



# Defining the Wind Energy Workforce Gap

Jeremy Stefek, Corrie Christol, Tony R. Smith,  
Matthew Kotarbinski, and Brinn McDowell

*National Renewable Energy Laboratory*

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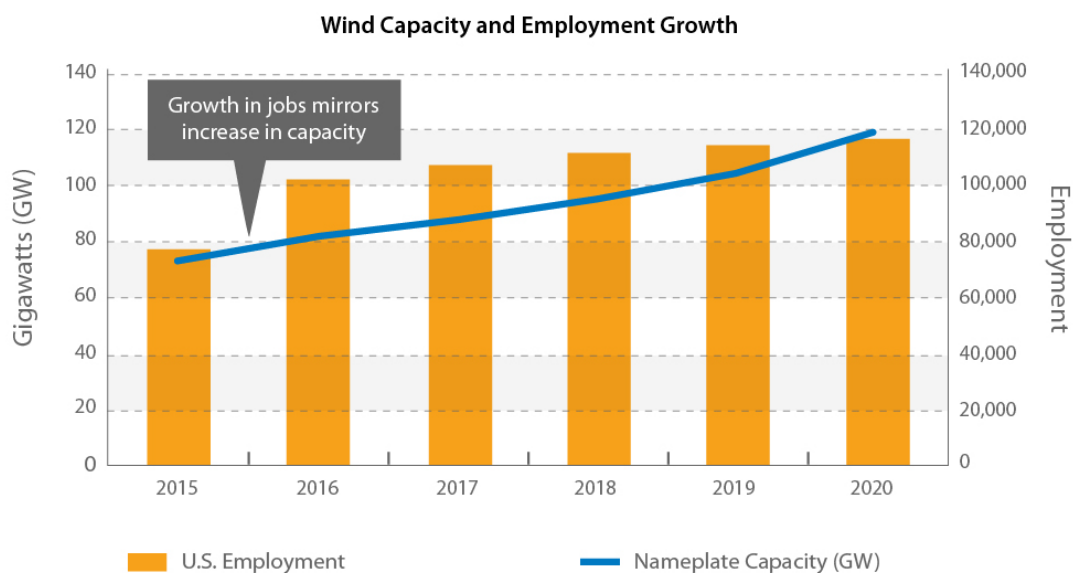
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## Executive Summary

Land-based wind energy is the largest renewable energy generation source in the United States, with a cumulative installed capacity of 119 gigawatts (GW) in 2020, representing 7.3% of electricity generation (U.S. Energy Information Association 2020). Between 2015 and 2020, wind capacity and employment have increased every year, with wind nameplate capacity increasing 45% over this duration (Figure ES-1). The wind energy industry is expected to continue this growth, as the nation scales up the deployment of land-based and offshore wind energy technologies to fulfill net-zero carbon emissions by 2050 while promoting a clean energy economy (U.S. Department of Energy [DOE] 2021).



**Figure ES-1. Increasing trends for wind capacity and employment are expected to continue. Graph courtesy of Wiser et al. (2020)**

As a result of the expected growth in the U.S. wind energy market for both land-based and offshore wind, there will be an increased need for employment within the industry. Employment in the U.S. wind industry has grown from 77,000 jobs in 2016 to 117,000 in 2020, with jobs in various sectors including manufacturing, construction, operations, sales, management, research and development (R&D), and professional support services—all of which require different education levels (Figure ES-1) (BW Research Partnership 2020a).

Despite the needed and anticipated growth in employment, wind industry employers, the potential workforce, and educational institutions all report difficulty in connecting the wind industry workforce pipeline. This disconnect, which we refer to below as the wind energy workforce gap, represents a barrier for future job growth in the wind energy and renewable energy industries.

Further, it signifies the missing link between wind industry employers, the potential workforce, and educational institutions—wind energy employers report having difficulty finding qualified candidates while the potential wind energy workforce (e.g., students and recent graduates)

reports difficulty finding jobs, and educational institutions report having difficulty placing students in jobs.

Two web-based elicitations were employed to survey the wind industry as well as current students and recent graduates from U.S. education institutions. The following takeaways highlight why the wind energy workforce gap exists and how to reduce employment barriers to better facilitate and connect industry, educational institutions, and the potential workforce with one another. The top reasons for the gap, as identified through questionnaire responses from wind energy employers and the workforce, include experience, education and training, and geographic factors (e.g., too few applications in areas hiring) as the top reasons. Key takeaways include:

**Experience** was the top challenge for wind energy employers hiring nonentry-level applicants and was also the top challenge for the total workforce.

- **Industry.** Experience was a challenge for more than one-quarter of all wind industry firms looking for entry- (27.6%) and nonentry-level (33%) job applicants, which ranked as one of the highest reasons among those firms who reported hiring difficulty. The operations and asset management sector had the most difficulty finding entry-level applicants with relevant experience, whereas manufacturing, education/training/advocacy, and development and siting sectors were most challenged with finding experienced nonentry-level job applicants.
- **Workforce.** 68% of total workforce respondents indicated that getting relevant work or industry experience was the greatest reported challenge for seeking employment.<sup>1</sup>

**Education and training** were identified as additional challenges for both employers and the total workforce. Employers reported difficulty finding qualified job applicants, whereas those in the potential workforce that had actively sought a career in the wind energy industry reported difficulty getting hands-on training that develops wind-energy-specific skills.

- **Industry.** More than a quarter of responding firms indicated that “there are enough applicants, but too many applicants do not have the training or education needed for the job” (29.7%). When looking for entry-level applicants, education and training was the top reason for hiring difficulty for manufacturing, R&D, and development and siting sectors. For nonentry-level positions, R&D, and operations and asset management sectors cited training and experience as their top reasons.
- **Workforce.** In addition to gaining relevant job experience, current and potential workers identified getting hands-on training (62%) or technical training (61%) to develop skills and expertise as a challenge or obstacle when searching for relevant opportunities in the wind industry.

**Geography** was another challenge for both employers and the total workforce. There is a disconnect between where wind industry job postings are located, and where the potential and current workforce is willing to live.

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<sup>1</sup> Throughout this report, the term “potential workforce” refers to students who are in education programs or recent graduates that are not yet working in the industry, whereas the term “current workforce” refers to both entry- and nonentry-level workers who are currently working in the wind energy industry, and lastly, the term “total workforce” refers to the potential and current workforce together.

- **Industry.** The third-highest reason among wind firms searching for both entry- and nonentry-level applicants was that there are not enough applicants for available positions in areas where wind is being developed. Construction and education/training/advocacy firms indicated this as their top difficulty for both entry- and nonentry-level positions.
- **Workforce.** The geographic location of jobs and finding employment opportunities where one lives or is willing to live was ranked the second-highest challenge for the total and potential workforce (67%) and the top challenge for the current workforce (64%). Respondents located in urban and suburban areas indicated that finding employment opportunities where they live or are willing to live is a considerable challenge (26%) at a higher rate than those who live in rural areas (19%).

## Workforce Development Opportunities

Effective communication was indicated as an area of improvement between industry hiring managers and education/training programs when trying to place students into the wind industry. Many industry respondents (39%) regularly offer internships as an opportunity for current undergraduate and graduate students to gain skills and experience in the wind industry. However, 60% of the total workforce respondents have not participated in wind-energy-related internships, and nearly 20% of the total workforce respondents had not heard of these types of internship opportunities. Wind industry and educational institutions could leverage partnerships to ensure that students are made aware of experience-gaining opportunities, such as internships, jobs, and skill development workshops.

According to Keyser and Tegen, creating pathways between industry and the potential workforce through experience-gaining opportunities like DOE-sponsored programs, has been reported to help close the wind energy workforce gap (Keyser and Tegen 2019). However, 54% of industry respondents indicated that they have not worked with or contacted a U.S. educational institution to find qualified candidates and only 35% have partnered with university career offices. Of the 19% of potential and total respondents that reported their participation in an internship, approximately 50% of those obtained employment in the industry. Additionally, students and recent graduates who participate in DOE-sponsored wind energy workforce programs indicate a higher interest in wind energy and are shown to be twice as likely to enter the wind industry than those who do not. Furthering connections with the potential workforce could address some of the disconnect between finding and hiring qualified workers. Opportunities that could be leveraged in the wind industry for workforce development include the high student interest in wind careers, the positive perception of the U.S. wind industry, established DOE-sponsored programs to support workforce development, and the ability to connect with the existing workforce.

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# 1 Wind Energy Workforce Background

## 1.1 Goal

Expected growth in the U.S. wind energy market—both on land and offshore—will increase the need for employment in the industry. Currently, a gap exists in the wind energy workforce despite strong interest from the potential workforce and established programs for education and training. We define the wind energy workforce gap as a disconnect between wind industry employers, the workforce, and educational institutions—wind energy employers report having difficulty finding qualified candidates while the potential wind energy workforce (e.g., students and recent graduates) reports difficulty finding jobs, and educational institutions report having difficulty placing students in jobs. Throughout this report, the term:

- “potential workforce” refers to students who are in education programs or recent graduates that are not yet working in the wind energy industry
- “current workforce” refers to both entry- and nonentry-level workers who are currently working in the wind energy industry
- “total workforce” refers to the potential and current workforce respondents together.

The reasons for the wind energy workforce gap are uncertain. As a result, the National Renewable Energy Laboratory (NREL), along with BW Research Partnership, designed and conducted a research project to understand those reasons from the perspective of the wind industry as well as students and recent graduates from U.S. education institutions. This report shares insights as to what the wind energy workforce gap is and why it exists, and how to inform industry, educational institutions, and the potential workforce so that they can reduce barriers and better connect the wind energy workforce through existing and novel pathways. The insights in this report were collected from two web-based surveys: one for industry and the other for current and recent graduates in education programs.

## 1.2 Methodology

### *Industry Employers*

Up to 296 wind energy employers with locations in the United States completed a survey. Survey participants were chosen using a recontact sample from the “United States Energy and Employment Report” of wind energy employers (industries: utilities, construction, manufacturing, wholesale trade, professional and business services, and other services including repair and maintenance), a recontact sample from the prior NREL wind energy workforce survey from 2017, a sample of American Wind Energy Association members, and an online panel of employers that met all screener qualifications for wind energy. The surveys were conducted online between March 20, 2020, and June 3, 2020, and averaged 14 minutes in length. The margin of error for responses in the report is +/- 5.69% at a 95% confidence interval.

## ***Student and Recent Graduates***

### ***Current Student and Recent Graduates at Participating Institutions***

A survey of 563 current students or recent graduates (within the last 3 years)—from institutions that participate in the U.S. Department of Energy’s (DOE’s) Collegiate Wind Competition, are home to DOE’s Wind Application Centers, or otherwise house wind energy programs or wind energy courses—were recruited to take the web survey. Students and recent graduates were contacted directly based on participant lists provided by NREL or were directed to the survey via professors or instructors that were contacted to share the survey. The survey was conducted between April 22, 2020, and May 29, 2020, and averaged 12 minutes in length.

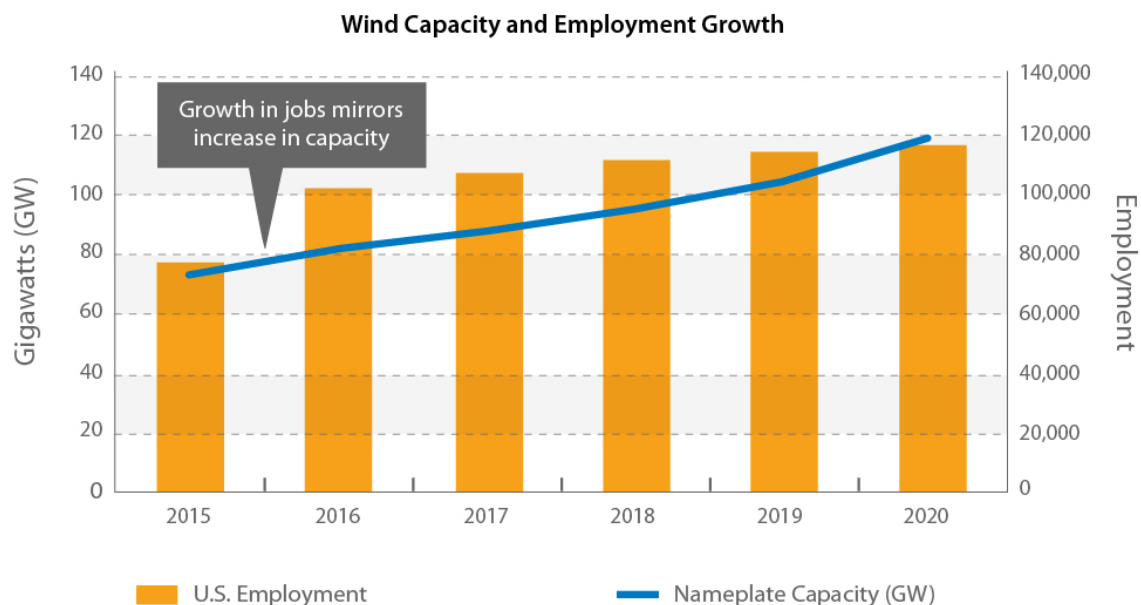
### ***Current Student and Recent Graduates With Relevant Degrees***

A survey of 206 current students or recent graduates (within the last 3 years) at educational institutions were recruited to take the survey. Students and recent graduates were recruited from online panels and had to meet a set of criteria (current or recent graduates for relevant degrees) to participate in the web survey. The survey was conducted between April 22, 2020, and May 29, 2020, and averaged 11 minutes in length.

## **1.3 Growth of Wind Energy**

Land-based wind energy is the largest renewable energy generation source in the United States, with a cumulative installed capacity of 119 gigawatts (GW) in 2020, representing 7.3% of electricity generation (U.S. Energy Information Association 2020). The capacity increased 45% from 2015 to 2019 (Figure 1).

The wind energy industry is expected to grow, as the nation scales up the deployment of wind energy technologies to fulfill net-zero carbon emissions by 2050 while promoting a clean energy economy (DOE 2021). While most of the wind capacity installed in the United States to date is land-based, a new national goal of 30 GW of offshore wind by 2030 will accelerate the development of the domestic offshore wind energy industry (DOE 2021).



**Figure 1. Increasing trends for wind capacity and employment are expected to continue. Graph courtesy of Wiser et al. (2020)**

## 1.4 Wind Energy Employment

As wind capacity grew, the wind energy industry matured, creating jobs in manufacturing, construction, operations, sales, management, research and development (R&D), and professional support services—spanning all educational levels. Employment in the U.S. wind industry has grown from 77,000 jobs in 2016 to 117,000 in 2020 (Figure 1) (BW Research Partnership 2020a). The median hourly wage for wind energy workers is \$25.95—35.6% higher than the national hourly wage—indicating that these jobs have a high quality of pay. Similar to other energy-related jobs, the compensation varies across occupations (BW Research Partnership 2021).

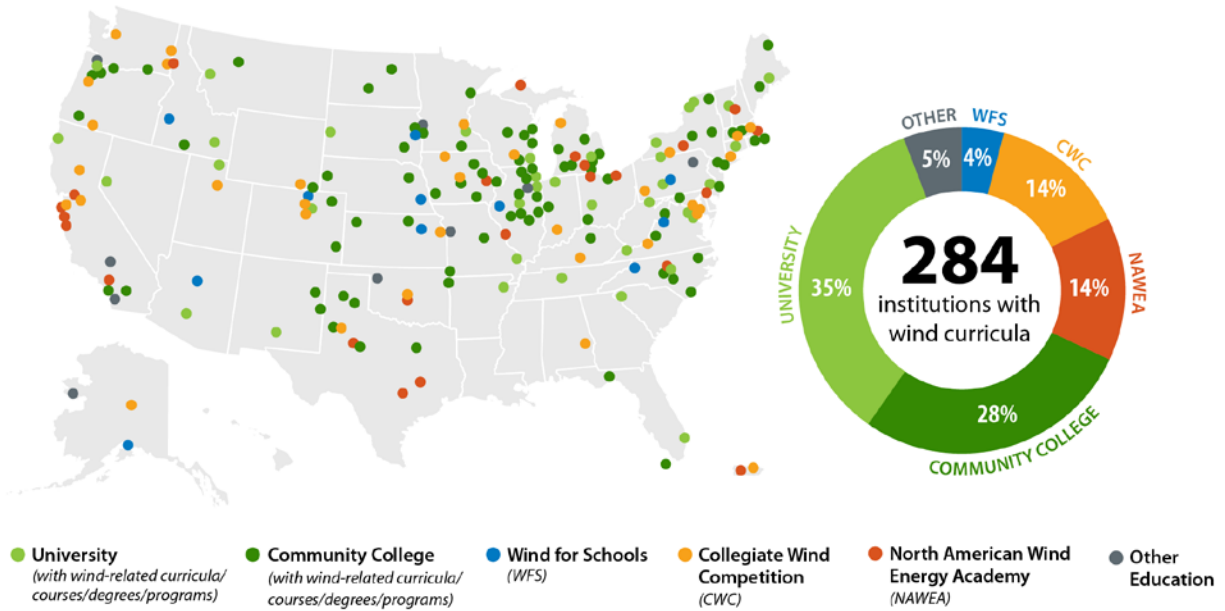
Employment in the industry is estimated to need an additional 7,700 positions annually to meet a goal of 20% wind by 2030 (Keyser and Tegen 2019). The offshore wind industry is estimated to employ more than 44,000 workers by 2030 (DOE 2021). These jobs will require developing an adequate workforce with the appropriate skills, education, and experience to meet industry requirements.

## 1.5 Wind Energy Education

Wind energy education and training programs provide pathways for students to meet the wind industry workforce needs. More than 280 renewable energy certificate or degree programs exist in the United States (Figure 2), many of which offer a specialization in wind energy.<sup>2</sup> DOE’s Wind Energy Technologies Office also sponsors programs and initiatives to further support wind-related coursework and educational opportunities across the country, including the

<sup>2</sup> NREL maintains a list of Wind Energy Education and Training Programs at <https://windexchange.energy.gov/training>. This list is based on data collected in Spring 2020 to send out a survey to students and recent graduates from these programs.

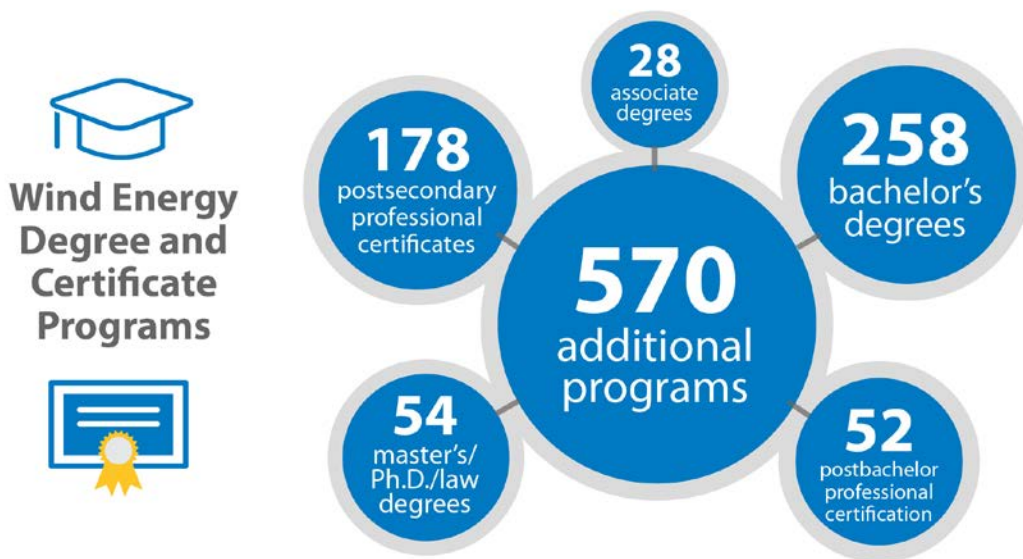
[Collegiate Wind Competition](#) (CWC), [Wind for Schools](#) (WFS), and the [North American Wind Energy Academy](#) (NAWEA). As of 2020, DOE-sponsored programs have engaged with 70 universities, three 4-year colleges, and a community college.



**Figure 2. Map of U.S. renewable energy educational programs with a wind focus, highlighting institutions who have participated in DOE-sponsored wind energy programs. Image created by John Frenzl, NREL**

“The Wind Energy Workforce in the United States: Training, Hiring, and Future Needs” (Keyser and Tegen 2019) report suggests that to meet the increased land-based and offshore wind energy workforce demand, new or expanded programs and coursework will be needed to provide skills and training (Figure 3), including vocational, university, and other programs.





**Figure 3. To meet a workforce demand of 7,700 positions annually, 570 additional programs are needed across different education levels.<sup>3</sup> Image created by John Frenzl, NREL**

As of 2019, only 20%–30% of students who graduate from existing programs enter the wind energy workforce (Figure 17). The percentage of graduates entering the workforce will need to increase to meet the growing needs of the industry and reduce the workforce gap. Assuming the 20%–30% of students entering the wind industry remains constant, then an estimated 570 additional programs with a wind component would be needed to meet 7,700 positions annually, including: 178 postsecondary professional certificates, 28 associate degrees, 258 bachelor's degrees, 52 postbachelor professional certifications, and 54 master's/Ph.D./law degrees (Keyser and Tegen 2019).<sup>3</sup>

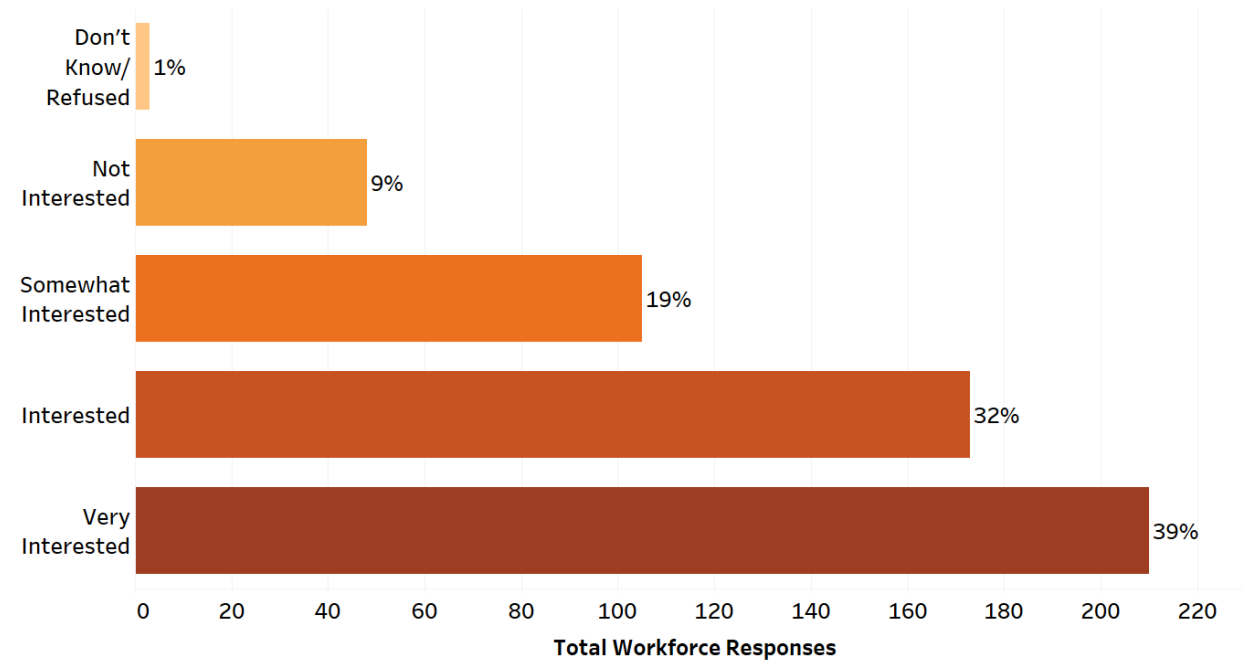
## 1.6 Student Interest

In 2020, NREL conducted a survey of students enrolled in degree programs applicable to the wind energy industry. Students and recent graduates in U.S. educational programs (Figure 2) have a high level of interest in building a career in the wind energy industry. Specifically, survey results indicated very interested (39%) or interested (32%) (Figure 4).

