

Results of 2021 Energy Education Stakeholder Survey

Kenneth Walz^a, Andrew McMahan^b, Gabrielle Temple^c, and Kathleen Alfano^c

a- Madison Area Technical College, Madison, WI

b - Central Carolina Community College, Sanford, NC

c - College of the Canyons, Santa Clarita, CA



**Center for Renewable Energy
Advanced Technological Education
CreateEnergy.org**

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CREATE Energy 2021 Energy Education Stakeholder Survey Results

Abstract: This paper presents the results of a recent energy education stakeholder survey that was conducted to examine energy industry trends and educational programming needs for the next decade. The survey was sent to over 700 faculty ranging from middle school to university level along with 150 industry representatives. The survey generated a response rate just over 10% for both the educator and industry groups. The top three technologies identified as areas for growth in the next decade were solar photovoltaics, energy storage, and electric vehicles. The biggest obstacle faced by faculty were a lack of tools, materials, and supplies necessary to provide hands-on learning with energy technology. Educators expressed a strong preference for face-to-face instruction that included access to tools and equipment, and also indicated a need for electronic open educational resources that were compliant with website accessibility requirements. The results of the survey are presented along with analysis, conclusions, and recommendations for engineering educational programs that address energy technology.

Introduction – The Need for an Energy Education Survey

Wise investment of resources requires data to drive decision making. Educational institutions have a multitude of academic programs that are worthy of investment, but financial and human resources are both finite in their supply. These resources can be spent on a wide range of activities intended to enhance student experiences, to improve educational outcomes, and to satisfy the demands of employers – but data is required to enable educational leaders to make sound decisions that are in the best interests of their constituents.

The CREATE Energy Center administered its first energy education survey in 2008. The survey has been repeated roughly every three years to achieve several objectives:

- Document technological changes and trends in the energy sector
- Respond to immediate energy industry needs
- Forecast areas for future growth in energy technology
- Identify gaps in current energy education programs and practices.
- Supply data for educational leaders and academic program development
- Use data to shape curriculum and faculty professional development

CREATE Background

Funded by the National Science Foundation Advanced Technological Education Program, the CREATE Energy Center (createenergy.org) was originally founded in 2002 by College of the Canyons, and is now led by Madison Area Technical College. The goal of the CREATE Center is to advance the field of renewable energy by supporting two-year college programs while serving as a source of mentoring, industry networking, faculty professional development, and educational materials [1]. CREATE has produced renewable energy program profiles, faculty and alumni interview spotlights, an ongoing newsletter, blog, and a robust collection of hands-on laboratory instructional materials. The CREATE community of practice includes over 900 energy educators representing all fifty U.S. states and three U.S. territories. The CREATE Center delivers hands-on Renewable Energy Institutes for educators [2], provides guidance in the development of energy infrastructure and instructional campus laboratories [3], and has conducted a number of international faculty programs related to renewable energy [4-7]. CREATE has delivered several webinars and programs on the subject of energy jobs, featuring

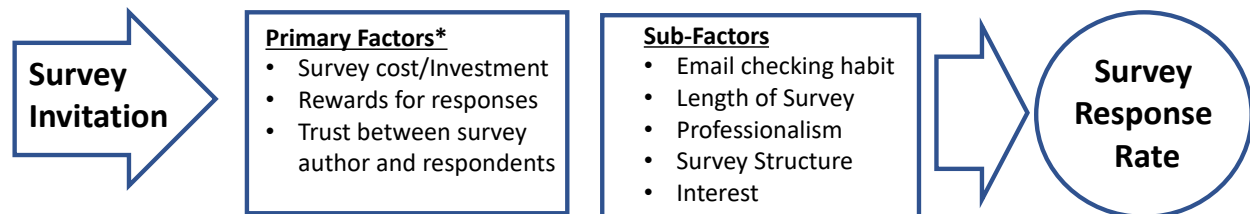
the DOE Energy Employment Report, the Solar Jobs Census, Career Pathways, Third Party Industry Certifications, Workforce Development, and Solar and Energy Storage Technology. Partners include the National Renewable Energy Lab, The Interstate Renewable Energy Council, and the North American Board of Certified Energy Practitioners, among others.

