International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

Green Innovators: Knowledge, Awareness, and Practices of Industrial Technology Students Towards Renewable Energy Innovations

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International Journal of Science and Research Archive, 2025, 17(02), 1027-1033

Publication history: Received 18 October 2025; revised on 24 November 2025; accepted on 26 November 2025

Article DOI: https://doi.org/10.30574/ijsra.2025.17.2.3155

Abstract

Renewable energy innovations are transforming the way we generate and use energy, making significant strides towards a sustainable future. This study was conducted to elicit the knowledge, awareness and practices of industrial technology students Apayao State College-Conner Campus towards renewable energy innovations. The data were gathered using an adopted survey questionnaire and interpreted using mean, percentage and frequency and thematic analysis. The results highlight a promising engagement with renewable energy across knowledge, awareness, and practices. Respondents show strong familiarity with solar energy, energy storage, and renewable system components, coupled with high awareness of environmental benefits and active participation in sustainability efforts. Notable areas for improvement include understanding smart grids, environmental advantages over fossil fuels, and advancements in renewable technology. Industrial technology students display significant dedication through involvement in organizations, campus initiatives, and collaborative projects, reflecting a proactive approach to promoting renewable energy. These findings emphasize the importance of targeted educational initiatives to bridge knowledge gaps and further advance renewable energy adoption and advocacy. It is recommended to support collaboration among students, faculty, and industry professionals to explore innovative renewable energy solutions.

Keywords: Renewable Energy; Knowledge; Awareness; Practice; Renewable Energy

1. Introduction

Energy plays a significant and essential role in developing a nation's economy and social growth. Thus, governments around the world are decreasingly reliant on the remaining fossil fuel sources of energy and are concentrating on the deployment of low-carbon energy sources to reduce carbon emissions into the environment, specifically renewable energy sources.

Renewable energy is a naturally replaceable and sustainable energy source which can be reused again (Celikler, 2013). A few examples of natural renewable energy resources are solar, wind, biomass, geothermal, wave and falling-water energy (Daugherty and Carter, 2010). In discussing the advantages and benefits of renewable energy, it was postulated that renewable energy is sustainable, cleaner, safer, non-poisonous and non-polluting to the environment (Morgil et al. 2006).

Renewable energy innovations are transforming the way we generate and use energy, making significant strides towards a sustainable future. These innovations include advancements in solar power, wind energy, green hydrogen, and grid integration technologies (Dudin et al. 2019). By harnessing these technologies, we can reduce our reliance on fossil fuels, decrease greenhouse gas emissions, and promote energy independence. The integration of renewable

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energy sources into our daily lives is essential for achieving global climate goals and ensuring a cleaner and greener planet.

The Philippines has a growing economy and population, which puts constant pressure on the country's energy supplies, more than half of which are mainly imported fossil fuels. Much like the rest of the world, the country faces the choice of continuing to rely on imported fossil fuels or expanding its renewable energy (RE) capacity (Cowlin et al. 2018). The study by Lloyd and Nakamura (2022) about public perceptions of renewable energy in the Philippines, it found out that high awareness and concern for the climate crisis among Filipinos, with 86.2% supporting renewable energy expansion and 80.8% willing to install it on their property if affordable. The adoption of renewable energy by individuals and households has been slow.

In order to provide awareness and knowledge related to renewable energy, the role of education institutions is considered crucial even though it faces challenges as listed by Açıkgöz, (2011), that there are only limited studies related to public opinions about renewable energy and renewable energy not being treated as a separate discipline until it was acknowledged as a new area rather than as a topic within technical and engineering studies. In this sense, it is believed that renewable energy should be taught as early as the primary school level to provide initial knowledge, awareness and values to all primary students (Kandpal and Garg, 1998) as an introduction to studies within higher institutions of learning including technical colleges and universities.

In providing understanding and educating students and society about RE, the role of educators was seen as essential and unique in creating awareness, promoting, clarifying the occurred phenomena and building positive attitudes among community members concerning the development of renewable energy (Ocetkiewicz et al., 2017).

Hence, this study aims to explore the issue through by eliciting the knowledge, awareness and practices of Industrial technology students towards the implementation of renewable energy locally. It will also address the SDG 9 (Industry, Innovation, and Infrastructure) which aims to build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation, which aligns well with the focus on renewable energy innovations. By understanding how students perceive and engage with renewable energy technologies, educators and policymakers can tailor curricula, training programs, and initiatives to better prepare the next generation of industrial technologists for the challenges and opportunities of a green economy.

2. Methodology

2.1. Research Design

This study was utilized through quantitative-descriptive methods using an adapted survey questionnaire (Derasid et al.,2021) to gather the research data.

2.2. Locale of the Study

This study was conducted at Apayao State College - Conner Campus.

2.3. Respondents of the Study

The respondents of this study are the BS Industrial Technology students enrolled of the Apayao State College-Conner Campus for AY 2024-25. Random sampling was used.

2.4. Research Instrumentation

An adapted survey questionnaire (Derasid et al.,2021) was used to gather research data. It was composed of 5 parts: Part I elicited the demographics of the respondents, Part II was for the level of knowledge regarding renewable energy innovations, Part III was for the level of awareness, Part IV measures the practices and behaviors of industrial technology students in relation to renewable energy usage and promotion, and Part V was for the recommendations.