<sup>3</sup> This estimation shows that there is a need for new programs (e.g., coursework, certificate, or degree) while continuing to develop existing programs to meet wind industry demand. These estimates are based on the additional new hires needed each year, and data collected in 2017 on the number of students enrolled in each program as well as how many of those students enter the wind industry.



How interested would you be in building a career in the wind energy industry? (n=539)



**Figure 4. Workforce interest in wind energy careers**

Respondents that reported interest in wind energy employment were significantly more likely to have participated in wind-related courses, internships, degree programs, wind-related certificates, or DOE-sponsored programs than those who did not. Therefore, connecting students who have interest in a career in the wind energy industry (especially those in wind-focused vocational and higher education programs) with wind energy employers is crucial to ensuring a complete workforce pathway.

## 1.7 Workforce Development Connections

U.S. employers, educational institutions, and students and graduates each have a role in developing the wind energy workforce (Figure 5).

For example, wind industry employers seek individuals with the necessary education/training and experience to meet job requirements. Educational institutions (e.g., vocational schools, community colleges, universities) are committed to training the next generation of workers or professionals transitioning into the wind industry, ensuring they have the skills and competencies to succeed in their respective careers. Students and graduates are looking to use their education and experience to meet industry needs while building their own careers. Additionally, inspiring the next generation of pre-K-12 students to seek out careers in wind (and renewable energy) is crucial for sustaining the wind energy industry.

Students and potential workforce are not entering the wind industry and employers are reporting difficulty finding qualified applicants.

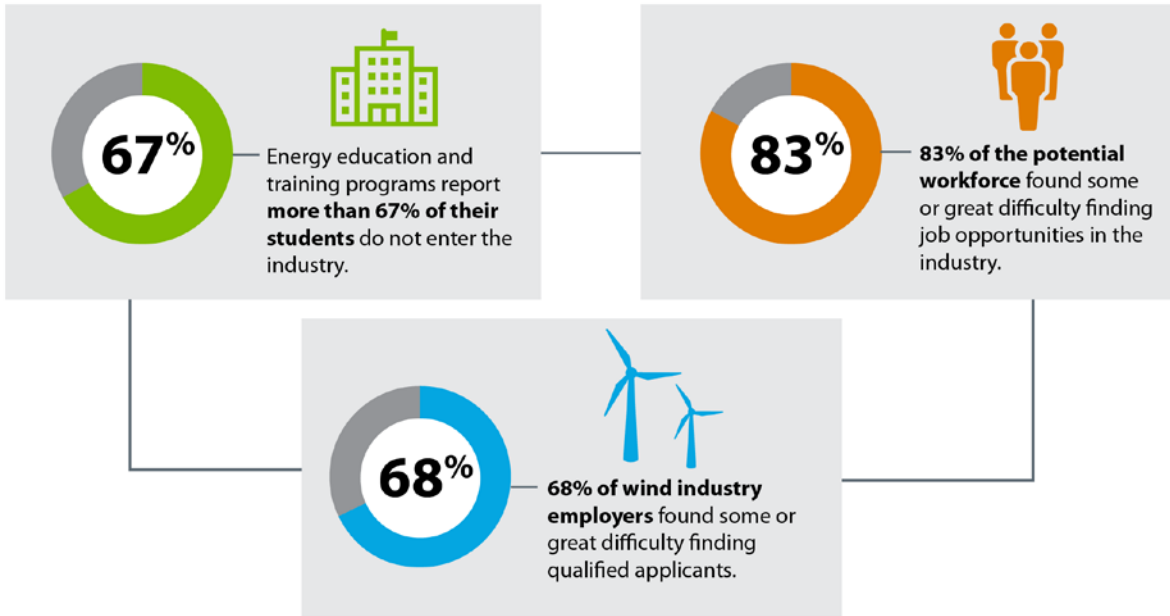


Figure 5. Wind workforce development pathways need to connect to support industry growth.  
*Image created by John Frenzl, NREL<sup>4</sup>*

<sup>4</sup> If over 50% of employers within an industry report at least some difficulty finding qualified applicants, then this is an initial indicator of a challenging workforce environment and anything over 60% is a more prominent barrier for employment growth (BW Research Partnership 2020b).

## 2 What Is the Wind Energy Workforce Gap?

Wind industry employers, the workforce, and educational institutions all report difficulty in connecting the wind energy workforce pathway. The disconnect that we refer to as the wind workforce gap represents a barrier for future job growth in the wind energy and renewable energy industries.

Narrowing this wind energy workforce gap—which would involve decreasing hiring difficulty while increasing graduates’ ability to find jobs—could reduce recruiting costs, better satisfy employer needs, and grow the domestic wind energy workforce (Keyser and Tegen 2019). It is informative for decision makers and other stakeholders to understand why the gap exists to balance workforce supply and demand.

Difficulty finding qualified wind energy workers spans occupations and education levels, from trade workers receiving training at apprenticeships and vocational programs to engineers and applied scientists earning degrees at higher education institutions. The stated difficulty is not limited to one occupation. In a 2012 survey of wind energy employers (focused primarily on land-based wind), 62% of firms reported difficulty finding qualified applicants across a list of occupations (Leventhal and Tegen 2013). In a 2017 follow-up survey, an average of 68% of wind industry respondents reported some or great difficulty finding qualified applicants (Figure 5) (Keyser and Tegen 2019). Table 1 shows the level of difficulty in finding qualified applicants across wind-energy-related occupations.

**Table 1. Level of Difficulty Reported Across Wind-Energy-Related Occupations Comparing 2012 and 2017 Data**

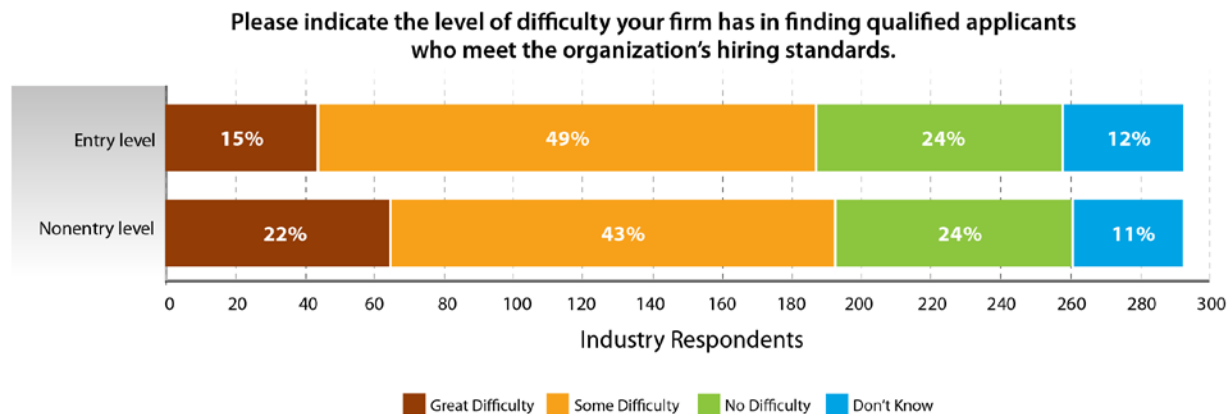
	<b>Some or Great Difficulty (2012)</b>	<b>Some or Great Difficulty (2017)</b>
Professors & teachers	84%	30%
<b>Product designers and design engineers</b>	<b>75%</b>	<b>74%</b>
Trade workers	71%	94%
<b>Wind technicians</b>	<b>79%</b>	<b>33%</b>
Professional trainers and industry educators	77%	53%
<b>Programmers and computer scientists</b>	<b>74%</b>	<b>70%</b>
Engineers	66%	-
Civil engineers	-	84%
Power system and transmission engineers	-	77%
Electrical and mechanical engineers	-	66%
Other engineers	-	77%
<b>Research Scientists and Engineers</b>	-	<b>79%</b>
<b>Scientists</b>	<b>71%</b>	-
<b>Research engineers</b>	<b>69%</b>	-
Attorneys	44%	89%
Paralegals	44%	-
<b>Transportation/logistics workers</b>	<b>41%</b>	<b>80%</b>
Land-leasing agents	46%	-
<b>Developers</b>	<b>52%</b>	<b>80%</b>
Construction managers	72%	-
<b>Construction laborers</b>	<b>73%</b>	<b>39%</b>
Resource assessors & surveyors	44%	91%
<b>Admin/clerical</b>	<b>35%</b>	<b>46%</b>
Government regulatory workers	73%	93%
<b>Accountants, bookkeepers, and finance</b>	-	<b>50%</b>
<b>Development finance</b>	<b>40%</b>	-
<b>O&amp;M accountants &amp; bookkeepers</b>	<b>60%</b>	-
Assembly workers	67%	72%
<b>Economists and policy experts</b>	-	<b>70%</b>
Sales and marketing professionals	-	61%
Manufacturing salespeople	64%	-
Manufacturing managers	74%	-
Managers of sales, operations, & training	61%	-
<b>Supply chain &amp; purchasing managers</b>	<b>54%</b>	-
Applied and field scientists (biologists, environmentalist, archaeologists, etc.)	-	94%

## 2.1 Industry Hiring Difficulty

Based on 2020 survey results, wind energy employers report some or great difficulty in finding qualified, entry-level (64%) and nonentry-level (66%) applicants who meet their organization’s hiring standards.<sup>5</sup> Figure 6 shows the level of difficulty that organization employers reported when searching for qualified applicants across all occupations. This difficulty in searching for applicants defines the workforce gap as experienced by the industry.<sup>6</sup>

<sup>5</sup> The use of job posting labels such as “entry-level” are not used consistently, nor are the definitions of these terms. Industry and workforce respondents defined these terms when they completed the survey.

<sup>6</sup> Industry first identified difficulty in hiring in 2012 and it was reinforced by data collected in 2017, indicating that this difficulty predated the COVID-19 pandemic. However, evidence shows that the pandemic has exacerbated hiring difficulty across many industries, including the wind industry.



**Figure 6. Wind energy employers reported difficulty in finding entry-level and nonentry-level job applicants (n=293). Image created by John Frenzl, NREL**

If over 50% of employers within an industry report at least some difficulty finding qualified applicants, then this is an initial indicator of a challenging workforce environment and anything over 60% is a more prominent barrier for employment growth (BW Research Partnership 2020b).

The level of hiring difficulty reported by wind energy industry employers has industry sector, geographic, and firm size considerations (detailed in the upcoming sections).

### 2.1.1 Industry Sector

The ability to hire qualified staff in the wind energy industry can vary according to industry sector, including manufacturing (with component parts manufacturing); construction; development and siting; R&D; operations and asset management; and education, training, and advocacy.<sup>7</sup> Figure 7 shows that the highest level of hiring difficulty is in the manufacturing, R&D, and construction sectors for both entry- and nonentry-level jobs.

<sup>7</sup> Wind industry sectors also include finance, legal, insurance, government/regulatory, and transportation and logistics. However, these sectors did not have enough response data to report difficulty levels.

Level of difficulty firms have finding qualified applicants who meet the organization's hiring standards according to industry sector.

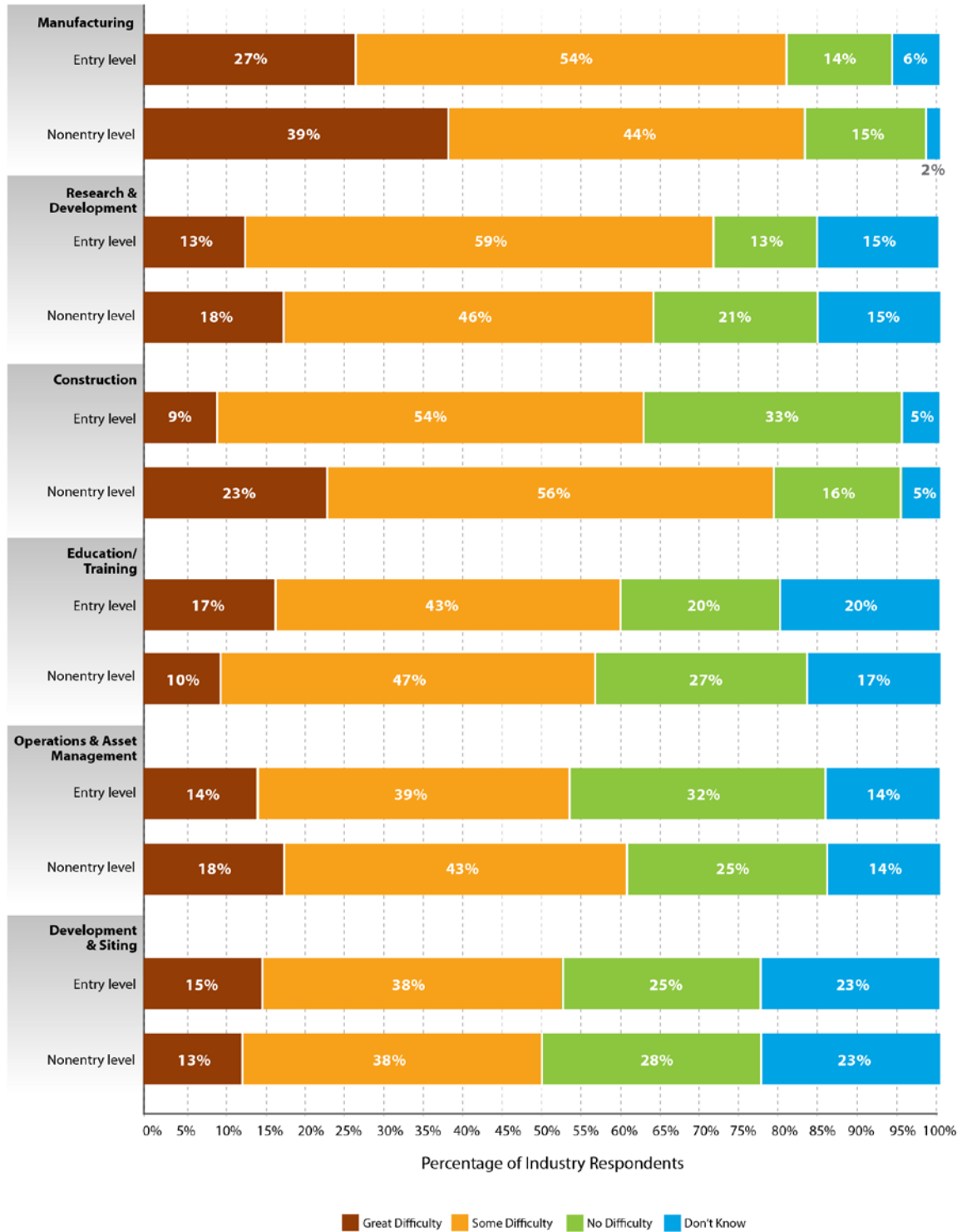


Figure 7. Reported hiring difficulty based on wind industry sector for entry- and nonentry-level jobs. Image created by John Frenzl, NREL

Level of difficulty firms have finding qualified applicants who meet the organization's hiring standards according to industry sector and percent of respondents that hire trade workers

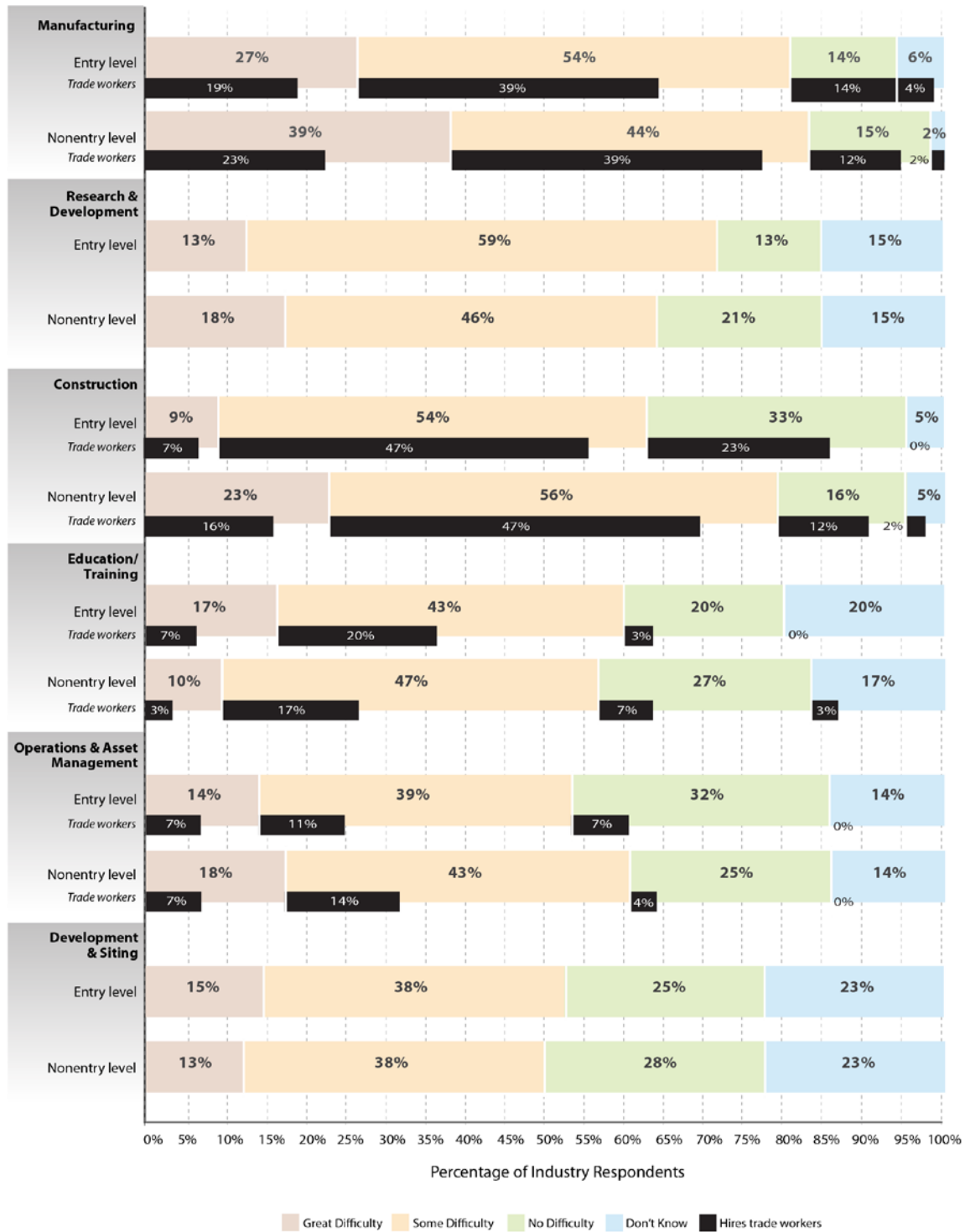


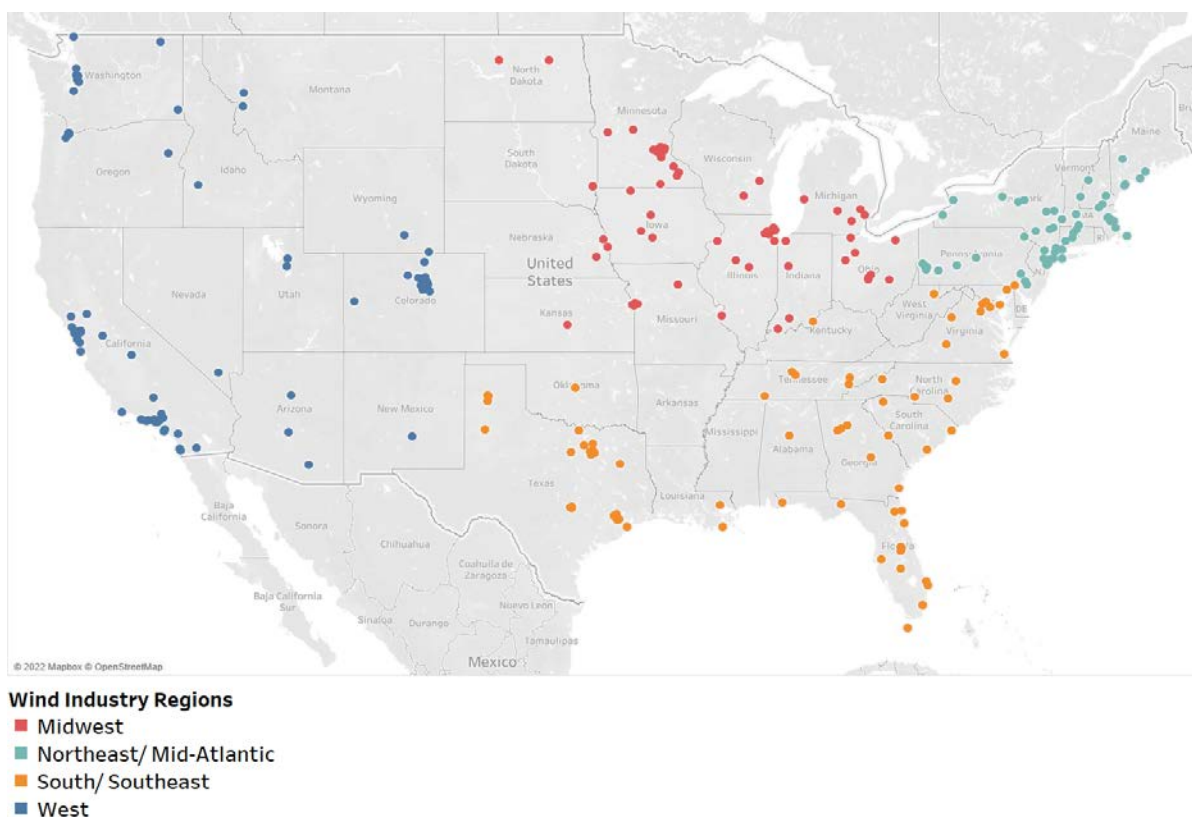
Figure 8. Hiring difficulty reported by wind industry sectors who employ trade workers. Image created by John Frenzl, NREL

The hiring difficulty reported by construction and manufacturing firms is directly correlated to occupations related to trade workers. Figure 8 shows how hiring difficulty relates to firms who hire trade workers (represented by a black bar)—manufacturing and construction firms report great hiring difficulty is related to finding entry-level trade workers, such as welders and electricians.<sup>8</sup> Industry respondents indicated that R&D, development, and siting sectors do not hire trade workers, hence why they have no results.

