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Fan Manufacturer Regional Market Share Research

Prepared For NEEA:
Chris Cardiel, Sr. MRE Scientist

Prepared by:
Christopher Dyson, Principal Consultant
Mersiha McClaren, Director

DNV Energy Insights, Inc.
621 SW Morrison Street
Suite 500
Portland, OR 97205

Northwest Energy Efficiency Alliance
PHONE
503-688-5400
EMAIL
info@neea.org

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1 EXECUTIVE SUMMARY

1.1 Background

The primary purpose of this study is to inform the design and development of the Northwest Energy Efficiency Alliance's (NEEA's) Efficient Fans Program. This program is designed to influence the regional fan system market with a focus on accelerating adoption of stand-alone or non-embedded efficient fan systems (i.e., those that are not embedded in packaged equipment). The primary objectives of this research were to:

1. Develop a list of fan system manufacturers active in the alliance's four-state region (Idaho, Montana, Oregon, and Washington).
2. Assess the total size and general nature and composition of the regional fan system market with regard to total units sold annually, as well as annual sales by sector, state, horsepower bin, Fan Energy Index (FEI) rating, and presence and type of variable-speed drives or motor controls.
3. Determine the regional market share, in terms of annual units sold, of each of the fan system manufacturers identified as being active in the region.

The study kicked off on June 24, 2022 with data collection completed in November 2022 and data analysis finished in December 2022.

1.2 Methodology and Fan Manufacturer Database

The DNV study team completed in-depth phone interviews with five fan manufacturers and conducted a partial interview with a sixth manufacturer which also provided sales data.[1] This fulfilled a Northwest Energy Efficiency Alliance (NEEA) request to complete high-quality interviews with 5–8 fan manufacturers who are major players in the NEEA region.

Prior to conducting interviews, the DNV study team created a fan manufacturer database that served as the sample frame for these six manufacturer interviews. The team developed the database from lists of fan manufacturers generated through three recent fan market studies, as well as publicly available information on the Air Movement and Control Association International, Inc. (AMCA) website.[2] The team supplemented these four source lists with information from the Zoominfo Business-to-Business (B2B) database as well as other online research.

The study team prioritized the fan manufacturers interviews using a five-point system where a manufacturer received one point for each mention in one of the four source lists and an additional point if DNV had completed an interview with them for a 2021 NEEA fan market study.[3] The body of the report contains additional methodological details including the topics which the manufacturer interviews covered.

1.3 Key findings

The following are the study's key findings (note that findings related to sales volume and market share refer to dollar value, as opposed to unit quantity):

[1] One interview covered sales for a manufacturer that was originally counted as two separate manufacturers in the manufacturer database. The study team learned that one of these manufacturers was a wholly-owned subsidiary of the other, even though both manufacturers sold fans under different brand names and had separate sales divisions. Because this sixth manufacturer provided the study team with actual sales data, the team was able to answer most of the researchable questions from these sales data. The team supplemented this information with a short interview and follow-up email queries.

[2] AMCA FEI certified product finder

[3] Northwest Energy Efficiency Alliance (NEEA) | Commercial & Industrial…

- *The non-embedded commercial, industrial, and agricultural (C/I/A) fan market in the NEEA region is very diverse:* The average market shares of the non-embedded C/I/A fan market in the NEEA region by geography, market sector, motor size, FEI certification, and variable-frequency drive (VFD)/control pairings which appear in this Executive Summary mask a great diversity in the market shares of individual manufacturers, as shown in the report body.
- *The four-state NEEA region accounted, on average, for 6–9% of the total 2021 U.S. sales of non-embedded fans used in C/I/A applications.*[4] However, for one manufacturer the four-state NEEA region accounted for as much as 20% of their national sales.
- *Washington's market share represented more than half of the NEEA region's non-embedded C/I/A fan sales:* Washington's 56–58% share of 2021 non-embedded C/I/A fan sales was larger than the market shares of the other three NEEA states combined.
- *Although on average, the commercial sector accounted for almost half of the non-embedded C/I/A fans sold in the NEEA region, the market sector distribution varied significantly for individual manufacturers.* The commercial sector has the largest market share (46%–62%) in the NEEA region followed by the industrial sector (34–35%). However, when the team looked at manufacturer-specific NEEA region non-embedded C/I/A sales by market sector it told a more complicated story. The commercial sector was the largest sector for only three of the interviewed manufacturers. For two of the manufacturers the industrial sector was their largest sector and for the remaining manufacturer the institutional sector – primarily large fans for university laboratories and wastewater treatment facilities – was the largest sector.
- *Similarly, although a large majority of the non-embedded C/I/A fans sold in the NEEA region were in the smallest two fan size bins on average, the fan size distribution varied substantially among individual manufacturers.* The average percentage of fans in the smallest two fan bins (including horsepower from 0.7 to 2.8 kW) ranged from 55% (straight average) to 84% (sales-weighted average).[5] However, as discussed in more detail in the body of the report, the fan size mixes of the manufacturers were more variable than the average shares would indicate. For example, two of the manufacturers reported having the large majority of their sales in Power Bin 1 (0.7 to 1.4 kW), two others said that all or most of their sales were in Power Bins 2–4 (spanning 1.4 to 11.2 kW), and the fifth manufacturer reported most of their sales in Power Bins 5–7 (spanning 11.2 to 89.6 kW).
- *The manufacturers estimated, on average, that 60–67% of their fans sold were FEI certified.* However, as was the case with market sector and fan size, there was wide variation in the percentage of FEI-certified fans that the manufacturers reported. When the study team asked the manufacturers why some of their fans were not FEI-certified, they mentioned factors such as price competition in the commercial fan markets, some of their smaller fans not being designed for FEI certification, and the use of a European certification that has similar specifications to the U.S.-based AMCA certification.
- *The manufacturers estimated, on average, that 33–57% of their fans were sold with VFDs and an additional 21–26% had some type of non-VFD control – mostly consisting of fans with electronically commutated (EC) motors.* Two of the six manufacturers said that they did not know what percentages of the fans they sold were integrated with VFDs or other controls. Both reported that most VFDs or other controls were added to their fans downstream either by their manufacturer representatives or by end use customers. However, one of these two manufacturers speculated that the

[4] This NEEA region market share was 6% based on a sales-weighted average and 9% based on a straight average. All subsequent ranges in this report are made up of these two averages. The sales weights were based on self-reported sales revenues which we collected from all but one of the manufacturers. For this last manufacturer we estimated their annual revenue based on the following information: 1) the manufacturer's reported volume of non-embedded fans for 2021; 2) the manufacturer's reported distribution of these 2021 non-embedded fan sales by horsepower bin, and 3) sales data from another manufacturer which provided average sales prices for fans in different horsepower bins.

[5] The weighted average is much larger than the straight average because the largest fan manufacturers specialize in these smaller fans.

vast majority of their fans were likely paired with VFDs downstream due the size of their fans, their typical applications, and the reduced costs of VFDs*:*

1.4 Conclusions and Considerations

The findings summarized above lead to the following conclusions and recommendations.

