, sector, equipment, motor size, motor type, and whether the units are equipped with an ASD at the manufacturer level). The team asked for as many of these variables as participants could provide; some variables were necessary for analysis and others were “nice to have.” For more information on variables, see Table 2 in the Data Collection Methodology section.

The second activity was to collect sales data from pump and fan **distributors** to supplement the characterization of total motor horsepower in the shipments data and to create a regionally representative rate of industrial pump and fan equipment that are equipped with an ASD at the distributor level. There are two paths to market for ASDs: they can be paired and sold with the equipment they control, or more commonly they are sold separately from the equipment (i.e., an end user or installing contractor might purchase a fan and then separately purchase an ASD to pair together during on-site installation). Through market actor interviews conducted earlier in 2021², the team identified that equipment distributors have the best insight into the sale of equipment paired with ASDs (as equipment and ASDs, when sold together, are most often paired at the distributor level). Therefore, the sales data from pump and fan distributors can also provide quantities of ASDs sold with equipment, which the team thought represented roughly 20% of all ASDs entering the market according to the interviewed market actors.

To simplify, the team refers to the project scope as answering two research questions:

- Research Question 1: **What is the market size and characterization of pump and fan motor HP sold in the NW’s industrial sector?**
- Research Question 2: **What percentage of relevant equipment is sold with ASDs?**

A summary of the data collection scope is seen in Table 1.

Table 1: ASD Data Collection Scope

Parameter	Scope Requirement
Equipment	Standalone pumps and fans >1 HP
Sector	Industrial ³
Analysis Period	Jan 1, 2014 - Present
Geography	Equipment sold in Idaho, Oregon, Washington, or Montana ⁴

The following section presents the key takeaways from this data collection project.

² <https://www.bpa.gov/-/media/Aep/energy-efficiency/momentum-savings/2021-bpa-asd-market-actor-interview-findings.pdf>

³ Consistent with the Seventh Power Plan’s definition: https://www.nwcouncil.org/sites/default/files/7thplanfinal_appdixg_consresources_1.pdf

⁴ For the ASD market model, the team defines the “region” consistent with the definition used by the Northwest Power and Conservation Council: Washington, Oregon, Idaho, and western Montana (western Montana constituting 57% of the state). This definition is not used for data collection; instead, the team assumes sales trends for western Montana follow state trends. Any analyses and analysis results discussed in this memo will be applied only to the in-region portion of Montana in the ASDs market model.

Key Takeaways

1. The team was not able to collect enough sales data from industrial pump and fan manufacturers and distributors to produce an aggregated and representative dataset.

The team's data collection efforts did not produce as many participants or as high a quality of data as hoped. The team received data from 10 market actors, which covered an estimated 19% of NW industrial pump sales and 36% of NW industrial fan sales. However, the low number of participants in each stratum (for example only two fan manufacturers shared data) made it difficult to share the results publicly.



Implication: The team will not use fan and pump sales data as direct inputs to the ASD market model. The data is still valuable, however, and will be used to corroborate other sources rather than as standalone model inputs. Specifically, the team was able to use sales data to corroborate the distribution of equipment by motor size assumed in the ASD market model.

2. The team was able to develop preliminary estimates of industrial fan and pump market size and characterize the major players in the supply chain using secondary data sources.

One significant outcome of this research are the findings from the team's initial assessment of the NW industrial fan and pump market. Building off prior supply chain findings, market research, and publicly available data sources, the team created a characterization of the industrial fan and pump market. This characterization included a list of major players and their relative market shares, which revealed that fan equipment manufacturing is concentrated in a few major market players, whereas fan distribution, pump manufacturing, and pump distribution are more fragmented markets. The team also developed preliminary estimates of the total industrial fan and pump market sizes using secondary data. The team estimated that about 14,000 industrial rotodynamic pumps greater than 1 HP and 23,000 industrial standalone fans greater than 1 HP are sold in the NW each year.



Implication: This was one of the first energy efficiency efforts to characterize the size of the industrial fan and pump market in the NW, providing a clearer picture of the market that will be useful in future ASD, fan, and pump program design, modeling, and research. More immediately, the total fan and pump market size estimates developed in this research will be used to corroborate and compare with results of the upcoming ASD market model.

3. The portion of equipment sold with ASDs from pump and fan distributors is very small, so pump and fan sales data are not a viable source for capturing ASD sales.

The collected pump and fan sales data showed very few pump and fan equipment being sold with ASDs. Distributors and manufacturers who provided sales data reported that ASDs are often thought of as ancillary equipment and are not tracked with the equipment they sell. The small number of ASDs in the collected sales data creates a challenge in identifying ASD sales trends, as one large project can significantly skew a distributor's data year over year. Moreover, the number of ASDs sold with fan and pump equipment is so small that the team suspects that the vast majority of ASDs are not sold with equipment but rather sold separately and paired with equipment at installation. This updates the team's prior characterization of the ASD market: instead of having two paths to market, ASDs are predominantly sold separately from equipment.



Implication: Future data collection efforts informing ASD sales and saturation will need to look at sources other than fan and pump distributors, such as motor and drive market actors, installing contractors, or stock assessments. While motor and drive manufacturers and distributors could potentially provide information on the number of ASDs sold in the region, the team suspects they would not have granular information on the applications and installation contexts of those ASDs. The team recommends BPA conduct pilot studies to investigate what data can be collected from motor and drive market actors and installing contractors.

4. Market actors serving the industrial sector are difficult to reach, protective of data, and limited in prior experience with energy efficiency efforts.

Despite being well-connected in the industrial pump, fan, and drive markets in the NW and leveraging all available connections in outreach, the team had trouble collecting data from market actors serving the industrial sector. Market actors were difficult to engage, hesitant to share data, and largely unfamiliar with data requests from energy efficiency professionals. Many of them do not use a central database to store sales and product tracking information, and almost none have data in a format that is ready to export. Where they do track information, the data are lean and focused on the number of units sold and price but lack the detailed information necessary for energy efficiency analysis such as horsepower, efficiency, ASDs, and customer application.



Implication: Future data collection efforts with industrial fan and pump market actors must take these challenges into account to set realistic expectations and plan around potential roadblocks. For example, the team found that scheduling longer outreach timeframes, priming all available connections before outreach, and leveraging any and all outreach strategies (including conferences or in-person visits) would be beneficial in increasing participation from industrial market actors. Separate from sales data collection, there may be alternative ways to collect data to characterize the industrial pump and fan market. For example, characterizing the industrial stock of motor-driven equipment through targeted site data collection could replace the need for annual sales data. Stock characterization could provide the key equipment and ASD data variables needed to characterize energy consumption (HP, equipment efficiency, install location, motor efficiency, and presence of ASD) as well as commissioning and installation-specific characteristics that sales data cannot inform. Incorporating a longitudinal component would allow the stock information to also characterize market transformation, which is usually achieved through annual sales data collection.

