# A Case for Integrating Climate Change Education into Technician Training

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**Abstract:** This paper explores the integration of climate change content into technician training programs to better equip the workforce for the challenges posed by a changing climate. Technicians play a crucial role in industries such as energy, construction, and manufacturing, where their technical expertise is vital for driving sustainability and resiliency. However, many technician programs lack content on climate science, sustainability practices, and renewable energy despite the growing demand for such skills in the workforce. The paper outlines the importance of incorporating climate change education into technician curricula and provides examples of how existing programs can be adapted to emphasize climate resiliency, energy efficiency, and renewable energy. It also addresses the challenges educators face in implementing these changes, including resistance to curriculum revisions, limited resources, and a lack of expertise. Potential solutions, including professional development, industry partnerships, and the use of open educational resources, are discussed as strategies to overcome these barriers. By integrating climate change education into technician training, educational institutions can ensure that graduates are prepared to support industries in their transition to a more sustainable and climate-resilient future.

**Keywords: technician education, climate change education, sustainability, renewable energy, climate resilience, energy efficiency, workforce development, curriculum development**



## *Introduction*

In recent years, conversations surrounding climate change have shifted from debate to urgent action across global industries [1,2]. As society grapples with the significant environmental, social, and economic impacts of a warming planet, the role of technicians in addressing these challenges has become increasingly relevant. We define technicians as professionals who use a high level of science and engineering skills in their jobs but do not necessarily need a bachelor's degree [3]. Technicians, who operate at the intersection of technology, infrastructure, and daily operations in various industries, wield considerable influence over energy consumption, emissions, and the adoption and delivery of sustainable practices, helping to mitigate the effects of climate change [4,5].

Industries, driven by both regulatory pressures and economic imperatives, are increasingly recognizing the need to integrate sustainable practices into their operations. This shift is altruistic but mostly pragmatic, driven by the dual goals of cost reduction and mitigating the effect of climate change on their infrastructure. Businesses recognize that adopting sustainable practices can lead to long-term financial advantages, including reduced energy consumption, increased operational

efficiency, greater equipment durability, and a stronger brand reputation [6-9]. Additionally, these efforts help mitigate the impacts of climate change, such as rising temperatures, flooding, and extreme weather events. Companies nationwide are actively developing and implementing sustainability policies and resilience plans [10-14].

For technicians, understanding climate change is no longer optional but essential for navigating this evolving landscape. Climate change education provides technicians with the knowledge and tools to analyze environmental impacts, identify opportunities for improvement, and implement sustainable solutions. By embedding climate change education into technician training programs, educational institutions can empower future professionals to serve the needs of industry while contributing to broader environmental goals. Engineers, especially civil engineers who must design and build structures intended to withstand environmental conditions, have increasingly recognized the importance of integrating climate change education into their curricula [15-16]. Nevertheless, relatively little has been done in technician education to incorporate climate change elements.

**Current State of Technician Training Programs**

Technician training programs play a crucial role in preparing individuals for careers in various technical industries. These programs are designed to provide specialized education that equips students with practical skills and industry-specific knowledge necessary to excel in their chosen fields. The Engineering Technology Accreditation Commission (ETAC) of ABET (formerly the Accreditation Board for Engineering and Technology) serves as the primary accrediting body for technology programs globally [17]. ETAC of ABET accredits more than 500 programs in the United States, highlighting its dedication to maintaining high standards and ensuring the quality of technical education [18]. Among these accredited programs, electrical and mechanical fields feature the most prominent, comprising 20% and 30% of the total, respectively (figure 1).

