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Education and Training Program to Improve Preparedness and Increased Access to Energy Workforce for Engineering Technology Graduates

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Abstract

Elizabeth City State University (ECSU) implemented a comprehensive education and training program to strengthen the renewable energy curriculum and increase the pipeline of qualified workers, especially underrepresented minorities for the growing energy industry. The overarching goal is to meet the current and future energy industry workforce needs, especially in the renewable energy sector. The project activities were designed based on three tenets, which include mentoring, research, and education/training. The project components included, enhancing renewable energy courses, establishing a wind and solar energy systems training laboratory, a year-round hands-on project-based training, a residential summer bridge program, undergraduate research experience, and summer internships. The activities afforded through the project will help ensure that the energy sector has a sustained pipeline of a qualified workforce. The project implementation and challenges, project delivery components, and results from pretests and posttests and participant surveys are presented in the paper.

Introduction

The mission of the U.S. Department of Energy (DOE) is to ensure America's security and prosperity by addressing its energy, environmental and nuclear challenges through transformative science and technology solutions. Their recent Quadrennial Energy Review reported a growing demand for skilled workers across a range of energy sectors because of retirements, infrastructure growth, and changing energy technologies [1]. Science, technology, engineering, and mathematics (STEM) education and a diversified workforce are the essential building blocks to accomplishing the U.S. Department of Energy's mission. Further, the Consumer Energy Alliance has indicated, STEM education is a must for the next generation of energy workers as a STEM bachelor's degree nearly doubles the likelihood of working in the energy industry. Currently, the energy industry is facing three key workforce challenges: (i) technical and soft skills gap, (ii) lack of awareness of job opportunities, and (iii) underrepresentation of minorities and women. The adoption, sustenance, and success of renewable energy projects depend on a large scale of enhancing renewable energy awareness and skills [2]. Bridging the skill gap on one hand will improve energy access and on the other hand create new jobs, providing employment opportunities to millions.

Employment in the wind industry in the United States increased 32% from 2015 to 2016 [1] and 5.6% from 2016 to 2017 compared to 1.8% and 1.6% in non-farm employment growth nationally [3]. In the last few years wind energy technician has become the second fastest-growing occupation in the United States [4], following solar installer at number one. Hence, an available and qualified workforce is essential for any industry. For the workforce to grow, career options need to be communicated as early as the high school level as young people consider potential occupations and educational programs. A recent review of the existing renewable energy training programs identified a lack of connection between theoretical and practical training for beginners in the solar Photovoltaic (PV) field [4]. The review has found that during the initial steps of solar training, beginners often struggle with the identification of the system components and their technical specifications.

Several institutions of higher learning in the U.S. and around the globe have started integrating renewable energy training into their curriculum [5-8]. In [5], authors discussed efforts to integrate advanced approaches in a microgrid, test-rig emulators, and real-time simulation into early postgraduate and undergraduate engineering education. It described two experiments designed for groups of early-stage researchers and postgraduate students in the field of Offshore Renewable Energy as part of an H2020-funded weeklong training course and focus on a medium-speed rotary emulator for wave energy applications, and a wind turbine emulator that demonstrated the operation of a Doubly-Fed Induction Generator in a two-machine coupled rig.

In [6], an interdisciplinary and multidisciplinary approach is discussed that involves the design and development of renewable energy projects allowing students to work on projects that can be relevant to current leading-edge research and technologies. In [7], authors explored a student-oriented curriculum model on Renewable Energy Sources (RES) as an important solution to the energy problem, and training talents with relevant skills and qualities have become a key part of their overall energy strategy. Based on Taylor Principle and PDCA Cycle Theory (Plan, Do, Check, Act), this paper proposed a "Student-centered Inquiry" RES course model together with three reference templates for the design, teaching, and evaluation processes of the course.

In 2020, Elizabeth City State University (ECSU) received a grant from the U.S. DOE under its Minority, Education, Workforce, and Training (MEWT) program to implement a comprehensive education and training program to strengthen STEM education and increase the pipeline of qualified workers, especially underrepresented minorities for the growing energy industry. The goals and objectives of the program are as follows.