Survey Implementation

In April, 2021 the CREATE leadership team began work to implement another round of energy education stakeholder surveys to update the data. In a divergence from past survey practice, the team proceeded to develop & distribute two different surveys to capture feedback from CREATE’s two key groups of stakeholders (academia and industry). A subcommittee was formed and tasked with developing the two surveys to gather feedback from educators and industry regarding areas of future growth (5-year horizon) as well as more immediate needs for supporting energy education across the US.

In May 2021, the subcommittee further defined the scope of the two surveys, determined which questions to include, explored the most informative way to collect data and analyze results, evaluated available platforms for implementing the survey, and discussed the mechanisms for soliciting and encouraging participation. This methodology is supported by recent research [8] documenting that “survey response rate was highly influenced by interests of participants, survey structure, communication methods, and assurance of privacy and confidentiality”. The CREATE committee took all of these factors into consideration when evaluating survey content, structure, and implementation, to try and ensure the best possible response rate. Draft surveys were then distributed to the CREATE leadership team for review. Feedback received by the leadership team resulted in changes to the surveys layout, wording, and question order; and following revisions the leadership team approved the surveys and indicated they were ready for distribution.

Figure 1. Factors Influencing Survey Response Rates (graphic adapted from [8]).



** Primary factors based on Dillman’s Tailored Design Method [9]*

Distribution and Participation Rate

For development of the survey, Qualtrics Core Software program was used to capture and measure data received. CREATE partner, Central Carolina Community College had a license for Qualtrics Core and the Institution Research Office was able to build the survey under this license and provide a link to deploy the survey. While building, researching and designing the survey several software platforms were tested including SurveyMonkey and Google Forms. Based on pilot testing and research, the CREATE team found that Qualtrics software offered many unique features to provide the best user experience and gathering of data, which was consistent with another recent study [10] that found “many educators are using this tool to collect, analyze, and

communicate education, outreach, and engagement evaluation data in an efficient and effective way.”

To distribute the survey links, MailChimp, an American marketing automation platform and email marketing service for managing mailing lists and creating email marketing campaigns was used to reach the CREATE mail list. MailChimp has been the primary virtual marketing communication CREATE has used to reach its target energy audience since 2016. A recent research study analyzing online mailing tools for educational purposes [11] concluded that, “(We) consider Mailchimp to be the most convenient service for Internet distribution, which provides such functionalities as A/B testing, consolidated statistics, automation, integrations, availability of ready-made templates of letters, pop-up forms, and subscription forms.” This has been the shared experience of the CREATE for communication and outreach, and this validated the team’s decision to use Mailchimp as the vehicle to disseminate the survey.

The survey was sent to two distinct groups, Educators and Industry, as CREATE was soliciting different feedback from each group. Some of the questions were duplicated in the surveys (questions 1-4) as these questions have a shared value between the two groups.

The CREATE MailChimp lists are split by categories that break down as follows: Faculty, Industry, Administrators, Government, Students, and Other. This allows CREATE to target specific messages to each group within MailChimp. The survey was sent out to the two groups via MailChimp. The Industry list of 107 participants had a 17.8% open rate and a 5.6% click rate. The second survey sent to the Faculty list of 706 participants had a 23.4% open rate and a 4.9% click rate and to Educational Administrators with a list of 58 participants and a 25.9% open rate and a 1.7% click rate. In addition, CREATE Principle Investigators reached out to an additional 50 industry advisory members directly. There was a 50-day window from when the survey was released May 27, 2021 to when the last survey was completed on July 14, 2021.

In July, 2021 CREATE held a virtual Zoom Special Interest Group as part of the High Impact Technology Exchange Conference to share and validate the results of the Energy Education Survey. There were 35 faculty and industry members in attendance to provide input on the survey questions and validity of results. In addition, a follow up Virtual Zoom stakeholder meeting was held on August 5, 2021 to allow any faculty and industry members who were unable to make the Special Interest Group to review the results of the survey. This stakeholder meeting was attended by 19 additional faculty and industry members and 16 previous attendees. Those in attendance agreed with the aggregated results of the Energy Education Survey and provided additional qualitative data to support the results and how the survey instrument will be used in the future.

Results

Responses from a selection of survey questions are presented to highlight the findings for the greater community of engineering and energy educators. Some questions presented were asked on both the Faculty Survey as well as the Industry Survey, while others were only applicable to individuals responding to the Faculty Survey.