This memo summarizes the data collection outcomes from the team's first industrial pump, fan, and ASD sales data collection effort. It discusses the data collection process, methodology, key findings, lessons learned, and recommendations for future data collection efforts. Although the data from this round of data collection was insufficient to serve as direct model inputs, it was valuable in characterizing an under-characterized market and corroborating inputs and results of the upcoming ASD market model.

Data Collection Methodology

This section details the team’s data collection process, including an initial market assessment to determine the population frame and data collection targets, a data request, outreach activities, and review of the collected data.

Initial Market Assessment

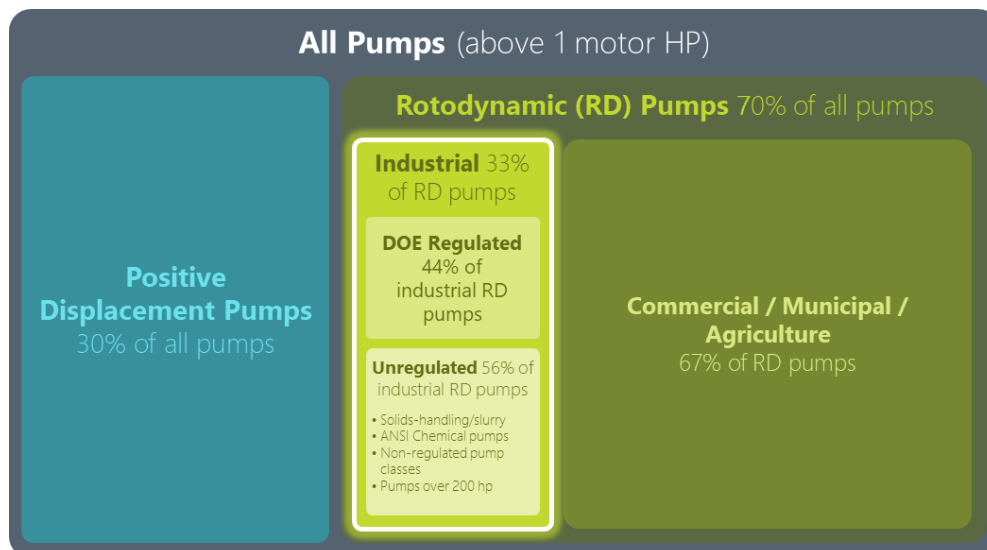
To identify the market actors to target, the team first created an initial characterization of the industrial fan and pump market in the NW, including a definition and estimated size of both the fan and pump market, as well as a list of major players and relative market share. The team then developed preliminary market breakdowns by combining BPA’s previous market research⁵, information from the U.S. Department of Energy (DOE), and information from industry associations like the Hydraulic Institute (HI).

The team’s assessment of the market serves as a key outcome from this research project, creating an estimate and a size characterization for a previously undefined market. This estimated total market size and breakdown of the market by key market players provided the team a foundation to begin outreach. Results of the initial market characterizations are included below.

Estimated Pump Market Size

The team limited scope of this research to industrial rotodynamic pumps greater than 1 HP, as shown by the highlighted box labeled “Industrial 33% of RD pumps” in Figure 1.⁶ These include DOE regulated and unregulated pumps. Based on secondary data sources listed above, the team estimated that there are roughly 350,000 scope-relevant industrial rotodynamic pumps sold nationwide each year, and about 14,000 in the NW.⁷

Figure 1: Research Scope of Relevant Pump Sales



⁵ <https://www.bpa.gov/-/media/Aep/energy-efficiency/momentum-savings/2021-bpa-asd-market-actor-interview-findings.pdf>

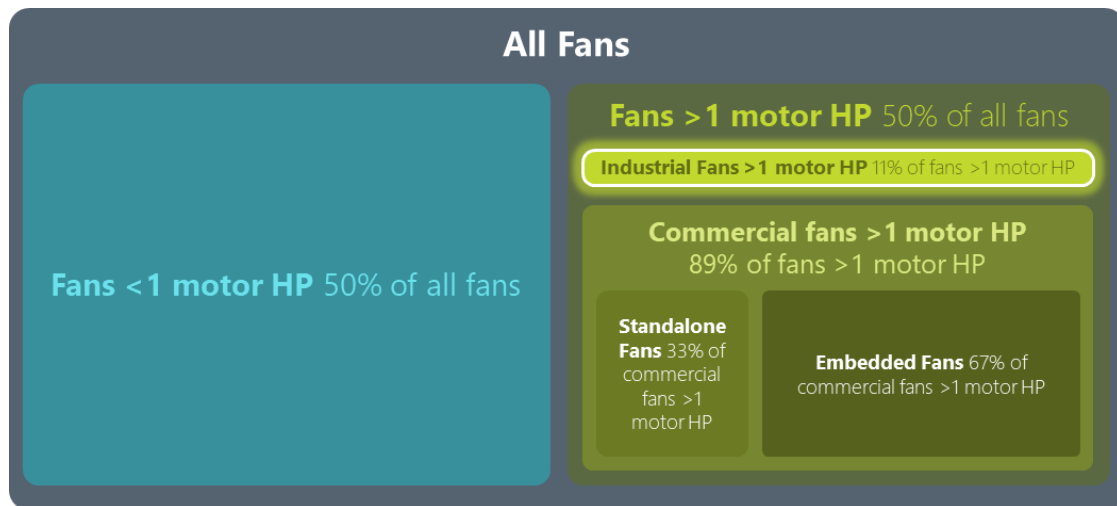
⁶ This scope aligned with BPA’s ASD Market Model Scope.

⁷ See Appendix A for more detail on market characterization sources and methods.

Estimated Fan Market Size

Relevant fans in the project scope included all industrial standalone fans greater than 1 HP, as shown in Figure 2 by the box labeled “Industrial fans” representing 11% of fan sales greater than 1 HP in the US. The team’s market size estimates, based on secondary data sources, indicate about 469,000 scope-relevant fans sold nationwide each year, and roughly 23,000 in the NW.⁸