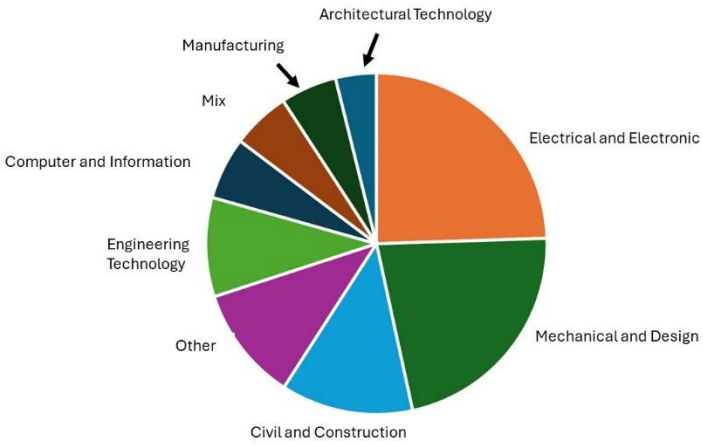


*Fig. 1. Distribution of Technology programs accredited by ETAC of ABET*

ETAC of ABET-accredited technician training programs provides a structured pathway for individuals to develop essential technical skills for diverse industries. Additionally, many non-ABET-accredited technology programs exist, often due to niche specializations, regional factors, or accreditation

differences. Noncredit Continuing Education programs, accounting for 40% of community college enrollment [19], also serve as a significant entry point into technical fields [20]. Technician curricula emphasize hands-on training in areas like equipment maintenance, computer systems, electrical wiring, and mechanical systems. These programs ensure graduates master industry-specific skills, including safety, regulatory compliance, and emerging technologies, preparing them for immediate workforce contributions.

Despite the thorough training in technical competencies, a notable gap exists in addressing environmental sustainability and climate change within technician training programs. Most curricula do not integrate dedicated coursework on the environmental impacts of industry practices, strategies for resiliency, and sustainable technologies. This omission is significant considering the increasing global emphasis on environmental stewardship and sustainable development goals. The current structure of technician training programs, while robust in technical education, often overlooks the broader implications of industrial practices on the environment. This oversight can limit technicians' ability to adopt and implement sustainable solutions within their roles, potentially hindering progress toward reducing carbon emissions and promoting resource efficiency. Additionally, it affects their employability as industries increasingly seek individuals with expertise in climate resiliency and green technologies [21-23].

**Integrating Climate Change Education: A Conceptual Framework**

Integrating climate change education into technician training programs is essential for preparing a workforce capable of addressing the needs of industry in the 21st century. A comprehensive approach involves curriculum development, innovative pedagogical strategies, and robust assessment and evaluation mechanisms. However, one of the biggest impediments to incorporating climate change content into these programs is that most technician training programs are already packed with essential coursework, making it challenging to add new material. This difficulty arises because the existing curricula are designed to ensure students acquire the fundamental technical skills required for their professions. As technology advances, the technical content for many disciplines has been increasing, necessitating that students learn more material, leaving little room for additional coursework. To overcome this, educators and curriculum developers might find creative solutions, such as integrating climate change topics into existing courses, leveraging online and blended learning formats to supplement in-person instruction, and creating interdisciplinary projects that address both technical skills and climate literacy.

Additionally, there is no one-size-fits-all approach to the climate content because each technical field and region has unique requirements. The needs of electrical technicians differ from those of manufacturing technicians. An electrical technician might need to understand how increasing temperatures affect transformers and other electrical components, while a manufacturing technician will need to know how to implement sustainable practices and manage the impacts of climate change on production processes and supply chains. Furthermore, regional differences also play a crucial role. In the Southwest, where temperatures can soar, and the sun is plentiful, students in energy production technology programs might have more opportunities in solar energy. In contrast, in the Northeast, technicians might focus on ensuring that electrical infrastructure can withstand severe winter storms

and fluctuating freeze-thaw cycles, as well as optimizing heating systems for energy efficiency during cold months.

**Input from Industry**

As part of a National Science Foundation (NSF) funded Advanced Technological Education (ATE) grant, the authors are collaborating with industry partners in the energy and transportation sectors to identify essential program and student learning outcomes for technicians to remain competitive in the job market. This collaboration aims to ensure that any revisions to existing technology programs are aligned with the evolving needs of the industry, particularly in the context of natural disaster resiliency.

To achieve this, interviews were conducted with 25 industry professionals who bring expertise in their respective fields and experience in resiliency. These professionals provided valuable insights into the most critical skills and competencies that technicians need to develop to address climate-related challenges effectively. The interviews revealed that, alongside traditional learning outcomes, certain competencies related to climate change adaptation are considered essential for employment in these sectors. The industry partners were asked to prioritize each learning outcome on a scale from 1 to 5, with 1 representing the least important and 5 representing the highest priority. This prioritization helps to address the specific needs of their industry and ensures that the training programs are tailored to produce graduates who are well-equipped to handle the demands of their roles. The results of this prioritization are listed in Table 1 below.