The question, “*In the next five years, which of the following do you see as changing significantly due to new and emerging technologies and advanced research and development?*”, was asked to

both survey groups in an effort to observe any differences in perception among the two audiences. Respondents were given a list of 13 energy related topics, and asked to rank their top five choices, in order of importance, from 1-5.

For the faculty survey the top five topics selected by participants were Energy Storage, Electric Vehicles, Solar Photovoltaics, Grid Operation, and Energy Efficiency/Energy Management. The results of this question showed that not only did Faculty and Industry identify the same 5 areas as “changing significantly due to new and emerging technologies”, the ranked order of those 5 areas was also the same.

Table 1a and 1b. Energy Stakeholder survey responses to the question: “In the next five years, which of the following do you see as changing significantly due to new and emerging technologies and advanced research and development?”

Faculty Survey Results	
Field of Study	Normalized Results
Energy Storage	100
Electric Vehicles	95
Solar Photovoltaics	89
Grid Operation	67
Energy Efficiency / Energy Management	49

Industry Survey Results	
Field of Study	Normalized Results
Energy Storage	100
Electric Vehicles	73
Solar Photovoltaics	63
Grid Operation	55
Energy Efficiency / Energy Management	19

The question, “In the next five years, rank what you see as the most important growth areas for the energy sector?”, was asked to both survey groups in an effort to observe any differences in perception among the two audiences. Respondents were given a list of 13 energy related topics, and asked to rank their top five choices, in order of importance, from 1-5.

Table 2a and 2b. Energy Stakeholder survey responses to the question: “In the next five years, rank what you see as the most important growth areas for the energy sector?”

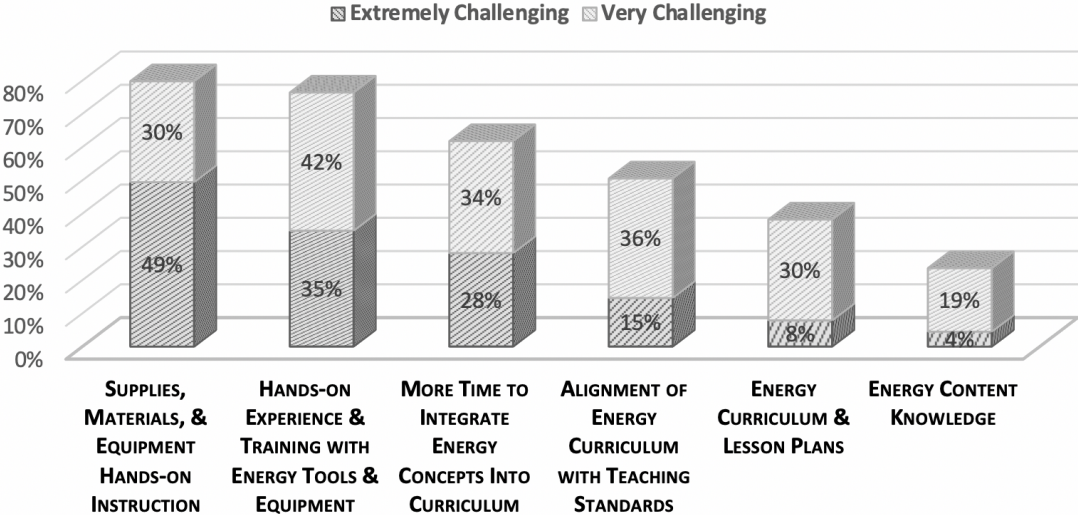
Faculty Survey Results	
Field of Study	Normalized Results
Solar Photovoltaics	100
Energy Storage	97
Electric Vehicles	83
Grid Operation	72
Wind	53

Industry Survey Results	
Field of Study	Normalized Results
Energy Storage	100
Electric Vehicles	77
Solar Photovoltaics	62
Grid Operation	52
Energy Efficiency / Energy Management	26

The question “What are the biggest obstacles schools and educators face preventing them from integrating energy education into their curriculum?” was only asked to educator respondents. Participants were asked to use a 5-point Likert Scale to rank each potential obstacle as; Extremely Challenging, Very Challenging, Moderately Challenging, Slightly Challenging, or