Figure 2: Research Scope of Relevant Fan Sales



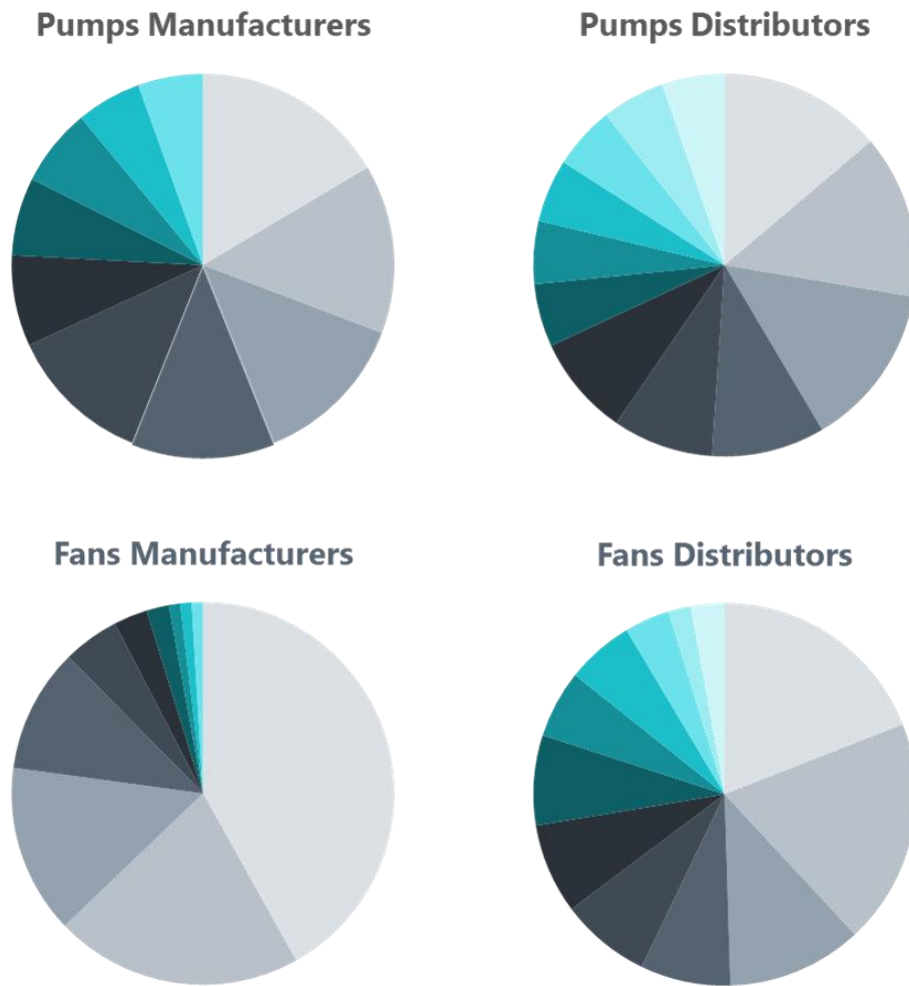
Market Actor Characterization

The team used this initial market characterization to identify the largest market actors in each category. Figure 3 shows the top 10 to 12 market actors in each category and their market size relative to one another. This figure does not characterize the smaller market actors, or the portion of the market they hold. The team developed this market characterization with the goal of prioritizing outreach to larger market actors.

This characterization shows that in the pumps market, there are multiple major players in each category (pump manufacturers and pump distributors) that have significant market share. Among industrial pump manufacturers, the team estimated that no company controlled more than 15% of the characterized portion of the market, while 5 different companies controlled between 10 and 15% of that same portion of the market. Fan distributors show similar trends as pump market actors, but fan manufacturers are more concentrated. Three fan manufacturers make up over 75% of the portion of the market included in Figure 3. This market information currently serves as one of the only regional assessments of market share, market actor distribution, and market size for the industrial pump and fan industries.

⁸ See Appendix A for more detail on market characterization sources and methods.

Figure 3: Distribution of Market Share across the top market actors, by market actor category



The team also used internet searches, existing knowledge, and input from other subject matter experts to create a database of company names, locations, branches, contact names, phone numbers, emails, and a characterization of which manufacturers each distributor carries. Developing this database showed that converse to the exclusive manufacturer-distributor relationships apparent in commercial pump and fan markets, many industrial distributors carry numerous, sometimes competing, equipment brands to ensure they have access to the best equipment for their customers. This fragmented nature of the industrial distributor market, relative to manufacturers, makes data collection difficult because it increases the number of participants necessary to achieve a given market coverage.

Data Request

The team set out to collect key information on equipment sales to refine the initial market size estimates, to further characterize industrial fan and pump sales, and to establish the percentage of equipment sold with ASDs over time. Specifically, the team requested the following fields in Table 2. The goal was to have each market actor export their sales in a granular database format where sales could be categorized and reported at the granularity of each of the variables listed below. The team hoped that all market actors could provide

this level of detail. However, the team did not expect manufacturers to track whether equipment was sold with an ASD or not at the distributor level.

Table 2: Data Request Variables of Interest

Data Variables	Priority	Target Market Actor
Year Sold	Need to have	Manufacturers & Distributors
Sector	Need to have	Manufacturers & Distributors
Motor HP	Need to have	Manufacturers & Distributors
Number of units sold	Need to have	Manufacturers & Distributors
Presence of an ASD	Need to have	Distributors
Sold to / Installed Location	Need to have	Manufacturers & Distributors
Equipment Efficiency	Nice to have	Manufacturers & Distributors
Industry	Nice to have	Manufacturers & Distributors
Motor Efficiency	Nice to have	Manufacturers & Distributors
Motor Model Number	Nice to have	Manufacturers & Distributors

A significant part of data outreach involved learning what data industrial pump and fan market actors tracked. From prior discussions with these market actors and data collection efforts in other markets, the team knew that each market actor would likely have a different data tracking system. Therefore, the team requested data in any format the market actor could provide, with the expectation that the analysis team would need to clean and modify the data structure.

In addition to receiving the sales data from market actors, it was critical for the analysis team to understand and aggregate the data correctly. Therefore, market actors were also asked a series of firmographic and general market questions (shown in Table 3) to ensure the team could correctly frame the sales data within the larger market. These additional questions helped inform market trends (e.g., COVID impacts), confirm the team’s characterization of each market actor, and triangulate market size and share estimates.

Table 3: Firmographic Questions

Firmographic questions:

- 1 | How many branches do you have in the NW?
- 2 | What % of your sales (\$) are pumps?
- 3 | What % of your sales (\$) are fans?
- 4 | What % of your sales are industrial?
- 5 | Who are the biggest industrial [fan/pump] manufacturers and distributors in the NW region (OR, WA, ID, MT)?
- 6 | What % of industrial [fan/pump] sales in the NW do you think you represent?
- 7 | Our research is focused on industrial standalone fans > 1 HP. We estimate 496,000 fans within that scope are sold nationwide each year, and 23,000 sold in the NW (OR,WA,ID,MT). [For pump market actors - Our research is focused on industrial rotodynamic pumps > 1 HP. We estimate 350,000 pumps within that scope are sold nationwide each year, and 14,000 sold in the NW (OR, WA, ID, MT)]. Are these estimates consistent with your understanding of the [fan/pump] market?
- 8 | Please describe any major changes/trends in your company sales from 2014-2021. Changes might include increasing or decreasing sales overall or of a particular product.
- 9 | How has COVID impacted your sales? Were sales higher or lower than they would have been without COVID, and by approximately how much? Do you think COVID had a temporary impact, or do you think it will impact long-term sales?