Goals and Objectives

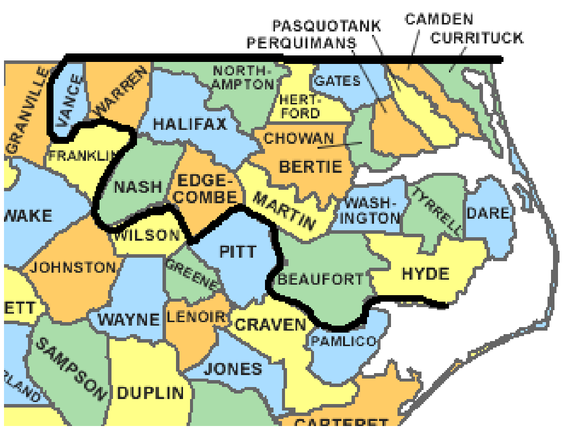
The goals of the MEWT program project at ECSU were to **Goal 1:** Enhance STEM education and training at ECSU to meet the current and future energy industry workforce needs, especially in the renewable energy sector.

Goal 2: Build the interest, skill, and knowledge necessary for undergraduate students to pursue energy-related STEM careers. The specific **objectives** of the proposed MEWT project are **Objective 1:** to increase the number of historically underserved and underrepresented students from the northeastern North Carolina (NENC) region and beyond who are interested in energy-specific STEM careers, **Objective 2:** to engage students in participatory activities such as inquiry-based hands-on learning, research, work-based learning, use of advanced technology, in a mentoring relationship with professionals working in the STEM fields, and **Objective 3:** to engage faculty members, especially from minority groups or from minority-serving institutions (MSIs) in expanding energy curriculum and student training activities at their institutions.

The expected outcomes include ***Short-term*** - (i) Increased knowledge of energy topics, increased awareness of energy careers and emerging technologies; ***Medium-term*** - (i) heightened awareness of DOE program and resources, (ii) inspired and prepared diverse population who will pursue STEM careers, especially careers in the energy industry; ***Long-term*** – (i) increased number of historically underserved students from rural NENC who are interested in pursuing technical careers with DOE/national laboratories and energy-specific careers, (ii) promote institutional partnerships for collaborative efforts in strengthening the future energy workforce. The renewable energy education and training supported efforts to engage underserved communities and foster greater inclusion of underrepresented groups in energy-related research and the workforce.

Methodology and Approach

Northeastern NC has long suffered the effects of poverty and has lacked the opportunities for most students to encounter the 21st Century workplace that is readily accessible in more urban areas of the state. However, with the recent growth in the renewable energy sector, especially solar and wind in the region, there now exists the potential to link secondary and postsecondary education to the energy industry. The MEWT project site at ECSU also serves as an educational, research and development, and technical resource to assist school districts, community colleges, and other interested MSIs in designing innovative, energy career-relevant curricula, instructional approaches, and uses of technology. The MEWT project has the potential to strengthen the student pipeline and seek opportunities to maximize student exposure to energy-focused STEM curricula and training and careers by offering extended learning activities.



<u>MEWT Project Site at ECSU:</u> NC boasts the nation's second fastest-growing renewable energy sector, with several large and medium solar and wind installations and enterprises. ECSU. located in the NENC, is in proximity to Southeast's largest wind farm with a generating capacity of 208 megawatts from 104 tall turbines. In addition, a 20-megawatt solar farm operated by Duke Energy Renewables that features nearly 100,000 solar panels stretching over a half-mile of farmland is located in the south of the city. ***<u>Geographic Area Served:</u>*** The MEWT project served the 21 contiguous counties located in the northeastern corner of NC. This region (indicated by a dark outline on the map) is by far one of the most economically disadvantaged, underserved, and rural communities in the state and nation. This region of the state is known geographically as the state's Coastal Plains region.