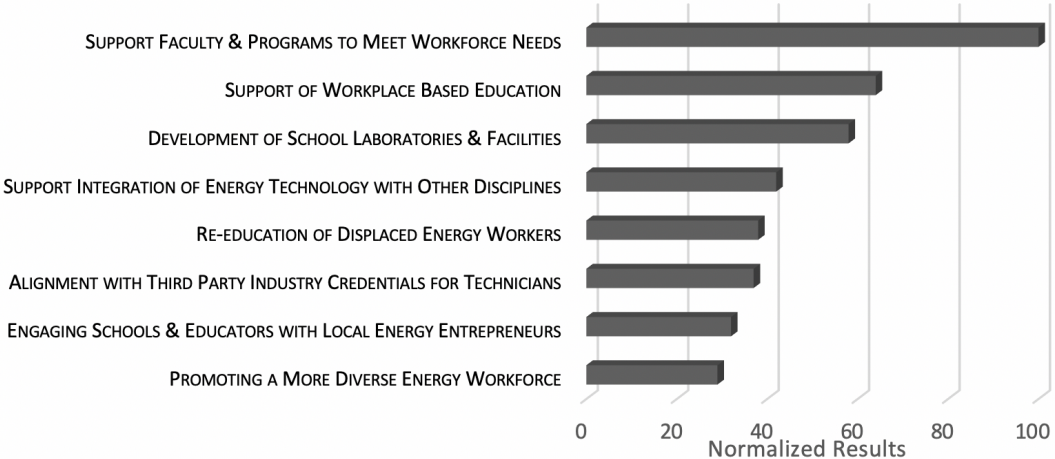
Not Challenging. The obstacle reported as the most challenging was “Supplies, materials, and equipment for students to deliver hands-on instruction”, with 79% of survey participants indicating it as “Extremely” or “Very” Challenging.

Figure 2. Energy Stakeholder survey responses to the question: “What are the biggest obstacles schools and educators face preventing them from integrating energy education into their curriculum?”



Another question only asked on the Faculty survey was “What are the most important priorities that CREATE should pursue for developing a national energy workforce?”. Respondents were given a list of 8 ways that CREATE could support the development of a national energy workforce, and asked to rank their top five choices, in order of importance, from 1-5. The choice “Support Faculty & Programs to Meet Workforce Needs” was identified as most important.

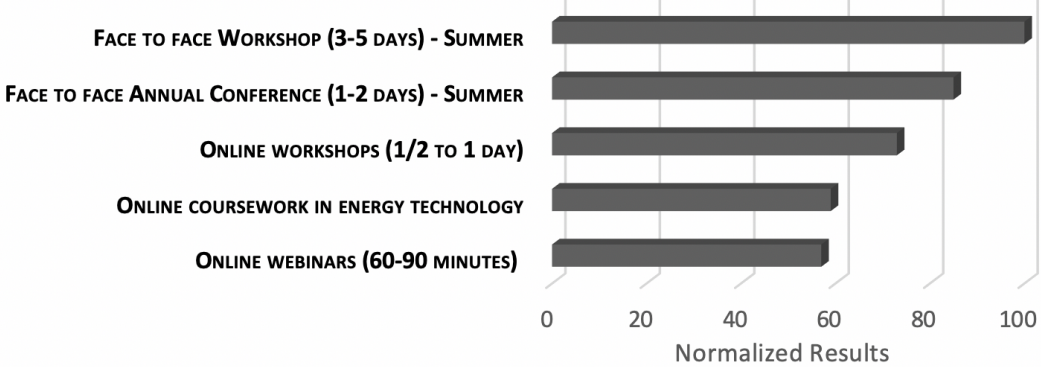
Figure 3. Energy Stakeholder survey responses to the question: “What are the most important priorities that CREATE should pursue for developing a national energy workforce?”



For the question, “What formats of professional development programming for teachers are most important for CREATE to provide over the next five years?” faculty survey respondents were provided with five different methods for professional development and asked to rank all

