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Learning Module Design: Toward an Improved Distributed Wind Workforce

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Abstract:

As energy needs have grown in the USA, wind energy projects have expanded to meet these needs. Distributed wind energy, projects that are deployed and connected at the distribution level of the electric grid, are uniquely positioned to support further growth with onsite and hybridized generation options. The Distributed Wind (DW) industry is facing a critical shortage of qualified workers to support installations which will serve the growing energy needs of the USA. This project addressed this workforce gap by designing curriculum tailored to meet the unique needs of the DW industry. Research was performed to better understand this workforce gap by engaging with stakeholders, investigating education and training pathways, and reviewing expected qualifications and characteristics of workers. From these studies, the scope of this project was narrowed to focus specifically on Wind Turbine Technicians ("Windtechs") and proposed curriculum designs that will increase awareness of and improve preparation for these roles in DW. Four learning modules were designed to address challenges related to location, awareness, and skills, but one gap was deemed outside the scope of this project: the unique benefits of working in DW compared to other industries. The first learning module is a site visit with a DW Wind Tech with a focus on a 'day in the life' experience. The second learning module is a DW career playbook made publicly available online for any user to discover career pathways in the wind industry. The third and fourth modules are simulation-based online activities, one focused on task completion and the other on stakeholder interactions to provide realistic challenges for training purposes. This gap analysis, curriculum design, and the proposed learning modules are presented in this paper. The proposed modules offer flexible and accessible solutions to address a growing need in the USA focused on energy resiliency and workforce development. Further development and stakeholder feedback, especially from two-year colleges and industry partners, is needed prior to full deployment and publication of the modules. Following the presentation, attendees will be invited to provide feedback on the gaps analysis and proposed learning modules toward future publication. This project was supported by the Visiting Faculty Program through the Department of Energy and completed in partnership with researchers and a working group at Pacific Northwest National Lab.

Keywords: technical colleges, experiential learning, industry involvement, pathways

Background:

With the growing need for energy, the USA will need to broaden its efforts in power generation and utilize diverse sources. As new technologies and projects are installed, improved availability, reliability, and variety will provide for a more robust energy portfolio. According to the most recent Short-Term Energy Outlook published by the US Energy Information Administration, electricity consumption is expected to grow in the coming years, especially in the commercial and industrial sectors [1]. The same report predicts that wind generation will rise by 6% in 2026 and 2027 despite recent pauses in offshore wind projects. Distributed wind (DW) provides a unique opportunity for many developers, especially from commercial and industrial sectors, with the ability to produce energy onsite and offset retail power costs [2]. These DW projects already produce 1,110 MW from 92,000 installed turbines across the USA

with the potential for profitable capacity to increase up to 1,400 GW [3, 4]. Though DW projects may be attractive to support growing energy needs, the wind industry is facing a workforce gap. The National Wind Energy Workforce Assessment from 2024 projects a shortage of 125,000 workers by 2030 [5]. Reasonings for this workforce gap are attributed to [6]:

- ***Experience:*** Applicants did not have enough relevant working experience to perform the jobs.
- ***Education/training:*** Applicants did not have the requisite education or training to perform the jobs.
- ***Geography:*** There is a mismatch between jobs in rural areas but the workforce lives in urban or suburban areas.

To better understand the needs of DW employers, researchers at the Pacific Northwest National Lab held working group meetings with core stakeholders in the industry [7]. These meetings found that the DW industry faces further obstacles in building its workforce, especially for hiring Wind Turbine Technicians (Windtechs), due to the unique sector-specific challenges:

- ***Multifunctional workers:*** DW employers desire multifunctional workers who can not only address a variety of technical problems (electrical and mechanical), but also interact with stakeholders such as customers. Preparation across these skills is uncommon for most technicians, including Windtechs.
- ***Awareness:*** Though the public is well aware of land-based wind farms and offshore turbines, many workers may be unaware of available jobs in the DW industry. Because these projects are typically built onsite where the power is needed, it may not be clear that this is a separate industry from the large-scale wind projects.
- ***Benefits:*** With added skills desired and potentially higher responsibilities, it is unclear whether the DW employers are able to provide higher benefits for their employees. The DW industry may also be competing with the larger wind industry for the same employees.