### 2.1.2 Geography

Geography is another factor in understanding hiring difficulty for wind energy industry employers. Ensuring the wind energy workforce meets the employment needs of various geographic areas is an important consideration for training and education institutions and the industry as a whole.

Figure 9 shows the location of industry firms in different regions who responded across the United States. Employers are represented in every region including the West (blue), Midwest (red), South/Southeast (orange), and Northeast/Mid-Atlantic (teal).<sup>9</sup>



**Figure 9. Locations of wind energy firms by region according to respondents<sup>10</sup>**

<sup>8</sup> Assembly workers and construction laborers are not included in this hiring difficulty as these occupations are considered separate from trade workers.

<sup>9</sup> Wind energy industry firms have been grouped based on the census regions of the United States: [https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us\\_regdiv.pdf](https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf).

<sup>10</sup> Alaska, Hawaii, and Puerto Rico are not shown on the map, as there were no respondents from these regions.



Respondents answered hiring- and staffing-based questions for their headquarters, individual location, or for their headquarters and firm’s additional locations. Most respondents were comfortable answering the hiring- and staffing-based questions for all of their firm’s locations (77%), whereas 23% were only comfortable with their individual location.<sup>11</sup>

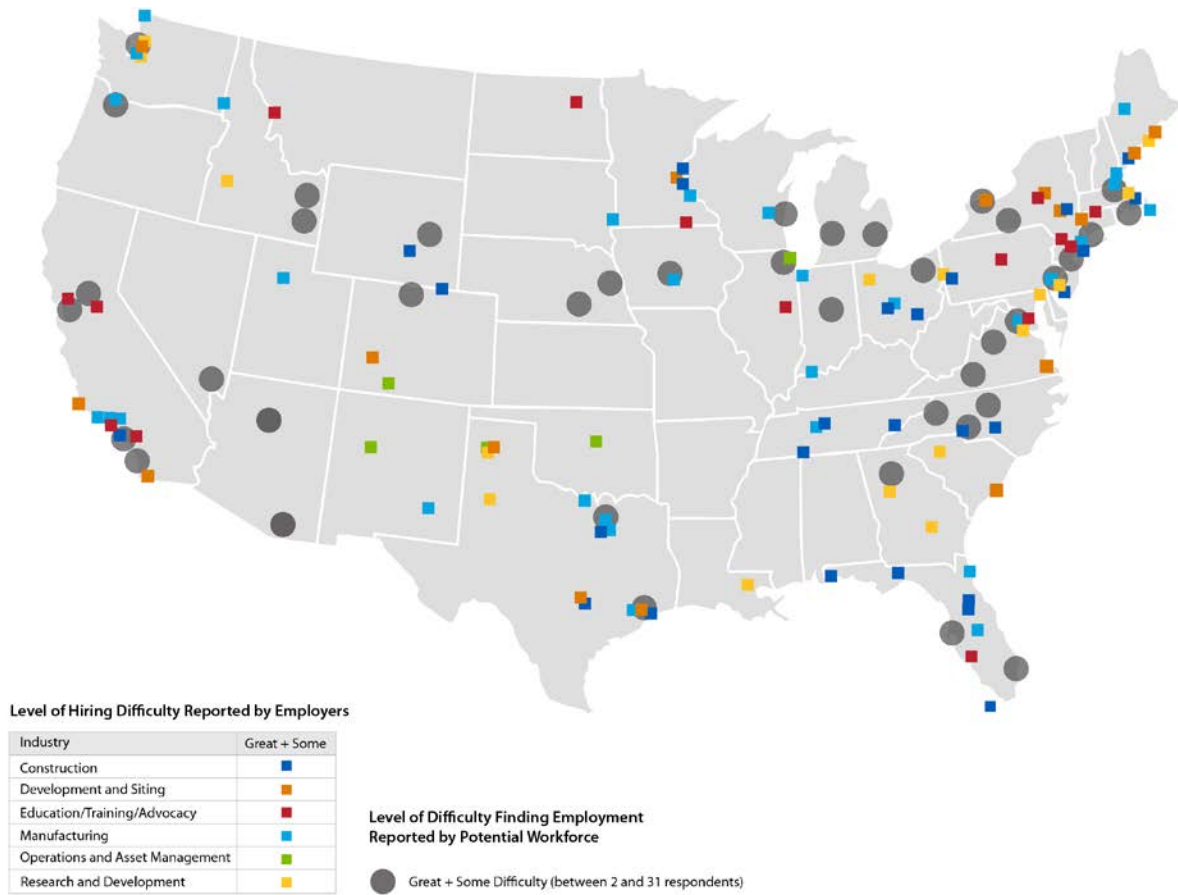
Wind industry firms in the South or Southeast reported the highest level of difficulty finding entry-level applicants (78%), followed by the Northeast/Mid-Atlantic (71%), Midwest (63%), and West (50%). The hiring difficulty by region for entry-level and nonentry-level jobs is summarized in Table 2.

**Table 2. Wind Industry Hiring Difficulty by Region for Entry- and Nonentry-Level Jobs**

	Entry Level			Nonentry Level		
	Great difficulty	Some difficulty	Total difficulty	Great difficulty	Some difficulty	Total difficulty
<b>South/Southeast</b>	15.1%	62.8%	<b>77.9%</b>	15.8%	48.5%	<b>64.4%</b>
<b>Northeast/Mid-Atlantic</b>	18.2%	52.3%	<b>70.5%</b>	25.8%	40.3%	<b>66.1%</b>
<b>Midwest</b>	19.4%	43.5%	<b>62.9%</b>	26.7%	44.2%	<b>70.9%</b>
<b>West</b>	10.9%	38.6%	<b>49.5%</b>	22.7%	34.1%	<b>56.8%</b>

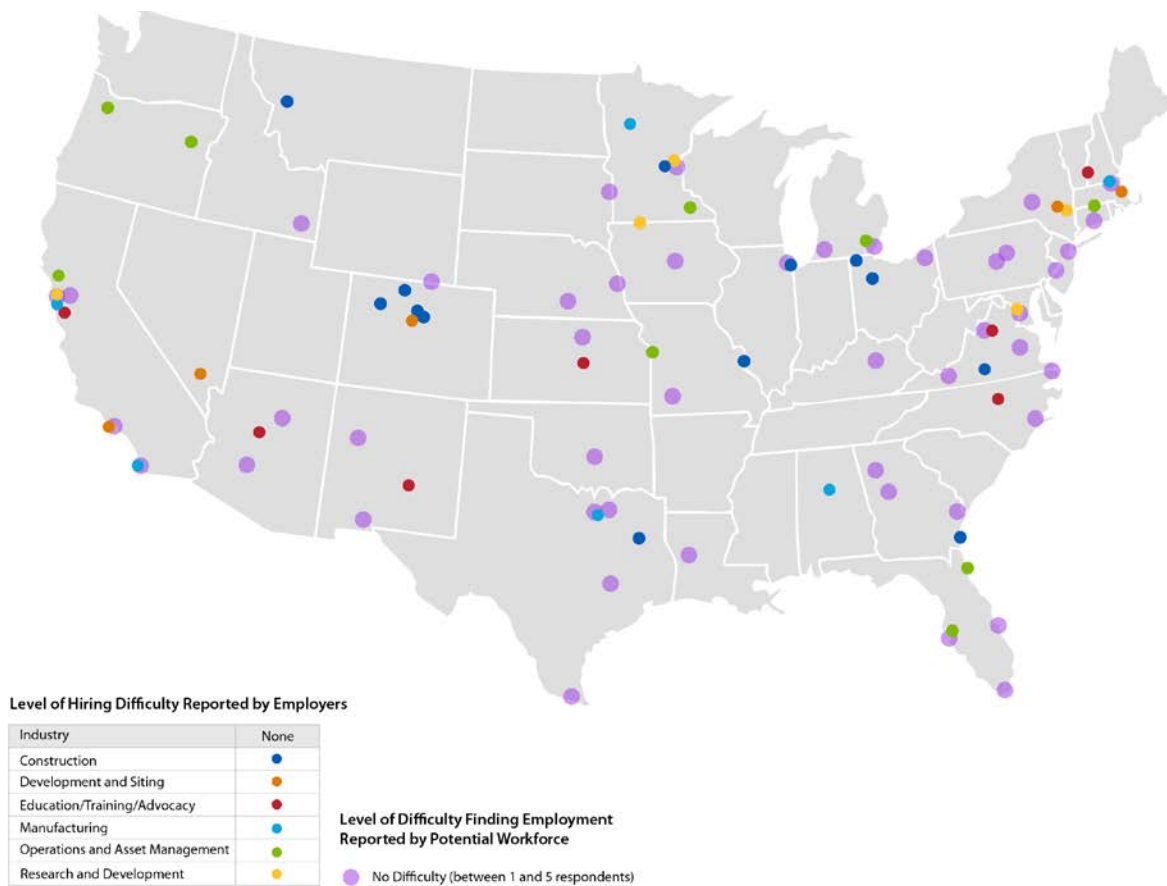
The difficulty reported by wind energy industry employers varies based on the firm’s region in the United States and what the primary wind industry activities are within that region, such as manufacturing in the South/Southeast or deployment in the Midwest. Figure 10 shows the location of wind firms based on industry segment, who stated they have some or great difficulty finding qualified applicants. Figure 11 shows the location of wind firms based on industry segment who stated they do not have difficulty finding qualified applicants. Figure 12 combines these data sets into one map. Figure 10, Figure 11, and Figure 12 also show, by location, where the potential workforce has reported some, great, or no difficulty finding employment, respectively.

<sup>11</sup> The dots represented on the map show a firm’s headquarters or individual (nonheadquarters) location that independently answered the questionnaire. If a firm’s headquarters answered the questionnaire for their additional locations, then only the headquarters location is represented on the map.



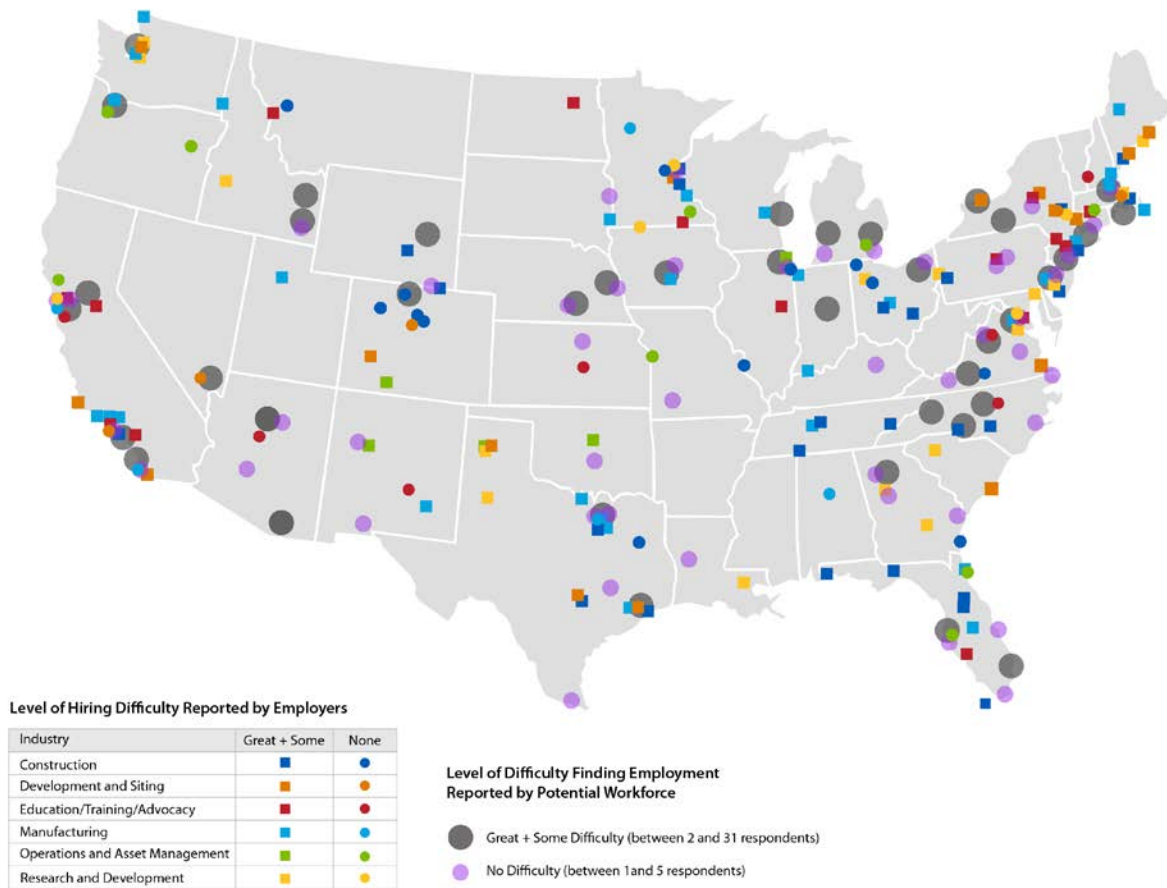
**Figure 10. Level of hiring and finding employment difficulty according to location, as reported by the potential workforce.<sup>12</sup> Image created by Jennifer Breen Martinez, NREL**

<sup>12</sup> This map only refers to the contiguous United States, excluding Alaska, Hawaii, and Puerto Rico.



**Figure 11. Level of hiring difficulty according to location, as reported by the potential workforce.<sup>13</sup>**  
*Image created by Jennifer Breen Martinez, NREL*

<sup>13</sup> Please refer to footnote 9.



**Figure 12. Level of difficulty according to location, as reported by both the wind industry and potential workforce for hiring or finding employment, respectively.<sup>14</sup> Image created by Jennifer Breen Martinez, NREL**

Figure 12 overlays industry employers who have reported some, great, or no difficulty in hiring by location, as well as the potential workforce who reported some, great, or no difficulty in finding employment by their location. This map shows difficulty levels to help identify the geographic disconnect between wind energy employers and those seeking employment.

### 2.1.3 Firm Size

Small wind firms [1 to 9 employees] reported the least total difficulty in hiring entry-level candidates (49% some and great difficulty). The level of difficulty is higher for both medium [10-49 employees] (80% some and great difficulty) and large-sized firms [50 employees or more] (82% some and great difficulty). For hiring nonentry-level candidates, small, medium, and large firms reported 52%, 83%, and 82% some or great difficulty hiring qualified applicants, respectively.

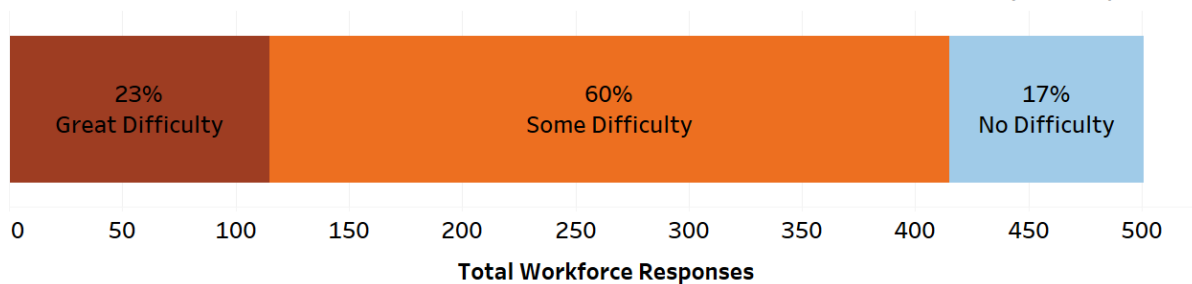
## 2.2 Total Workforce Difficulty

The total wind energy workforce (e.g., students and recent graduates from U.S. educational institutions including those working in the wind energy industry) reports difficulty finding

<sup>14</sup> Please refer to footnote 9.

employment opportunities. Those who searched for a career in the industry (500 respondents) reported great difficulty (23%) or some difficulty (60%) finding employment opportunities (Figure 13).

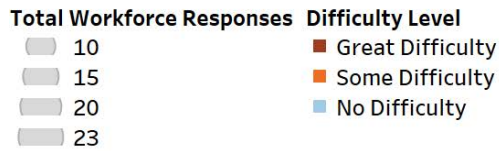
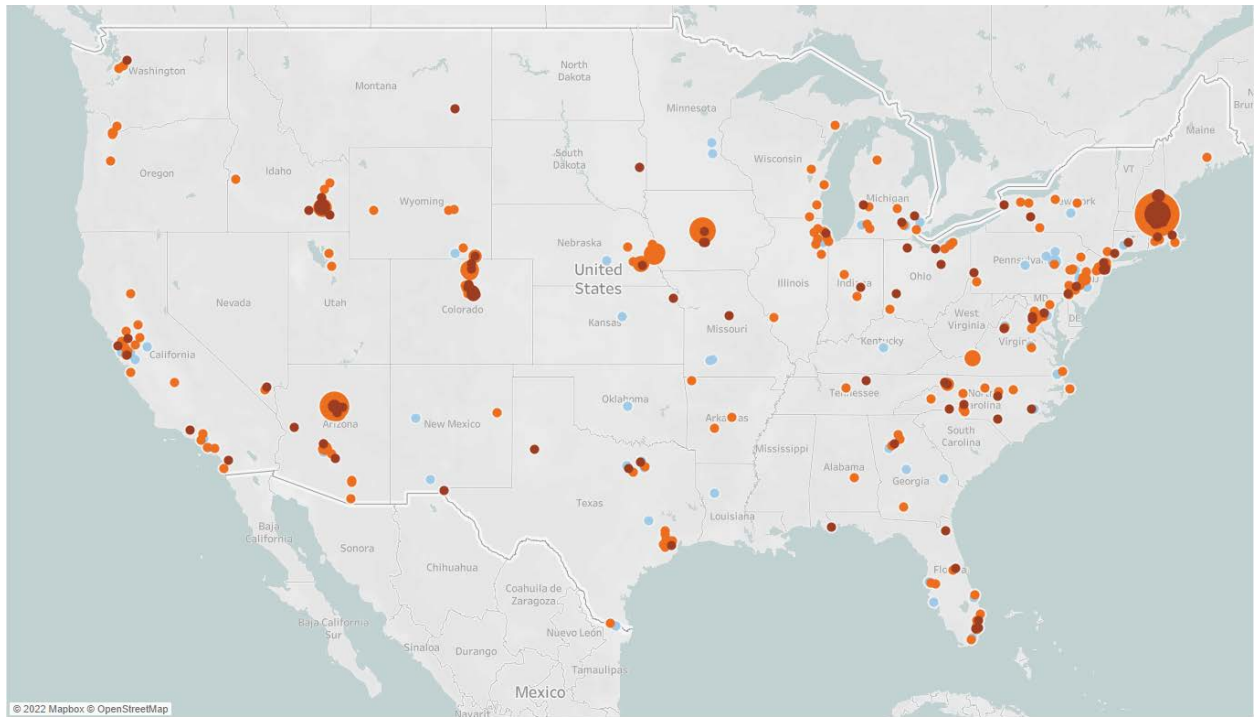
Please indicate if you feel finding employment opportunities is a great difficulty, some difficulty, or no difficulty for work in the wind energy industry. (n=500)



**Figure 13. Workforce respondents to the questionnaire reported difficulty finding jobs in the wind energy industry (83% total)**

Additionally, 244 out of 769 respondents had no job-searching experience for a position in the wind energy industry. Results show that students and recent graduates are significantly more likely to have interest in wind energy employment if they participated in a wind energy course, degree program, internship, or DOE-sponsored program.

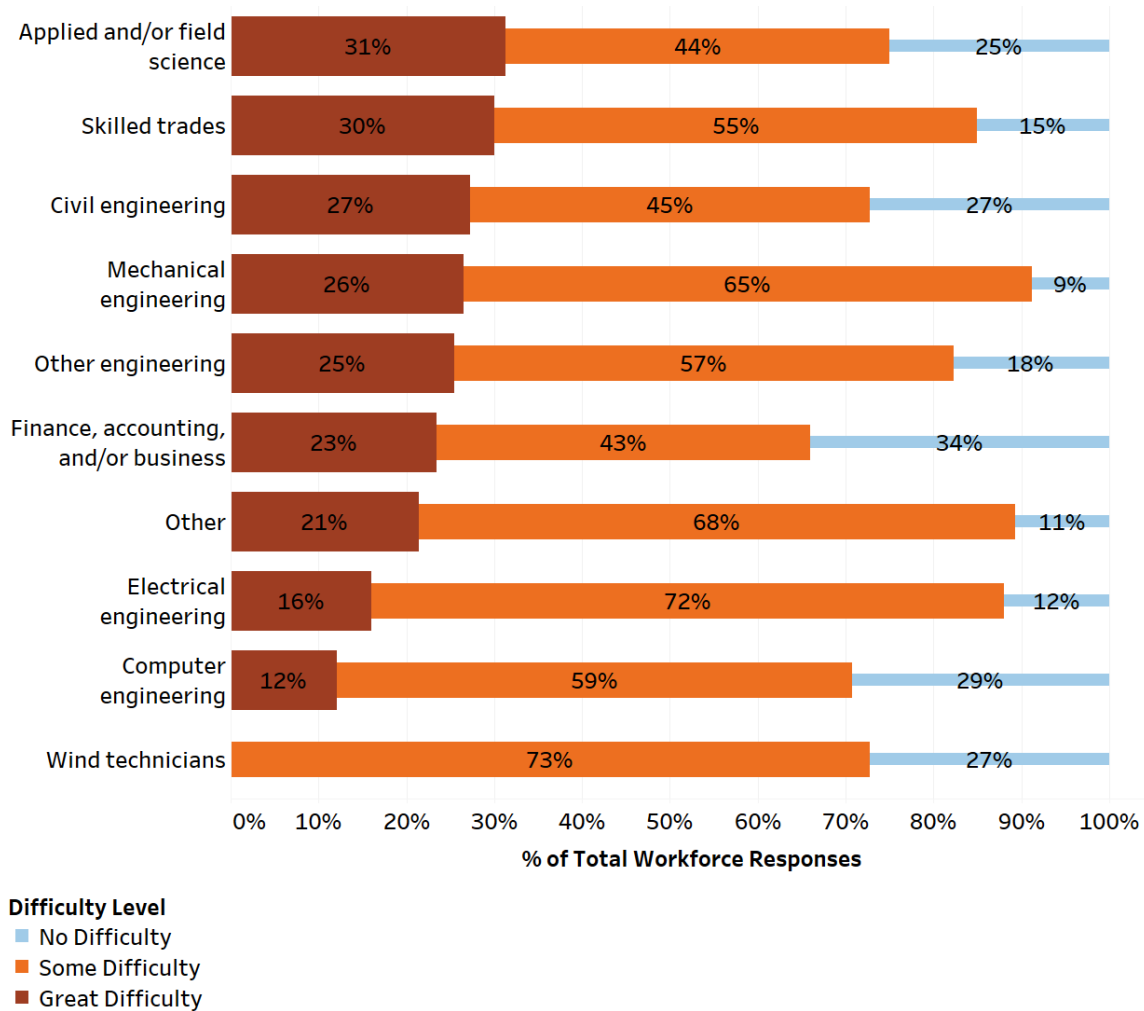
Geography plays a role in the workforce gap. Figure 14 shows that difficulty finding an employment opportunity is not limited to one region of the United States. Response clusters likely correspond to the location of educational institutions, but the assumption is that this workforce could be used within the region, or their education and training could be transferred to another area of the country—representing a national wind workforce gap from a total workforce perspective.