Condensed Data Request

Initial communication with market actors revealed that many were not able to provide the detailed data the team requested. The Data Collection Outcome section provides more detail on these data gaps. Other contacts were hesitant about the amount of internal time it would take to fulfill the request or wary of sharing sensitive data.⁹ For these reasons, the team developed a condensed data request, shown in Table 4, to offer market actors unable to fulfill the detailed data request. This allowed the team to gather usable data from market actors who otherwise would have declined to participate. Four market actors who declined to share detailed sales data agreed to provide answers to the condensed data request. Their answers provided the team with useful insights which the team incorporated into the Findings section in combination with detailed sales data.

⁹ The team prepared an NDA and offered it to all potential participants.

Table 4: Condensed Data Request

This condensed format distilled the data request into five summary data requests including:

- 1 | Total fan or pump sales (\$ or units) by year
- 2 | Percent of equipment sales by HP bin¹⁰
- 3 | Percent of equipment sold with ASDs by HP bin
- 4 | Percent of sales that are traditional vs advanced motors
- 5 | Percent of motor sales that qualify as NEMA premium efficiency

Population Frame and Sampling Strategy

In the under-characterized market of industrial fans and pumps, there was insufficient evidence to warrant stratifying market actors by location, firm size, or application. The team's goal was to maximize the amount of sales data that can be collected. Thus, the team attempted a census approach by reaching out to every potentially relevant market actor and expending additional resources for larger companies. The team weighed the risk of potentially compromising regional representativeness by targeting the largest market actors but concluded that the lack of an existing full category sales dataset and the expected difficulty of reaching these market actors outweighed any potential concessions in regional representativeness. The potential to get an insufficient number of participants, or too little market coverage, were identified as greater risks.

To develop a population frame, the team created a list of relevant market actors by combining multiple disparate sources including a Northwest Energy Efficiency Alliance (NEEA) Extended Motor Products (XMP) contact list, subject matter expert input, a snowball sample developed by asking participants who else should be included in the research, and web research findings. The resulting population frame included 4 strata: 17 fan manufacturers, 21 fan distributors, 24 pump manufacturers, and 38 pump distributors, as well as 14 other contacts at relevant engineering services firms or program implementers.¹¹ At a minimum, the team needed to collect data from at least three market actors in each stratum to ensure anonymity in reporting and sought to collect data from at least four market actors in each stratum.

Data Collection Outreach

To reach potential participants, the team employed many different outreach tactics, most commonly emailing and phone calling. As detailed in Table 5, the team leveraged all outreach avenues available, often tapping connections multiple times by reaching out during planning and then again after data collection was underway. In total, the outreach team sent over 500 emails and made over 200 phone calls to a total of 107 identified relevant contacts (representing 95 unique firms).

¹⁰ The team divided HP into 6 different bins for analysis

¹¹ The team explored purchasing a proprietary list of contacts but there were none available.

Table 5: ASD Data Collection Outreach Avenues

Data Collection Avenue	Outreach Activity and Outcome
Hydraulic Institute (HI)	The team worked closely with Pete Gaydon of HI to set up meetings with his contacts at pump manufacturers. Pete set up an email introduction with all 10 key targets on the team’s initial list of the largest pump manufacturers. While three contacts agreed to participate from this outreach, only one sent data.
NEEA’s XMP program team	The team coordinated with NEEA staff to ensure this research was complementary to the XMP initiative, which is in contact with similar market actors. The team was able to coordinate and collect data from two market actors that are also participants in the XMP initiative.
DNV-GL/NEEA	DNV-GL had recently completed interviews with fan distributors on behalf of NEEA and offered to send an introductory email to participants. This did not result in any additional participants.
BPA Energy Smart Industrial (ESI) program staff	BPA’s ESI program staff offered warm introductions with market actors they had previously worked with. This facilitated three meetings with market actors and two fan manufacturer participants.
Team connections from prior research	The team has been working in the fans, pumps, and ASD markets for years and coordinated with other internal staff to solicit leads with any potential participants. This effort resulted in introductions to multiple market actors, five meetings with market actors, and two participants.
Cold calls/emails	The team performed an extensive online search to supplement the population frame and potential contacts. They sent an average of 5 emails, phone calls, or voicemails to each contact, which resulted in numerous meetings and three additional participants.

The team offered market actors an incentive of \$1,000 for a full data submission and \$500 for a condensed data request submission. Some market actors were not interested in the incentive, whereas it was a clear motivator for others. In other cases, the incentive was not enough to offset the amount of internal time it would take to prepare a data export like the team requested; the team heard this from large and small market actors alike and the perspective seemed to stem more from a firm’s internal culture rather than firm size or data storage practices¹².

After a potential participant expressed interest, the team then set up a videoconference to walk through the data request in detail, answer any questions they had about the project, and verify that the market actor’s offerings fell within the project scope.

¹² One contact that declined to participate explained it as “we try to stay lean, and laser focused on our mission. So, I could probably have somebody put that request together but it would take them away from their work and on principle we tend to deny requests like this.”

Quality Control and Data Review

Upon receipt of data, the team completed two rounds of quality control (QC) review. An initial round of review, completed within two days of submission, confirmed completeness of the data. The team reviewed temporal coverage and fields of interest for completeness (shown in Table 2) and confirmed they understood how to read and reference the data. The second, more detailed, round of QC occurred when the analysis team uploaded the data to the project database. This review focused on anomalies across multiple crosstabs including:

- Quantity of sales by year and sector
- Horsepower total and weighted average of total equipment sold
- Quantity with and without ASD by year
- Weighted average motor and equipment efficiency by year
- Quantity by state

The team followed up with participants with any outstanding questions to confirm understanding prior to providing an incentive.

Data Collection Outcome

This section details the direct results of data collection with the intent to provide metadata associated with data collection, including participants, market coverage, data quality, and data gaps. Findings, conclusions, and recommendations will be discussed in the next sections.

Participants

As presented in Table 6, ten total market actors provided data: six sent detailed sales data, and four responded to condensed data requests.

Table 6: Participants by Market Strata and Data Submission Type

Equipment	Market Actor Type	Detailed Data	Condensed Data	Total	Initial Targets
Pumps	Manufacturers	1	1	2	At least 4 or 40-50% of market
Pumps	Distributors	2	1~	3	At least 4
Fans	Manufacturers	2*	0	2	At least 4 or 25-50% of market
Fans	Distributors	1	2	3	At least 4
		6	4	10	

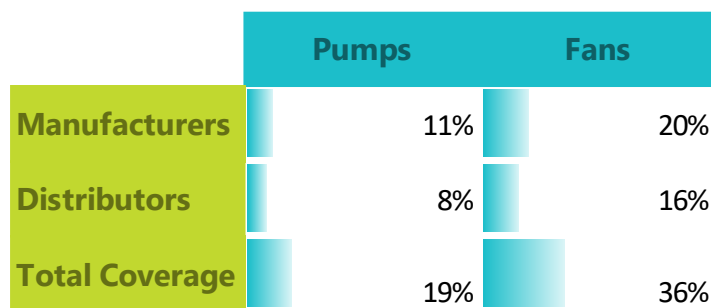
* One fan manufacturer sent full data, but their sales were outside of the project scope.