To better serve the needs of the DW industry, these gaps in the workforce must be addressed. This paper provides an overview of a gap analysis with proposed curriculum designs to bridge the gaps. Note that this paper specifically focuses on a portion of the DW workforce in highest need: Windtechs. Basic job functions of a Windtech include installing, maintaining, and repairing wind turbines, typically with training from a technical school and on-the-job experience [8]. While only about 13,600 people were employed as Windtechs in the USA in 2024, the Bureau of Labor Statistics projects that this job will grow 50% from 2024-2034 [9]. Education for this role typically requires a certificate or associate's degree in a technical field from a technical school or community college [10]. Though most technical schools or community colleges offer discipline-specific training in mechanical or electrical engineering technology, some schools have specific certifications in renewable energy technology or even wind energy technology. Third party providers also offer training for Windtechs, much of which is built on programs from the Global Wind Organization or the American Clean Power organization [11, 12]. Figure 1 below shows all of the wind energy technology educational or training programs offered across the nation.

Figure 1: A screenshot of the Wind Training Web App – Education and Training Database published by NREL [13]

Objective:

The main objective of this project was to improve the DW workforce, more specifically for Windtech roles. Three primary tasks were achieved with one proposed for completion following the conference presentation:

- *Task 1:* Review the current status of workforce development for DW systems
- *Task 2:* Identify gaps in the workforce development journey
- *Task 3:* Draft a proposed curriculum for DW workforce development
- *Task 4:* Finalize the curriculum based on stakeholder feedback (upcoming)

Task 1 required an inspection of existing education and training programs, research regarding the skills and qualifications of the career pathway, and participating in and reviewing notes from stakeholder meetings. Task 2 investigated gaps based on the research completed in Task 1 to better understand why DW companies struggle to find qualified candidates for Windtech roles. Task 3 targeted those gaps through the design of customized learning modules with options for adaptations. Task 4 will provide better refinement of the draft curriculum based on feedback from two-year college representatives at the ASEE Annual Conference.

Results:

As shown in Figure 1, there are a variety of wind education and training programs available across the USA. In comparison to Figure 2, though many of these programs exist in areas where wind turbines are common, many wind turbine sites lack nearby education and training options. This mismatch between education/training and job opportunities was confirmed through discussions with DW companies during the stakeholder meetings. Of the five DW companies represented, only two had an education/training

program within 200 miles of their headquarters. Clearly, geography can be a hefty challenge when it comes to hiring Windtechs.