Over seventy-five (75%) of ECSU's population originates from the Tier I counties surrounding Elizabeth City. These 21 counties are designated qualified opportunity zones. These 21 targeted counties served by ECSU have poverty level rates that are higher than both the state of NC and the United States of America. The students coming from this region face several barriers to pursuing postsecondary education, including geographical isolation, and limited opportunities for rigorous college-prep courses. With many socio-economic and achievement challenges that prevail in the rural northeastern NC region, the leadership at ECSU understands that to prepare its students for the challenges of the 21st century, its emphasis on STEM learning is an important key to developing productive, responsible, and contributing members of society.

Program Components and Activities:

The MEWT project at ECSU adopted the experiential and authentic learning framework, which makes student engagement the top priority, where students learn by doing, discovering, reflecting, and applying. Authentic and experiential learning creates an environment necessary to nurture the 21st Century soft skills including critical thinking and problem-solving, communication, collaboration and teamwork, and learning to learn.

The program activities were designed based on three tenets which include mentoring, research, and education/training. The education and training components included enhancing renewable energy courses, establishing a wind and solar energy systems training laboratory, a year-round hands-on energy training program, a residential bridge program, undergraduate research experience, and summer internships. In addition, professional development training was afforded to faculty members from other minority-serving institutes (MSIs). They were introduced to renewable energy curriculum development, developing laboratory modules, and hands-on training with advanced energy trainers so they can enhance STEM education and integrate energy courses at their respective campuses. The program components are briefly described next.

Enhancing Renewable Energy Curriculum: Three renewable energy courses were redesigned to integrate hands-on learning modules specifically focused on preparing students for industry certification. These courses were:

ENGT 200 Intro to Renewable Technologies - This is an interdisciplinary course suitable for both science and non-science majors who would like to learn about energy, renewable energy resources, and potential solutions to the energy crisis. Topics include, in part, energy and environment, fossil fuel energy resources, nuclear energy, combined heat and power, and renewable energy resources such as wind, hydro, tidal, photovoltaic solar, solar thermal, geothermal, fuel cell, and bioenergy.

Course Outline:

1. Energy and Environment
2. Renewable vs. Non-renewable energy resources
3. Combined Heat and Power (CHP)
4. Hydroelectric Systems

5. Wind Power
6. Wind Turbine Systems (wind farm site visit)
7. Geothermal Energy & Geothermal Heat Pumps
8. Fuel Cells
9. Biomass and Biofuel
10. Introduction to Solar Energy
11.Solar Photovoltaic Systems (solar farm site visit)
12.Solar Photovoltaic Site Analysis (LAB)
13.Solar Photovoltaic Modules and Circuits (LAB)
14.Solar Photovoltaic System Components (LAB)
15.Solar Thermal Systems (site visit)

ENGT 250 Introduction to Wind & Hydro Power Systems - This course introduced concepts, designs, tools, techniques, and material requirements for systems that convert wind and water into usable energy. Topics included the analysis, measurement, and estimation of the potential energy of wind and micro-hydro systems.

ENGT 300 Solar Photovoltaic Systems - This course presented the technical aspect of photovoltaics, including solar fundamentals and proper system siting, electrical load analysis and system sizing, system types, components, applications, wiring, and best practices with respect to installation, maintenance, and troubleshooting. Hands-on project activity included the installation of an off-grid PV system with energy storage capability.

Wind and Solar Energy Systems Laboratory: The funding helped ECSU to acquire laboratory equipment to establish the Wind and Solar Energy Systems Laboratory.