- *The interviewed fan manufacturers likely account for the large majority of the fan sales in the NEEA region.* As noted, the study team targeted the fan manufacturer interviews based on how frequently recent Northwest fan studies listed a given manufacturer on their target lists. Of the seven manufacturers who appeared most frequently on those study target lists, this study completed interviews with five of them. There was a significant drop-off in the NEEA region sales volume between the five-point manufacturers and the three- or four-point manufacturers.[6] This suggests that the lower rated manufacturers that DNV did not interview do not have significant sales volumes in the NEEA region. Finally, conversations with NEEA staff and the study's online research also indicated that the completed interviews were with the "major players" in the Northwest fan market.
- *The NEEA Efficient Fans Program has the opportunity to match the diverse nature of the non-embedded C/I/A fan market in the NEEA region through intentional program design choices.* The study shows that some fan manufacturers active in the NEEA region specialize in smaller fans while others focus on larger fans. Some manufacturers focus on the commercial sector while others target the industrial or institutional sectors. Two manufacturers pair the vast majority of their fans with VFDs, two manufacturers pair less than a third of their fans with VFDs, and two manufacturers leave the pairing of VFDs with their fans to manufacturer representatives or customers. There is also great variation in the frequency of FEI certification among the manufacturers. This diversity will complicate the marketing and delivery of NEEA's Efficient Fans program because it limits "one-size-fits-all" strategies.
- *There are opportunities to increase the incidence of FEI-certified fans, but financial incentives may be needed to move the market:* For four of the six manufacturers active in the NEEA region, the average share of FEI-certified fans is only 40%, and this represents an opportunity for the NEEA Efficient Fans Program. However, the fan manufacturer interviews indicated that most non-FEI-certified fans were smaller fans used in commercial applications that face significant price competition. So, this would suggest that the NEEA program may want to introduce upstream/midstream incentives to reduce the price barriers of the more efficient fans in these smaller power bins.

[6] The Methodology section of the report explains this scoring system.

2 STUDY DESCRIPTION AND FINDINGS

This section of the report describes the background, design, and detailed findings of the fan manufacturer regional market share research.

2.1 Background

The primary purpose of this study is to inform the design and development of the Northwest Energy Efficiency Alliance's (NEEA's) Efficient Fans Program. This Program is designed to influence the regional fan system market with a focus on accelerating adoption of efficient stand-alone or non-embedded fan systems (i.e., those that are not embedded in packaged equipment). The primary objectives of this research were to:

1. Develop a list of fan system manufacturers active in the alliance's four-state region (ID, MT, OR, and WA).
2. Assess the total size and general nature and composition of the regional fan system market with regard to total units sold annually, as well as annual sales by sector, state, horsepower bin, Fan Energy Index (FEI) rating, and presence and type of variable-speed drives or motor controls.
3. Determine the regional market share, in terms of annual units sold, of each of the fan system manufacturers identified as being active in the region.

The study kicked off on June 24, 2022 with the study workplan, manufacturer database, manufacturer interview guide, and manufacturer recruitment script guide all completed in the July–August 2022 period. The study team conducted its first fan manufacturer interview in September 2022 with interviews continuing through November 2022. DNV received access to the sales data from one of the manufacturers in early December 2022.

2.2 Methodology and Fan Manufacturer Database

The study team completed in-depth phone interviews with five fan manufacturers and conducted a partial interview with a sixth manufacturer which also provided sales data. This fulfilled a NEEA request to complete high-quality interviews with 5–8 fan manufacturers who are major players in the NEEA region.

Prior to conducting interviews, the DNV study team created a fan manufacturer database that served as the sample frame for these six manufacturer interviews. The database was developed from lists of fan manufacturers generated through earlier studies fielded by NEEA and regional utility stakeholders, complemented by a publicly available list of FEI-certified fan manufacturers made available by AMCA. Some of these source lists provided information on key contacts while others only provided the manufacturer names. The team supplemented these four source lists with information from the Zoominfo B2B database as well as other online research.

The study team produced three lists for the manufacturer database:

1) *All Manufacturers:* This was a list of 60 fan manufacturers who appeared on at least one of four above-mentioned source lists
2) *Regionally Active Manufacturers:* This was a subset of the All Manufacturers list which included 47 fan manufacturers who were active in NEEA's four-state region. The study team determined the regional activity of manufacturers based on their listing in the sample frames of prior studies of the Northwestern fan market, on generic online research, and on queries in the Zoominfo database (which provided not only office locations but also employee counts).

3) *Short List of Major Manufacturers:* This was a subset of the Regionally Active Manufacturers list which included 13 fan manufacturers who were active in the NEEA region, and which had been mentioned in at least two of the four source lists[7]

The All Manufacturers and Regionally Active Manufacturers lists provided contact information and company information such as annual revenue, product brands, and AMCA FEI certification. The Short List of Major Manufacturers provided a prioritization list for the target interviews.

The study team prioritized the 13 fan manufacturers in the Short List of Major Manufacturers using a five-point system whereby a manufacturer received one point for each mention in one of the four source lists and an additional point if DNV had completed an interview with them for the 2021 NEEA fan market study. Table 1 breaks down these manufacturers by how many points they scored on the 5-point scale. NEEA instructed the study team to target fan manufacturers with three or more points. The table shows that the team completed interviews for all four of the 5-point manufacturers, one of the 4-point manufacturers, and two of the 3-point manufacturers. One of the 4-point manufacturers refused the interview, and the study team was unable to contact representatives of the remaining 4-point or 3-point manufacturers.

Table 1: Sample Frame and Disposition for Major NEEA-Active Fan Manufacturers

Scores on Short List of Major Manufacturers	# of Major Manufacturers with Score	# of Major Manufacturers with Completed Interviews
5-point scores	4	4*
4-point scores	3	1
3-point scores	4	2*
2-point scores	2	None attempted
Total	**13**	**7**

* As noted, one interview covered sales for a manufacturer that was originally counted as two separate manufacturers (one 5-point manufacturer and one 3-point manufacturer) in the manufacturer database.

The interview guide, provided in Appendix A, covered the following topics.

- *Interviewee and company information:* The interview guide included questions about the interviewee's job title and responsibilities as well as the number of employees at the office where they worked.[8]
- *Defining the relevant fan types:* The guide ensured that the interviewees understood that their market share estimates should be limited to non-embedded fans that are used in C/I/A applications.
- *Geographic distribution of fan sales:* The guide included questions about the volume and distribution of the manufacturers' non-embedded fan sales across the four-state NEEA region.

[7] One potential limitation of the sample design employed in this study is that the source documents may have included variously narrow foci that could have excluded mention of larger manufacturers that did not reflect the research objectives of those studies. While reliance on only one or even two of these sources could raise concerns about source bias, the manufacturers with whom DNV completed interviews were cited in 3-4 sources and this diversity of sources (and research foci) should mitigate these source bias concerns. In addition, the volume of self-reported regional fan sales dropped significantly from the 5-point manufacturers to the 3-4 point manufacturers, providing some measure of evidence that study respondents represented major market players rather than being selected for inclusion on the basis of biased sources.

[8] Due to the impacts of the COVID-19 pandemic, many interviewees were working from their home offices therefore complicating the definition of their local office.