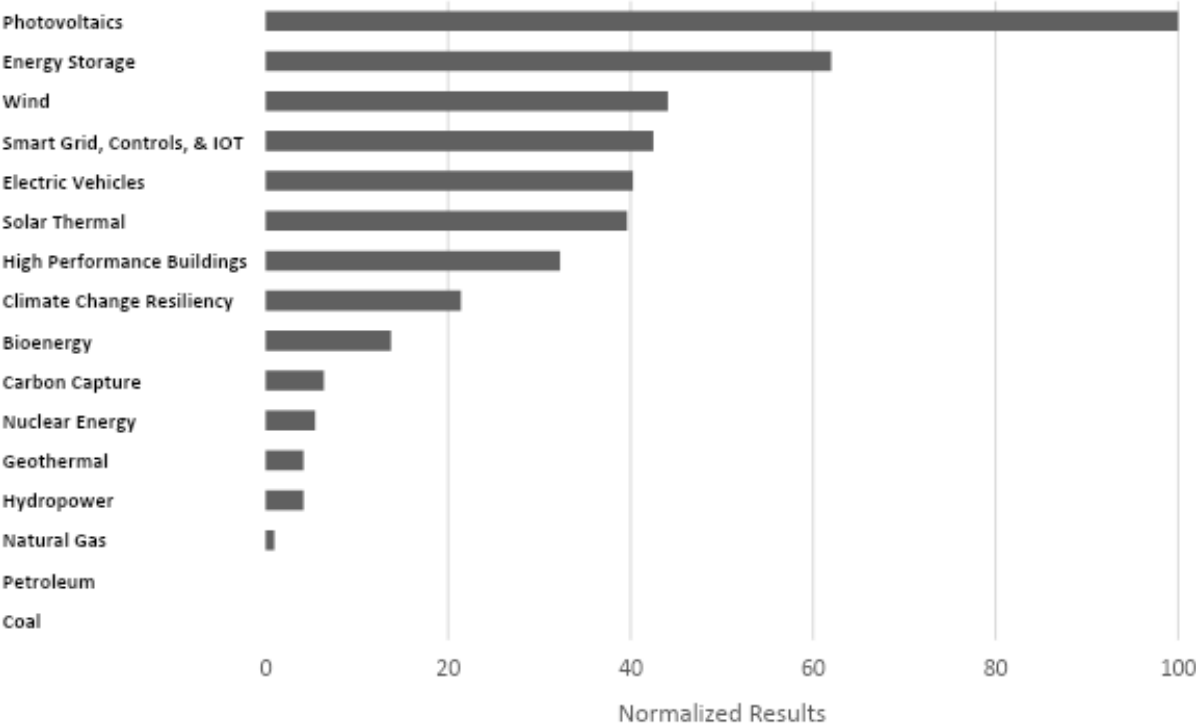
option from most preferable to least preferable. The results for this question show that faculty prefer all types of in-person delivery to online offerings if given the choice.

Figure 4. Energy Stakeholder survey responses to the question: “What formats of professional development programming for teachers are most important for CREATE to provide over the next five years?”



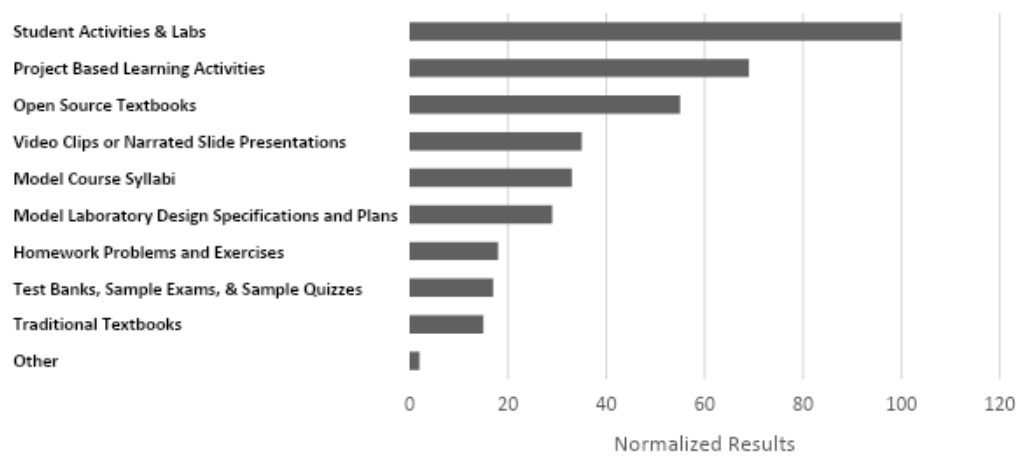
In an effort to gauge interest in which topics would be of most interest to faculty, the question “What topics/technologies for faculty professional development are most important for CREATE to provide?” provided Faculty survey respondents with a list of 16 potential topics for future CREATE professional development events. Participants were asked to rank their top five choices, in order of importance, from 1-5.

Figure 5. Energy Stakeholder survey responses to the question: “What topics/technologies for faculty professional development are most important for CREATE to provide?”