**Figure 14. The total workforce’s response when asked about the difficulty level of finding employment opportunities in the wind energy industry—the size of the circles indicates total number of responses by zip code<sup>15</sup>**

<sup>15</sup> Please refer to footnote 9.

What degree are you working towards? + Please indicate if you feel finding employment opportunities is a great difficulty, some difficulty, or no difficulty for work in the wind energy industry.



**Figure 15. Breakdown of the difficulty in finding wind energy jobs by currently enrolled students**

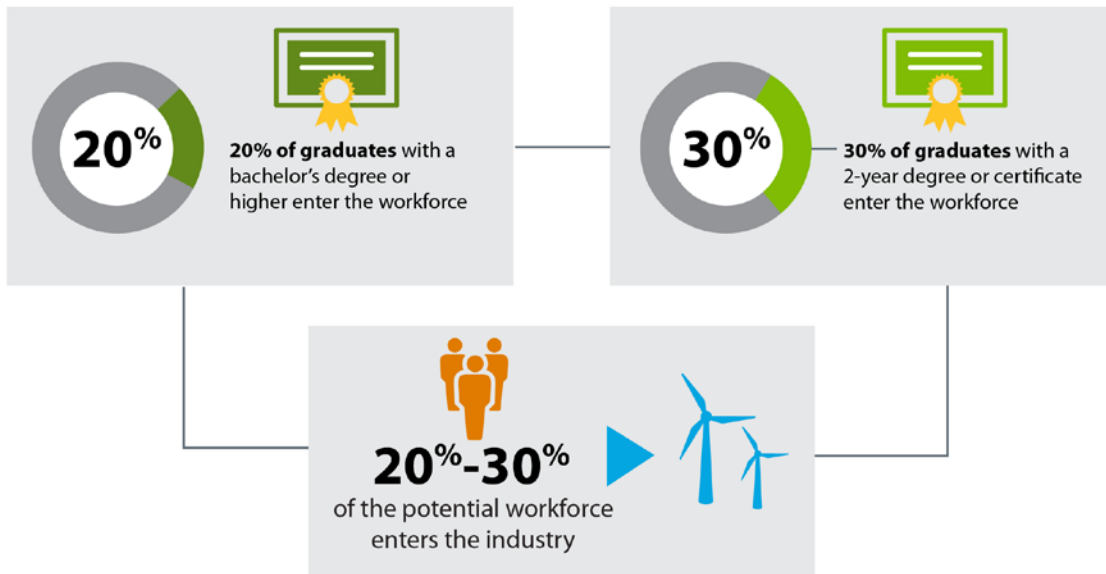
The total workforce’s level of difficulty in finding employment in the wind industry can also be broken down by various areas of study, as shown in Figure 15.

Each industry segment requires specific training and skills to meet job roles. Understanding how students in different areas of study can connect with the industry is critical to reducing the wind energy workforce gap. For example, industry segments, such as construction (which employs skill trades and civil engineers) and R&D (which employs engineers) both report high levels of difficulty in the workforce pathway.

### 2.3 Educational Institutions’ Difficulty

Engagement with educational and training programs within the United States that focus on wind energy curricula indicates more than 67% of students on average who attend wind energy education and training programs do not enter the wind industry (Keyser and Tegen 2019). Figure 16 summarizes responses about graduates from educational institutions that have a specific wind

energy program, or renewable-energy-specific program with a wind component. Of the 52 educational institutions that responded, 34 offer 2-year degrees or certificate programs, and 18 offer bachelor's degree and higher programs. Graduates with a bachelor's degree or higher or those with a 2-year degree or certificate enter the wind workforce at an average rate of 20% and 30%, respectively. Having only 20%–30% of graduates enter the wind energy industry indicates that there is opportunity for improvement when connecting potential workers with career pathways.



**Figure 16. Education institutions report that most graduates from wind- or renewable-energy-specific programs do not enter the wind energy industry. Image created by Jennifer Breen Martinez, NREL**

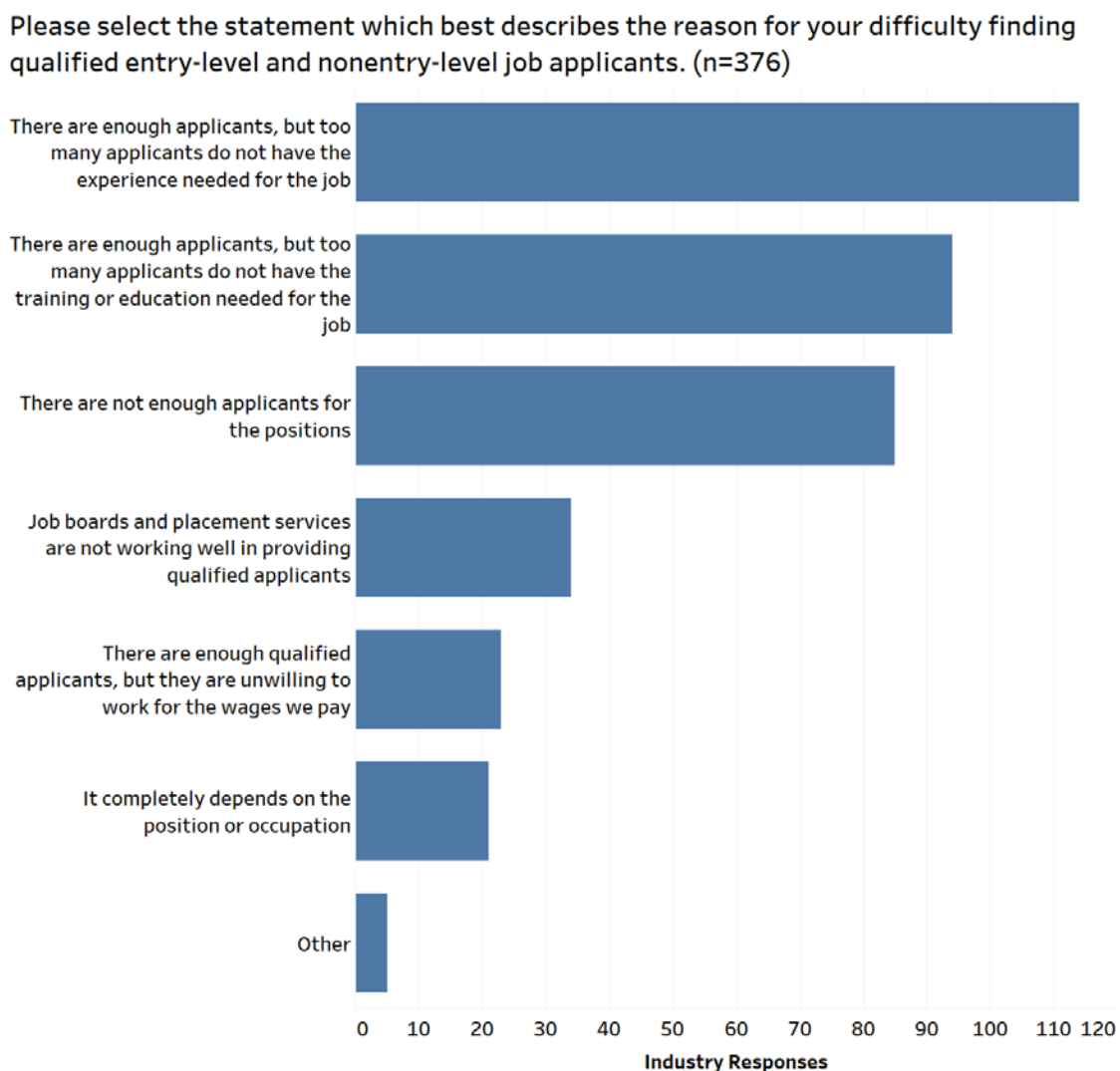
The wind industry reports hiring difficulty, the workforce reports difficulty finding opportunities, and educational institutions report difficulty placing graduates into wind energy careers. To facilitate pathways into the wind energy workforce, students and jobseekers need assistance connecting to employers. Insights into the workforce gap confirm the need for all stakeholders to ensure that an adequate workforce is available to meet industry demand.



### 3 What Are the Reasons for the Gap?

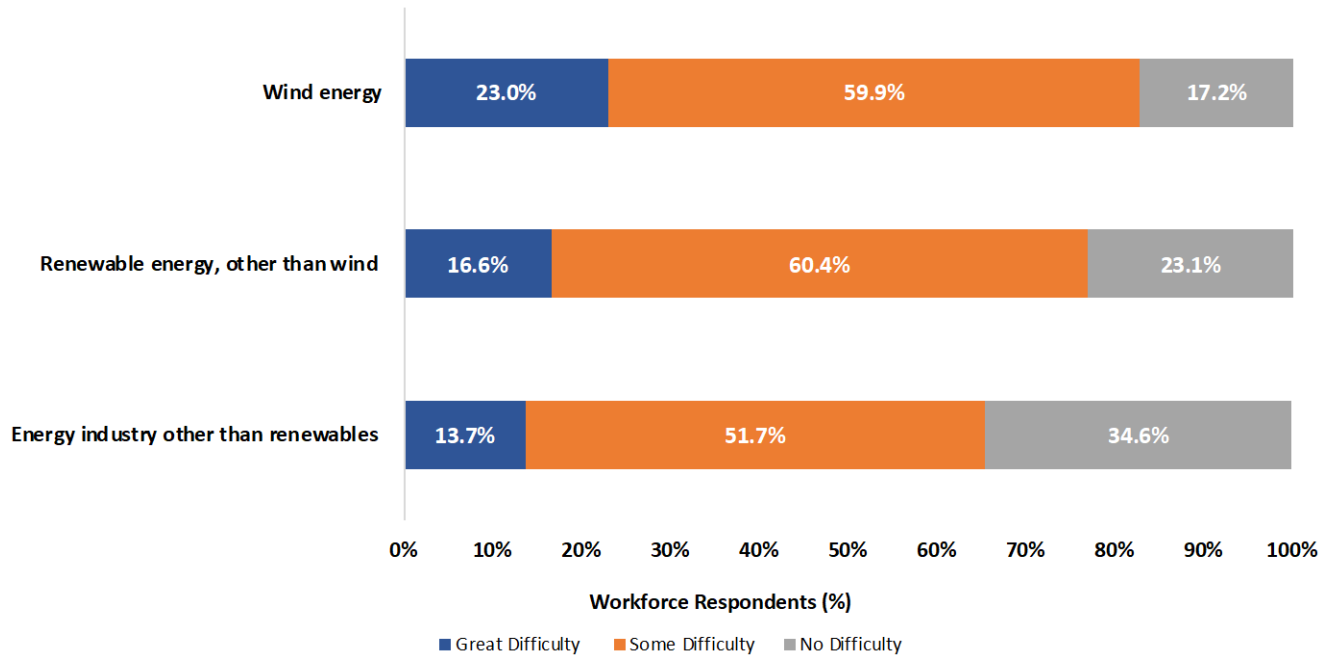
The reasons for the wind energy workforce gap, as identified through questionnaire responses from wind energy employers and the workforce, include educational, experience, and geographic factors. Understanding these reasons is critical to overcoming barriers to wind energy workforce development.

Wind energy employers were asked about their difficulty in finding qualified job applicants. Figure 17 shows the top reasons as identified by industry for both entry- and nonentry-level job applicants. Education and training, experience, and too few applicants were the top reasons for both types of applicants.



**Figure 17. The top reasons for hiring difficulty for wind industry employers include experience, education or training, and not enough applicants**

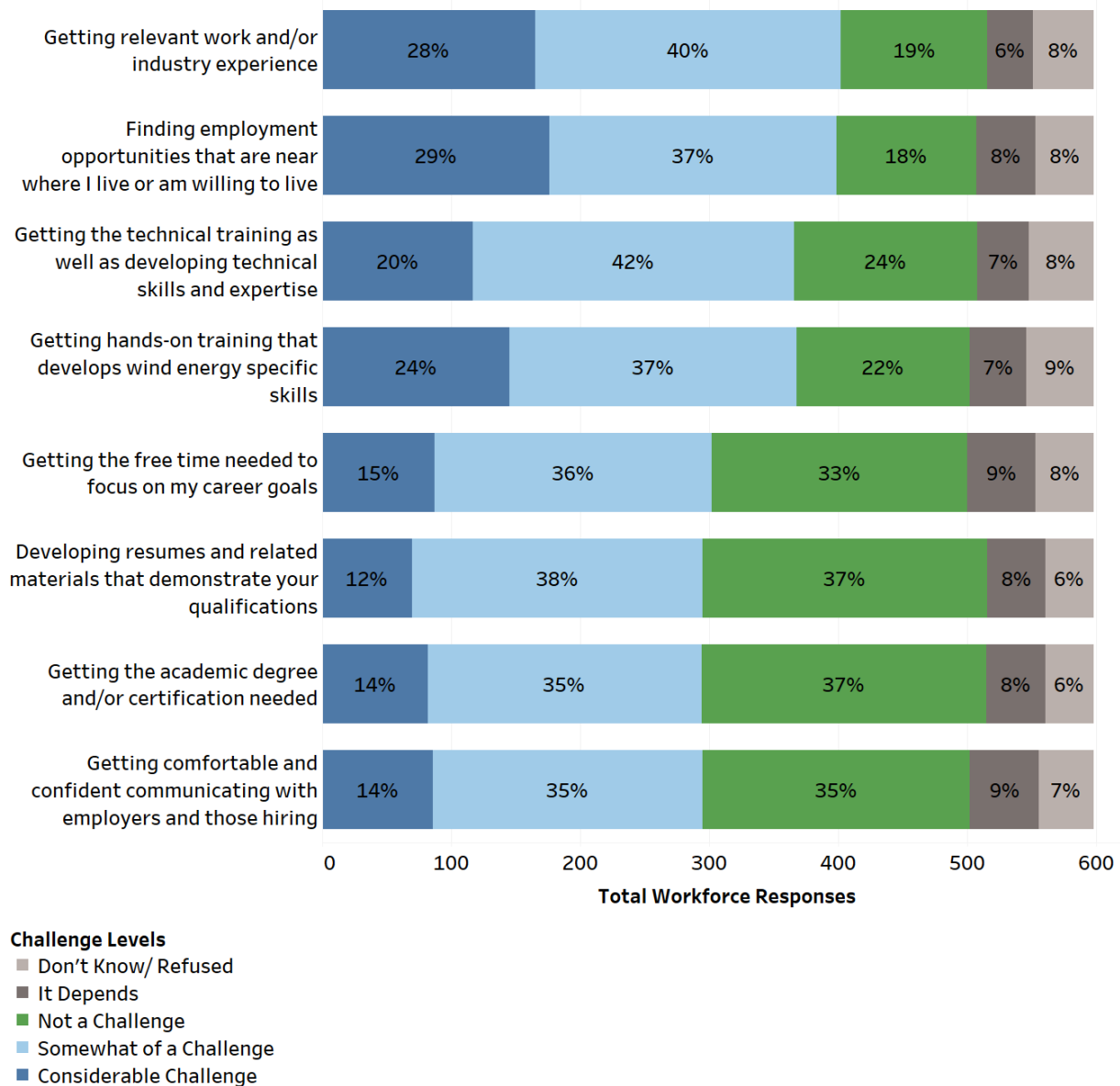
The total workforce was asked about their challenges with finding relevant work opportunities in the wind energy industry. As shown in Figure 18, of the respondents that had searched for employment in an energy industry sector, 83% had difficulty finding opportunities in wind energy, compared to those who had searched for opportunities in renewable energy other than wind (77%) and those who had searched for opportunities in energy other than renewables (65%).



**Figure 18. Difficulty finding employment opportunities by energy industry**

Figure 19 shows the top employment obstacles as experienced by the total workforce. Similar to wind energy employers, the total wind workforce is challenged by education and training, experience, and geography, or the ability to find a job that is located near where they live or would be willing to live.

What have been the challenges or obstacles you faced finding relevant work opportunities in the wind energy industry? (n=600)



**Figure 19. Challenges and obstacles experienced by the total wind workforce**

Other factors influencing the workforce gap include international hiring as well as the connections, or lack thereof, between the potential workforce, industry, and educational institutions.

### 3.1 Experience

Experience was the top challenge for wind energy employers hiring nonentry-level applicants. This reason was also the top challenge for the total workforce when combining responses for both considerable and somewhat of a challenge.

### 3.1.1 Industry

The challenge of finding applicants with the experience needed for a position was not reported by all sectors or firm sizes in the industry equally, and the level of challenge also depended on whether the firm was looking for an entry- or nonentry-level position.

Experience was a challenge for more than one-quarter of all wind industry firms looking for entry- (27.6%) and nonentry-level (33%) job applicants. As shown in Table 3, the operations and asset management sector had the most difficulty finding entry-level applicants with relevant experience, whereas manufacturing, education/training/advocacy, and development and siting were the most challenged with finding experienced nonentry-level job applicants.

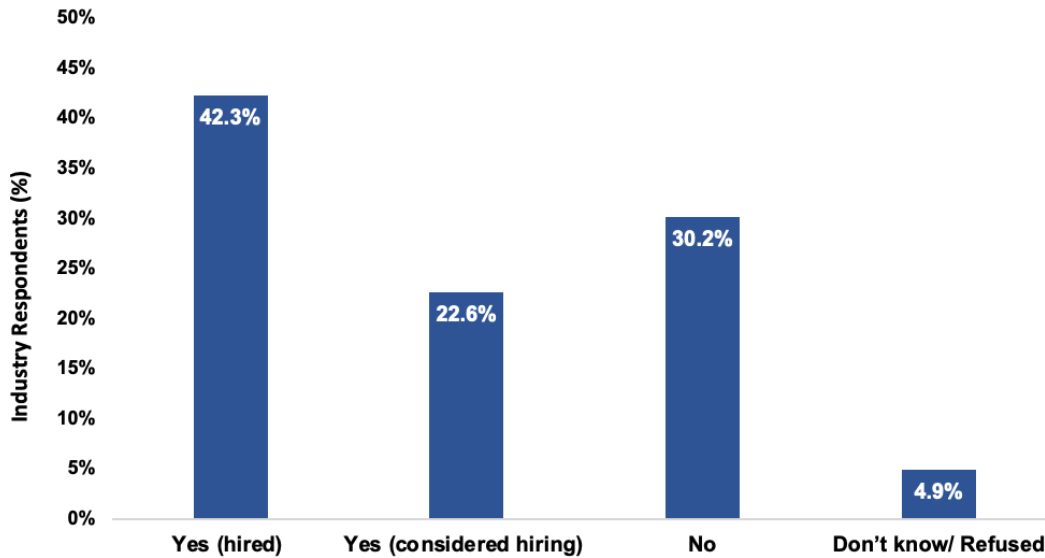
**Table 3. Top Reasons for Difficulty Hiring Entry- and Nonentry-Level Applicants by Industry Sector, Highlighting Experience**

	Top Reasons for Hiring Difficulty	
	Entry Level	Nonentry Level
<b>Manufacturing</b>	There are enough applicants, but too many do not have the training or education needed for the job	There are enough applicants, but too many do not have the <b>experience</b> needed for the job
<b>Research and development</b>	There are enough applicants, but too many do not have the training or education needed for the job	There are enough applicants, but too many do not have the training or education needed for the job
<b>Education/training/advocacy</b>	There are not enough applicants for the positions	There are enough applicants, but too many do not have the <b>experience</b> needed for the job
<b>Construction</b>	There are not enough applicants for the positions	There are not enough applicants for the positions
<b>Development and siting</b>	There are enough applicants, but too many do not have the training or education needed for the job	There are enough applicants, but too many do not have the <b>experience</b> needed for the job
<b>Operations and asset management</b>	There are enough applicants, but too many do not have the <b>experience</b> needed for the job	There are enough applicants, but too many do not have the training or education needed for the job

When looking at firm size, small firms (1-9 employees) cited experience as the top reason for difficulty in finding both qualified entry- and nonentry-level applicants. Medium-sized (10-49 employees) and large-sized (50 or more employees) firms both cited experience as the top reason for difficulty with finding nonentry-level applicants.