- *Market sector:* The guide covered the distribution of the manufacturers' non-embedded fan sales across the industrial, commercial, agricultural and other nonresidential sectors.
- *Fan size:* The guide included questions about the distribution of the manufacturer's non-embedded fan sales across different power bins.
- *FEI:* The guide covered what percentage of the manufacturer's non-embedded fans were FEI-certified products and possible barriers to FEI certification.
- *Variable-frequency drives (VFDs) and other motor controls:* The guide covered what percentage of the manufacturer's non-embedded fans were sold with VFDs or other motor controls, which brands were typically chosen for these controls, and reasons for adding these controls.

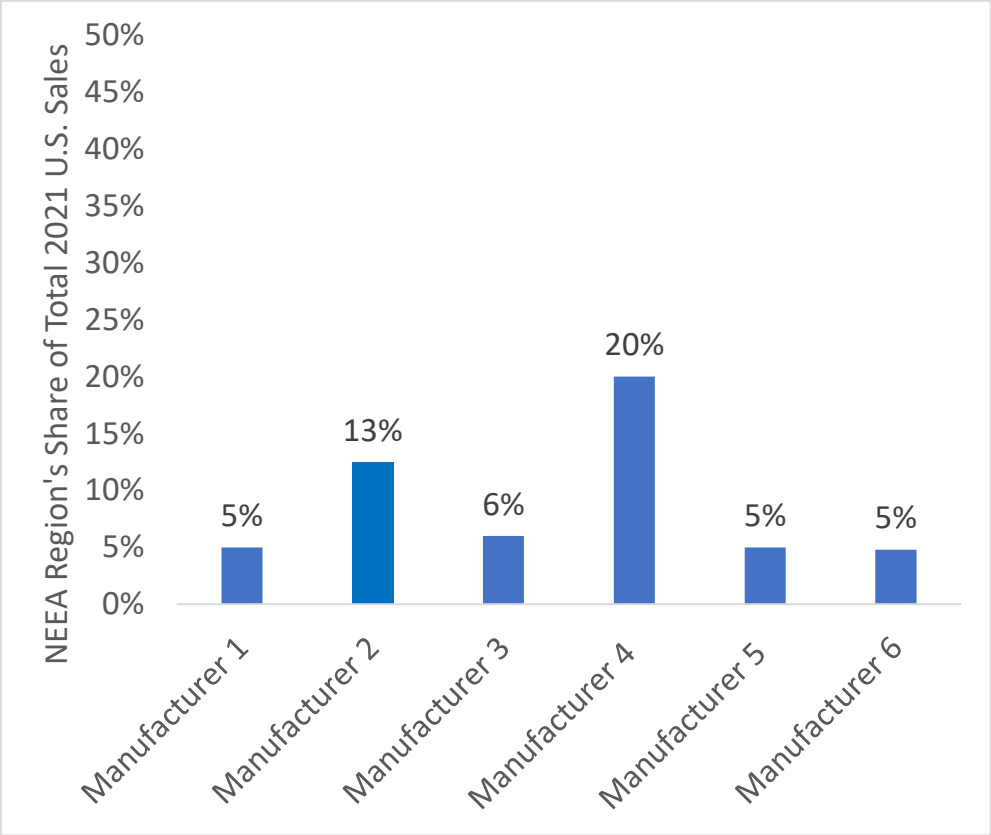
In most instances, DNV sent the interview guide to the interviewees before the interview so they could provide more data-based information. As noted, one interviewee provided DNV with sales data, while others referenced their sales data while providing market share information in the interviews. Besides analyzing the interview responses, the study team also analyzed the detailed sales data from the one manufacturer who provided these.

2.3 Regional Market Share and Geographic Distribution of Non-Embedded C/I/A Fan Sales

The study team asked the fan manufacturers whether they sold non-embedded C/I/A fans in the four-state NEEA region. All the manufacturers reported sales of these products in the region. (Note that all calculations of sales volume and market share outlined in the following pages refer to volume and share by dollar value, as opposed to unit quantity.)

The team asked the manufacturers what percentage of their total U.S. sales of non-embedded C/I/A fans were represented by sales in the four-state NEEA region. The straight average regional market share was 9% and the sales-weighted average regional market share was 6%. However, Figure 1 shows that for one manufacturer the four-state NEEA region accounted for 20% of their national sales.

Figure 1: NEEA Region Non-Embedded C/I/A Sales as a % of Total U.S. Sales



The team then asked the fan manufacturers how their sales of these fans in the region were distributed across the four states.

Figure 2: Distribution of Non-Embedded C/I/A Fans Sales by State

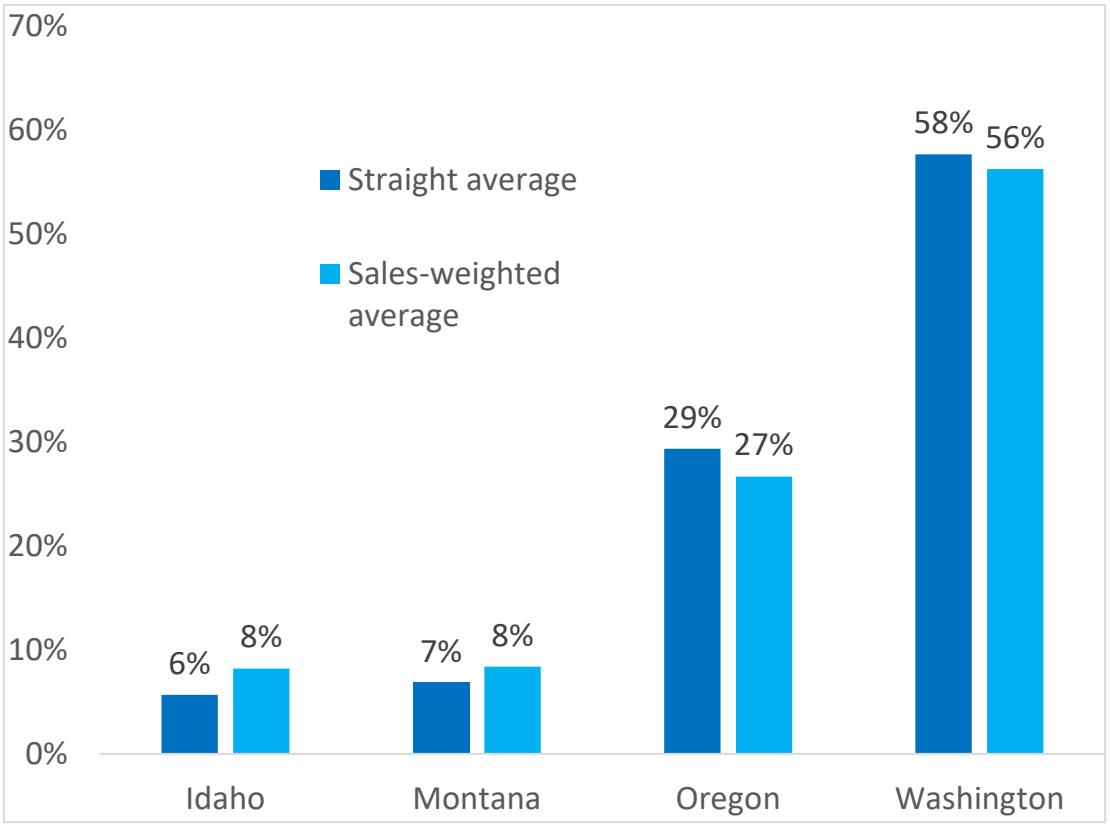


Table 2 shows that they reported, on average, that over half (56-58%) of their fan sales were in Washington with Oregon having a market share half as large (27–29%). The manufacturers estimated only single-digit market shares for Montana (7–8%) and Idaho (6–8%).