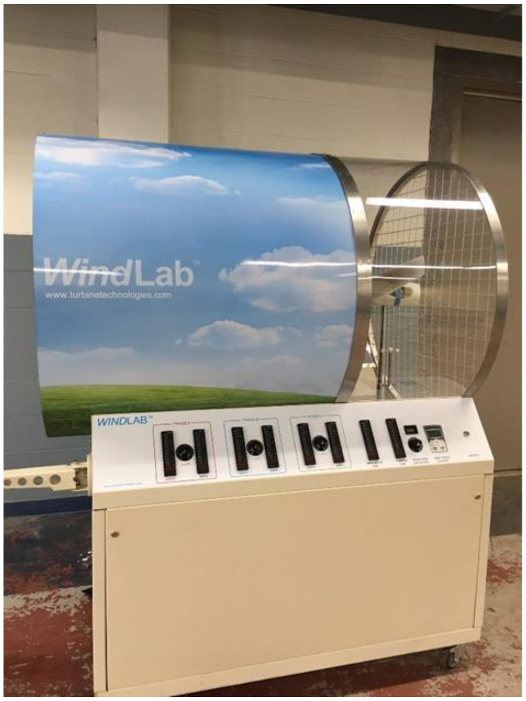


Photo 1a. Wind Energy Lab Trainer   Photo 1b. Solar/Wind Energy Training System

This laboratory helped significantly enhance the curriculum, specifically renewable energy courses. A lab space of approximately 1500 sq. ft was designated to set up this lab. This new laboratory equipment was critical in enhancing existing renewable energy courses and imparting necessary training to prepare students for certification and the workplace.

Year-Round and Residential Summer Renewable Energy Training: The cohorts were recruited from existing ECSU students who have completed at least two renewable energy courses. The students met after class (Fridays and Saturdays) to engage in hands-on training to give them the necessary training and skills required for renewable energy-related jobs. The Summer Bridge Program was designed to be an intensive one-week long program offered during the summer. The purpose of the summer activity was to actively engage in a technical design project to provide them with a better understanding of the applications of energy-related concepts covered in their STEM courses. Students completed wind turbine assembly and installation, and data collection activities during the summer program. In addition, participants were exposed to various industry certifications and opportunities to explore careers. The targeted training focused on preparing students for the North American Board of Certified Energy Practitioners (NABCEP) Associate Certification Program. The NABCEP Associate Program is intended for individuals working or seeking employment in the renewable energy industry, including students in renewable energy programs.
The topics covered during these sessions were as follows:

PV Solar Training Topics

I. **Basic Electricity:**

I. **How Electricity is made**
   a. Renewable Energy Technologies
   b. Non-renewable Energy Technologies

II. **Basic Electricity:**
- How electricity is made
- Basic Electrical Circuit & Ohm's Law
- Series, Parallel & hybrid electrical Circuits
- Safety & troubleshooting

II. **Intro to Solar Energy**
- Photovoltaic effect (3D animation)
- PV Modules and Solar Electric Systems
- PV Circuits
- PV System Components
  - Charge controllers
  - Inverters
  - Batteries
  - Balance of the System (BOS)

III. **Siting of Active Solar Collectors and Photovoltaic Modules**
- Solar Pathfinder

- Sun charts
- National Electrical Code & Troubleshooting
- NABCEP Certification (Students were given "Solar Photovoltaic Basics: A Study Guide for the NABCEP Entry Level Exam"}
- Installation of an off-grid PV system with energy storage capability (Hands-on activity)

Wind Power Training Topics

I. **How Electricity is made**
   a. Renewable Energy Technologies
   b. Non-renewable Energy Technologies

II. **Basic Electricity:**
- How electricity is made
- Basic Electrical Circuit & Ohm's Law
- Series, Parallel & hybrid electrical Circuits
- Safety & troubleshooting

III. **Intro to Wind Power**
- Weather Basics
- Wind Energy Conversion
- Wind Turbine Generators & Betz Limit
- Vertical Axis Wind Turbine Aerodynamics and Design.
- Are Vertical Axis Wind Turbines Better?
- Why Do Wind Turbines (usually) Have 3 Blades?
- What's inside a wind turbine?
- Off-grid Wind Turbine system Components
  - Charge controllers
  - Inverters
  - Batteries
  - Balance of the System (BOS)

IV. **Wind Turbine Site Consideration**
- Wind Turbine Site Assessment
- Wind Power: Capacity Factor, Intermittency, and what happens when the wind doesn’t blow
- Guy-wired Wind Tower Installation Guidelines
- Installation of an off-grid WTG system with energy storage capability (Hands-on activity)