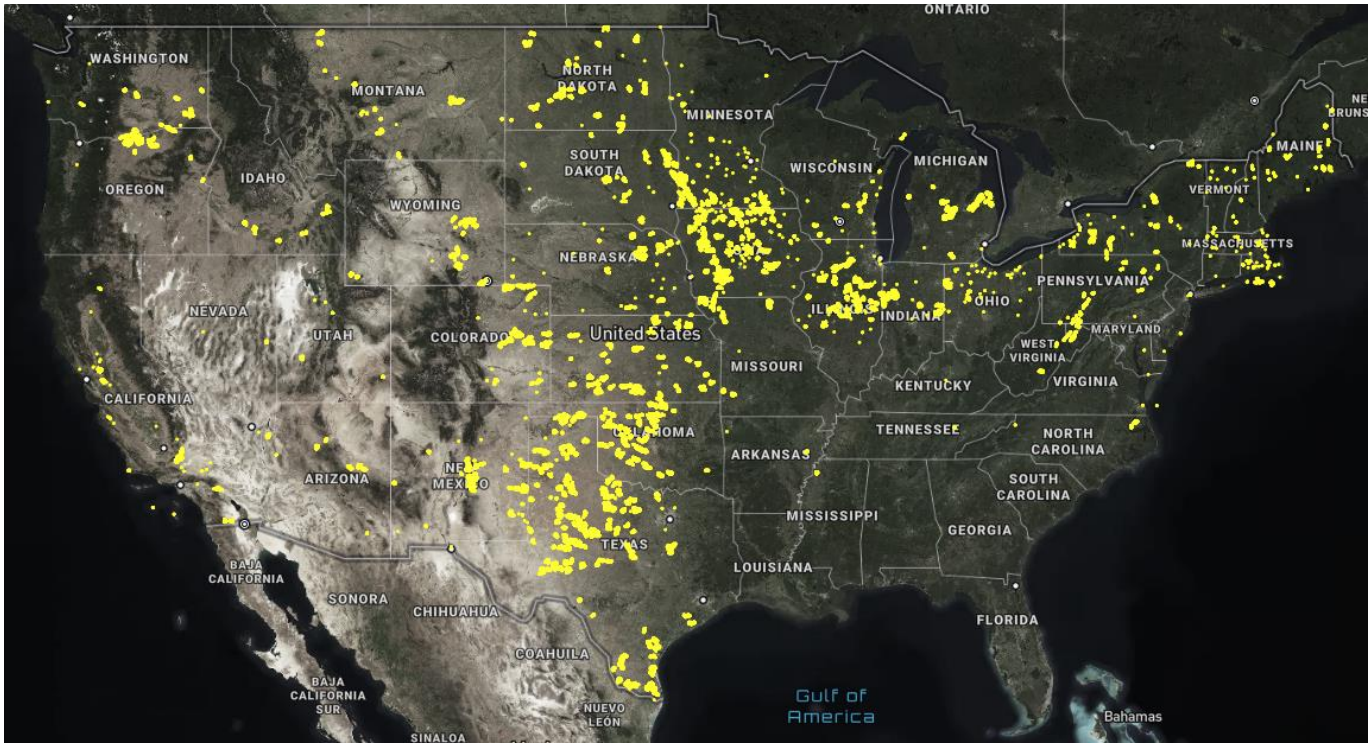

Figure 2: Locations of land-based and offshore wind turbines in the USA as of December 2025 (75,417 turbines across 1,794 projects included) [14]

In addition to reviewing the location of these education and training programs, the author reached out to three community colleges with Windtech programs to request more information. Input from the community college representatives provided the following conclusions:

- The training provided through these programs is applicable to DW in addition to large-scale wind farms
- The programs have strong partnerships with industry through guest speaker roles or recruitment events like career fairs
- The graduates of the programs do not struggle to find jobs and are successfully employed in the wind industry

The comments and feedback from the community colleges stand in direct contrast to the struggles stated by DW employers. Whereas DW employers struggled to find qualified candidates, whether because of education/training or relevant experience, graduates from these Windtech programs were gainfully employed. This contradiction warranted further investigation with special focus on the mismatch between expected qualifications by DW employers and the preparation offered through Windtech programs.

Because Windtech is a newer and somewhat unique career pathway, each program provides slightly different offerings though all include a few overarching disciplines such as exposure to mechanical and electrical technologies. Some programs also incorporate renewable energy coursework and training while

others supplement their programs with guidelines and certifications from the Global Wind Organization or American Clean Power organization. Note that these programs typically focus primarily on technical training like mechanical, electrical, and hydraulic systems as well as safety. Professional skills are also highly valued, especially personal skills (troubleshooting and self-knowledge) and leadership [15]. In addition to these qualities, meetings with DW companies uncovered other professional skills including an ability to engage with customers, role and task balancing, as well as an openness to challenges [7]. Unfortunately, these professional skills are difficult to quantify and are not explicitly stated as core learning objectives in most Windtech programs. Thus, incorporating non-technical skills toward a multifunctional worker role was deemed an important factor to address through this project.