Table 2: Distribution of Non-Embedded C/I/A Fans Sales by State

Company	Idaho % of Total NEEA Region Sales	Montana % of Total NEEA Region Sales	Oregon % of Total NEEA Region Sales	Washington % of Total NEEA Region Sales
Manufacturer 1	10%	20%	30%	40%
Manufacturer 2	0%*	0%*	60%	40%
Manufacturer 3	6%	7%	11%	76%
Manufacturer 4	5%	5%	30%	60%
Manufacturer 5	3%	6%	8%	80%
Manufacturer 6	10%	3%	37%	50%
Straight average	**6%**	**7%**	**29%**	**58%**
Sales-weighted average	**8%**	**8%**	**27%**	**56%**

*Manufacturer said that sales in these states were near zero, but not zero.

The fan manufacturers cited several reasons why their fan sales were higher in Washington and Oregon compared to the other NEEA states including:

- The higher urban population density in Washington and Oregon
- The greater prevalence of high-rise buildings in Washington and Oregon
- An expanding cannabis market in Oregon driving fan installations for related agricultural facilities

2.4 Market Sector Distribution of Non-Embedded C/I/A Fan Sales

The study team asked the fan manufacturers about the distribution of their 2021 non-embedded C/I/A NEEA-region fans sales in the four-state NEEA region across the commercial, industrial, and agricultural market sectors. Figure 3 shows that the commercial sector was the largest sector, especially when based on the sales-weighted averages. However, when the team looked at manufacturer-specific NEEA region non-embedded C/I/A sales by market sector (Table 3), they told a more complicated story. This table shows that the commercial sector was the largest sector for only half of the interviewed manufacturers. For two of the manufacturers the industrial sector was their largest sector and for the remaining manufacturer the institutional sector – primarily large fans for university laboratories and wastewater treatment facilities – was the largest sector.

Figure 3: Average NEEA Region Non-Embedded C/I/A Sales by Market Sector

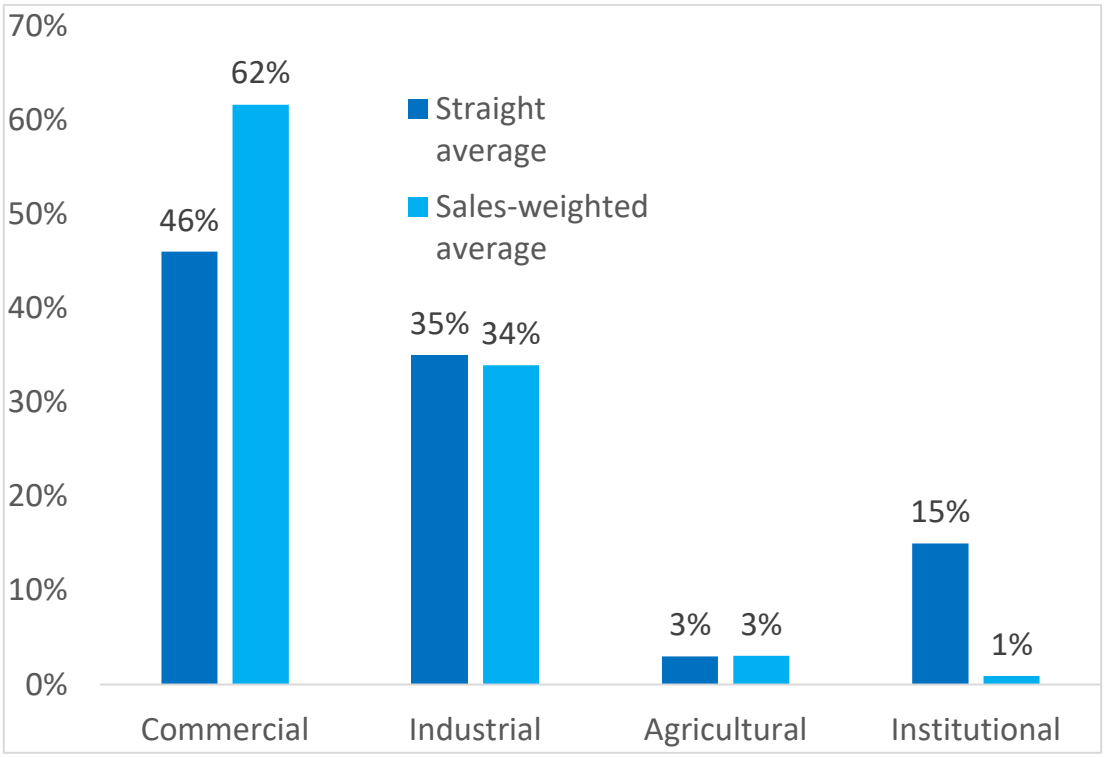


Table 3: Manufacturer-Specific NEEA Region Non-Embedded C/I/A Sales by Market Sector

Company	Commercial Sector	Industrial Sector	Agricultural Sector	Institutional Sector
Manufacturer 1	10%	87%	3%	0%
Manufacturer 2	10%	70%	20%	0%
Manufacturer 3	75%	20%	5%	0%
Manufacturer 4	80%	15%	5%	0%
Manufacturer 5	10%	0%	0%	90%
Manufacturer 6	89%	11%	0%	0%
Average	**46%**	**35%**	**6%**	**15%**
Sales-weighted average	**62%**	**34%**	**3%**	**1%**

Some manufacturers provided examples of the types of subsectors within these major sectors in the NEEA region that frequently use non-embedded fans. For the industrial sector, these subsectors included:

- Processing plants for meats and vegetables (e.g., french fry processing)
- Pulp and paper production

- Wastewater treatment
- Marine applications (e.g., providing supply and exhaust combustion air for the engines on both commercial and passenger fleets)

For the commercial sector, the manufacturers identified the lodging, retail, pharmaceutical, commercial real estate, data center, and bitcoin mining subsectors as significant users of non-embedded fans. They also included fans used in multifamily buildings as part of this commercial sector. One fan manufacturer said that relatively inexpensive power in the Northwest has attracted both bitcoin mining and data centers – both big users of non-embedded fans – to the region. This manufacturer identified bitcoin mining as an opportunity for improving fan efficiency:

> *I would say that across the country now, a very popular method of bitcoin mining is taking a van, like that you would see on a tractor trailer, a 50-foot van, and putting servers in that van, cutting holes in it, and putting our prop fans or maybe centrifugal fans and hooking that up to that in the middle of the hinterland … all that power is on the grid, and that has to be a big load. And that would be a place to look for, for efficient fans.*

For the agricultural sector, common non-embedded fan applications in the NEEA region included ventilation in greenhouses used for cannabis production, cooling for cows and other animals, and ventilation for storage of vegetables such as potatoes and onions.

It is worth noting there were small differences or uncertainties as to how the manufacturers defined specific subsectors. For example, one manufacturer defined wastewater treatment as an industrial application while another assigned it to the institutional sector. Similarly, one manufacturer defined the school subsector as being part of the commercial sector while another assigned it to the institutional sector. There was also uncertainty as to whether to assign bitcoin mining to the commercial or industrial sectors (the percentages in Table 3 reflect the assignment of bitcoin mining to the commercial sector).