Industry partners highlighted the importance of technicians understanding climate processes such as the greenhouse effect, carbon cycle, and climate projections, as this foundational knowledge enables them to grasp the environmental context of their work. However, this was not the most crucial. Awareness of sector-specific impacts, rated a priority score of 4, is essential; energy technicians, for example, must understand how rising temperatures and extreme weather affect production and distribution, while transportation technicians address climate impacts on infrastructure and vehicle performance. Knowledge of technologies to reduce environmental impacts, rated 3.5, includes energy-efficient systems and renewable energy for electrical technicians and sustainable HVAC and green building practices for mechanical technicians. The highest priority (4.5) was given to expertise in technologies that mitigate climate change, such as smart grid integration for electrical technicians and energy-efficient building systems for mechanical technicians. Finally, the ability to assess and adapt to climate risks also rated 3.5, is crucial for resilience, requiring technicians to evaluate vulnerabilities and implement measures to protect infrastructure and operations from climate disruptions.

**Table 1. Prioritized Learning Outcomes for Technician Training**

| Learning Outcomes | Description | Priority |
|---|---|---|
| Knowledge of Climate Processes | Understand fundamental climate science, including the greenhouse effect, carbon cycle, and projections. | 2 |

| | | |
|---|---|---|
| Awareness of Sector-Specific Impacts | Identify how climate change affects their specific industry. | 4 |
| Knowledge of Technology to Reduce Impact on Environment | Familiarity with technologies and practices that lower greenhouse gas emissions. | 3.5 |
| Knowledge of Technologies to Mitigate Climate Change Impacts | Implement technologies and strategies to mitigate climate change impacts on industry operations. | 4.5 |
| Ability to Analyze and Adapt to Climate Risks | Evaluate climate-related risks and adapt strategies and systems accordingly to ensure resilience. | 3.5 |

**Proposed Curriculum**

Integrating climate change education into technician training programs requires a comprehensive and strategic approach to ensure relevance and accessibility without overwhelming already packed curricula. Most technology courses are tightly structured, leaving little room to introduce entirely new courses. Embedding climate science topics into existing courses is a practical approach. For instance, Introduction to Technology courses that cover topics such as foundational concepts, ethics, and teamwork can incorporate content on climate change—its causes, impacts, and relevance to modern industry. By framing these topics within ethical and professional contexts, students can see their direct application to future roles. The industry survey suggests that technicians do not need to become experts in climate science but require enough background knowledge to understand and apply resiliency principles in their work. This foundational understanding helps them contextualize broader discussions on energy efficiency, resource conservation, and the environmental impact of technology, ensuring that they are prepared to contribute to sustainable practices within their industries. If the curriculum allows, offering science electives such as climate science or environmental science can provide students with an opportunity to delve deeper into such topics. These courses could explore the scientific principles underlying climate change, the impact of human activity on the environment, and emerging technologies designed to mitigate these effects.

Integrating climate-related technology topics into existing courses equips students with essential skills while preserving structured curricula. HVAC courses can address energy efficiency by teaching about low-global-warming refrigerants and optimizing airflow with smart thermostats. Automotive programs could explore electric and hybrid vehicles, focusing on battery technology and energy optimization. Electrical engineering students might study renewable systems like solar PV design, while mechanical technology programs could cover geothermal heat pumps for efficient heating and cooling. These concepts build on existing curricula, adding a climate change context to enhance relevance and understanding.

Creating sector-specific courses within different technology disciplines can equip students with targeted expertise in climate-related technologies. For construction technology, a course on sustainable building practices could cover climate-resilient design, energy-efficient materials, and strategies for reducing carbon footprints in construction projects. In electrical technology, a course on renewable

energy systems could focus on the design and maintenance of solar, wind, and battery storage systems. Automotive technology programs could include a specialized course on electric vehicle technology, covering powertrains, charging infrastructure, and battery recycling.

