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Reflection on the NSF Great Lakes Wind Energy Challenges REU Site Program

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Reflection on the NSF Great Lakes Wind Energy Challenges

REU Site Program

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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 and particularly in 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 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 is funded by the NSF Division of Engineering Education and Centers (EEC) and co-hosted by Cleveland State University (CSU) and Case Western Reserve University (CWRU) in Cleveland, Ohio. Between 2023 and 2025, the program received approximately 200 applications and admitted 29 undergraduate students for a ten-week intensive summer research experience at CSU and CWRU. 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.

Methodology: GLWind REU program timeline and activities

The full cycle of the REU activities is summarized in Table 1. The application process opens in early January each year on the NSF ETAP website. In conjunction with this, the announcement of the GLWind REU program is disseminated by PIs and faculty mentors to potential applicants through social media and various mailing lists. The review of applications continues until the end of March, during which participants are selected based on their academic backgrounds, majors, and motivation to apply for the program. Additionally, factors such as geographic location, the type of colleges attended, and the students' academic year are considered in the selection process. Following the rigorous review, admission emails are sent out by April 10th, with several students placed on a waitlist. To prepare selected students

for the upcoming summer research, three webinars focusing on mentoring training are conducted via Zoom. By the last week of May, REU students arrive and embark on an immersive experience that includes research and other professional activities. Over the summer, specifically during Weeks 2-10, the REU student cohort engages in ongoing wind energy research within established learning and research communities at CSU and CWRU. They participate in weekly seminars covering the latest advancements in wind energy research and professional development. Additionally, students visit utility-scale wind turbines on the CWRU campus and present their research posters at the Summer Intersection Symposium, as well as at professional conferences after summer (Fig. 1). Beyond their research activities, REU students also can explore the rich and diverse culture of Cleveland, visiting historical landmarks such as the Rock & Roll Hall of Fame Museum and The Cleveland Museum of Art. To ensure continuous program enhancement, annual evaluations are conducted through surveys and focus group interviews, providing valuable feedback to PIs and faculty for potential improvements.

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.

GLWind REU results and evaluation

The GLWind REU program focused on recruiting students from non-R1 universities, community colleges and liberal arts colleges without established research programs in engineering. From 2023 to 2025, the REU program supported 27 students and 2 additional students with local funding. The program received 50, 45, and 95 applications, respectively, through the NSF ETAP website, resulting in admission rates of 18%, 20%, and 10%. Among admitted students, 39% were rising sophomores, approximately 60% came from non-R1 universities, and 55% were women.

As the direct outcome of GLWind REU summer research, REU students presented posters in teams to showcase their work at the annual Summer Intersection Symposium at CWRU in week 10 of the program. All students are offered the opportunity to continue the research work if they fit in academic curriculum and schedule. A few students continued collaborating with their faculty mentors in the fall and generated new results to present at professional conferences.

The 2023 cohort produced six posters for the Summer Intersections, one abstract for an international conference and two research articles as co-authors. The 2024 cohort presented five posters at the Summer Intersections and four abstracts at two international conferences. Five of 10 students from the 2025 cohort submitted abstracts to two professional conferences. So far, our REU students have presented at the 2023, 2024 and 2025 American Physical Society Division of Fluid Dynamics Annual Meetings, Texas Tech Engineering 2025 Research Day, the 15th Americas Conference on Wind Engineering, and ASME Power Conferences. Four students have submitted journal papers beyond summer research (Zhang et al., 2025, Agarwal et al., 2026). A poster was presented by the PI Zhang in the NSF Grantee session at the 2025 American Society for Engineering Education (ASEE) Annual Conference in Montreal, Canada.

At the end of the summer each year, 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 usually field trips, research projects, and integrated learning communities because they provide opportunities for networking, hands-on learning, and collaboration. Participants value activities that directly contribute to their research skills, career discussions, and networking. Weekly seminars were consistently ranked lower due to their perceived lack of relevance and interruption to direct research work. 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 certain concerns about transportation, safety, and pest control that, for some students, detracted from their overall experience. Feedback on postdoc/graduate mentoring was mixed.

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 improve analytical thinking, teamwork and communication skills.
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 demonstrated a positive impact on the participants' career paths. For some students, it confirmed their existing interest in research, reinforcing their commitment to this field. One student, 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 REU program that not only supported academic and research goals but also catered to personal growth and well-being. The responses highlight that the GLWind REU 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 professional development.

Outlook

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

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