2.5 Motor Size Distribution of Non-Embedded C/I/A Fan Sales

The study team asked the fan manufacturers about the distribution of their 2021 non-embedded C/I/A NEEA-region fans sales by fan size. Five of the six interviewed manufacturers provided either sales data or sales estimates for this breakdown. Table 4 shows how these five manufacturers estimated the distribution of their NEEA-regional non-embedded C/I/A fan sales by fan size bin. On average, the majority of the estimated fan sales were in the smallest two fan size bins. In these size bins, the weighted average is much larger than the straight average because the largest fan manufacturers specialize in these smaller fans. However, the table also shows differences in the distribution of fan sizes among the individual manufacturers. Two of the manufacturers reported having the large majority of their sales in Power Bin 1, two others said that all or most of their sales were in Power Bins 2–4, and the fifth manufacturer reported most of their sales in Power Bins 5–7.

The fan manufacturers also mentioned the types of customers or applications which would use the bigger fans. These included wastewater treatment facilities, data centers and university laboratories.

Table 4: Manufacturer-Specific NEEA Region Non-Embedded C/I/A Sales by Fan Size[9]

Pwr. Bin	HP Range (kW)	Manuf. 2	Manuf. 3	Manuf. 4	Manuf. 5	Manuf. 6	Average	Weighted Average
1	**Up to 1.4 kW**	0%	68%	25%	0%	86%	**36%**	**72%**
2	**1.4 to 2.8 kW**	47%	15%	25%	0%	7%	**19%**	**12%**
3	**2.8 to 5.6 kW**	47%	9%	20%	5%	3%	**17%**	**8%**
4	**5.6 to 11.2 kW**	5%	3%	20%	5%	3%	**7%**	**3%**
5	**11.2 to 22.4 kW**	0%	2%	10%	20%	1%	**7%**	**2%**
6	**22.4 to 44.8 kW**	0%	2%	0%	30%	0%	**6%**	**1%**
7	**44.8 to 89.6 kW**	0%	1%	0%	30%	0%	**6%**	**1%**
8	**89.6 to 179.2 kW**	0%	0%	0%	10%	0%	**2%**	**0%**
9	**179.2 to 358.4 kW**	0%	0%	0%	0%	0%	**0%**	**0%**
	Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

2.6 FEI Rating Distribution of Non-Embedded C/I/A Fan Sales

The study team asked the fan manufacturers to estimate what percentage of their 2021 non-embedded C/I/A were FEI-certified. The manufacturers estimated, on average, that 60-67% of their fans sold were FEI certified. However, as Figure 4 shows, there was wide variation in the percentage of FEI-certified fans that the manufacturers reported.

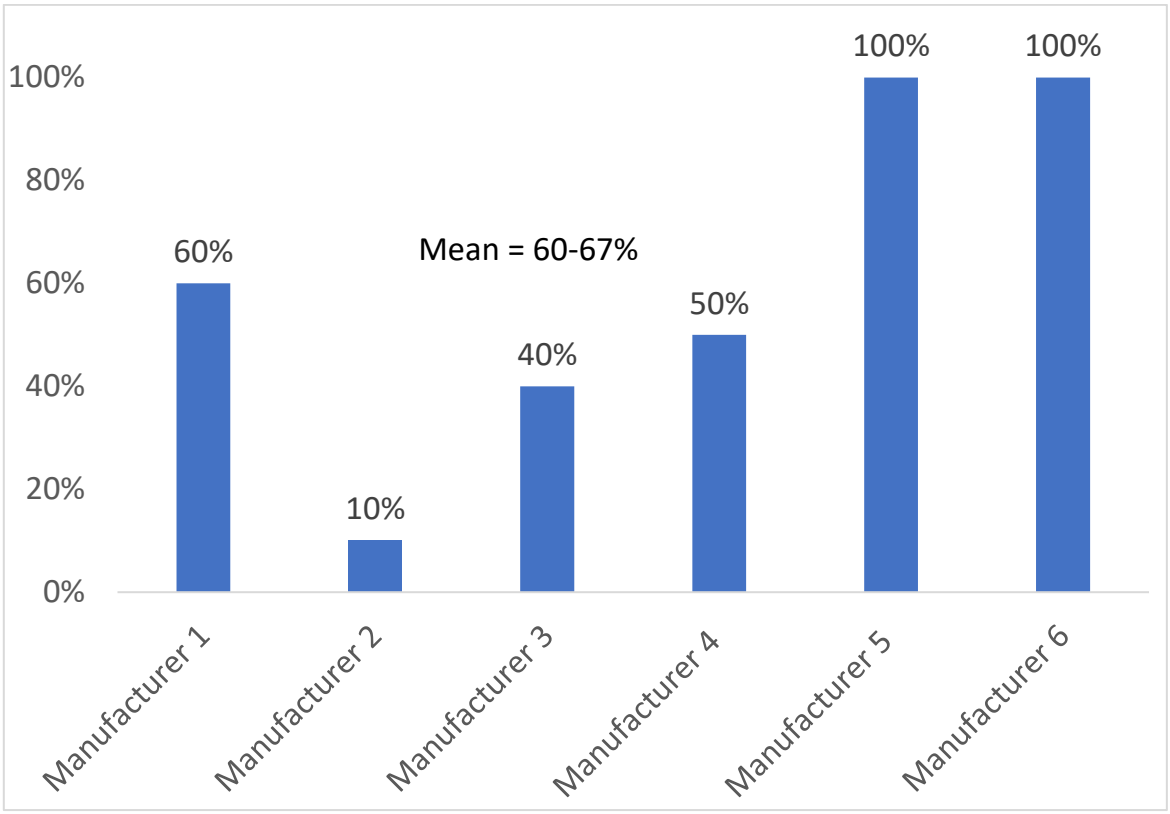
The team asked the fan manufacturers who had reported less than 100% of their fan sales as being FEI-certified why all their fans were not FEI-certified. They cited various reasons including:

- *Price competition in the commercial fan markets:* "In the commercial market specifically, there's no value selling [FEI-certification]," said one manufacturer. "It's a price-based market. …. However, for industrial, typically, we can [sell the FEI certification] because we can run an easier ROI and show them: 'Hey, this is what we're saving here.'"
- *Smaller fans not designed for FEI certification:* "If there are exceptions to the FEI … that's [Brand X] our brand for a ceiling fan … [as used] in a restroom or a conference room," said one manufacturer. "And my current understanding is that's an exception and exemption from the FEI, … that specifically those small ceiling fans are not part of the FEI program."[10]"
- *Using a European standard:* One manufacturer said that they produce their fans in Europe and that they use a European certification that has similar specifications to the U.S.-based AMCA certification. This company is working to get their products AMCA-certified.

[9] As noted, Manufacturer 1 did not provide estimates for the breakdown of their fan sales by horsepower bin.

[10] In reviewing a prior version of this report one member of the NEEA staff observed that "Ceiling fans may be regulated separately and have their own test procedure and standard under DOE: Appliance Standards Rulemakings and Notices (energy.gov). They also have their own CFEI metric."