Lastly, Faculty survey participants were asked “*What types of instructional materials and educational resources are most important for CREATE to provide?*”. Faculty were provided 10 types of educational resources and asked to rank the top five most helpful types of educational materials CREATE could provide. Survey responses showed that faculty were most interested in receiving activities that contributed to in-class, lab, and project-based learning activities.

Figure 6. Energy Stakeholder survey responses to the question: “*What types of instructional materials and educational resources are most important for CREATE to provide?*”



Discussion

Solar photovoltaics has been the top choice for growth and technological change in the last several iterations of the Energy Education Survey, and Solar PV retains a commanding position as the top ranked priority for faculty professional development. This no doubt is a direct reflection of the extraordinary growth of the solar PV industry over the past two decades.

Energy storage surpassed solar PV in the rankings for growth and technological change for the first time and climbed into the second position for priorities for faculty professional development. This is a significant jump that has occurred since the previous survey and is likely reflective of the fact that energy storage technology has become much more cost effective and is now finding traction in the energy marketplace.

Electric vehicles received comparatively few votes for any questions included in the last survey completed 3 years ago, but EVs have surged into the top 5 rankings for growth, technological change, and desired topics for faculty professional development. By comparison, biofuels were ranked highly in CREATE surveys a decade ago, but did not receive any votes for growth or technological change in this iteration, and have since slid far down the list of priorities for faculty professional development. This is indicative of the much larger paradigm shift that is poised to re-shape the transportation sector in the upcoming decade.

Despite COVID and two years of everyone becoming more familiar and comfortable with remote learning and video conferencing tools, participants still have a strong preference for face-to-face professional development. This may be indicative of online “burnout”, but it probably also indicates the value that people place on the opportunity to grow their professional networks and develop collegial relationships with other educators - which is much more

difficult to do in a virtual environment. This also likely indicates a pent-up desire for face-to-face interaction, so conference organizers and entities that provide professional development might expect to see increased attendance and participant demand once the COVID pandemic has eased.

Participants expressed strong preference that CREATE should focus its efforts on supporting faculty and educational programs that are targeted to meet workforce needs. This activity was strongly favored over all others. Other activities such as re-education of displaced energy workers, and promotion of a diverse energy workforce were ranked much lower. This result should not be interpreted as discounting the importance of these latter activities. Rather the finding emphasizes the importance placed on supporting faculty and academic programs. We also suspect that respondents likely felt that CREATE was uniquely positioned to best contribute in this way, whereas other organizations might be better suited to address the energy justice, participation, and equity aspects of the energy workforce.

By far, the priority for instructional resources indicated a strong preference for materials that promote hands-on student activities such as labs and project-based learning. This has been a consistent finding across each iteration of the CREATE survey since its original conception nearly 15 years ago. This result likely indicates both the value placed on hands-on learning, and the fact that there is a shortage of high-quality instructional materials of this type.

An interesting development in this survey was the heightened importance placed on open-source textbooks and other types of electronic presentations and instructional media, along with the declining importance of traditional textbooks. This has been a gradual shift in the survey responses over several years that was amplified in this survey iteration. Several respondents also included comments indicating that it was difficult to find electronic instructional materials that supported close captioning, text-to-speech, altText and image metadata, and other such functions necessary to meet accessibility requirements for distance learning. It is highly likely that these results and comments are attributable to the switch to digital instruction that resulted from the COVID pandemic.

The lack of “Supplies, materials, and equipment for students to deliver hands-on instruction”, was the single greatest obstacle faced by educators. Follow up questioning revealed that the average annual budget that faculty respondents had for instructional materials and supplies was \$2,157. However, this value was heavily skewed by a ten respondents that had supply budgets in excess of \$5,000. ***More than a quarter of the respondents had no budget for supplies***, and the median value was only \$500. Several people commented that their supply budgets had been zeroed out in response to COVID to reallocate resources to other priorities, and they did not know if, or when, those funds might be restored. This presents a serious challenge for educators to stay current with technological changes happening in the energy industry, and hinders the integration of new energy instructional activities into the curriculum.