Undergraduate Research Experience (URE): Five (5) students were selected from the pool of existing majors to engage in a semester-long undergraduate research experience (URE). In this URE, students worked closely with faculty mentors on a specific research problem. The research project immersion helped students in enhancing their research skills, data analysis ability, content knowledge, and experimental design skills, and develop an awareness of how their effort fits into the broader scientific and engineering challenges associated with energy and the environment. The primary undergraduate research experience activities were conducted in the Energy Materials Research Lab at ECSU. The research projects included investigating novel materials for next-generation energy storage devices and battery development. The URE participants attended bi-weekly program meetings, and seminars/workshops, presented at symposia, and submitted a final project paper. Some of the undergraduate research projects included (i) Wind Resource Assessment in Northeastern XX, (ii) Development and Implementation of a Guy Wire Monopole Wind Power System with Wind Data Collection Capability, (iii) Metal Free Caffeine Carbon Nanotube Composites for Water Splitting Reaction in Acidic Media, and (iv) Carbonized Vitamin Carbon Nanotube Composite for Hydrogen Production via Water Splitting Reaction.

Summer Internships: Two (2) students received the opportunity to engage in an 8-week summer paid internship opportunity in the area of energy research. Originally, the project team had planned to place the students in one of several Department of Energy facilities and/or within the state, federal, and private enterprises. However, due to COVID-19 restrictions, there were limited to no options for an internship at federal laboratories and hence students engaged in a virtual internship at the Center for Sustainability Energy and Environmental Engineering on the campus of a partnering institution.

Students worked with a faculty mentor on researching stable sources of energy for ocean buoys. One of the problems that needed to be solved here was to find a stable, self-maintenance energy source. Different methods including the use of pendulum motion, gravitational force, rotational force, and kinetic energy harvesting were some of the other power conversion techniques that were studied to convert and power multiple energy applications. Finally, ocean waves were determined to be the best source of power for our case, since ocean waves constantly move, thus providing an opportunity for an infinite supply of energy.

Professional Development for Faculty: ECSU team also conducted a workshop for faculty members from other MSIs who were interested in developing renewable energy courses or curricula at their institutions. During the day-long professional development training, participants were introduced to renewable energy curriculum development, developing laboratory modules, and hands-on training with advanced energy trainers. The faculty participants also had an opportunity to interact with a solar energy industry representative to learn more about the skill sets the industry is expecting from graduates. In addition, an online repository of training resources was set up that can be shared across multiple institutions or faculty groups who are interested in replicating similar curricula at their institution.

Results and Discussion

Student Training

Twenty (20) Engineering Technology students were selected to receive targeted training on building, installing, and testing solar photovoltaic systems and wind turbines. During the semester, these students were given a pre-test at the beginning of the training and a post-test at the end of the week-long experience. The results of the pre and post-tests are shown in Table 1.

Table 1. Pre and post-test scores

Pre-Test: Solar PV	Post-Test: Solar PV	Pre-Test: Wind Power	Post-Test: Wind Power
59.81	82.69	51.00	72.00

The targeted training continued in the form of a summer bridge that ran for a week, where students engaged in hands-on training to give them the necessary training and skills required for building and installing renewable energy systems. Before beginning the summer project, students had developed sufficient competency during the semester through various experiments and training conducted on Friday/Saturday sessions.

Photo 2. Students installing a 1300W ground mount photovoltaic (PV) system at the renewable energy demonstration and training site

Photo 3. Students completing the wiring for the solar panels

Another group of students worked on building wind-turbines and installing them on ECSU campus. Photos next show students in action during the wind turbine installation. At the end of the summer program, students had built and installed four fully functional wind turbines on campus.

Photo 4. Students taking measurements as they prepare to install a small wind turbine on campus

Photo 5. A fully installed wind turbine

MSI Faculty Professional Development

ECSU project team hosted a day long renewable energy workshop for 20 faculty members from other minority serving institutions (MSIs). The Renewable Energy Workshop opportunity was marketed to all 2-year and 4-year (both public and private) MSIs within NC, VA, SC, DE, DC, and MD. We received a total of twenty-six (26) applications from 16 different colleges and universities. We selected 20 participants who represented 13 different colleges and universities from 5 different states. In total four Females and sixteen Males. Seventeen (17) of the participants had no prior renewable energy curriculum/course experience.

A google classroom was setup for participants that acted as repository for the workshop material and will be made available to all participants for future reference as well. Faculty participants were given a pretest and posttest to assess their knowledge before and after the workshop. The summary results of the pre and post tests are shown in Table 2.