Figure 4: % of NEEA Region Non-Embedded C/I/A Sales That Are FEI-Certified



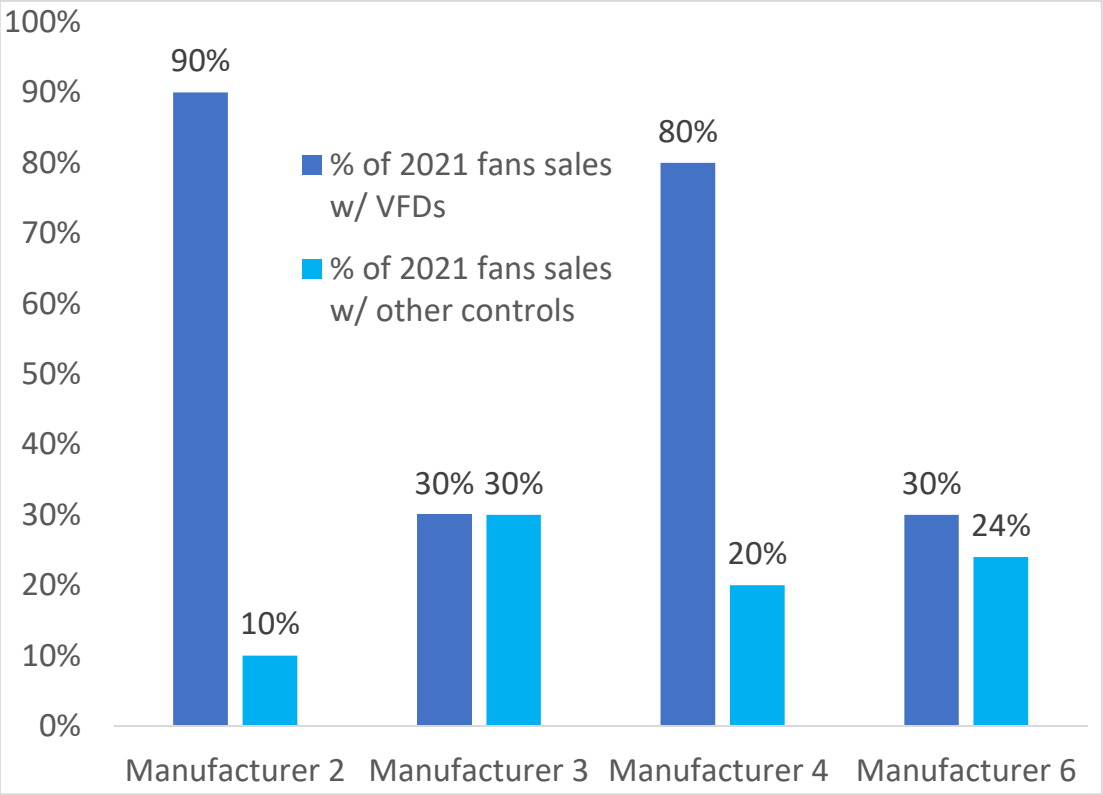
The study team also asked the fan manufacturers about their most common types of FEI-certified fans. Some generalized these broadly as being fans used in industrial applications. Others named specific fan types such as curb-mounted upblast and downblast centrifugal fans, curb-mounted upblast kitchen grease exhaust fans, square inline fans above a ceiling, and high plume dilution centrifugal fans often used in laboratories.

2.7 VFDs and Other Fan Controls

The study team asked the fan manufacturers what percentage of the C/I/A fans they sold in 2021 in the NEEA region were integrated and sold with VFDs or with controls systems other than VFDs. Four of the six manufacturers provided estimates. Due to the large sales weights of the manufacturers who specialize in smaller motors, the sales-weighted average of VFD-controlled fans was much lower (33%) than the straight average (58%). On average, the manufacturers estimated that 21-26% of their fans had some type of non-VFD control – mostly consisting of fans with EC motors.

However, Figure 5 shows some variation among the fan manufacturers, with two selling all their fans with some sort of control and the other two selling slightly over half their fans with controls. Fan size was the primary explanatory factor for these differences. The latter two manufacturers sold primarily smaller fans (e.g., Power Bin 1).

Figure 5: % of NEEA Region Non-Embedded C/I/A Sales That Have VFDs or Other Controls



The two remaining manufacturers said that they did not know what percentages of the fans they sold were integrated with VFDs or other controls. Both reported that most VFDs or other controls were added to their fans downstream either by their manufacturer representatives or by end use customers. However, Manufacturer 5 speculated that the vast majority of their fans were likely paired with VFDs downstream due the size of their fans, their typical applications, and the reduced costs of VFDs:

> *The large proportion of work [for our fans] goes into labs and universities … and whenever we have to select the direct-drive motor … I would say 98%, 95% of the time, we are stipulating that it is controlled with a VFD. I mean, VFDs are so cheap now. ... So, I would be surprised if there was anybody, unless it's a really small motor …. down on the lower end, but anything over a 20-horsepower motor, I think, today, will have a VFD on it.*

One manufacturer noted that customers often prefer that the fan be sold without the VFD already paired. "Usually what's happening is a customer is buying an alternating current (AC) product from us and then integrating it into whatever VFD system they had set up or … pushing it into whatever [application] they're trying to manipulate onsite for that project," he said. "So usually, we're still just only selling the fan."

Another manufacturer reported promoting their EC motor products over VFD pairings:

> *We don't play well in any kind of VFD work just because our EC motors don't utilize that … they utilize a business management system, and everything is integrated through the fan electronics. … And that's a big selling point on our product is that everything is compact and smaller now. You don't need all that extra room for the VFDs and all the wiring and all that extra equipment. So potentially, you're saving money. … And we can basically design our product in and calculate when they're going to see their ROI on their product and investment.*

The study team asked the manufacturers what types of VFDs, or other motor controls, were most frequently paired with the fans they sold. They named ABB, Allen-Bradley, Danfoss, Invertek, Schneider, Square D, TECO, and Yaskawa as VFD brands that they, or their manufacturer reps, often paired with their fans. None of the manufacturers said that they made their own VFDs. For the non-VFD controls, the manufacturers named some of the same companies listed above for VFDs. However, some manufacturers reported that they did develop electronic drives for their smaller fans in-house. One manufacturer mentioned using pulse-width modulation (PWM) drives on their induction or ferrite-assisted synchronous reluctance motors and integral speed control or remote speed dials for their brushless DC motors.