~ This pump distributor sent condensed data for compressor sales with very limited pump information, then did not respond to follow-up communication from the team.

Market Coverage

Participant sales data (detailed and condensed data combined) constituted an estimated coverage of 19% and 36% of the industrial pumps and fans markets, respectively. For more information on how the team developed market share estimates, see Research Question 1 discussed in the Findings section.

Table 7: Sales Data Market Coverage



The team was able to combine sales data from manufacturers and distributors into a total market coverage estimate because of minimal overlap between market actors (less than 1% of total sales). The team reviewed each market actor's supply chain to identify companies who might exist in the same channels. Since almost all the participants did not sell each other's products, the team was able to combine data sets of sold equipment without double counting, resulting in additive market coverage between distributors and manufacturers.

Data Gaps

In general, there was a wide variety of data storage practices among market actors, including both participants and non-participants. All market actors the team spoke with had some form of basic sales tracking; however, when the team began asking about specific motor sizes, efficiencies, or model information, there was significant divergence. Some market actors had all these data fields and more, whereas others were not interested in tracking these types of variables since they are not necessarily needed for the seller's internal processes.

The data quality from market actors who participated and provided detailed sales data is shown in Table 8 and Table 9. These tables are not representative of all the data collected within the fan and pump market. Rather, they only reflect participants of this project, who typically had better data tracking infrastructure than non-participants. In both the participant and non-participant groups, manufacturers tended to have better data tracking than distributors. The team observed that distributors declined to participate because they did not have the data available, whereas manufacturers declined because of internal labor concerns or data sensitivity, not lack of data.

Table 8 provides detailed pump data submissions.

Table 8: Pump Detailed Data Submission Variable Gaps

Data Element	Manufacturer	Distributor 1	Distributor 2
Sale Date	✓	✓	✓
Customer Sector	✓	*	✓
Motor Size (HP)	✓	✓	✓
Units Sold	✓	✓	✓
Equipment Type	✓	✓	✓
Motor Type	✓	✗	✗
Presence of ASD (Y/N)	NA	✓	✓
Location	✓	✓	✓

* Provided contextual, not detailed, information, e.g., x% of sales are industrial

NA not applicable as manufacturers did not have insight in ASD info, as the team expected.

✗ means that the market actor was not able to provide data.

The collected pump data meets basic screens for reporting market size and horsepower distribution and includes data from at least three market actors to ensure anonymity in reporting. However, the team concluded that the data quality was insufficient to publish the data in an aggregated and regionally representative dataset. The Findings section discusses this in more detail.

The team also requested information about the following variables, which were classified as "nice to have," with limited success: equipment efficiency, motor efficiency, model information (often received and used to fill in, where possible, drive and HP information), facility type, and price. Table 9 provides detailed fan data submissions. Although the team received three detailed data sets from fan market actors, one of them did not have fan sales within the project scope so it is not included in the summary of submissions. As a result, the collected fan sales data did not meet the anonymity screen of at least three data submissions.

Table 9: Fan Detailed Data Submission Variable Gaps

Data Element	Manufacturer	Distributor
Sale Date	✓	✓
Customer Sector	✓	*
Motor Size (HP)	✓	*
Units Sold	✓	✓
Equipment Type	✓	✓
Motor Type	✓	✗
Presence of ASD (Y/N)	✓	✗
Location	✓	✓

* Provided contextual, not detailed, information, e.g., x% of sales are industrial

Temporal Gaps

The data collected did not have significant temporal gaps. The most common reason participants were not able to provide sales data for older years was due to a change in their tracking software. Typically, participants did not have reservations about sharing as many years of data as they could. Table 10 reflects only those participants who sent in detailed data submissions.

Table 10: Temporal Range of Data Submissions

		2014	2015	2016	2017	2018	2019	2020	2021
Pumps	Manufacturer	✗	✗	✗	✓	✓	✓	✓	~
	Distributor	✓	✓	✓	✓	✓	✓	✓	~
Pumps	Distributor	✗	✗	✗	✗	✗	✓	✓	~
Fans	Manufacturer	✓	✓	✓	✓	✓	✓	✓	~
Fans	Distributor	✗	✗	~	✓	✓	✓	✓	~

✗ missing

~ partial

✓ complete

Findings

The team did not have enough confidence in the collected sales data to publish the data in an aggregated and regionally representative dataset, nor did the team use the collected data as direct quantitative inputs for the ASD model. However, the team was able to glean information from the collected data to corroborate other data sources that address the research questions:

- Research Question 1: **What is the market size and characterization of pump and fan motor HP sold in the NW's industrial sector?**
- Research Question 2: **What percentage of relevant equipment is sold with ASDs?**

This section summarizes the team's findings related to both research questions and additional lessons learned collecting data in the industrial pumps and fans market.

Research Question 1: What is the market size and characterization of pump and fan motor HP sold in the NW's industrial sector?

Total market size: Sales data did not refute initial estimates from secondary data; COVID 19 had a negative impact on equipment sales

The team did not collect sufficient sales data to extrapolate and calculate the total fan and pump market size with an acceptable level of confidence. The resulting market size estimates based on participant reported sales and market shares are unreliable, ranging widely between participants for each market. As the team saw in data collection and interviews with these market actors, it is difficult to get a full picture of the market and each individual market actor may not have enough insight into the total market to fully confirm the total market size.

However, the number of sold units reported by the 10 participants does not exceed the initial market size estimates of roughly 14,000 industrial standalone pumps and 23,000 industrial standalone fans sold in the NW per year. This data does not contradict the team's initial market size estimates, as shown in the Initial Market Assessment section above. In addition to examining the collected sales data quantitatively, the team qualitatively asked each participant to comment on the team's initial market size estimates. Participants offered additional insight¹³ that corroborated the team's initial market size estimates as reasonable. Note that these estimates are not perfect and are based on secondary data sources but represent the best available estimate of market size at this point in time. The team plans to leverage these estimates to refine the estimates of total industrial fan and pump market size calculated in the upcoming ASD market model (in both number of units sold and total number of motor HP sold).

As mentioned in the Data Collection Methodology, participants answered a series of open-ended questions about the market in addition to sharing detailed quantitative sales data. A major thread of agreement among participants was that COVID 19 had a negative impact on their sales. For example, one pump manufacturer reported a 13% reduction in sales. However, participants disagreed on the duration of COVID's effect on sales, with some saying that as soon as supply chains opened back up their sales would return to normal and others positing that price increases, labor shortages, and freight capacity issues would impact sales for several years. The uncertainty surrounding the COVID-19 pandemic likely contributed to differing opinions in its effect on equipment sales.