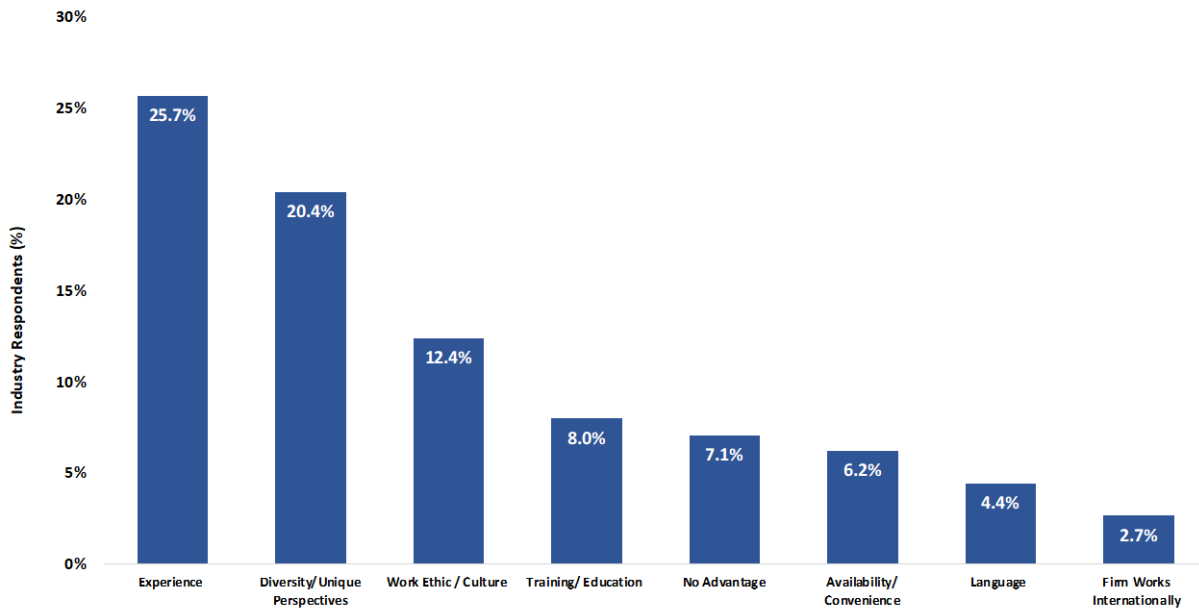
With the challenges that employers are facing in finding qualified job applicants, some U.S.-located firms are looking internationally to fill positions. Figure 20 shows that nearly two-thirds of wind energy firms have either hired individuals with experience or education outside the United States (42%) or have considered but not hired individuals with experience or education outside the country (23%). Additionally, medium-sized firms (52%) and large-sized firms (56%) were most likely to have hired these workers compared to small-sized firms (25%). At least half of wind energy manufacturers (56%), research and development firms (53%), and construction firms (50%) have hired individuals with experience or education outside of the country.

Has your firm hired or considered hiring applicants for wind-energy positions who have received education or industry experience outside of the United States for your U.S.-based wind positions?



**Figure 20. Occurrence of international hiring**

For those firms that had hired or considered hiring individuals from outside the United States, more than a quarter cited experience as the primary advantage to finding and recruiting workers (Figure 21).

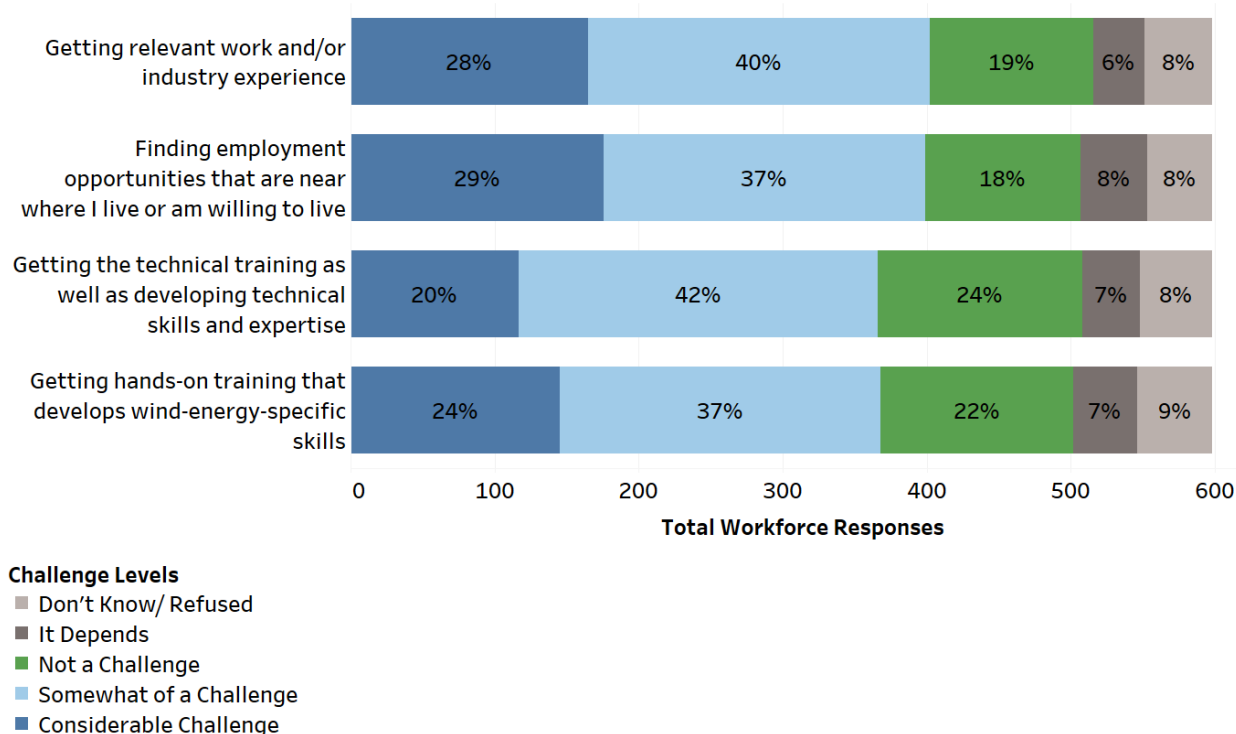


**Figure 21. Advantages of international hiring**

### 3.1.2 Workforce

Getting relevant work or industry experience was the greatest reported challenge for the total workforce survey respondents when combining considerable and somewhat of a challenge (Figure 22). Considering that experience is one of the industry’s top reasons for hiring difficulty (Table 3) and the most reported advantage to hiring international workers (Figure 21), it is important to better understand the level of experience needed and identify opportunities for the potential workforce to gain this experience to develop a qualified, domestic workforce.

What have been the challenges or obstacles you faced finding relevant work opportunities in the wind energy industry? (n=600)



**Figure 22. Top challenges or obstacles faced by the total workforce when searching for work opportunities in the wind energy industry**

### 3.2 Education and Training

Education and/or training was identified as a challenge for both employers and the total workforce. Employers reported difficulty finding qualified job applicants, whereas those in the total workforce that had actively sought a career in the wind energy industry reported difficulty getting hands-on training that develops wind-energy-specific skills.

Education and training are likely highly dependent on the skills and competencies required for each job. Because the wind industry needs to fill various job types across education levels, the specifics of education and training will vary across industry segments and occupations.

### 3.2.1 Industry

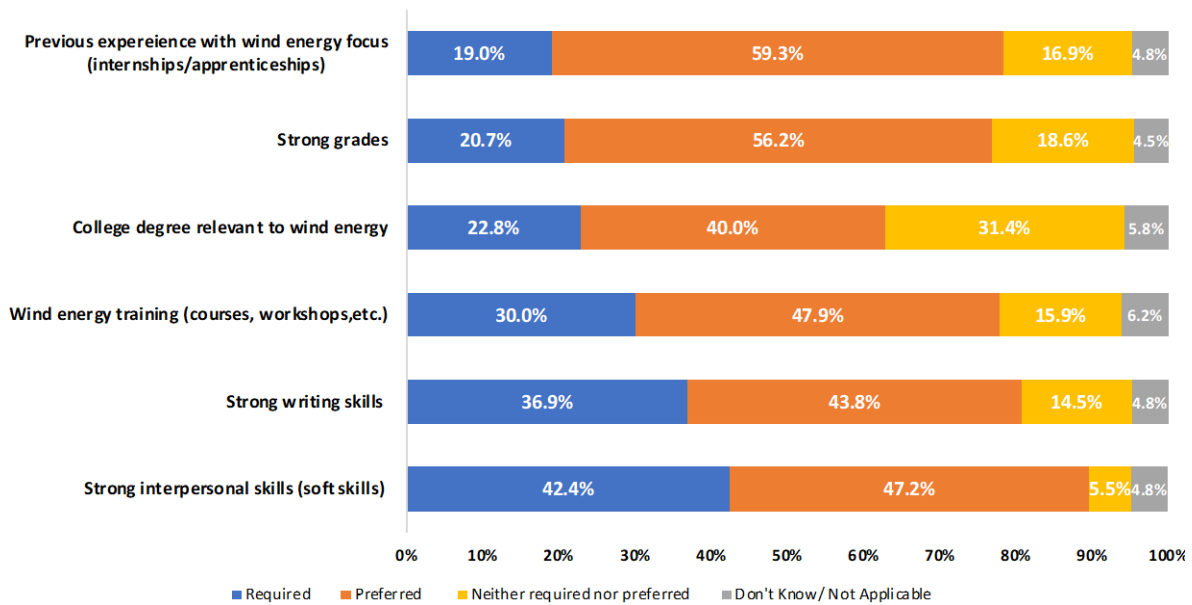
As with experience, the challenges to finding qualified applicants that had the training or education needed for a job varied according to industry sector, firm size, and whether the company was looking for entry- or nonentry-level applicants.

More than a quarter of responding firms indicated that “there are enough applicants, but too many applicants do not have the training or education needed for the job” (29.7%). When looking for entry-level applicants, training and education were the top reasons for hiring difficulty for manufacturing, R&D, and development and siting sectors. For nonentry-level positions, R&D, and operations and asset management sectors cited training and experience as their top reasons (see Table 4).

**Table 4. Reasons for Difficulty Hiring Qualified Applicants by Industry Sector, Highlighting Training and Education**

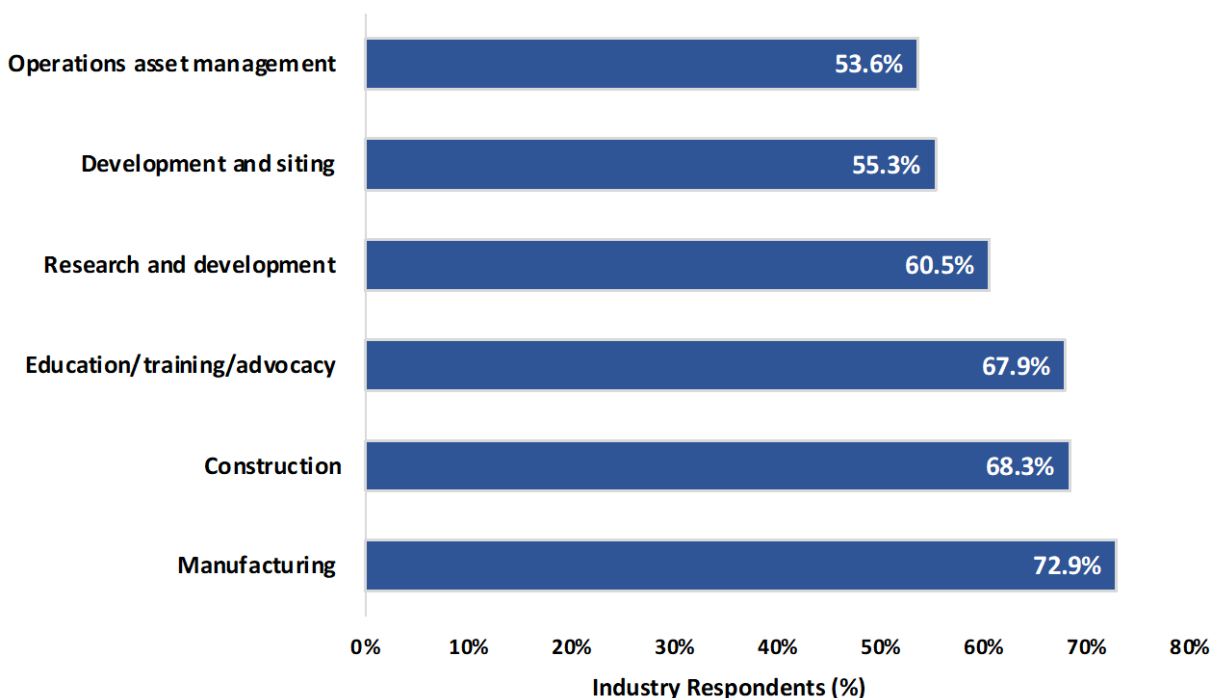
	Top Reason for Hiring Difficulty	
	Entry Level	Nonentry Level
<b>Manufacturing</b>	There are enough applicants, but too many do not have the <b>training or education</b> needed for the job	There are enough applicants, but too many do not have the experience needed for the job
<b>Research and development</b>	There are enough applicants, but too many do not have the <b>training or education</b> needed for the job	There are enough applicants, but too many do not have the <b>training or education</b> needed for the job
<b>Education/training/advocacy</b>	There are not enough applicants for the positions	There are enough applicants, but too many do not have the experience needed for the job
<b>Construction</b>	There are not enough applicants for the positions	There are not enough applicants for the positions
<b>Development and siting</b>	There are enough applicants, but too many do not have the <b>training or education</b> needed for the job	There are enough applicants, but too many do not have the experience needed for the job
<b>Operations and asset management</b>	There are enough applicants, but too many do not have the experience needed for the job	There are enough applicants, but too many do not have the <b>training or education</b> needed for the job

Figure 23 shows that when looking for entry-level wind applicants, more than 60% of all respondents required or preferred wind-energy-specific training (77.9%) or a college degree relevant to wind energy (62.8%). Additionally, participating in an internship or apprenticeship program with a wind energy focus was highly ranked. These types of programs help meet both the industry need for experienced applicants, but also an adequately trained workforce.



**Figure 23. Hiring priorities for entry-level wind applicants**

Some firms (62.6%) meet their workforce needs by offering in-house training courses or programs that are specific to wind-energy-related work. When looking at individual sectors of the wind industry, more than half of all sectors offer in-house training, with manufacturing providing the most in-house opportunities (Figure 24).



**Figure 24. Industry sectors offering in-house training**



### 3.2.2 Workforce

In addition to gaining relevant job experience, current and potential workers identified getting hands-on training (62%) or technical training (61%) to develop skills and expertise as a challenge or obstacle when searching for relevant opportunities in the wind industry.

The industry’s requirements and preference for wind-specific education or training correspond to the challenges employers are facing finding qualified applicants.

### 3.3 Quantity of Applicants

Wind energy firms have identified another top reason for hiring difficulty: there are not enough applicants for available positions (Table 5). As shown in Figure 17, this was the third-highest reason among firms as they searched for both entry- and nonentry-level applicants. Table 5 shows the breakdown according to industry sector and experience level.

Construction and education/training/advocacy firms identified the number of applicants as their top reason for experiencing hiring difficulty. This was the case for both entry- and nonentry-level positions for each firm.

When reviewing responses by size, medium- (10-49 employees) and large-sized (50 or more employees) firms indicated that “there are not enough applicants for the positions” as the top reason for difficulty finding qualified entry-level applicants.

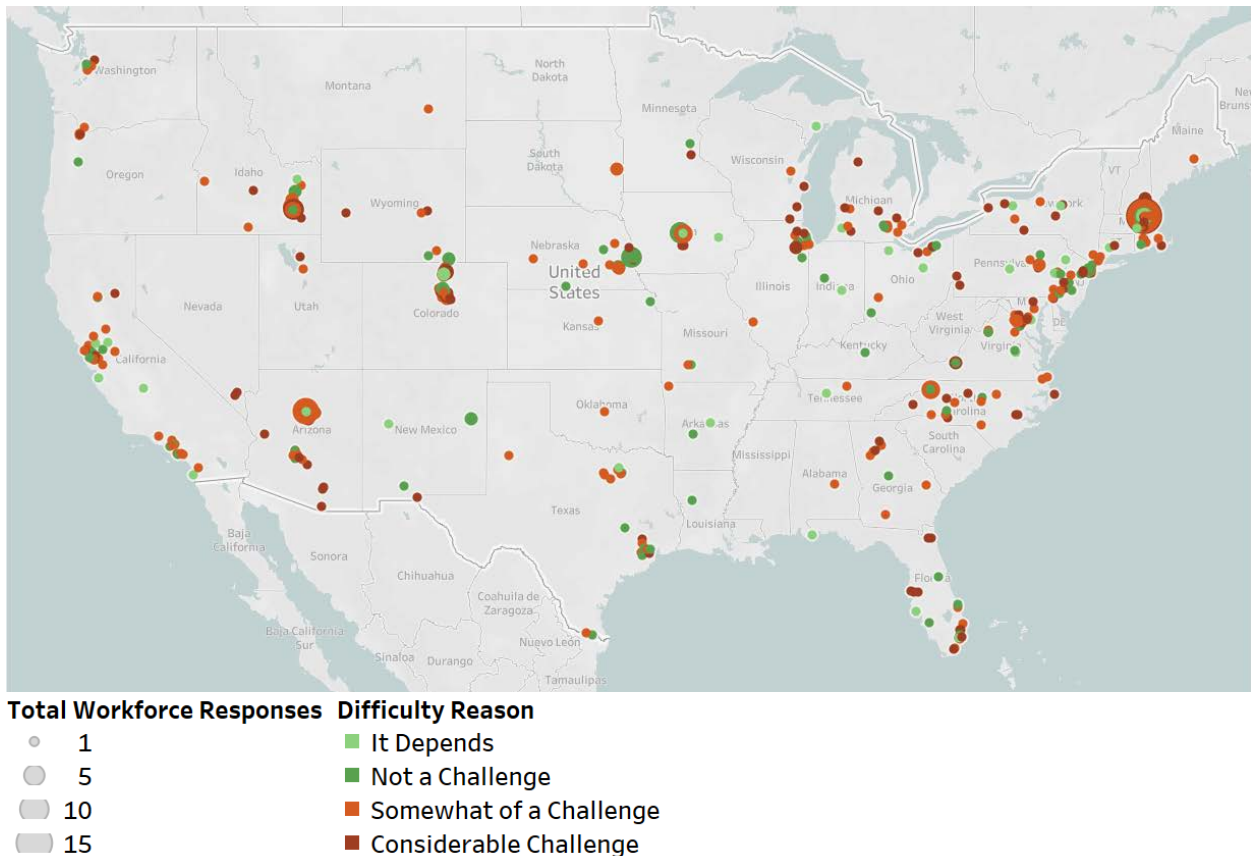
**Table 5. Reasons for Difficulty Hiring Qualified Applicants by Industry Sector, Highlighting the Response, “Not Enough Applicants”**

	Top Reasons for Hiring Difficulty	
	Entry Level	Nonentry Level
<b>Manufacturing</b>	There are enough applicants, but too many do not have the training or education needed for the job	There are enough applicants, but too many do not have the experience needed for the job
<b>Research and development</b>	There are enough applicants, but too many do not have the training or education needed for the job	There are enough applicants, but too many do not have the training or education needed for the job
<b>Education-Training-Advocacy</b>	There are <b>not enough applicants</b> for the positions	There are enough applicants, but too many do not have the experience needed for the job
<b>Construction</b>	There are <b>not enough applicants</b> for the positions	There are <b>not enough applicants</b> for the positions
<b>Development and siting</b>	There are enough applicants, but too many do not have the training or education needed for the job	There are enough applicants, but too many do not have the experience needed for the job
<b>Operations and asset management</b>	There are enough applicants, but too many do not have the experience needed for the job	There are enough applicants, but too many do not have the training or education needed for the job

### 3.4 Geography

The geographic location of jobs and finding employment opportunities where one lives or is willing to live was the second-highest ranked challenge for the potential workforce (67%) and the top challenge for the current workforce (64%). Figure 25 shows the geographic distribution of respondents in urban, suburban, and rural areas that had searched for wind energy employment opportunities.

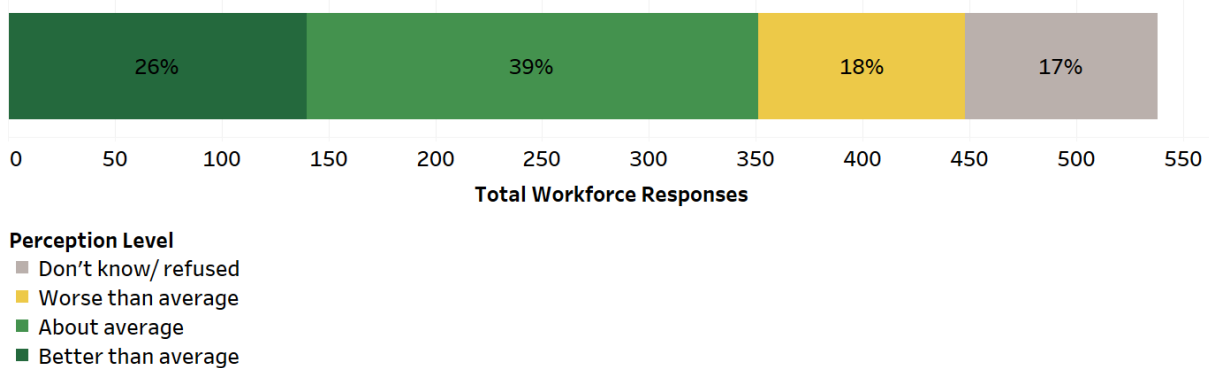
Respondents located in urban and suburban areas indicated that finding employment opportunities where they live or are willing to live is a considerable challenge (26%) at a higher rate than those who live in rural areas (19%).



**Figure 25. Location of respondents that indicated difficulty finding employment opportunities in the wind energy industry near where they live or are willing to live; the size of the circles indicates total number of responses by zip code<sup>16</sup>**

<sup>16</sup> Please refer to footnote 9.

For each of the following attributes of employment, please indicate if you feel the wind energy industry is better than average, about average, or worse than average when you compare it to working in other comparable industries? (n=538)



**Figure 26. Perceptions about attributes of employment in relation to the wind industry**

The physical location of where wind opportunities are located has been noted as a challenge by respondents. Compared to respondents’ perception of other industries, almost one in six (18%) indicated that the wind industry was worse than average in the opportunities it provides to work in locations they would like to live (Figure 26).

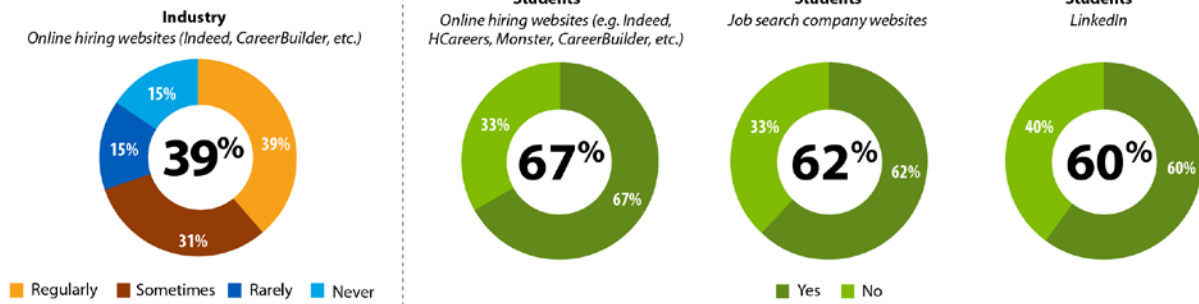
### 3.5 Connecting With the Wind Energy Workforce

Wind industry employers use job posting and recruitment sites as well as educational institutions to market employment opportunities for workforce candidates. Those in the workforce are also seeking opportunities through job postings and recruitment sites while also going directly to company websites for opportunities (Figure 27).