Hands-on training and practical applications are essential for effective learning. Laboratory exercises can replicate real-world scenarios, such as installing and troubleshooting solar PV systems or maintaining smart electrical systems for electrical technician students. Fieldwork provides valuable practical exposure, such as visits to renewable energy plants and recycling facilities. Construction technician students could explore climate-resilient infrastructure, including sea walls designed to withstand rising sea levels or buildings constructed with materials and techniques engineered to endure higher temperatures.

Leveraging technology and digital tools enhances the learning experience and equips students with modern skills essential for the green economy. Simulation software, virtual labs, and online resources provide valuable opportunities for interactive and immersive learning. For example, students can use software to model the impacts of different energy systems on efficiency or employ geographic information systems (GIS) to analyze environmental data. Additionally, virtual reality (VR) can offer immersive training experiences, such as allowing mechanical technician students to explore the internal mechanics of a wind turbine or a geothermal heat pump system, fostering a deeper understanding of these technologies without requiring physical equipment. Fortunately, many free resources, including educational modules, simulations, and interactive activities, are available through Open Education Resources (OER) platforms. Sites like the National Science Foundation's (NSF) Advanced Technology Education (ATE) Central also provide a wealth of materials to support climate-related education [24].

Collaboration with industry is essential to provide real-world experiences and insights into the skills graduates need. Internships, apprenticeships, and case studies based on real-world projects can highlight climate change mitigation and adaptation efforts. For example, a case study on a community design project aimed at mitigating wildfire risks could highlight technicians' roles in addressing such challenges. Capstone projects offer opportunities for students to tackle climate-related issues in their field. Electrical technician students might design a small-scale solar PV system for a community center, while construction technician students could develop a plan for retrofitting a building with energy-efficient HVAC systems.

The examples provided demonstrate how existing curricula can be adapted to emphasize climate resiliency, renewable energy, and energy efficiency. These revisions will vary depending on regional needs and industry demands, ensuring that programs are tailored to the specific climate challenges faced in different areas. Ultimately, these changes prepare technicians with the skills necessary to support industries focused on building climate resilience and enhancing operational efficiency.

**Challenges and Solutions**

Incorporating resiliency content into technology programs presents several challenges for educators. One of the primary obstacles is resistance to curriculum changes. Many technology programs have established structures that leave little room for new content, and faculty may hesitate to modify courses due to concerns about disrupting core objectives or a lack of familiarity with climate change topics. Additionally, many educators lack the expertise to effectively teach climate science or sustainability, creating further barriers to integration.

Limited resources also pose a significant challenge. Programs operate with tight budgets, making it difficult to acquire the necessary tools, such as updated materials, simulation software, and hands-on equipment, to teach climate-related content. Without access to renewable energy systems or climate-resilient infrastructure models, educators may struggle to provide students with the practical experiences needed to understand and apply sustainability concepts.

To overcome these challenges, several solutions can be implemented. Professional development opportunities are essential for building instructors' expertise in climate science and sustainability. Programs like the NSF ATE provide funding for technology programs seeking to update and enhance their curricula [25]. Additionally, existing ATE projects provide technical support, expertise, and training to help colleges enhance their curriculum.

Industry partnerships are another effective solution. Collaborating with companies focused on increasing efficiency or building climate resilience helps ensure that course content aligns with industry needs. These partnerships can provide real-world experiences and relevant expertise, ensuring students gain the skills that employers in the green economy require. Finally, open educational resources (OER) offer cost-effective tools to support climate change education. A wealth of freely available resources, such as simulations and interactive modules, can supplement traditional teaching materials. By leveraging these resources, educators can enrich their programs without significant financial investment.

## *Conclusions*

Integrating climate change education into technician training programs is crucial for preparing a workforce to address environmental challenges. Technicians play a key role in sustainability, and equipping them with the knowledge to tackle climate change is essential. This paper highlights how training programs can focus on climate resilience, renewable energy, and energy efficiency, aligning with industry needs. While challenges like curriculum resistance and limited resources exist, solutions such as professional development, industry partnerships, and open educational resources can help. These strategies ensure graduates are ready to support sustainable practices and help industries become more climate-resilient, ultimately contributing to global climate change mitigation.

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