Based on the research performed, the following gaps and strategies were identified as core to the DW workforce challenges:

Table 1: Curriculum strategies to address gaps in the DW workforce

Gap	Description	Strategy
Location	DW requires workers in areas where there are few to no Windtech training options	Consider curriculum that can be easily integrated independent of location
Awareness	DW is a smaller, lesser-known, and less visible field than utility-scale wind	Design curriculum to engage learners in the unique aspects of the job
Skills	DW requires multifunctional worker traits above the typical expectations of a Windtech	Include a mix of technical and professional skills relevant to the job

For simplicity, education/training and relevant experience were combined into a single gap ‘Skills’ since there seemed to be significant overlap in the expected qualifications as well as various expectations that were independent of where the skills were developed. For example, maintenance on hydraulic systems could be taught through a technical course at a community college or learned through on-the-job training with a company. One significant gap that was not included in this analysis was benefits. Though there may be unique benefits (salary or otherwise) to working at DW companies in comparison to large-scale wind farms, research into this gap did not uncover significant information to provide clear conclusions. Based on these gaps, curriculum strategies are proposed that directly address each.

Learning modules were chosen as the ideal curriculum for this project since they require little startup and are flexible for integration into a variety of programs. This curriculum option may also be adapted to online or virtual options providing learning opportunities independent of location. Four learning modules are proposed with core features outlined in Table 2. The full outline of the proposed modules are available by request to the author. Each outline includes an overview, context, stakeholders, learning objectives, content, activity, assessment, review, resources, and alternatives.

Table 2: Learning module outlines with core features described

	Site Visit with a DW Windtech	**DW Career Playbook**	**DW Windtech Task Simulation**	**DW Windtech Stakeholder Simulation**
Context	High school career day, technician class or training	Publicly available online for any setting	Available as online module for technician class or training	Available as online module for technician class or training
Activity	Participants would experience a 'day in the life' learning both technical & professional skills needed to be successful as a DW Windtech	User would uncover career options in the wind industry & increase awareness of opportunities, pathways, & skills required	User would complete technical tasks in an online interactive platform based on unique yet realistic challenges.	User would complete tasks by interacting with stakeholders in an online interactive platform based on case studies provided by DW Windtechs
Alternatives	Virtual reality option would remove location dependency	Generative AI bot with chatting capabilities	Combination with the stakeholder simulation >>	Simpler version could use personas & discussion

As first iterations of the learning modules, more development and refinement is required from stakeholders, especially education/training programs, potential DW employees, and experienced Windtechs. Based on this feedback, the modules could then be redesigned and presented as simple or analog versions for further testing and revision. Initial versions of the learning modules may require equipment onsite or an ability to travel to a DW installation whereas future iterations may require software engineers or app developers to produce immersive online activities. Providing the option for virtual learning environments broadens the reach of these modules to directly address the location challenge. To improve awareness, DW companies specifically are encouraged to suggest or distribute these modules directly to local two-year programs that may offer similar technical training. Though not directly described as part of the learning modules, industry involvement in the education/training programs (as guest speakers or career fairs) will also directly improve the DW workforce pathways.

Conclusions:

Though the proposed learning modules address the challenges of location, awareness, and skills, the lack of information around the benefits of working as a Windtech in DW is a significant limitation to this work. It's possible that further investigation into the benefits may resolve this gap (if the benefits are strong) or widen the gap (if the benefits are poor). Previous attempts to review job postings for Windtechs at DW companies did not reveal any open opportunities so it is likely that this information would need to be retrieved directly from the employers themselves.

In summary, the proposed learning modules are a first step toward improving the DW workforce and building a stronger pathway for those interested in the industry. With feedback from core stakeholders,

including those from two-year colleges, the learning modules can be improved and deployed. Future work on this project may involve building assessments to better understand the impact of these modules on potential Windtech employees as well as the DW companies.

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