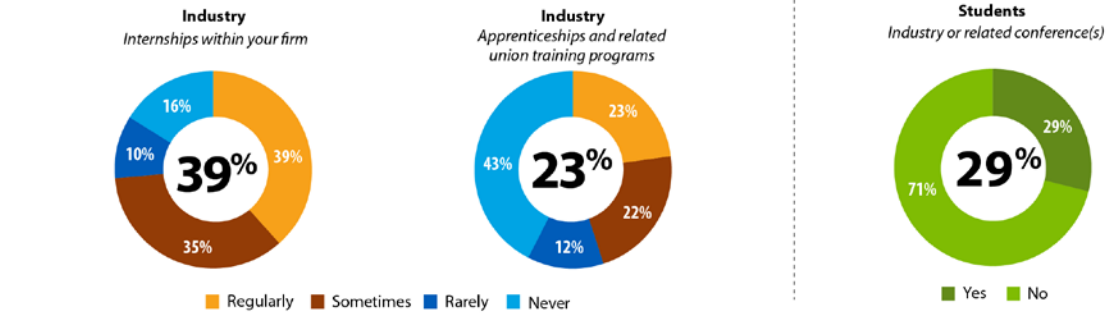
Figure 27 shows that 39% of respondents use job posting and recruitment sites to market the opportunities available to the workforce. Another 25% report that they work directly with educational institutions to hire graduates. While the industry and workforce were marketing and/or seeking opportunities through these web resources, 38% of surveyed industry partners promote internships within their firms. However, apprenticeships (including union and training programs) were not being used as workforce opportunities. Nearly 43% of respondents said they never use apprenticeships as tools for recruiting staff.

Internships and their unique employment-education hybrid nature are where the disconnect seems to be the most prevalent between industry and students. While 38% of industry respondents use internships within their firm to find qualified applicants, students may be participating in internships but did not indicate participation in the survey.

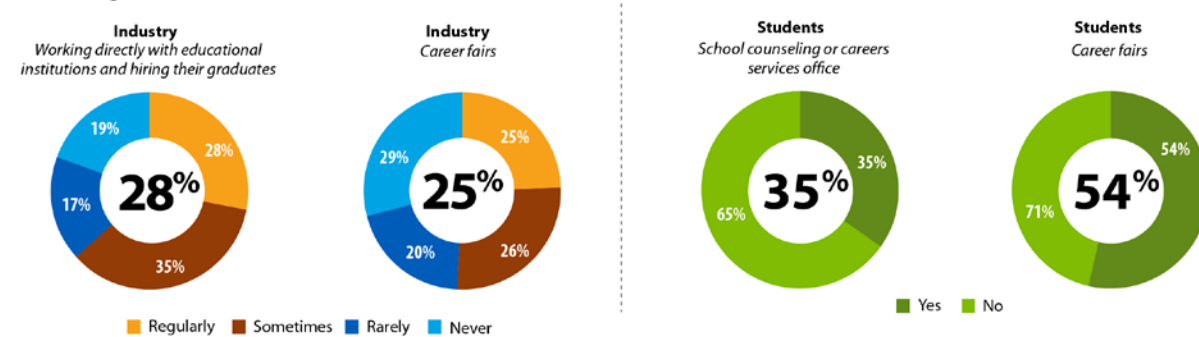
### Job Search Platforms



### Hiring Programs



### Connecting with Educational Institutions



### Networking

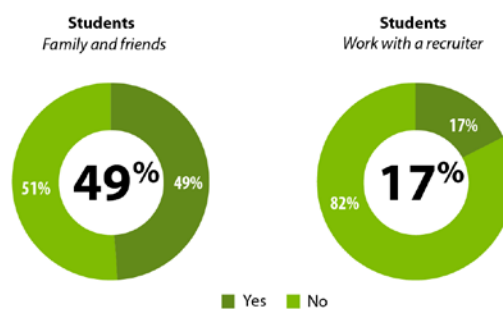
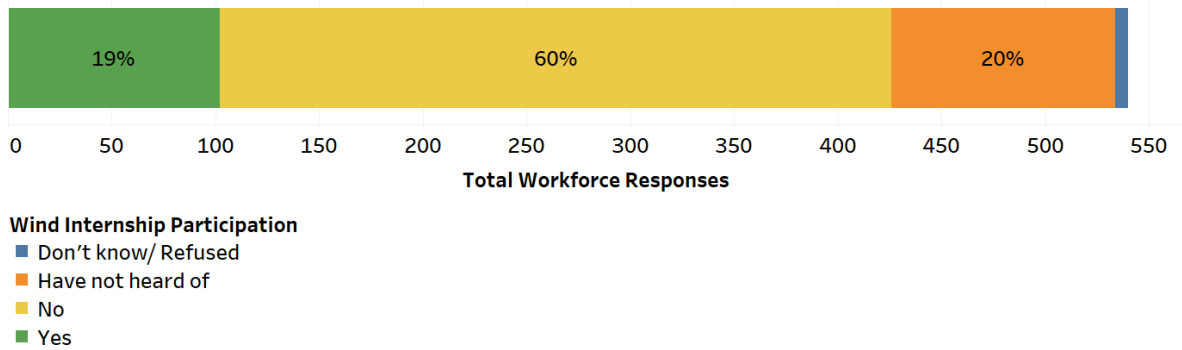


Figure 27. Understanding where employers look for applicants and where the workforce looks for jobs can help connect the wind industry workforce. Image created by Jennifer Breen Martinez, NREL

Sixty percent of total workforce respondents have not participated in internships within the wind industry. Only 19% participated in wind-industry-specific internship experiences. As Figure 28 shows, 20% of respondents had not heard of wind industry internship opportunities.

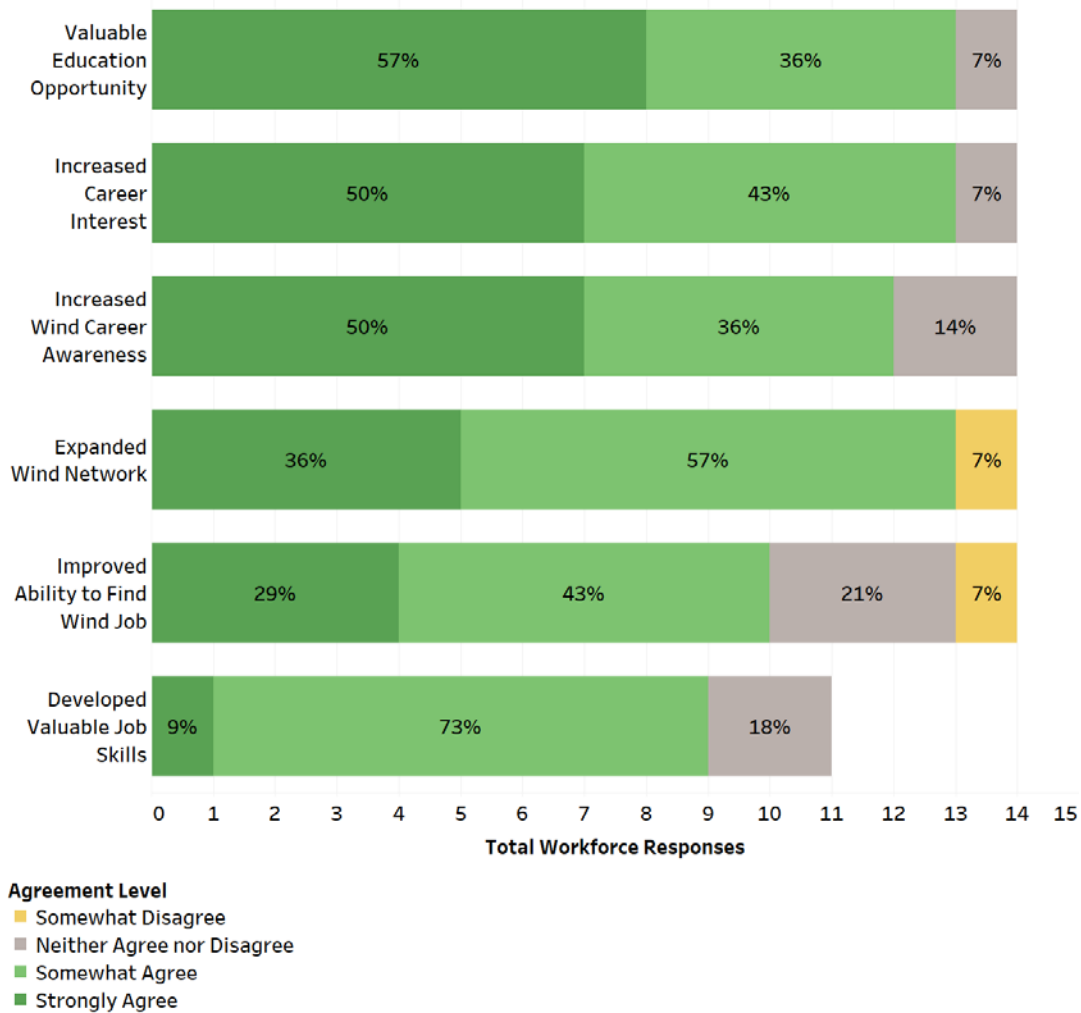
Please tell me if you are or have ever participated in an internship in the wind energy industry.



**Figure 28. Most student and recent graduate respondents have not participated in a wind energy internship**

Students find internships to be a valuable workforce pathway into the wind industry. However, with only 19% of respondents reporting their participation in an internship and only approximately 50% of those actually obtain employment in the industry, there is a notable gap between what industry offers students in this space.

For each of the following statements, please indicate if you agree, disagree, or neither as they relate to your experience with internships in the wind energy industry?



**Figure 29. Experience of those students or recent graduates who participated in a wind energy internship**

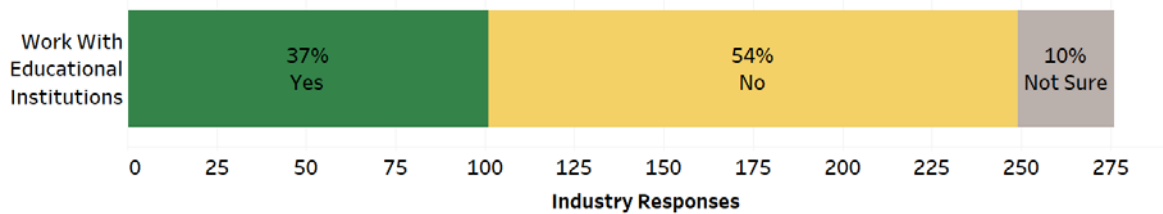
Figure 29 shows that skill development and ability to find a job seem to be areas of improvement for wind internship opportunities. These areas of improvement, combined with the fact that many students need paying internships, have geographic challenges, as well as other program-specific requirements that could contribute to the disconnect between industry offerings and potential workforce participation in wind industry internships.

### 3.6 Connecting With U.S. Wind Energy Educational Institutions

Improving the connection between U.S. educational institutions and their students is important to ensuring that highly qualified applicants connect with positions in the wind industry. Many educational programs offer courses, degrees, and other hands-on training with a focus on wind and renewable energy to provide the needed skills and competencies for wind industry occupations—including engineers, lawyers, wind technicians, and skilled trades.

The majority (54%) of industry respondents have not worked with or contacted a U.S. educational institution to find qualified candidates, which likely increases the disconnect between industry and students looking for positions in the wind industry (Figure 30). Additionally, just over half (54%) of the wind industry reported attending career fairs and 35% partner with university career offices (Figure 27).

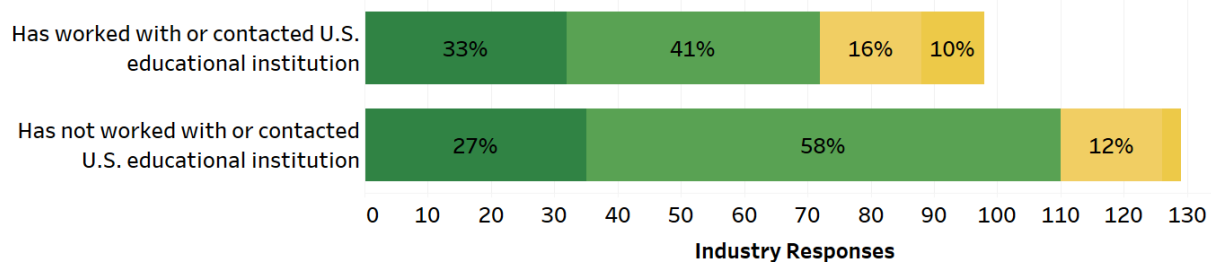
Has your firm worked with or contacted any U.S. universities, colleges, community colleges, technical schools, or other educational institutions about finding or developing qualified job candidates at your firm? (n=276)



**Figure 30. Industry respondents have not worked with or contacted a U.S. educational institution about connecting with or developing job candidates**

Overall, the wind energy industry is satisfied (73%) with U.S. educational institutions and universities focused on preparing the workforce and their ability to provide qualified workers for their firm, with only 18% reporting dissatisfaction. However, firms that have worked with or contacted postsecondary educational institutions about finding or developing qualified job candidates report a lower satisfaction rate with these institutions and their ability to provide qualified wind industry workers (Figure 31).

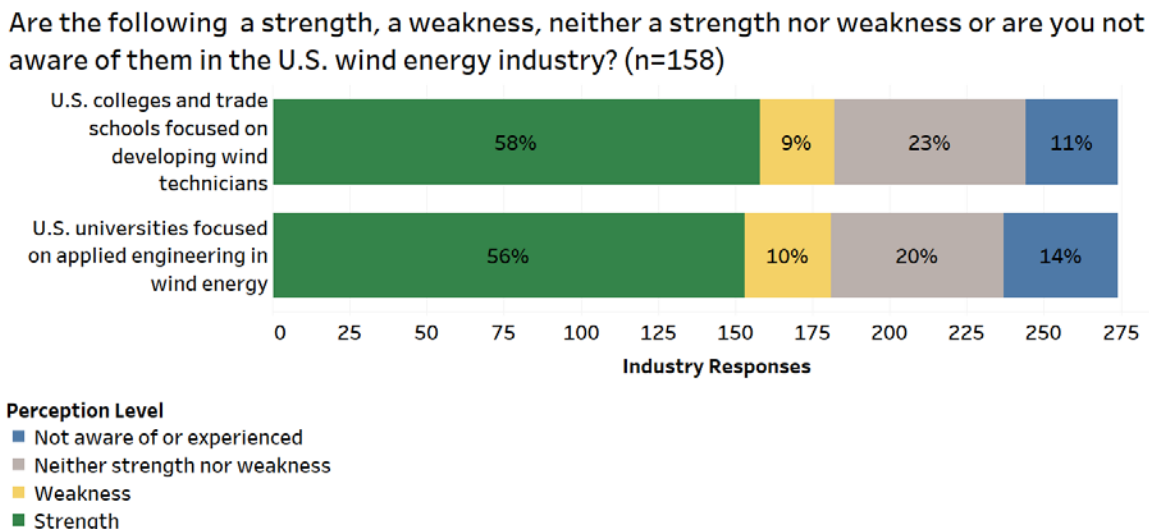
How satisfied are you with the U.S. educational institutions and universities focused on preparing people to work in the wind industry and their ability to provide qualified workers for your firm? (n=227)



**Satisfaction Level**  
 ■ Very dissatisfied  
 ■ Somewhat dissatisfied  
 ■ Somewhat satisfied  
 ■ Very satisfied

**Figure 31. Industry respondents' satisfaction level with U.S. education institutions' ability to provide qualified workers**

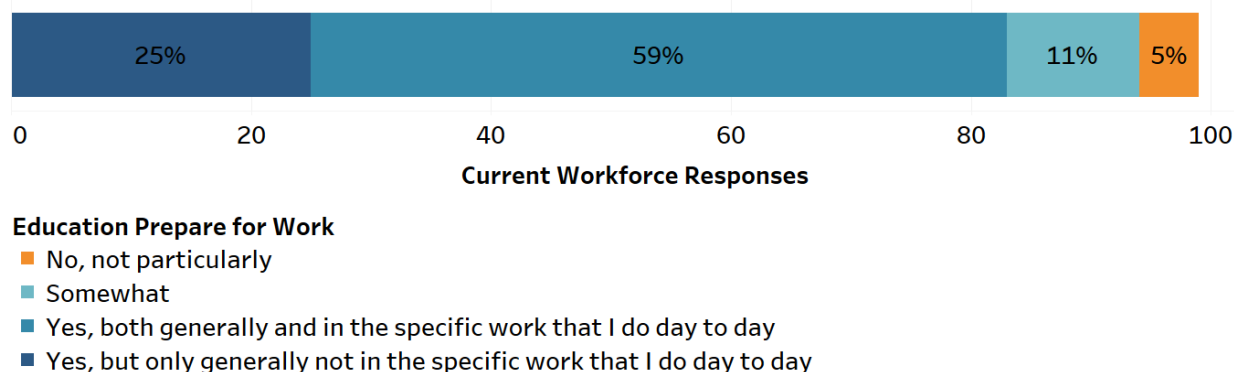
Industry respondents report that both college/trade school programs, designed to provide training for wind technicians and universities focused on applied engineering in wind energy, are strengths within educational and training opportunities (Figure 32).



**Figure 32. Industry reports wind-focused education opportunities are an overall strength**

The current workforce (students and recent graduates who currently work in the wind industry) report higher levels of education preparation in their current job roles than reported by industry respondents. Of the current wind energy workforce, 84% indicated that their education prepared them for the work they are doing today—either generally or in specific day-to-day tasks. More than half (59%) reported that their education prepared them for their current wind-energy-related work, both generally and in their specific day-to-day work (Figure 33).

Did your education prepare you for work in the wind industry? (n=99)

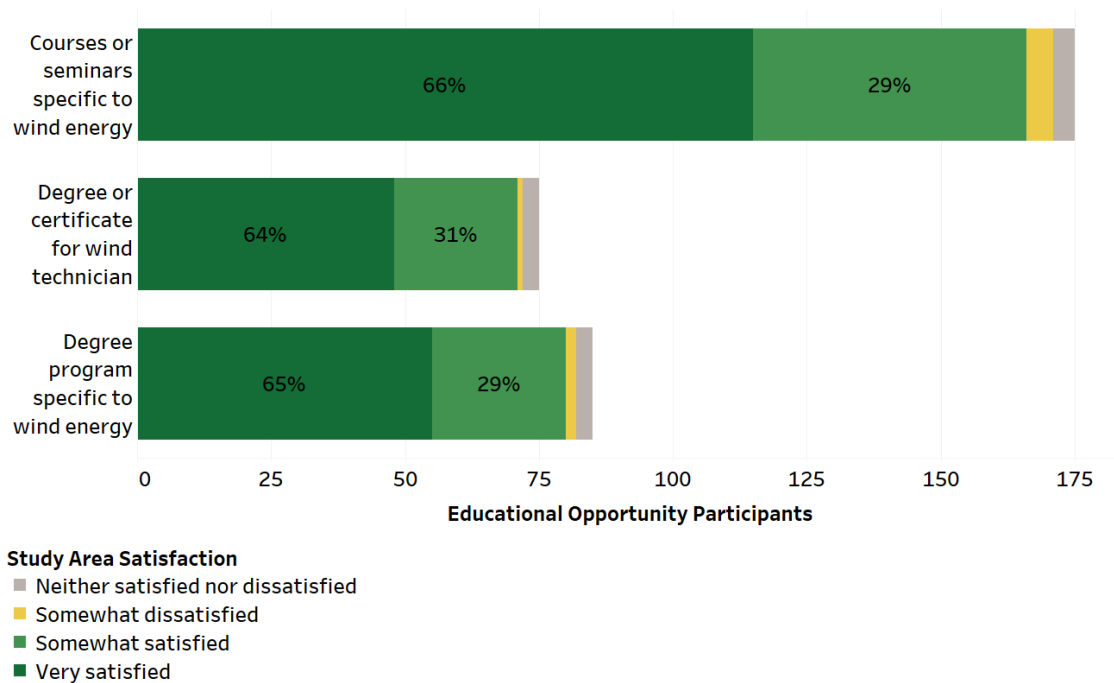


**Figure 33. Current wind energy workers feel their education has prepared them for their career**

Respondents that participated in wind-energy-related education opportunities (e.g., educational opportunity participants), such as courses or seminars, degree programs, and degrees/certificates specifically for wind technicians, also report high levels of satisfaction with their areas of study (Figure 34).



## Are you satisfied or dissatisfied with your primary area of study?

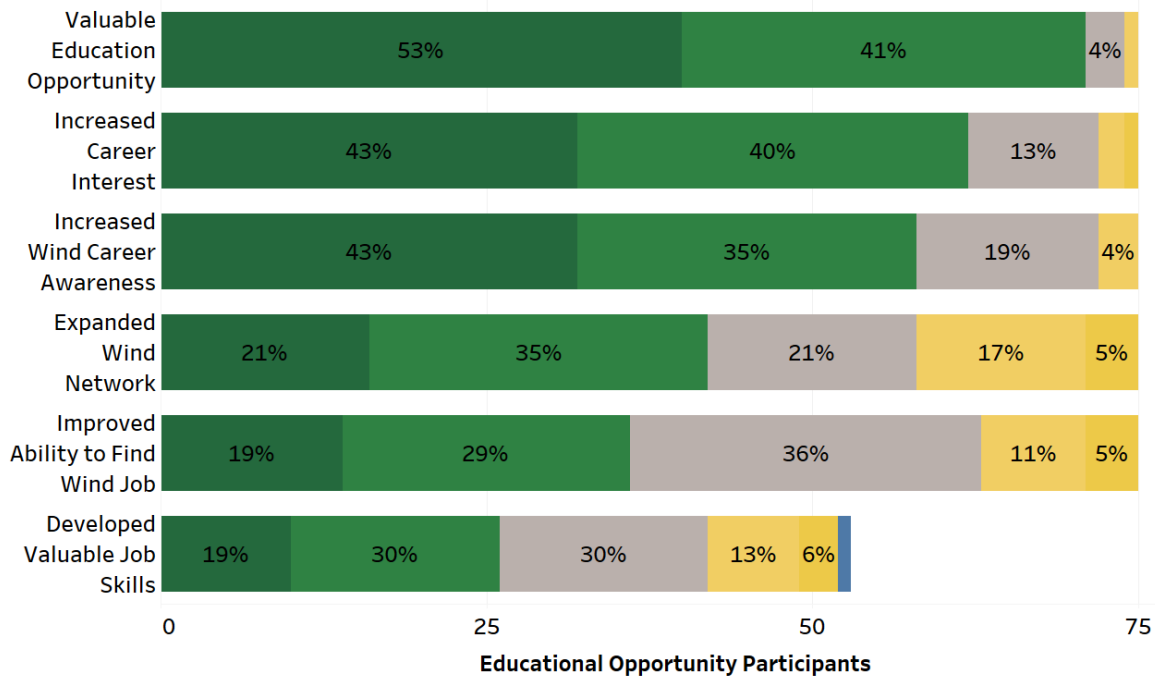


**Figure 34. Student satisfaction with their study area; results are categorized by education opportunities that respondents participated in**

Most students who have participated in courses or seminars specific to the wind industry report a high level of satisfaction (66% very and 29% somewhat) in their area of study. This area of study is not specific to one study area but could be a wide range of courses, such as engineering, business, policy, or law. The same holds true for degree programs. Yet, satisfaction of wind technicians may be more directly correlated to a wind-technician-specific associates degree or certificate program.

