Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #45910

BOARD # 222: Advancing Wind Energy Research and Education through the Great Lakes Wind Energy Challenges REU Site Program

Dr. Wei Zhang, Texas Tech University
Prof. Xiong Yu

Advancing Wind Energy Research and Education through the Great Lakes Wind Energy Challenges REU Site Program

Wei Zhang[1,3], Xiong (Bill) Yu[2], Kathleen O'Hara[4], Yong Tao[1]
[1]Mechanical Engineering, Cleveland State University, Cleveland, Ohio
[2]Civil and Environmental Engineering, Case Western Reserve University, Cleveland, Ohio
[3]Civil, Environmental and Construction Engineering, Texas Tech University, Lubbock, Texas
[4]School of Education & Counseling, Cleveland State University, Cleveland, Ohio

Motivation

We are facing a wide range of grand challenges across the world, such as the continuous increase of energy demand, more frequent extreme weather disasters, and uncertainties associated with climate change. Wind energy, an affordable renewable resource—achieving costs as low as $0.04 per kilowatt-hour in a growing number of regions (Gielen et al., 2019; Wiser et al., 2008)—holds great potential to meet rising energy demands, mitigate the causes of climate change, and contribute to a cleaner, sustainable, and domestic energy generation portfolio. To fully realize the potential of wind energy, we must address research challenges arising from the complex, coupled phenomena that span spatial and temporal scales relevant to both wind energy and the broader power system. This necessitates a diverse, talented pool of future scientists and engineers in wind energy research and industries to tackle these issues. Despite the national and global demand for wind energy research and development (Veers et al., 2019), many undergraduate students of non-R1 universities lack opportunities to participate in active wind energy research. To tap the nation's diverse student talent pool and broaden participation in science and engineering, there is a critical need to provide these students with access to wind energy research early in their career and motivate them to pursue graduate education, career path or research and development-oriented jobs in the wind energy sector.

The Great Lakes Wind Energy Challenges (GLWind) REU site funded by the NSF Division of Engineering Education and Centers (EEC), co-hosted by Cleveland State University (CSU) and Case Western Reserve University (CWRU) in Cleveland, Ohio, has supported nine undergraduate students in a ten-week intensive summer research program during 2023 and 2024 (Years 1 and 2). The educational outcome aims at a diverse group of talented US students who are motivated and prepared to apply the research and communication skills developed in the REU program to succeed in broader STEM fields, and a structured, personalized mentoring mechanism for undergraduate students that will be disseminated to a larger engineering community via the ASEE conference.

GLWind Challenges REU program timeline and activities

The full cycle of the REU major activities is summarized in Table 1. Application is open in early Jan. at the NSF ETAP website. Call for PIs and faculty mentors in their network also distribute applicants through social media and various mailing lists. Review of applications will continue until March 15. Participants are selected based on students' academic background, majors, and their motivation to apply for this program. Geographic locations, type of colleges and genders are factored in the selection process to promote a diverse representation. Admission emails are sent out around April 10th with several students on the waitlist. Three webinars are conducted via zoom focusing on mentoring training. REU students arrive in the last week of May and engage in research and other professional activities. During

summer Weeks 2-10, the REU student cohort actively engaged in ongoing wind energy research within existing learning and research communities at CSU and CWRU. They attended weekly seminars on the latest wind energy research and professional development, visited utility-scale wind turbines on the CWRU campus, and presented their research posters at the Summer Intersection Symposium and professional conferences beyond the program (Fig. 1). In addition to research, REU students also enjoyed the rich diverse culture and historical landmarks of Cleveland, including Rock & Roll of Fame Museum and The Cleveland Museum of Art. Annual program evaluations via surveys and focus group interviews were carried out to inform PIs and faculty about potential improvements and ensure continuous program enhancement.

Table 1: Timeline of the three-year GLWind REU Program. Student recruitment and selection (cyan), mentoring training and summer research activities (green), and formative/summative assessment (yellow).