The team also asked the fan manufacturers what factors influenced the pairing of VFDs or other motor controls with the fans they sold in 2021. The factors they cited included:

- *Reduced costs and simplification of maintenance:*
    - "VFD is the new technology to influence speed and adjustability in the fan, it used to be variable midshaft," said one manufacturer. "The [VFD] sell point for us is essentially less maintenance. … So if you brought a VFD, you're removing some … of your shortest lifespan parts on a fan …. you're removing a set of bearings. You're removing a shaft. You're removing belts and pulleys, so it's just less parts to maintain."
    - "With the VFD or EC motor, what's driving [their adoption] is going toward direct drives as opposed to belt drives," said another manufacturer. "By getting rid of the belts, then you get rid of the fan shaft bearings. So the belts and the motor, the fan shaft bearings and the belts are sources of frustration because you need to maintain them, and people don't want to maintain them."
- *Increased energy efficiency, reduced drive loss:*
    - "So going from the motor shaft to the fan shaft … , [with the] pulleys, and then that belt going around there, you're going to have a drive loss anywhere from 3% to 20%," one manufacturer observed. "So if people are wanting to save energy, they would like to get rid of that drive loss, and then now you're in a direct drive. And if you're direct drive, how do you change the motor RPM to the desired fan RPM? And that's where you need an EC motor with a control or a VFD."
    - "If the fan is able to run in a stable condition through the spread of the VFD operation, then it's able to give you efficiency," said another manufacturer. "… With the lab fans, the energy efficiency is based on the fact that you're running the fan at a lower break horsepower. To do that … you have to make sure … the fan is selected correctly and for the right operation, then you can run it, and … save $.10 kilowatt hour on a large fan system. I show that I can save nearly $60,000 a year by controlling the fan correctly with a VFD and a correct selection."
- *Adjustability/flexibility for air balancing and other applications:*
    - "[The VFD] is also very important when it's a new building construction," said one manufacturer. "Nowadays, someone is bringing an air balancer in there, so you're going to have a certain amount of supply and exhaust air, and you've got pumps, etc. … They're trying to make sure you don't have an overwhelming positive or negative [pressure] in the building. The systems are laid out theoretically, but there's always something that's off on it. So, the VFD gives you adjustability to air balance your system once everything is installed on your building. So that's a sell point as well, …ease of adjustability."
    - "Most customers of [our] fans want speed control for adjustability/balancing of their system due to unexpected conditions; i.e. "set it and forget it". This technology is taking the place of fans historically supplied with belt drive variable pitch sheaves to allow for final adjustment and balancing. … We also see VFDs supplied where

variable air volume operation is desired; often for night “set back”... Certain applications required variable speed control by code either for VAV system trim and respond logic of DOAS demand control ventilation strategies …Finally, VFDs are also supplied with fans used in air handlers where variable volume operation is desirable to match system loads for heating, cooling and/or ventilation.”

- *Larger fans requiring VFDs for better control:* “In the larger horsepowers, you’re going to need a VFD,” said one manufacturer. “If it’s a three-phase fan, you’re typically always getting a VFD,” said another.

2.8 Conclusions and Considerations

The findings summarized above lead to the following conclusions and recommendations.

- *The interviewed fan manufacturers likely account for the large majority of the fan sales in the NEEA region.* As noted, the study team targeted the fan manufacturer interviews based on how frequently recent Northwest fan studies listed a given manufacturer on their target lists. Of the seven manufacturers who appeared most frequently on those study target lists, this study completed interviews with five of them. There was a significant drop-off in the sales volume between the five-point manufacturers and the three- or four-point manufacturers. This suggests that the lower rated manufacturers that DNV did not interview did not have significant sales volumes. Finally, conversations with NEEA staff and the study’s online research also indicated that the completed interviews were with the “major players” in the Northwest fan market.
- *The NEEA Efficient Fans Program has the opportunity to match the diverse nature of the non-embedded C/I/A fan market in the NEEA region through intentional program design choices.* The study shows that some fan manufacturers active in the NEEA region specialize in smaller fans while others focus on larger fans. Some manufacturers focus on the commercial sector while others target the industrial or institutional sectors. Two manufacturers pair the vast majority of their fans with VFDs, two manufacturers pair less than a third of their fans with VFDs, and two manufacturers leave the pairing of VFDs with their fans to manufacturer representatives or customers. There is also great variation in the frequency of FEI certification among the manufacturers. This diversity will complicate the marketing and delivery of NEEA’s Efficient Fans program because it limits “one-size-fits-all” strategies.
- *There are opportunities to increase the incidence of FEI-certified fans, but financial incentives may be needed to move the market:* For four of the six manufacturers active in the NEEA region, the average share of FEI-certified fans is only 40%, and this represents an opportunity for the NEEA Efficient Fans Program. However, the fan manufacturer interviews indicated that most non-FEI-certified fans were smaller fans used in commercial applications that face significant price competition. So, this would suggest that the NEEA program may want to introduce upstream/midstream incentives to reduce the price barriers of the more efficient fans in these smaller power bins.

3 APPENDIX A: FAN MANUFACTURER INTERVIEW GUIDE

Interview Information

Interviewer		Survey Length (min)	
Completion Date			

Contact Information

Phone	
Email	

Call Tracking

Date/Time	Notes
NEEA	

Introduction

[NOTE: THE QUESTIONS IN THIS INTERVIEW GUIDE WILL NOT NECESSARILY BE READ VERBATIM BUT MAY BE MODIFIED TO SUIT THE INTERVIEW]

Intro. Hi, my name is X OF DNV. We are conducting a study of the fan market in the Pacific Northwest. All the information we collect in this interview will be kept confidential; your name will not be included the study results. If you complete the full interview, you will receive a gift card with a value of $200.

[IF THEY ASK HOW LONG THE INTERVIEW WILL TAKE, TELL THEM ABOUT 45 MINUTES]

[ASK IF IT'S OK TO RECORD THE CALL].

[IF THEY REFUSE THE INTERVIEW (NOT THE RECORDING), THANK THEM FOR THEIR TIME AND HANG UP]

Company, Interviewee Background

First, I had a few background questions about you and your company.

1. What is your job title?
2. Approximately how many full-time employees are at the office where you work?

Defining the Fan Type for Sales Estimates

3. We are most interested in the market for fans that are not embedded in HVAC equipment and are used in commercial, industrial or agricultural applications. These fans are sometimes called non-embedded or stand-alone fans. Are you familiar with your company's sales patterns for these types of fans?
    a. [IF YES] Skip to Q4 [INTERVIEWER: FOR ALL SUBSEQUENT QUESTIONS ABOUT FAN SALES, BE CLEAR YOU'RE ASKING ABOUT NON-EMBEDDED OR STAND-ALONE FANS IN COMMERCIAL, INDUSTRIAL, OR AGRICULTURAL APPLICATIONS]

b. [IF NO] Are you at least familiar with your company's sales patterns for fans used in commercial, industrial or agricultural applications, whether or not they are embedded in HVAC equipment?

i. [IF YES] Skip to Q4 [INTERVIEWER: FOR ALL SUBSEQUENT QUESTIONS ABOUT FAN SALES, BE CLEAR YOU'RE ASKING ABOUT FANS IN COMMERCIAL, INDUSTRIAL, OR AGRICULTURAL APPLICATIONS]

ii. [IF YES] Can you provide a rough estimate of what % of your fans used in commercial, industrial or agricultural applications are non-embedded or stand-alone fans?
   1. [IF YES] Please provide your best estimate of this percentage __%

iii. [IF NO] Is there someone else in your company who would be more familiar with your sales of fans for commercial, industrial or agricultural applications?

   1. [IF YES, RECORD CONTACT INFO AND CONTACT REFERRAL TO SCHEDULE INTERVIEW]

   2. [IF NO, THANK INTERVIEWEE AND TERMINATE INTERVIEW]

Sales by Geography

4. We are most interested in your [INSERT WORDS: NON-EMBEDDED OR C/I/A AS APPROPRIATE] fan sales in the states of Idaho, Montana, Oregon, and/or Washington. In which of those states does your company currently sell fans in the commercial, industrial, or agricultural markets? [MARK IN THE TABLE BELOW ALL THAT APPLY]

5. About what % of your total [INSERT WORDS: NON-EMBEDDED OR C/I/A AS APPROPRIATE] 2021 fan sales do your sales in [STATES IDENTIFIED IN Q4] account for?