Respondents that participated in wind-energy-related education opportunities (e.g., educational opportunity participants) share that their experiences in wind-energy-related courses (Figure 35), degrees (Figure 36), and wind technician certificates/degrees (Figure 37) affected their educational experience in terms of “increased my interest in a career in the wind energy industry, improved my ability to find a job in the wind energy industry, expanded my network of people that I could connect with in the wind energy industry, developed valuable skills that I use in my current job, provided me a valuable educational opportunity, and increased my awareness of wind energy career opportunities.”

For each of the following statements, please indicate if you agree, disagree, or neither as they relate to your experience with courses or seminars specific to wind energy?

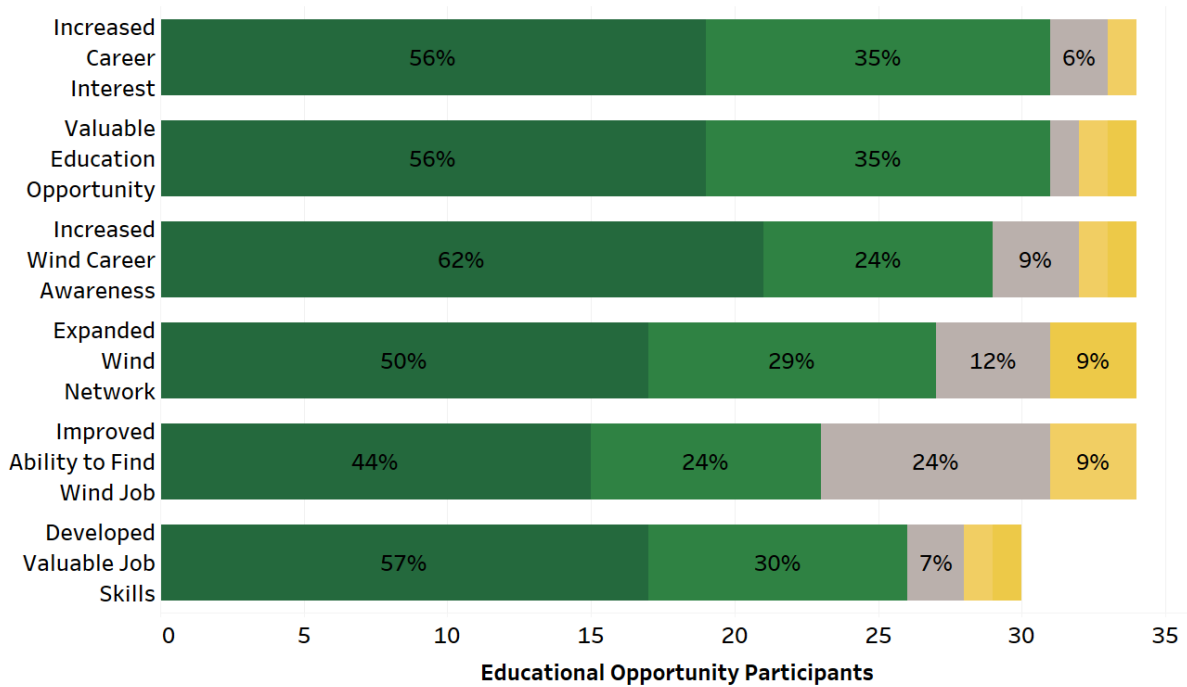


**Agreement Level**

- Don't Know/ Refused
- Strongly Disagree
- Somewhat Disagree
- Neither Agree nor Disagree
- Somewhat Agree
- Strongly Agree

**Figure 35. Wind energy courses rank highest in terms of a valuable education experience, increasing career interest, and awareness**

For each of the following statements, please indicate if you agree, disagree, or neither as they relate to your experience with a degree program specific to wind energy?

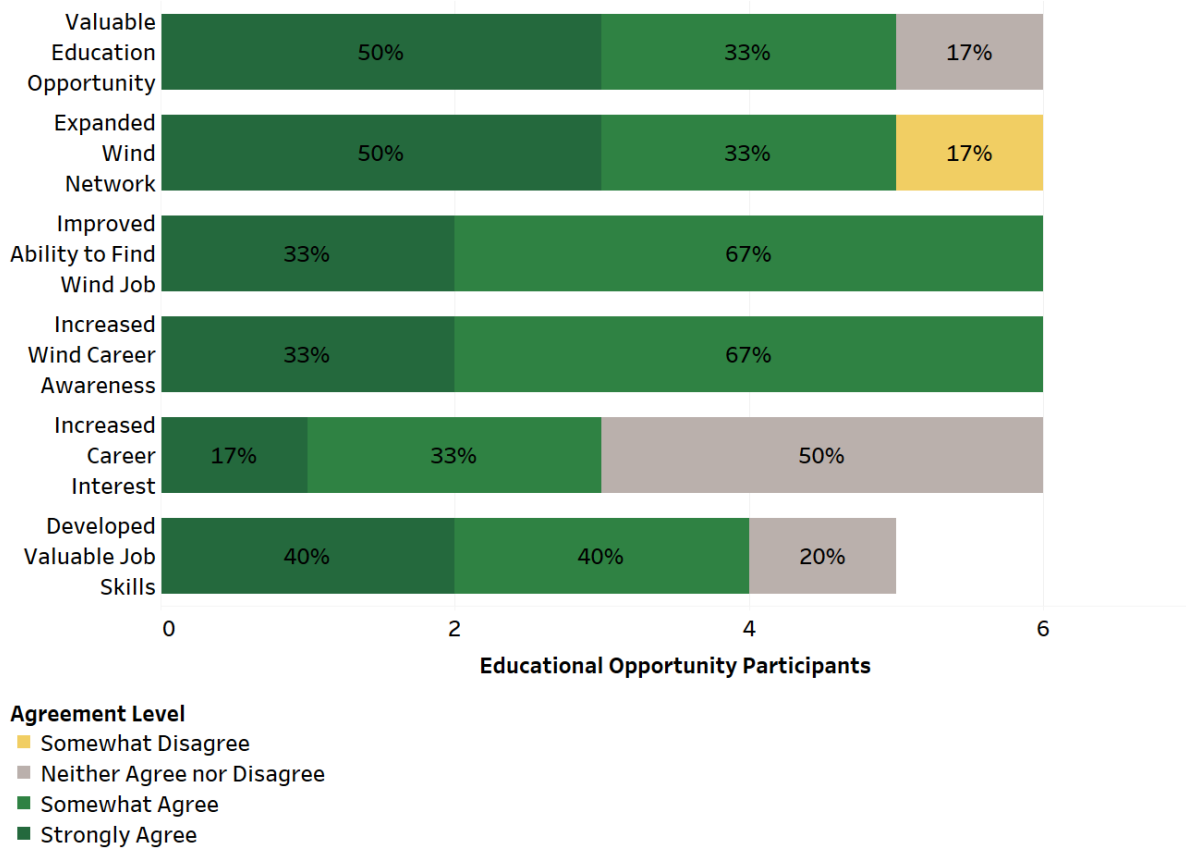


**Agreement Level**

- Strongly Disagree
- Somewhat Disagree
- Neither Agree nor Disagree
- Somewhat Agree
- Strongly Agree

**Figure 36. Wind energy degree programs rank highest in terms of a valuable education experience, increasing career interest, and developing valuable job skills**

For each of the following statements, please indicate if you agree, disagree, or neither as they relate to your experience with a degree or certificate for a wind technician?



**Figure 37. People with a wind technician certificate or degree rank highest in terms of ability to find a wind-energy-related job, have increased career awareness, and expanded their wind network<sup>17</sup>**

Overall, the U.S. wind industry could improve their connection with educational institutions in regions where employers are looking to hire, to ensure students have adequate education and training to fill job roles. Likewise, there is an opportunity for educational institutions to better communicate with students about how their knowledge and skills can be leveraged in the wind energy industry, especially because many current wind workers state their education prepared them for their career.

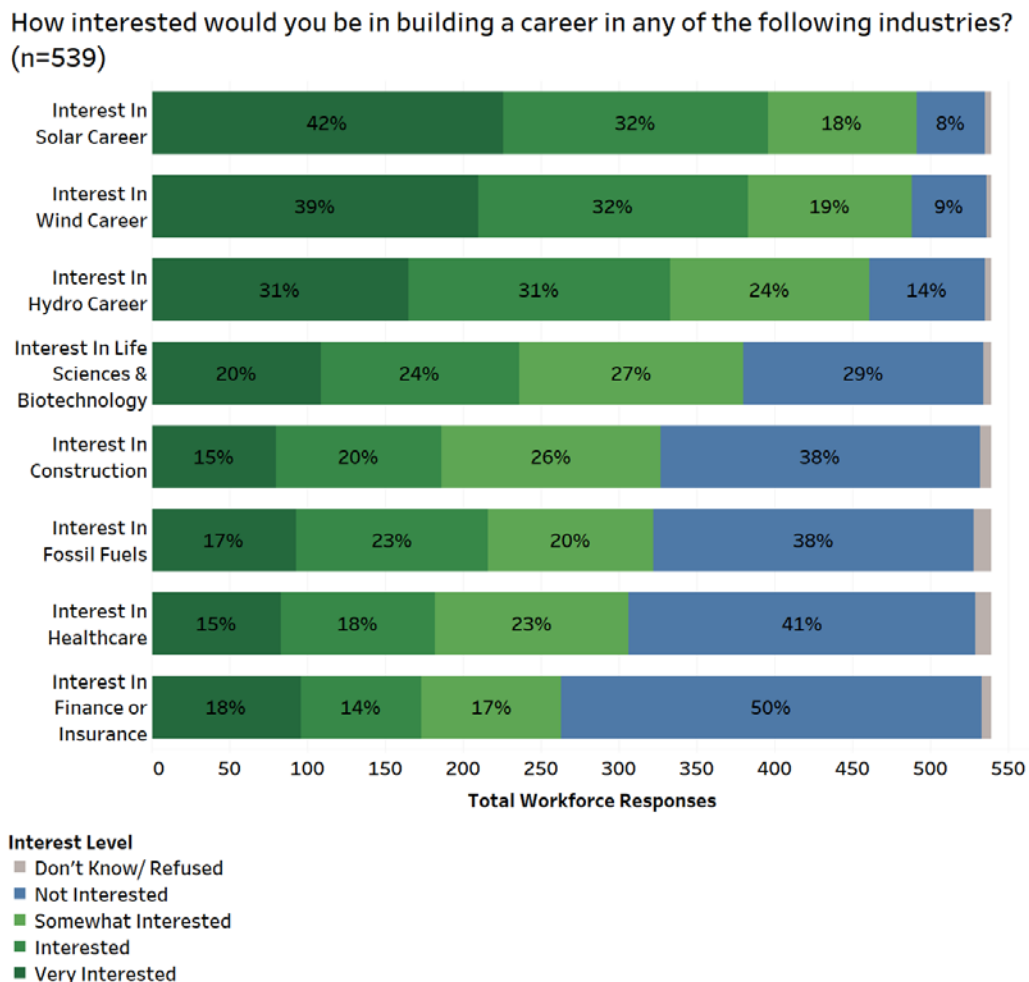
<sup>17</sup> Because of the small sample size relative to the industry workforce as a whole (n=6), these responses do not necessarily reflect characteristics of the entire workforce. However, this information does offer insight into how a small subset of people feel about their wind technician education.

## 4 Wind Energy Workforce Development Opportunities

By understanding the strengths and opportunities of the wind energy industry, we can overcome the challenges of the workforce gap to develop an adequate future workforce. Opportunities that could be leveraged in the wind industry for workforce development include the high student interest in wind careers, the positive perception of the U.S wind industry, established DOE-sponsored programs to support workforce development, and the ability to connect with the existing workforce.

### 4.1 Student Interest

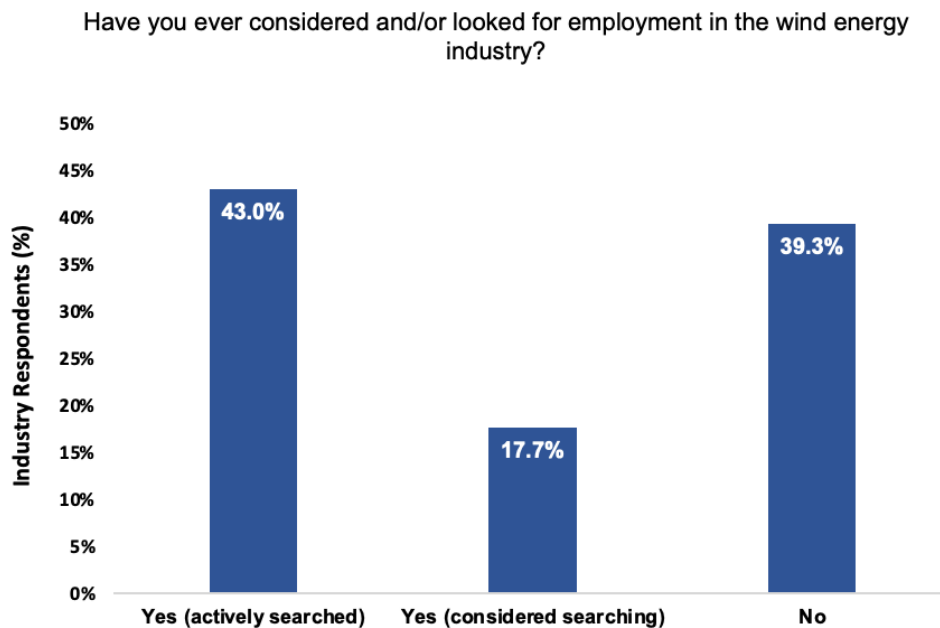
The interest level of students and recent graduates in building a wind-energy-related career indicates whether the industry has a sufficient workforce supply to meet the expected growth in land-based and offshore wind. Figure 38 shows the total interest among the total workforce (very interested and interested) in building a career in wind energy (91%) was nearly identical to solar energy (91%); both were at the top of the list when compared to other industry sectors.



**Figure 38. Interest levels across different industries show that careers in renewable energy are attractive to the workforce across U.S. education institutions**

There was significantly lower interest in fields such as fossil fuels and natural gas, and even less interest in the construction, healthcare, or finance industries as a place to build a career.

When specifically asked if the potential workforce had ever considered or looked for employment in the wind energy industry, about 61% indicated that they had considered working in the industry; however, only 18% reported that they have actively searched for jobs (Figure 39).

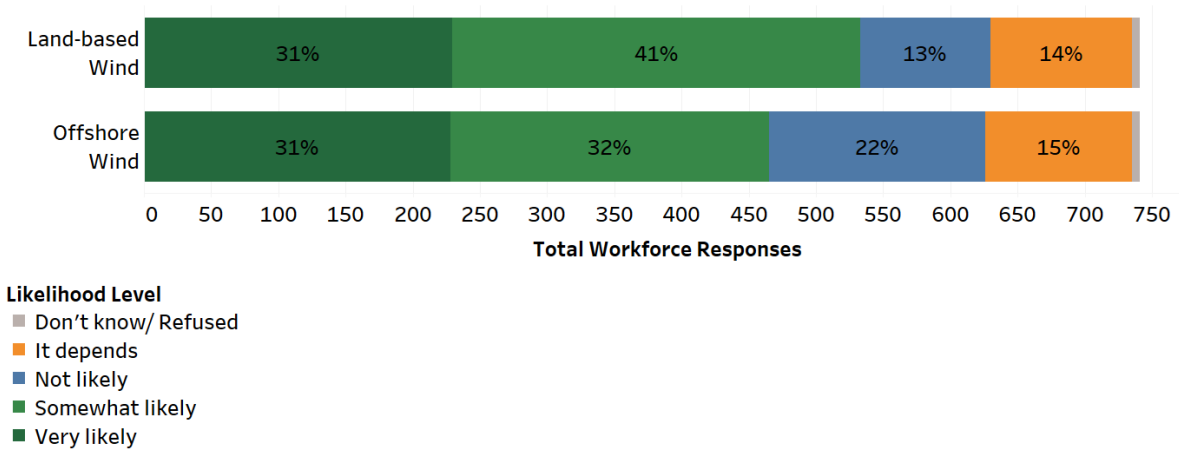


**Figure 39. Wind employment considerations for potential workers**

Potential or current workers who have either considered or actively searched for a job in the wind energy industry were looking for positions as an engineer (37%), wind technician (16%), intern or general entry-level position (11.0%), plant manager (7%), energy analyst (5%), legal, such as a lawyer or paralegal (4%), researcher (3%), sales representative (1%), cybersecurity (0.8%), or other position (9%).

Additionally, Figure 40 shows the total workforce reported a higher interest in seeking employment opportunities in the land-based wind energy industry (69%) than the offshore wind energy industry (61%). These results could indicate that more awareness may be needed around job opportunities for the emerging offshore wind industry.

If you were looking for a new employment opportunity and you saw a position in the wind energy industry, how likely are you to apply for it? (n=741)



**Figure 40. The likelihood that a member of the total workforce would apply for a land-based or offshore wind energy employment opportunity**

Ensuring that interested students and recent graduates connect with positions offered by the wind energy industry is important, even more so for the potential workforce that has direct experiences in wind-energy-focused educational programs. Table 6 shows the level of agreement from student or recent graduates who participated in a wind-energy-focused educational opportunity.

**Table 6. Agreement (Strongly Agree and Somewhat Agree) With the Statement Regarding a Wind-Specific Educational Opportunity and Industry Interest**

*For each of the following statements, please indicate if you agree, disagree, or neither as they relate to your experience in the following programs.*

	Degree Program Specific to Wind Energy	Internship in Wind Energy Industry	Courses/Seminars in Wind Energy
<b>Increased my interest in a career in the wind energy industry</b>	91.2%	92.9%	82.7%
<b>Increased my awareness of wind energy career opportunities</b>	85.3%	85.7%	77.3%

Respondents who considered or were interested in pursuing a career in the industry were more likely to participate or have participated in wind energy courses, classes, or degree/certificate programs. Current wind energy workers were much more likely to have been aware of and participated in wind energy programs and courses than potential workers.

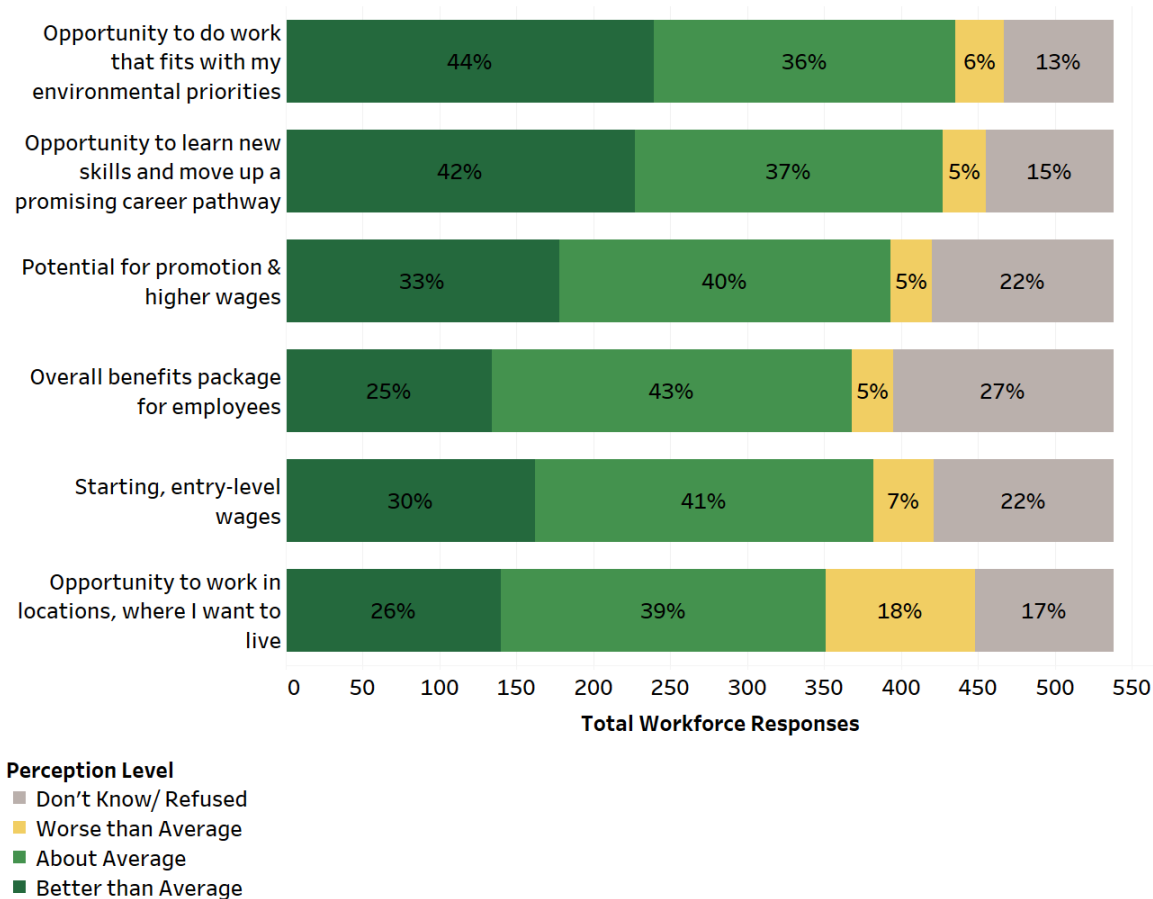
## 4.2 Wind Industry Perceptions

Potential and current employees indicate that their perception of the industry is better than average when thinking about working in a comparable industry. The two highest ranked

attributes are the “opportunity to learn new skills and move up a promising career pathway” (42%) and an “opportunity to do work that fits with my environmental priorities” (44%).

Figure 41 highlights the six characteristics of wind industry employment opportunities as evaluated by the total workforce. A ratio of approximately 8 to 1 respondents indicated the wind industry was better than average when compared to working in a comparable industry.