Table 2. Pre and post scores faculty professional development workshop

Pre-Test (/33)	**Post-Test (/33)**
Class Average (/33)	**Class Average (/33)**
15.6	21.09
(/100)	(/100)
47.27	63.90

Participants also completed a feedback survey at the end of the workshop. The results of the survey are summarized next.

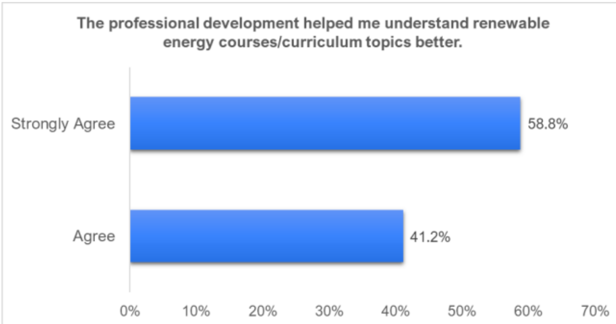


Figure 1a

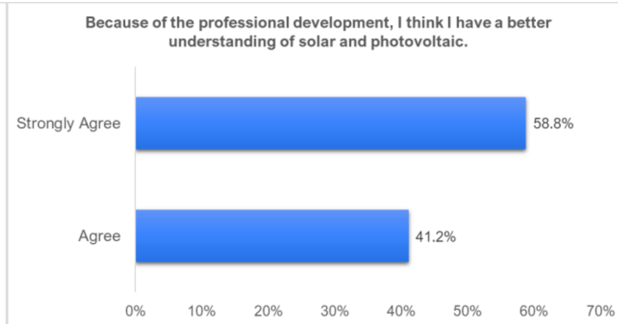
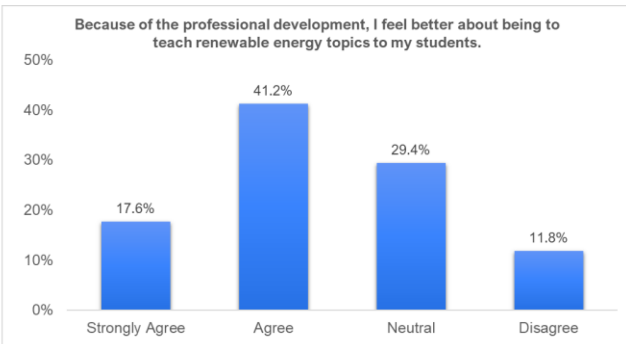


Figure 1b



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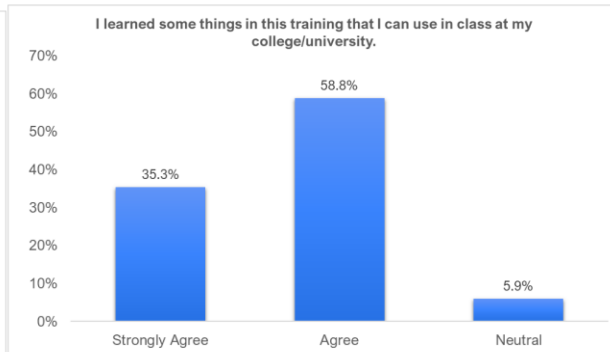

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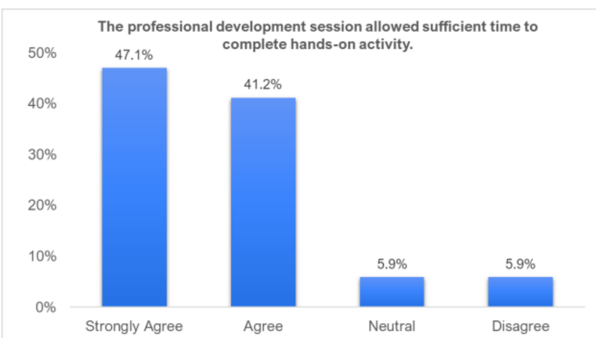