Participants also expressed a general consensus that over the past 10 years that niche and specialized product sales are growing at a faster rate than general fan and pump sales.

Characteristics of motor HP: Regional sales data corroborated the motor size distribution in the national 2018 Motor System Market Assessment Report

Distributions of pump and fan sales by motor size in the collected sales data, shown in Table 11 and Table 12, are largely consistent with the national motor size distributions from the 2018 Motor System Market Assessment (MSMA) report.¹⁴ The team does not, however, recommend using the distributions based on collected data because of small sample sizes (e.g., 10 or fewer units for a given HP bin) of participants (e.g., only two reporting participants) and inaccurate self-reported estimates of market share from participants.

¹³ Market actors mainly confirmed the reasonableness of these estimates and contributed additional benchmark numbers, which rarely aligned exactly with project scope but were helpful benchmarks.

¹⁴ https://www.nema.org/docs/default-source/motor-and-generator-guides-and-resources-library/u.s._industrial_and_commerical_motor_system_market_assessment_report_vol_1_4cbc82a3-a08a-462d-a774-e637c9998c8a.pdf

Instead, the team recommends using the national MSMA motor size distributions to represent the motor size distributions in the NW region.

The distributions shown in in Table 11 and Table 12 reflects reported units by HP weighted by one of three sets of market share estimates:

- **Cadeo-estimated market share based on secondary sources.** In the initial market assessment prior to data collection, the team developed total market share estimates using the secondary sources detailed in Appendix A: Market Characterization Sources (DOE, Census, and other industry sources).
 - For manufacturers, the team combined DOE, HI, and Air Movement and Control Association (AMCA) data then sanity checked market share estimates with subject matter experts.
 - For distributors, market share was based on the number of regional branch locations.
- **Participant self-reported market share.** Participating manufacturers and distributors reported their estimated market share, e.g., a pumps participant estimated their company has 40% market share in 2020.
- **Calculated market share based on reported sales.** The team calculated market share estimates as the ratio of participant-reported sales to the market size estimate established through secondary sources. For example, if a participant reported 500 pumps the calculated market share would be 3.57% based on 14,000 pumps.

Table 11: Characteristics of HP - Pumps

HP Bin	Source: 2018 MSMA	Calculated HP Distribution from Collected Data Sources		
		Source: Cadeo-estimated market share	Source: Participant-reported market share	Source: Calculated market share based on reported sales
1-5 HP	49%	65%	63%	63%
6-20 HP	28%	28%	34%	33%
21-50 HP	13%	4%	2%	3%
51-100 HP	6%	2%	0%	1%
101-200 HP	2%	0%	0%	1%
201-500 HP	1%	0%	0%	1%
501-1000 HP	0%	0%	0%	0%
1000+ HP	0%	0%	0%	0%

Table 12: Characteristics of HP – Fans

HP Bin	Source: 2018 MSMA	Calculated HP Distribution from Collected Data Sources		
		Source: Cadeo-estimated market share	Source: Participant-reported market share	Source: Calculated market share based on reported sales
1-5 HP	49%	54%	26%	13%
6-20 HP	28%	20%	17%	12%
21-50 HP	13%	10%	21%	26%
51-100 HP	6%	6%	13%	18%
101-200 HP	2%	5%	12%	17%
201-500 HP	1%	2%	4%	6%
501-1000 HP	0%	2%	4%	6%
1000+ HP	0%	1%	2%	3%

Because of the unreliability of the “participant reported market share” and the “calculated market share based on reported sales” due to low sample sizes and inaccurate self-reported market share, the team believes that the HP breakdown weighted by Cadeo-estimated market share is the most reliable regional estimate of the three sets of HP distributions. This estimate is largely consistent with MSMA national data in that the majority of sales are concentrated in the first three HP bins in descending order. For future modelling considerations, the team believes that applying national MSMA values to the region is a reasonable approximation.

As discussed above, the team asked all participants to estimate their market share as part of the data collection firmographic questions. They then probed further in conversations for a deeper understanding of how participants developed these estimates. In general, the team found that market actors’ estimates did not align with market shares calculated based on their submitted data. The discrepancy between participant’s market share estimates and the market shares calculated from sales data suggests limited transparency in the market and likely that market actors have a limited scope of view into areas of the market they are not active in. When asking market actors about their market share, the team observed that participants were answering only about the specific markets they compete in, not the total industrial market. For example, they might assume they have a 40% market share, but they are only active in the non-durable food sectors of the industrial market and are not considering durable applications, like metal. This suggests that the project’s definition of “industrial” might not be the most useful terminology when speaking to market actors who section the market into smaller segments.

In addition to horsepower, the team also hoped to provide breakdowns of equipment sales by year, equipment efficiency, motor efficiency, industry, and to compare the characteristics of equipment sold with/without ASDs. However, they did not receive the quantity or quality of data required to report at this level of granularity.

Research Question 2: What percentage of relevant equipment is sold with ASDs?

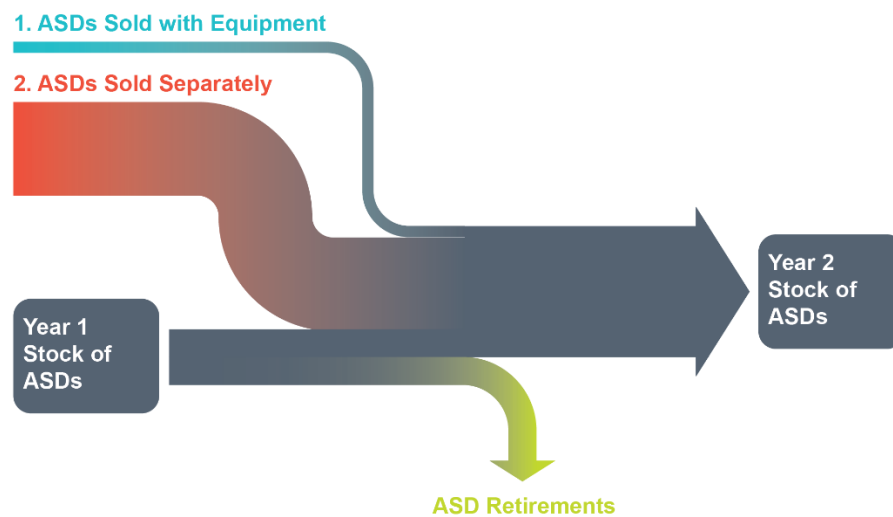
The pump and fan sales data collected from participating distributors through this research indicates that less than 1% of industrial pump and fan equipment sales are paired with ASDs. Although the collected data from this research is not sufficient to represent the entire regional industrial market, it does indicate that the portion of industrial equipment sold with ASDs is low.