	Pre-Year 1	Year 1	Year 2	Year 3
Jan. 10^{st}	Call for applicants (Emails/calls, REU website & social media)			
March 15^{th}	Application close; review and ranking			
April 10^{st}	Admit REU students and send welcome packet			
Mid - Late April	Mentoring training (three webinars, Week 0)			Summative assessment and reporting
Early May	Improvement plan based on formative assessment			
Late May	REU student arrival and orientation (Week 1)			
June – July	Summer research (Weeks 2 to 9)			
Early August	Student symposium and reflection (Week 10)			
Late August	Formative assessment of REU wind program			
Sep. – Dec.	Continuous collaboration and Conference presentation			

Figure 1: GLWind REU Students' attendance at the APS DFD 2024 Annual meeting and the REU cohort orientation in Summer 2024.

Wind Energy REU results and evaluation

As the direct outcome of GLWind REU summer research, REU students presented posters in teams to showcase their work in the summer intersection at CWRU in week 10 of the program. A few students continued research with their faculty mentors in the fall and generated new results to present at professional conferences. Two students from Cohort of Year 1 and four students from the Cohort of Year 2 attended the APS DFD annual meeting.

The GLWind REU program focused on recruiting women, underrepresented minorities, and students from non-R1 universities, community colleges and liberal arts colleges without established research programs in engineering. In Year 1, 56% of participants were from non-R1 universities, and 67% belonged to underrepresented minority groups (UMG) in STEM. In Year 2, 67% of participants were from non-R1 universities, and 44% were UMG.

After the summer of 2024, REU Students were asked to rank the following six program components: a) Integrated learning communities, b) Weekly Research, c) Field Trips, d) My Wind Research Video, e) Poster Presentation and f) Conference Attendance. Their top rankings were field trips, research projects, and integrated learning communities tend to be ranked higher because they provide opportunities for networking, hands-on learning, and collaboration. Weekly seminars were consistently ranked lower due to their perceived lack of relevance and interruption to direct research work. Participants value activities that directly contribute to their research skills, career discussions, and networking. The experiences of living on campus during the program varied widely among the students, shaped by several factors such as social environment, commute convenience, safety, cleanliness, and availability of support services. Most students found positive aspects of living on campus, like community building and access to resources. However, there were also concerns about transportation, safety, and pest control that, for some students, detracted from their overall experience.

Potential Improvement indicated by the program evaluation include:

1. Weekly Seminars: Consider making them more interactive and tailored to participants' interests to increase engagement and perceived value.
2. Field Trips and Poster Presentations: Continue incorporating these as they foster engagement and analytical thinking.
3. Activities/Field Trips: Increase the number of structured outings organized by the program and include them on the calendar from the start. A survey could help tailor activities to the cohort’s interests.

The GLWind REU program has a positive impact on the respondents' career paths. For some students, it confirmed their existing interest in research, reinforcing their commitment to this field. Others found that the program enhanced their decision to pursue research by providing valuable experience. One respondent, however, remains uncertain about their future career direction and feels the program did not clarify their path. The best aspects of the program, as highlighted by these students, include flexibility and autonomy in research, exposure to diverse academic perspectives, a supportive and financially accommodating environment, and enriching personal and social experiences. These elements combined to create a comprehensive program that not only supported academic and research goals but also catered to personal growth and well-being. The responses highlight that the program successfully fostered an environment where students could learn both independently and collaboratively, acquire new technical skills, and gain insights into research as a career path. Each student's unique experience demonstrates the

program's ability to cater to a range of learning styles and interests, while also providing a solid foundation for future professional development.

Outlook

The GLWind REU program positively influenced participants' career trajectories, confirming research interests, and providing valuable skills. Its best aspects included flexible research opportunities, exposure to diverse perspectives, and supportive mentoring.

Future goals include program renewal, expanded faculty involvement, innovative research topics (e.g., offshore wind development, wind hazard mitigation), stronger industry connections, and ongoing engagement with REU alumni. Results and mentoring frameworks will be disseminated through the ASEE annual conference to benefit the broader engineering community.

Acknowledgements

We acknowledge the support from the National Science Foundation (NSF) through grant #2150000.

References

Gielen, D., Gorini, R., Wagner, N., Leme, R., Gutierrez, L., Prakash, G., Asmelash, E., Janeiro, L., Gallina, G., Vale, G., et al. (2019). Global energy transformation: a roadmap to 2050.

Veers, P., Dykes, K., Lantz, E., Barth, S., Bottasso, C. L., Carlson, O., Clifton, A., Green, J., Green, P., Holttinen, H., et al. (2019). Grand challenges in the science of wind energy. Science, 366(6464).

Wiser, R., Bolinger, M., et al. (2008). Wind technologies market report.