6. We are trying to get a sense of the volume of [INSERT WORDS: NON-EMBEDDED OR C/I/A AS APPROPRIATE. REPEAT THESE WORDS AS NEEDED THROUGHOUT THE GUIDE TO REMIND THE INTERVIEWEE OF THE UNIT OF ANALYSIS] fans that are being sold in this four-state region. Can you provide an estimate of your company's 2021 sales of these types of fans?

   a. [IF YES, BUT THEY DO NOT HAVE THE SALES VOLUME HANDY, ASK THEM IF THEY CAN PROVIDE THESE DATA WITHIN A WEEK AFTER THE INTERVIEW AND FOLLOW UP]

   b. [IF NO] Could you tell me a little bit about why it's challenging to provide this estimate?

      i. [IF THEY SAY THAT THEIR SALES DATA IS NOT BROKEN OUT THIS WAY, PROBE FOR HOW IT IS BROKEN OUT GEOGRAPHICALLY. IF THE BREAKOUT IS LARGER THAN THE 4-STATE NEEA REGION, SEE IF THEY'RE WILLING TO ESTIMATE WHAT PROPORTION OF THIS LARGER REGIONAL SALES VOLUME IS ACCOUNTED FOR BY THE 4-STATE NEEA REGION]

      ii. [IF THEY ARE CONCERNED ABOUT THE SENSITIVITY OF THE SALE DATA, REPEAT REASSURANCES OF THE CONFIDENTIALITY OF THE TREATMENT OF THE DATA AND UNDERSTANDING IF THEY STILL CHOOSE NOT TO]

7. In percentage terms, roughly how were your 2021 northwest sales of fans for commercial, industrial, or agricultural markets distributed across these [quantity from Q4] states? [MAKE SURE TOTAL ADDS UP TO 100%]

State	Sell Commercial/Industrial/Agricultural Fans in State?	How 2021 C/I/A Fans Sales in NW States Were Distributed Across the Four States
Idaho	1.Yes 2. No 3. Don't know 4.Refused	%___ DK Refused
Montana	1.Yes 2. No 3. Don't know 4.Refused	%___ DK Refused
Oregon	1.Yes 2. No 3. Don't know 4.Refused	%___ DK Refused
Washington	1.Yes 2. No 3. Don't know 4.Refused	%___ DK Refused
	Total	**100%**

Sales by Sector

8. We are interested in how your 2021 fan sales in these [quantity from Q4] northwest states were distributed by non-residential sector. Please provide your best estimates as to how your 2021 fan sales in these [quantity from Q4] northwest states were distributed across the following non-residential sectors [READ IF INTERVIEW IS BY PHONE, IF VIDEO CALL, SHOW THEM THE TABLE. MAKE SURE TOTAL = 100%. IF THEY MENTION ANOTHER NONRESIDENTIAL SECTOR BESIDES THE 3 SPECIFIED, RECORD WHAT THAT/THOSE SECTORS ARE]

Sector	How 2021 C/I/A Fans Sales in NW States Were Distributed by Sector
Commercial	%___ DK Refused
Industrial	%___ DK Refused
Agricultural	%___ DK Refused
Other [SPECIFY]	%___ DK Refused
	100%

Sales by Horsepower

9. We are interested in how your 2021 fan sales in these [quantity from Q4] northwest states were distributed by the sizes of the fans. Please provide your best estimates as to how your 2021 fan sales in these [quantity from Q4] northwest states were distributed across the following horsepower bins [READ IF INTERVIEW IS BY PHONE, BUT DUE TO SIZE OF TABLE, THIS WOULD WORK MUCH BETTER AS A VIDEO CALL WHERE WE CAN SHOW THEM THE TABLE. MAKE SURE TOTAL = 100%. IF THEY ASK HOW WE'RE ASSESSING HP, TELL THEM WE'RE USING FAN BHP AT PEAK STATIC EFFICIENCY]

Power Bin	Horsepower Range	How 2021 C/I/A Fans Sales in NW States Distributed Across These Horsepower Bins?
1	0.7 to 1.4 kW	%___ DK Refused
2	1.4 to 2.8 kW	%___ DK Refused
3	2.8 to 5.6 kW	%___ DK Refused
4	5.6 to 11.2 kW	%___ DK Refused
5	11.2 to 22.4 kW	%___ DK Refused
6	22.4 to 44.8 kW	%___ DK Refused
7	44.8 to 89.6 kW	%___ DK Refused
8	89.6 to 179.2 kW	%___ DK Refused
9	179.2 to 358.4 kW	%___ DK Refused
		100%

Sales by FEI Certification

10. The Fan Energy Index or "FEI" is a measure of the relative energy efficiency of a fan compared to baseline equipment. It can be expressed as either:

FEI = Fan Efficiency/ Baseline Fan Efficiency

Or FEI = Baseline Fan Electrical Input Power/Fan Electrical Input Power

Are you familiar with the Fan Energy Index?

11. [IF Q10=YES] We are interested in what percentage of your 2021 fan sales, in terms of units sold, in these [quantity from Q4] northwest states were of FEI-certified products. These are also sometimes defined as AMCA 211 certified products. Please provide your best estimate of this percentage __%

12. [IF THEY GAVE A % ESTIMATE FOR Q11 GREATER THAN 0%] What is the predominant fan type that you sell that is FEI certified?

13. From your perspective, what factors or reasons explain why more of the fans you sold in 2021 were not FEI-certified?

Sales with VFDs or other Motor Controls

14. We are interested in what percentage of the fans you sold in 2021 in these [quantity from Q4] northwest states were integrated and sold with variable frequency drives, otherwise known as VFDs. Please provide your best estimate of this percentage __%

15. We are also interested in what percentage of the fans you sold in 2021 in these [quantity from Q4] northwest states were integrated and sold with control systems *other* than VFDs. Please provide your best estimate of this percentage __%

16. [IF THEY GAVE A % ESTIMATE FOR Q14 OR Q15 GREATER THAN 0%] What types of VFDs or control systems did you most frequently pair with fans sold in 2021?

17. Did you manufacture these VFDs or other control systems yourself? Or did you purchase these from other vendors? Or was it a combination of both?

    a. [IF PURCHASE FROM OTHER VENDORS OR COMBINATION OF BOTH] Which vendor(s) supplied most of the VFDs or other motor controls for the fans you sold in 2021?

18. From your perspective, what factors influenced the pairing of VFDs or other motor controls with fans you sold in 2021?

That's all the questions I had. Thank you so much for your time.

About DNV

DNV is a global quality assurance and risk management company. Driven by our purpose of safeguarding life, property and the environment, we enable our customers to advance the safety and sustainability of their business. We provide classification, technical assurance, software and independent expert advisory services to the maritime, oil & gas, power and renewables industries. We also provide certification, supply chain and data management services to customers across a wide range of industries. Operating in more than 100 countries, our experts are dedicated to helping customers make the world safer, smarter and greener.