Moreover, the number of ASDs sold by industrial pump and fan distributors is so small that the team contends the vast majority of ASDs are not sold with equipment but rather sold separately and paired with equipment at installation. Three participants who were asked about general market trends brought up an increase in ASD usage. Sales data for those participants, however, do not reflect an increase in ASD sales, further supporting the indication that ASDs are being sold separately from equipment serving the industrial sector.

In a previous research project, interviews with market actors covering all sectors (including commercial, industrial, agricultural, and residential sectors) identified that approximately 20% of all ASDs entering the region were sold with equipment.¹⁵ In contrast, this data collection project revealed that the subset of the ASD market serving the industrial sector is not sold with equipment.

Figure 4 illustrates the relative flow of ASDs entering the stock sold with equipment and sold separately from equipment for the industrial sector, noting the vast majority of ASDs are sold separately from equipment.

Figure 4: Relative Flow of ASD Sales into NW Industrial Market



This simplifies the supply chain for ASDs in the industrial market by eliminating one path to market, and means that if future researchers aim to characterize the sale of ASDs on industrial pumps and fans, data collection should focus on sales of ASDs sold separately from equipment. In the Recommendations section below, the team discusses potential ways to characterize this segment of the market.

This data collection effort also highlighted that ASD data tracking among market actors is widely variable. Many participants were not able to provide detailed ASD data or they were not able to match the drives to the equipment they were sold with. One struggle in analyzing the distributor data is that equipment and drives are separately coded because drives are not core to the business and are treated as an ancillary part. The team was able to count the total number of drive sales, but generally participants could not provide more detail than unit sales. Due to the small number of ASDs sold with equipment, the number of ASD sales from fan and pump distributors is highly variable year over year. One fan or pump distributor may double or triple their total ASD sales in a year if they have one large project. This inconsistency makes it difficult to establish sales trends for ASDs sold with equipment.

Findings on Industrial Sales Tracking

While the two research questions above were the main priority of this research, the team also made observations about how industrial pump and fan market actors track their sales data.

Among market actors, there are varying levels of data tracking, with some market actors able to provide every requested field, others who had only overall units and sales price, and still others who did not have central reporting systems. The level of data tracking appeared unconnected to firm size as there were small firms that tracked detailed data and large firms that could not provide both sales and product information. One large pump manufacturer (that declined to participate) stated that they “sell most of their equipment through a network of dealers and representatives, so it would be difficult to connect all the right databases to pull the final end user price plus the other fields of interest.” This sense that the data exist but in a format that is often too labor intensive to compile was pervasive with other potential participants as well. Given the research team’s experience collecting data in other markets, more exposure and familiarity with energy efficiency professionals/programs may increase market actors’ willingness and ability to track and share data.

“I would have to go back through my sales data line by line to add in HP, efficiencies, or VFD information. That’s just too much time”

– Distributor that declined to participate

Market actors typically did not have a central database and were unable to connect sales information with the detailed product specifications of interest to the team. Sometimes market actors included the model number in sales data, which the team used to identify equipment technical specifications (e.g., horsepower, efficiency, motor type). However, without a supporting data source for matching product specifications, this is a labor-intensive approach. Additionally, the model information included in sales data is often insufficient to match the equipment to a specific model (e.g., it may reference a model family, but not include information about the equipment size, details of the motor, or control strategies the equipment is sold with). To account for these challenges in future data collection the team may need to establish relevant product lists by either requesting lists from participants or web-scraping. In the case where model information is insufficient to match equipment, future researchers may need to follow up with participants to properly allocate those sales based on participant estimates.

Recommendations

A continued regional focus on energy efficiency for industrial motor driven systems will likely require additional data collection related to industrial fans, pumps, and ASDs. This section of the memo provides recommendations for future data collection based on findings and lessons learned from this project. Future data collection could inform one or both of the team's research questions, specifically how the stock and characteristics of industrial pumps and fans are changing over time, including insight into equipment paired with ASDs. For that reason, this section starts with a list of potential activities that could inform those research questions (Table 13) before ending with an additional set of tactical industrial sales data collection recommendations.

Strategic data collection approach

Sales data collected from fan and pump market actors in this research was able to inform the two research questions, but was not able to provide the level of confidence needed to fully answer them. The potential research activities listed in Table 13 could be conducted in tandem or singly to supplement existing knowledge.

Based on this data collection effort, collecting representative pump and fan sales data in the industrial sector could be challenging. Stock data collection could instead inform key variables needed for market modeling, providing an alternative path to characterizing the industrial fan and pump market. While stock information would provide good information on pumps and fans, a recurring data collection component would be needed to fully replace sales data collection.

For this reason, the team recommends investigating the feasibility of structuring a stock assessment as a longitudinal study to gather multiple years of data. The exact size and scope of the industrial stock assessment will vary based on future research needs, but to fully answer the two research questions of interest for this project the team recommends collecting, at a minimum, the variables listed in Table 2, including year, horsepower, efficiency, and presence of an ASD.

Table 13: Potential Data Collection Activities and Their Applicability to Research Questions

Data Collection Activity	Fan and Pump Information	ASD Information	Additional notes
Industrial Stock Assessment	<ul style="list-style-type: none"> Provides information on pumps and fans installed in a subset of industrial facilities in the region. Provides all key fan/pump metrics needed to characterize energy consumption (HP, equipment efficiency, install location, motor efficiency, and presence of ASD). 	<ul style="list-style-type: none"> Provides information on the number of ASDs installed from a sample of industrial facilities in the region. Provides information on the installation characteristics of ASDs (e.g., equipment ASD installed on, age of ASD, method of commissioning) that sales data cannot. 	<ul style="list-style-type: none"> A traditional stock assessment only collects information on one point in time. Depending on sampling approach, may not accurately capture recent installations. Stock assessments are large data collection projects that involve multiple regional stakeholders. Stock assessments are significantly more resource intensive than sales data collection efforts and put more of a burden on end users. To achieve regionally representative results, site sampling and attrition planning will be important to consider.
Motor and Drive Sales Data Collection (Manufacturers & Distributors)	<ul style="list-style-type: none"> <i>Not Applicable.</i> Motor and drive market actors do not have information on characteristics of fan and pump market. 	<ul style="list-style-type: none"> Directly characterize the number of ASDs entering the region every year. May know what type of equipment the ASDs are installed on. 	<ul style="list-style-type: none"> Interviews conducted by BPA in 2020 indicate that the number of actors in this market actor category is similar to that of pumps, representing a large and disaggregated market. There have been no sales data collection activities in this market before, increasing the uncertainty surrounding the data fields that these market actors could provide.
Installing Contractors Survey	<ul style="list-style-type: none"> Can speak to general trends in characteristics of fans and pumps installed in the region. May have data on pump and fan installations that can inform market size. 	<ul style="list-style-type: none"> Direct insight into the installation characteristics of ASDs in the region. Can address operational- and commissioning-specific questions May have data to inform ASD market size. 	<ul style="list-style-type: none"> Installing contractors are a disparate group of market actors. They have likely engaged with energy efficiency through utility incentive programs in the past. There is uncertainty surrounding the data fields that these market actors could provide.
Fan and Pump Sales Data Collection (work with manufacturers and distributors to track necessary data)	<ul style="list-style-type: none"> Market actors track quantity and price information but would need to begin tracking equipment specific information like HP, efficiency, model #, and presence of an ASD. Market actors need to begin tracking information in an easily exportable form, something that few currently do. 	<ul style="list-style-type: none"> <i>Not Applicable.</i> Fan and pump market actors do not sell significant numbers of ASDs with equipment. 	<ul style="list-style-type: none"> Allows the team to build on the relationships and work conducted through this project. Requires long-term investment to support market actors in tracking more information on their sales. Requires large investment from market actors to redesign their data tracking with little perceived return on investment for them.