Figure 1e

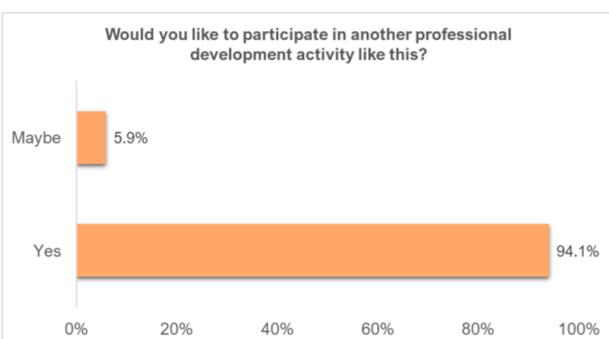

Figure 2a

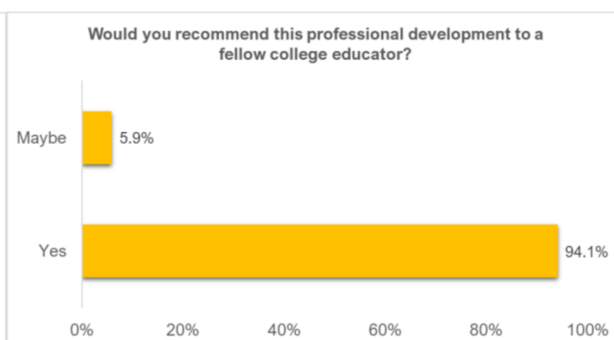

Figure 2b

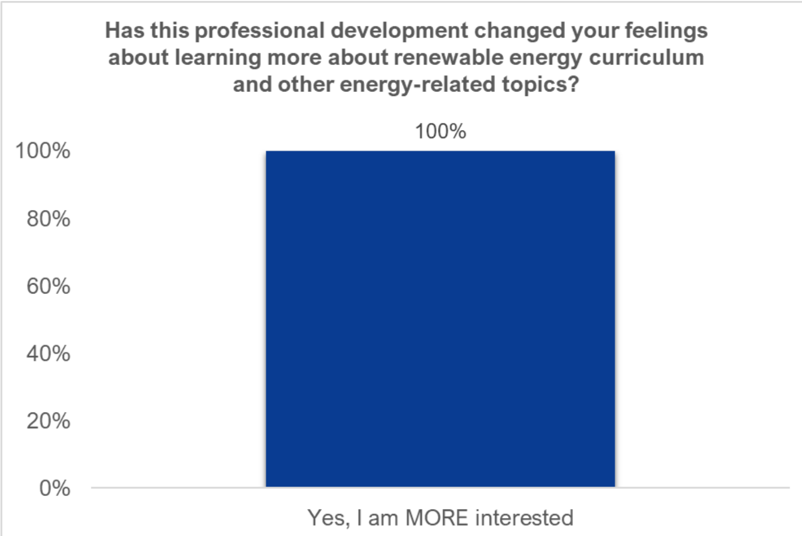

Figure 3

Summary of comments provided by the workshop participants are below:

- *"I enjoyed this professional development workshop. My only suggestion is to let the participants know about the hands-on activity so that they will be sure to dress appropriately for working outdoors."*
- *"Longer duration workshop with more hands-on activities could improve engagement in the workshop."*
- *"Good practical course."*
- *"The workshop lecture may be improved by briefly introducing yet systematically covering the thematic topic (e.g., photovoltaic electricity, wind power, geothermal energy, biofuels, etc.)."*
- *"Perhaps providing an itinerary of the workshop beforehand would have helped prepare me for being outdoors."*
- *"Overall, the workshop provided new insight about renewable energy and the technology for advancement."*
- *"It's a good workshop to learn in detail about renewable energy. It will help me to teach my students and do work in a research project."*

Challenges

The successful implementation of the U.S. DOE funded project was not without its challenges due to the COVID-19 pandemic. Some of the challenges presented due to the COVID-19 pandemic are as follows:

- Campus guidelines related to COVID-19 prevented the project team from hosting professional and workforce development workshops on campus for MSI faculty as per the original timeline. The faculty professional development workshop was delayed by one full academic year.
- Internship had to be done in virtual format.