The CREATE survey also asked educators to quantify how much funding their schools made available to faculty for professional development and training. The average amount of annual professional development funding per faculty member was \$379. However, this result was again heavily skewed by eleven respondents whose schools made available over \$1000 per faculty

member. ***Over half of the respondents indicated that their schools did not provide any professional development funds at all.*** Several respondents commented that funds that were once available had been slowly reduced over many years of budget cuts and contract concessions. Other's noted that their professional development budgets had been eliminated during the COVID pandemic. This was perhaps the most concerning finding of the study, since it directly impacts the ability of the academic community to maintain scholarly excellence. Although the survey did not directly collect data to quantify student populations, it is a reasonable assumption that the schools reporting the lowest (or non-existent) professional development budgets for teachers, probably also serve significant low-income and under-represented student populations. This creates a challenge for organizations like ASEE and venues like the ASEE conference. Promoting a diverse and inclusive community of faculty participants will be complicated by the fact that so many educators lack access to funds for professional memberships, conference registrations, and/or travel costs.

Recommendations

The data from this survey can help faculty and educational leaders plan how to adapt courses and educational programs to address emerging energy trends and to embed various new technologies into their curriculum. Engineering, engineering technology and energy education programs of all types would be wise to study the solar PV, energy storage, and electric vehicle sectors closely, and to examine how these technologies might best be addressed in their academic programs. Solar PV, energy storage, and electric vehicle technology have changed dramatically in the last three years, and the pace of the transformation happening in the energy sector is accelerating. Unfortunately, new technologies have entered the marketplace at the exact same time that academic programs have faced budget constraints that have diminished their ability to stay current with new innovations.

Since the first CREATE survey was conducted over a decade ago, respondents have consistently expressed a desire for continuing education that emphasizes hands-on access to tools and equipment used in the energy workplace, and this no-doubt also underscores the preference for face-to-face professional development. This result also presents a challenge to providers of faculty professional development programming, since investments in new solar photovoltaic, energy storage, and electric vehicle infrastructure and capital equipment will be needed to create the platforms required to provide faculty with professional development opportunities in these areas.

For employers, businesses, and industry organizations that are interested in supporting education, the CREATE survey results provide insights as to how industry might best support educators and contribute to programs and schools that prepare students for careers in the energy sector. In particular, donation of equipment, tools, supplies, and materials that facilitate hands-on learning would clearly be well received by educators, and would help to address the technological gaps that schools face in these sectors.

Federal agencies such as NSF, and the Departments of Energy and Labor fund numerous energy workforce education projects each year. The CREATE survey data may be useful to program administrators to guide the allocation of funding, and to evaluate what types of proposals might be most important to support. In particular, prioritization of funding for energy infrastructure

and equipment upgrades and for faculty professional development grant projects would have significant benefit. The lattermost activity may also be of heightened importance in light of recent changes to faculty support budgets implemented by many schools that were necessitated by the COVID-19 pandemic.

This data should also help grantees to tailor their projects to help address some of the areas of greatest need. For prospective new principal investigators, this data may also be useful to shape future grant proposals to respond to these exigencies. Given the scarcity of funds that most faculty reported for professional development, leaders of grant funded projects may wish to cite the data from the CREATE survey as justification for the inclusion of participant support funding in their grant budget requests.

Institutions and organizations that develop and disseminate electronic curriculum or instructional materials should also take action to implement accessibility standards to develop, procure, maintain, and use information and communications technology that is accessible to people with disabilities, as required under Section 508 of the Rehabilitation Act. This is relevant for projects that might create new electronic instructional materials for the energy sector, and also for organizations that have older legacy instructional materials that might pre-date the most current accepted practices. Furthermore, since information and communications technology is constantly changing, this is not a one-time activity or cost. Institutions and organizations that produce electronic content and instructional resources would be wise to provide staff training in accessibility standards, and to include examination and modification of electronic documents for section 508 compliance as a standard component of their annual budget going forward.

For organizations such as CREATE that provide faculty professional development, these findings provide guidance on how to structure programming to maximize the benefit to participating educators. In the past year, CREATE has launched some pilot initiatives to address the findings from the most recent energy stakeholder survey. This summer, CREATE will offer both virtual and face-to-face faculty professional development workshops in solar PV and energy storage technology. Participants in the face-to-face workshops will be provided with stipends to offset their cost of attendance. A new CREATE materials award program has also been launched that allows participating faculty to write a short application and receive up to \$1200 in lab materials to help implement new hands-on lab activities at their school. In the upcoming year, CREATE will further examine the intersection of Solar PV and energy storage with electric vehicle technology, and we hope to report on additional faculty programming in this interdisciplinary area in the near future.

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