For each of the following attributes of employment, please indicate if you feel the wind energy industry is better than average, about average, or worse than average when you compare it to working in other comparable industries? (n=538)



**Figure 41. The potential workforce perceptions of employment in the wind industry versus other industries**

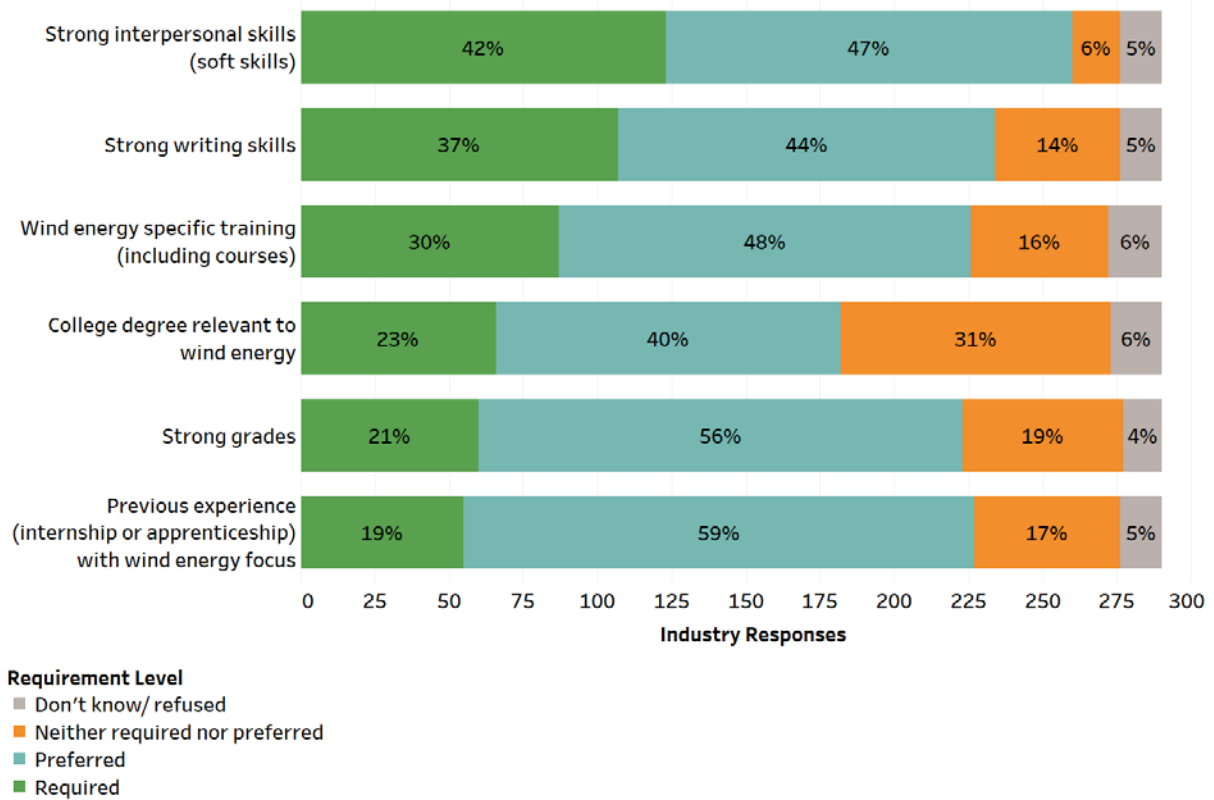
Students and recent graduates seeking employment in the wind energy industry should prioritize showcasing industry-related project work, skills, and technical coursework. It is those who can articulate and demonstrate their skills in building and maintaining strong relationships, as well as having strong writing skills, that will have a greater chance of employment as they seek roles in the wind industry (Figure 42).

Students should also consider the importance of an internship and/or apprenticeship experience in the wind industry as a pathway into a wind career. While the data shows only 19% of



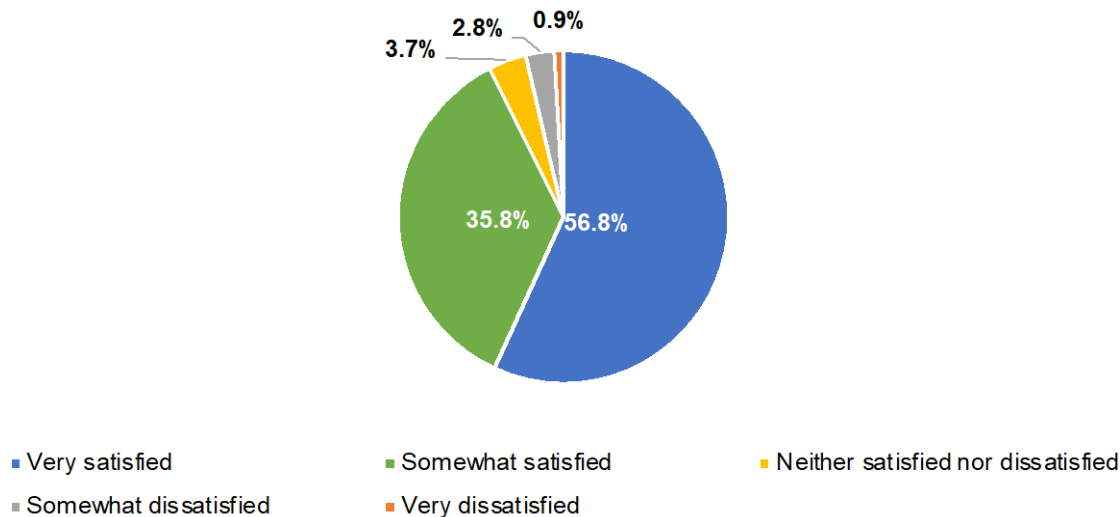
employers require an internship/apprenticeship, nearly 60% report they prefer candidates with this experience (Figure 42).

Thinking about the different types of entry-level positions that work in the wind energy portions of your business, do any of these individuals need or benefit from the following skill sets or educational certifications, and if so are they required or preferred? (n=290)



**Figure 42. Wind energy employers (across all industry segments) rate the importance of entry-level skills and educational certifications**

Additionally, current wind energy workers are highly satisfied with their work (Figure 43). Ninety percent of current wind energy workers indicated overall satisfaction (the sum of “very” and “somewhat” satisfied) and almost 60% reported that they are “very” satisfied with their current industry as a place to build a career. By comparison, potential wind energy workers who are currently working in a different industry had lower rates of satisfaction. About 6 out of 10 respondents indicated overall satisfaction and only 28% reported that they are “very” satisfied with their current industry as a place to build a career.



**Figure 43. Career satisfaction of the current workforce**

### 4.3 DOE-Sponsored Programs

Through sponsorship provided by DOE’s Wind Energy Technologies Office, NREL has implemented several programs to address the broad range of education, training, and workforce needs within the growing wind energy industry. These programs include the [CWC](#), [WFS/Wind Application Centers](#), [NAWEA](#), [KidWind](#), and [the National Energy Education Development project](#). Overall, students and recent graduates who participate in DOE-sponsored wind energy workforce programs indicate a higher interest in wind energy and are more likely to enter the industry.

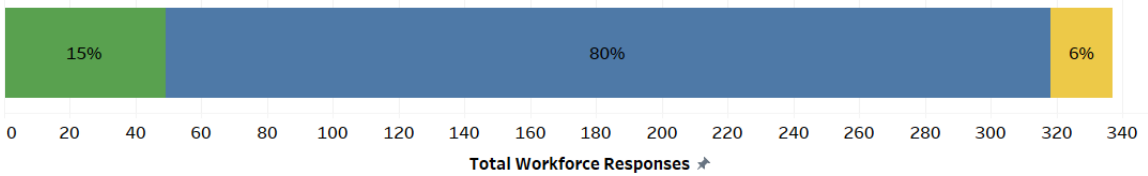
A student participating in a DOE-sponsored program is two times more likely to work in the wind energy industry than those who do not (Figure 44). One of the many goals of DOE-sponsored programs is ensuring students who participate in these programs and are interested in employment in the wind industry are placed in wind-energy-specific careers.

Does your job include work in the wind energy industry?

DOE-sponsored program participants



Nonparticipants



Current Wind Energy Employment

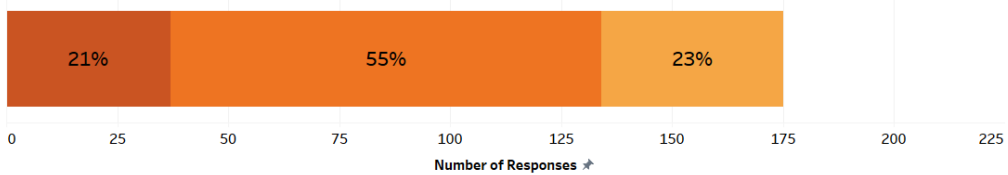
- Don't know/ Refused
- No
- Yes

**Figure 44. Participant and nonparticipant responses regarding if they are currently employed in the wind energy industry**

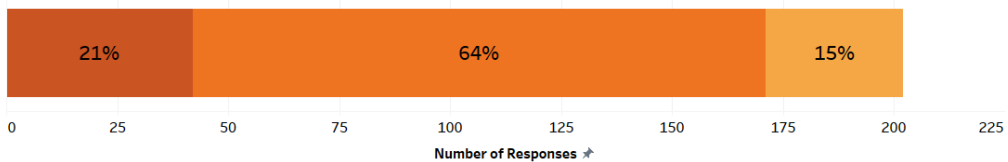
Participants in DOE-sponsored programs report difficulty entering the wind industry, but they report less difficulty than those who have not participated in such a program, as shown in Figure 45.

Please indicate if you feel finding employment opportunities is a great difficulty, some difficulty or no difficulty OR do you not have any experience looking for work in the wind industry?

Participants



Nonparticipants



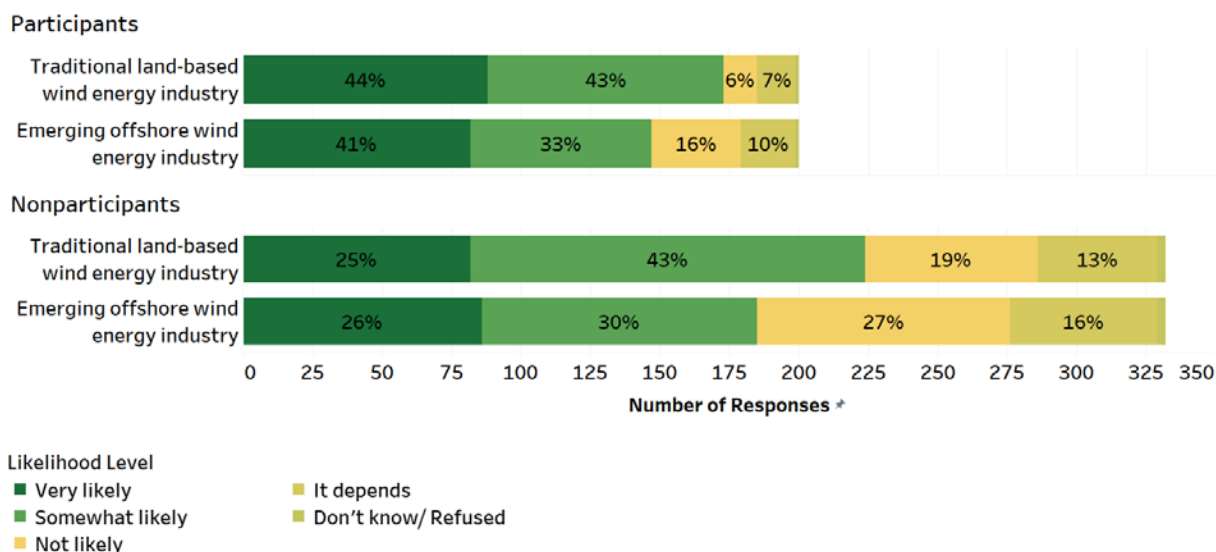
- Difficulty Level
- No Difficulty
  - Some Difficulty
  - Great Difficulty

**Figure 45. Participants indicate less difficulty finding employment opportunities in the wind industry (77% some or great difficulty) than nonparticipants (85% some or great difficulty)**

DOE-sponsored program participants rank geography (71% some or great difficulty), attaining relevant experience (68% some or great difficulty), and developing technical skills and expertise (67% some or great difficulty) as their primary challenges and obstacles to finding employment in the wind energy industry.

When students who participate in DOE-sponsored programs are introduced to the industry, they tend to be more interested in wind energy as a career path than those who do not participate in DOE-sponsored programs. Participation also increases student likelihood of applying to a position in the wind industry. The level of likelihood to apply for a wind-energy-related employment opportunity is a key indicator of interest and shows that exposure to DOE-sponsored programs is helping to close the wind energy workforce gap.

If you were looking for a new employment opportunity and you saw a position in the emerging offshore wind energy industry, how likely are you to apply for it?



**Figure 46. Participants are more likely to apply for a land-based and offshore wind energy employment opportunity than nonparticipants**

Figure 46 indicates that participants in DOE-sponsored programs were more likely (87%) to apply to a land-based wind employment opportunity than nonparticipants (67%). DOE-sponsored program participants were also more likely (74%) to apply to an offshore wind employment opportunity than nonparticipants (56%).

To understand the effectiveness of DOE-sponsored programs, participants were asked to indicate their level of agreement with six statements about their experience in one of the DOE-sponsored programs.<sup>18</sup> Table 7 shows the sum of participants that reported “strongly agree” and “somewhat agree.” In this table, blue indicates an agreement of 80%–89.9% and green highlights agreement of 90% or higher.

<sup>18</sup> These programs include the [Collegiate Wind Competition](#), [Wind for Schools/Wind Application Centers](#), [North American Wind Energy Academy](#), [KidWind](#), and [the National Energy Education Development project](#).

**Table 7. Program Experience – Total Level of Agreement for Participants**

	<b>CWC (n=114)</b>	<b>WFS (n=35)</b>	<b>WAC (n=15)</b>	<b>WFS and WAC (n=50)</b>	<b>NAWEA (n=13)</b>	<b>KidWind (n=13)</b>	<b>All DOE Programs (n=190)</b>
<b>Increased my interest in a career in the wind energy industry</b>	79.8%	80.0%	86.7%	82.0%	92.3%	69.2%	80.6%
<b>Improved my ability to find a job in the wind energy industry</b>	64.0%	74.3%	60.0%	70.0%	84.6%	23.1%	64.4%
<b>Expanded my network of people that I could connect with in the wind energy industry</b>	76.3%	88.6%	80.0%	86.0%	92.3%	53.8%	78.5%
<b>Developed valuable skills that I use in my current job</b>	82.8%	87.1%	44.4%	79.5%	54.5%	42.9%	77.4%
<b>Provided me with a valuable educational opportunity</b>	87.7%	82.9%	73.3%	80.0%	76.9%	76.9%	84.3%
<b>Increased my awareness of wind energy career opportunities</b>	84.2%	85.7%	86.7%	86.0%	84.6%	30.8%	80.6%

Note: CWC: Collegiate Wind Competition, WFS: Wind for Schools, WAC: Wind Application Center, NAWEA: North American Wind Energy Academy

## 4.4 Opportunities for Connection in the Wind Energy Industry

### 4.4.1 Internships

Many industry respondents (39%) regularly offer internships as an opportunity for current undergraduate and graduate students to gain skills and experience in the wind industry.<sup>19</sup> It is important to recognize that internships have many nuances that can often present challenges for employers, universities, and internship participants. These employment-like experiences typically range in length from one semester to one year. Typically, there are legal agreements put in place between employers, institutions, and students prior to the experience start date as well.

<sup>19</sup> For more information on what defines an internship, see the National Association of Colleges and Employees “[Position Statement: U.S. Internships.](#)”

Internships can carry liability in the form of required workers' compensation coverage and might require a relationship with an accredited institution of higher education. In the instance an internship experience is paid, the employer will assume the responsibility of that coverage. If a wind energy industry internship is unpaid, an employer may look to the student intern's university to provide this coverage.

Another nuance with internships is that of academic credit. Not all internships carry academic credit and those that do can often have additional requirements the employer must agree to prior to an intern beginning their position. Ultimately, it is imperative that industry, educators, and students be aware of the employment-like nature of an internship. Internships are excellent experiences for students to gain skills and for employers to educate the workforce about the wind industry. However, the internship model tends to mimic the work schedule and benefits to that of a part-time employee, wherein employee benefits, such as health insurance and retirement, are not offered.

#### **4.4.2 Cooperative Education Experiences**

Cooperative education programs<sup>20</sup> have evolved over the last 50 years as solutions for engineering students to gain real-world workforce skills, even if they reside in a more rural location. Engineering students take a semester to travel to a specific location where projects exist for them to apply their education while also receiving credit. There is potential here for industry and universities to partner to increase workforce pathway opportunities through these programs.

#### **4.4.3 Apprenticeships**

An apprenticeship<sup>21</sup> is a work experience not requiring a relationship with an accredited institution of higher education. This type of experience-gaining opportunity is primarily utilized for basic and skilled trades and craft positions, such as iron workers. However, there are some 2-year educational institutions offering academic credit for participation. These experiences are most often initiated by the employing industry partner and can vary in length from 1 to 6 years. Apprenticeships are often registered at the federal and/or state level and offer full-time pay and hours. Benefits are also included in many cases but not all.

Currently, there are only six wind-energy-specific apprenticeships registered with the U.S. Department of Labor. This number does not mean that there are no other wind-specific apprenticeship opportunities available, but that they are the only registered apprenticeship programs that meet specific, rigorous standards.

Apprenticeships are one pathway used as a career transition opportunity from other energy industries. Given the increased focus on collaboration with unions, educators, and workforce centers, there is an opportunity to educate interested parties about the benefits of creating and participating in registered apprenticeship programs.

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<sup>20</sup> For more information on what defines a cooperative education program, see the Cooperative Education & Internship Association's "[Co-op Vs. Internship: What's the Difference?](#)"

<sup>21</sup> For more information on what defines an apprenticeship, see the U.S. Department of Labor's "[Apprenticeship.](#)"

## 5 Conclusion

As the wind energy workforce gap continues to be a barrier to developing an adequate workforce, there need to be efforts from all stakeholders to ensure steps are taken to mitigate this gap. Wind energy employers report having difficulty finding qualified candidates while the potential wind energy workforce (e.g., students and recent graduates) reports having difficulty finding jobs, and educational institutions report having difficulty placing students in jobs.

Representatives from domestic wind industry companies have indicated challenges with filling job postings. A lack of qualifications, such as not having relevant experience, is one of the reasons employers are encountering difficulty when looking to hire potential workers. Experience was noted as a challenge for more than one-quarter of all wind industry firms looking for entry- (27.6%) and nonentry-level (33%) job applicants. Similarly, members of the total workforce (68%) responded that gaining applicable work experience is somewhat of a challenge or a considerable challenge when trying to find work opportunities in the wind industry.

Fostering connections between industry and members of the potential workforce has been shown to help bridge the gap in the wind industry workforce. For example, a student participating in a DOE-sponsored wind program is two times more likely to gain employment in the wind industry than someone who has not participated in such a wind program. Industry members could address the lack of experience within the potential workforce by partnering with DOE-sponsored wind programs or by developing new initiatives to encourage participation and present networking opportunities for students through these experiences.

Other industry sectors, such as education, training, advocacy, and construction, have reported that there are not enough applicants for the job opportunities being offered. As the industry continues to expand, the lack of an available workforce could be a large obstacle to reaching deployment goals in wind capacity. “The Wind Energy Workforce in the United States: Training, Hiring, and Future Needs” (Keyser and Tegen 2019) report suggests that nearly 570 additional programs will be needed to meet the projected demand of 7,700 additional positions annually. Of the programs currently available, only 20%–30% of students who graduate enter the wind energy workforce.

Based on survey responses, enhanced communication is an area for improvement, so that there is increased dialogue and participation between all relevant stakeholders. Educational institutions and industry hiring managers can increase student awareness of job postings, relevant skill development opportunities, and other areas of career support through outlets such as internal job boards, career fairs, and networking opportunities. Educational institutions could also work to make students conscious of the types of occupations available within the wind industry, such as through course guest speakers, internship/apprenticeship-based projects, and external conference participation. Additionally, industry employers could use consistent language in job postings so that experience level and skills required are clearly stated when the potential workforce starts to apply for these positions.

Respondents have indicated that geography is a hiring barrier across the United States. This geographic disconnect between where wind industry jobs are located and where the potential workforce is willing to live has also been a barrier for educational institutions and industry hiring

managers when trying to place the potential workforce within wind energy careers. Despite geography being a nationwide workforce barrier, addressing the wind capacity needs of a specific region is very important to the success of the industry. Education and training institutions can work with industry to develop specific programs and co-locate these in the areas where industry has difficulty finding applicants. As a result, addressing the challenges of experience, employment, and geography could lead to a motivated and qualified domestic wind energy workforce.

Future areas of research that are needed to bolster this industry include gaining a better understanding of why potential students choose certain programs, how increased investment in education institutions can affect the wind industry workforce development pipeline, and how qualified applicants find wind industry jobs. Additionally, the wind industry could research how to improve engagement with women and minorities, to diversify the workforce, and increase the potential workforce pool.



## References

- BW Research Partnership. 2020a. *Five Year Trends: The USEER: 2016-2020*. Energy Futures Initiative and National Association of State Energy Officials. <https://www.usenergyjobs.org/fiveyears>.
- BW Research Partnership. 2020b. *Wind Energy Workforce Report*. Internal report submitted to National Renewable Energy Laboratory.
- BW Research Partnership. 2021. *Wages, Benefits and Change*. Energy Futures Initiative and National Association of State Energy Officials. <https://www.usenergyjobs.org/wages>.
- Keyser, David, and Suzanne Tegen. 2019. *The Wind Energy Workforce in the United States: Training, Hiring, and Future Needs*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-73908. <https://www.nrel.gov/docs/fy19osti/73908.pdf>.
- Leventhal, Michael, and Suzanne Tegen. 2013. *A National Skills Assessment of the U.S. Wind Industry in 2012*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-7A30-57512. <https://www.nrel.gov/docs/fy13osti/57512.pdf>.
- U.S. Department of Energy. 2021. “Energy Secretary Granholm Announces Ambitious New 30GW Offshore Wind Deployment Target by 2030.” <https://www.energy.gov/articles/energy-secretary-granholm-announces-ambitious-new-30gw-offshore-wind-deployment-target/>.
- U.S. Energy Information Administration. 2020. “Wind has surpassed hydro as most-used renewable electricity generation source in U.S.” Today in Energy. <https://www.eia.gov/todayinenergy/detail.php?id=42955>.
- Wiser, Ryan, Mark Bolinger, Ben Hoen, Dev Millstein, Joe Rand, Galen Barbose, Naïm Darghouth, Will Gorman, Seongeun Jeong, Andrew Mills, Ben Paulos. 2020. “*Wind Energy Technology Data Update: 2020 Edition*.” Berkeley, CA: Lawrence Berkeley National Laboratory. [https://emp.lbl.gov/sites/default/files/2020\\_wind\\_energy\\_technology\\_data\\_update.pdf](https://emp.lbl.gov/sites/default/files/2020_wind_energy_technology_data_update.pdf).