- Due to COVID-related travel restrictions, recruiting students for the residential summer bridge program posed a challenge. Though project team recruited early on increased uncertainty as a result of pandemic, led the first summer bridge to be conducted virtually.
- The project team had to make changes to project implementation and introduce a year-round training program, where students met on Fridays to receive additional training instead of the originally planned 3-week long summer bridge for freshmen and transfer students.

Conclusion

The Minority Education, Workforce, and Training program at ECSU was geared towards better preparing students in Engineering Technology for jobs in the renewable energy industry. The activities included year-round and summer bridge programs, summer internship, renewable energy curriculum enhancement, laboratory support, and undergraduate research experience to provide students with knowledge and skills needed in the renewable energy industry. The activities developed a heightened awareness of energy-related careers and will help ensure a sustained pipeline of trained graduates to energy workforce. A structured renewable energy curriculum was developed, which is now offered as part of the departmental schedule every semester. The program helped ECSU to acquire laboratory equipment to establish the Wind and Solar Energy Systems Laboratory. This laboratory will continue to significantly enhance the STEM curriculum, specifically renewable energy courses. A total of seventy-five (75) students directly benefited through the education and training program through participation in renewable energy courses, engaging in undergraduate research, summer internship, and targeted renewable energy bridge training. In addition, twenty (20) faculty members from thirteen (13) different minority-serving institutions across five different states were afforded renewable energy curriculum development and hands-on lab training. Further, an online repository of training resources has been set up that can be shared across multiple institutions or faculty groups who are interested in replicating similar curriculum at their institution. Overall, the renewable energy education and training program helped ECSU build capacity to enhance renewable energy education and workforce training. The project team was able to implement the activities despite COVID-19 related challenges.

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References

[1] DOE. Transforming the Nation's Electricity System: The Second Installment of the QER, 2017, https://www.energy.gov/quadrennial-technology-review-0.

[2] H. Lucas, S. Pinnington, and L. F. Cabeza, "Education and training gaps in the renewable energy sector." *Solar Energy*, 2018, vol. 173, pp. 449–455.

[3] W. Lawhorn. "Solar and wind generation occupations: a look at the next decade," *Beyond the Numbers: Employment & Unemployment*, vol. 10, no. 4 (U.S. Bureau of Labor Statistics, February 2021), [online]. Available: https://www.bls.gov/opub/btn/volume-10/solar-and-wind-generation-occupations-a-look-at-the-next-decade.htm.

[4] D. Keyser and T. Suzanne, "The Wind Energy Workforce in the United States: Training, Hiring, and Future Needs," Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-73908, 2019. [online]. Available: https://www.nrel.gov/docs/fy19osti/73908.pdf.

[5] Sharma, S. and Sengar, N. "A Review of solar PV training manuals and development of survey based solar PV system training formats for beginners," *Solar Energy*, vol. 241, pp. 72-84, July 2022.

[6] D. B. Murray, N. Erdogan, N., Z. Alparslan,, and B. P. Hayes, *Designing laboratory experiments for electricity grid integration of renewable energy using microgrid, test-rig emulators and real time simulation tools*, EESD2021: Proceedings of the 10th Engineering Education for Sustainable Development Conference, 2021, 'Building Flourishing Communities', University College Cork, Ireland, 14-16 June.

[7] R. G. Belu, and A. Belu, *An Undergraduate Course on Renewable Energy Systems with Enhanced Marine Energy Content* Paper presented at 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference. 10.18260/1-2—36682.

[8] X. Wang, and L. Guo, "How to Promote University Students to Innovative Use Renewable Energy? An Inquiry-Based Learning Course Model." *Sustainability*, vol. 13, 2021. [online]. Available. https://doi.org/10.3390/su13031418.

[9] G. Stapleton and R. Collins, R. Quality Renewable Energy Training Programs for Technicians. *in 12th International Symposium on Renewable Energy Education*; Fabio G.S. Giucastro: Strömstad, Sweden, 2017.

[10] S. Bajpai and N. R. Kidwai, "Renewable Energy Education in India." *Comp. Prof. Pedagog*., vol. 74, pp. 103–113, 2017.