Given the options listed above and their limitations, it is likely that no single activity can fully answer both research questions to a level of confidence needed for modeling without additional data sources for corroboration. This data collection effort highlighted a disconnect between the industrial pump and fan markets and the industrial ASD market that indicates significant challenges to collecting comprehensive information on these equipment and ASDs from a single source.

Tactical Industrial Sales Data Collection Recommendations

In closing, the team offers several additional notes about tactics that worked well, could have been done differently, or should be employed in the future when collecting data from industrial market actors.

Leverage relationships and warm leads whenever possible. This was a major factor in winning participants. Industrial market actors were not familiar or receptive to this energy efficiency research request, so having an existing connection was instrumental and necessary to facilitate data collection.

Partner with entities that have existing industry connections. HI and NEEA were instrumental in facilitating introductions during this research. A more direct industry group collaboration would likely increase participation. The team recommends exploring the possibility of combining future research with groups like HI, AMCA, NEEA, DOE, and others to facilitate more introductions and leverage deeper connections to ensure market actors carry through with delivering data.

Employ polite persistence with market actor follow up. Multiple rounds of follow up emails and calls were often necessary to ensure the request was fulfilled, even with participants who agreed to send data.

Anticipate market actors will provide data in different formats. Each market actor tracks data differently with varying infrastructure for exporting and sharing their data. For that reason, the team stressed that market actors could provide the data in whatever formats were most convenient to them. It was important to convey clearly to market actors which data fields were necessary, and which were “nice to have” since potential participants tended to decline upon hearing a data field they could not report or a format that looks unfamiliar. These tactics are key to ensuring the right data is collected in a method most convenient for market actors.

Incorporate a survey or condensed data request for market actors that cannot share detailed sales data. Many market actors immediately declined to participate when the team relayed its data request because of the heavy lift required to prepare a data export. Having a lighter lift option for these market actors was helpful. The team crafted this condensed data request to support answering the main research questions with a lower level of granularity than individual unit sales data but sufficient detail to accurately model the industrial fan and pump market). For example, the condensed data request grouped equipment sales into motor HP bins. Exact HP data would have been better, but HP information in bins would be granular enough for energy efficiency market modelers.

Use multiple value propositions simultaneously. Some participants wanted to help energy efficiency initiatives, some wanted to aid programs increasing VFD sales, some were interested in learning more about how their sales compare to the market, and others were interested in the financial incentive the team offered for the data. It was impossible to tell which of these value propositions were going to be important to each participant but offering all four in the outreach helped sway potential participants.

Build a long data collection timeline to help improve results. The team had two pump manufacturers agree to participate and then drop out in the final weeks because they could not get the data together in

time. These market actors did not have processes in place for a data request like this and a combination of factors made this request take longer than expected. Factors included low priority on the data team's agenda, lack of a central database for exporting, sensitivity with sharing sales data, and a lack of experience working with energy efficiency professionals. A long timeline would also help ensure the team had time to conduct multiple rounds of outreach—often to the same companies through different connections to identify a decision maker. The outreach time for this collection effort was three months, however the team recommends five or more months in future research to account for multiple rounds of outreach and to provide companies additional time to work through challenges.

Rethink how to define the market for market actor outreach. The team observed that market actors tended to think specifically about their areas of competition and competency when asked about market size and share. This led to a wide range of unreliable responses and suggests that the project's definition of "industrial" might not be the most useful terminology when speaking to market actors who section the market into smaller segments. In future data collection efforts, the team recommends communicating the sector scope in terms of the facility types (or building types) included, as opposed to using generic terms like "industrial" or "commercial".

Develop relevant product lists to support data supplementation. Future efforts that rely on sales data collection should account for the sparsity of product details most market actors can provide for their sales. Developing a relevant product list through participant requests or web-scraping could support creating a more robust dataset.

Appendix A: Market Characterization Sources

This section provides additional detail on the team's initial market characterizations and calculations of fan and pump market size.

Table 14: Data Sources for Pump Sales Estimate

Data Source	Link	Notes
DOE's Energy Conservation Standard Rulemaking Framework Document for Commercial and Industrial Pumps	https://www.regulations.gov/document/EERE-2011-BT-STD-0031-0013	Rotodynamic pumps make up 70% of industrial sales by value DOE's proposed scope of coverage (from the Framework Document) accounts for 30% of industrial pump sales by value (inclusive of both rotodynamic and positive displacement pumps)
Hydraulic Institute's 2012 pump shipments covering DOE's Framework Document Scope	https://www.regulations.gov/document/EERE-2013-BT-NOC-0039-0068	
US Census MA333P: Pumps and Compressors	https://www.census.gov/data/tables/time-series/econ/cir/ma333p.html	

Assumptions used in pump sales (units) estimates:

- The distribution of pumps by sector in DOE's final scope (~33% to industrial) is consistent to the distribution of pumps by sector in the scope proposed in the Framework Document (the final scope includes 5 of the 9 pump classes of the original scope).
- The average price per unit of pumps identified in HI's 2012 pump shipments is roughly equivalent to the average price per unit of industrial pumps not included in that document.
- The shipments of industrial pumps to the NW can be reliably estimated using the ratio of industrial water used in the Region to the national industrial water use.

Table 15: Data Sources for Fan Sales Estimate

Data Source	Link
DOE's Fans and Blowers NODA 3 Life Cycle Cost Assessment	https://www.regulations.gov/document?D=EERE-2013-BT-STD-0006-0190
DOE's Fans and Blowers NODA 3 National Impact Analysis	https://www.regulations.gov/document/EERE-2013-BT-STD-0006-0192
Confidential anonymized information on 2012 fan shipments	Confidential

Assumptions used in fan sales (units) estimates:

- The distribution of embedded vs. standalone fans covered by DOE's regulation (within the industrial & commercial) is representative of the industrial market.
- DOE's 2012 NODA3 distribution of fan shipments to the NW is representative of the current fan market.
- The shipments of industrial fans to the NW can be reliably estimated using the ratio of manufacturing output in the region to the national manufacturing output.