2.5. Data Analysis

Percentage and frequency were used to measure the profile of the respondents. Weighted mean was used to measure the level of knowledge, awareness, practices from the respondents using 5 Point-Likert scale:

Table 1 5-Point Likert Scale as to Level of Knowledge

Scale	Mean range	Descriptive interpretation
5	4.20 – 5.00	Very Knowledgeable
4	3.40 – 4.19	Knowledgeable
3	2.80 – 3.39	Neutral
2	1.80 - 2.79	Slightly Knowledgeable
1	1.00 – 1.79	Not Knowledgeable

Table 2 5-Point Likert Scale as to Level of Awareness

Scale	Mean range	Descriptive interpretation
5	4.20 – 5.00	Fully aware
4	3.40 – 4.19	Aware
3	2.80 – 3.39	Neither
2	1.80 - 2.79	Not Aware
1	1.00 – 1.79	Fully not aware

Table 3 5-Point Likert Scale as to Level of Agree

Scale	Mean range	Descriptive interpretation
5	4.20 – 5.00	Strongly agree
4	3.40 – 4.19	Agree
3	2.80 – 3.39	Neither agree nor disagree
2	1.80 - 2.79	Disagree
1	1.00 – 1.79	Strongly disagree

Thematic analysis was used for the recommendations of the respondents.

3. Results and discussion

3.1. . Part I. Level of knowledge regarding renewable energy innovations

Table 4 Level of knowledge regarding renewable energy innovations

Statement	Mean	Interpretation
I can explain how solar panels convert sunlight into electricity.	3.77	Knowledgeable
I understand the differences between various types of wind turbines and their applications.	3.02	Neutral
I can describe how hydroelectric power is generated and its environmental impact.	3.75	Knowledgeable
I am knowledgeable about the principles and applications of geothermal energy.	3.55	Knowledgeable

I can identify the main components of a renewable energy system (e.g., solar panel, inverter, battery).	4.06	Knowledgeable
I understand the concept of energy storage and its importance in renewable energy systems.	3.83	Knowledgeable
I am aware of the latest advancements in green hydrogen production and its potential uses.	3.72	Knowledgeable
I can explain the role of smart grids in integrating renewable energy sources.	3.19	Neutral
I understand the economic benefits and challenges of transitioning to renewable energy.	3.72	Knowledgeable
I am knowledgeable about the environmental benefits of using renewable energy technologies over fossil fuels.	2.70	Slightly Knowledgeable
Overall Mean	3.53	Knowledgeable

The data in Table 4 highlights a generally knowledgeable understanding of renewable energy innovations, with an overall mean of 3.53, interpreted as "Knowledgeable." Respondents demonstrate strong familiarity with solar energy, energy storage, and the components of renewable energy systems, as evidenced by high mean scores (e.g., 4.06 for identifying system components). However, there are areas for improvement, such as understanding the environmental benefits of renewable energy over fossil fuels (mean: 2.70, "Slightly Knowledgeable") and the role of smart grids (mean: 3.19, "Neutral"). These findings underscore the importance of targeted educational initiatives to address gaps in knowledge, particularly in areas critical to advancing renewable energy adoption.

A related study by Kyei et al. (2025) delves into the critical role of public education in promoting renewable energy technologies as a pathway to achieving Sustainable Development Goals (SDGs). It highlights how public education initiatives can bridge knowledge gaps, enhance community engagement, and foster a supportive environment for renewable energy adoption. The research underscores that informed communities are more likely to embrace renewable energy solutions, as they better understand the environmental, economic, and social benefits. Moreover, the study emphasizes the need for tailored educational programs that address specific regional challenges and opportunities, ensuring that the transition to renewable energy is inclusive and equitable. By integrating public education with policy and technological advancements, the study suggests that societies can accelerate the shift towards sustainable energy systems, ultimately contributing to global efforts to combat climate change and reduce dependency on fossil fuels.

3.2. Part II. Level of Awareness regarding renewable energy innovations

Table 5 Level of Awareness regarding renewable energy innovations

Statement	**Mean**	**Interpretation**
I am familiar with the different types of renewable energy sources (e.g., solar, wind, hydro).	3.89	Aware
I am aware of the environmental benefits of using renewable energy over fossil fuels.	3.96	Aware
I can identify the latest advancements and innovations in renewable energy technology.	3.38	Neither
I understand how renewable energy can help reduce greenhouse gas emissions.	3.62	Aware
I am knowledgeable about the cost-effectiveness of renewable energy solutions.	3.70	Aware
I can explain the role of renewable energy in achieving sustainable development goals.	3.81	Aware
I am aware of government policies and incentives that promote renewable energy adoption.	3.43	Aware
I know the challenges and limitations associated with implementing renewable energy technologies.	3.43	Aware
I follow news and updates related to renewable energy innovations and developments.	3.60	Aware

I am aware of how renewable energy can be integrated into existing industrial processes.	3.47	Aware
Overall Mean	3.63	Aware

The data in Table 5 reflects a strong level of awareness regarding renewable energy innovations, with an overall mean of 3.63, interpreted as "Aware." Respondents exhibit a high degree of familiarity with renewable energy sources (mean: 3.89) and their environmental benefits (mean: 3.96). However, there is room for improvement in identifying the latest advancements in renewable energy technology (mean: 3.38, "Neither").

This suggests the need for more accessible information and updates on technological innovations. A related study by Farin and Abugho (2017) highlights that public awareness and acceptability of renewable energy technologies are influenced by education and exposure to information. Their research emphasizes that increasing awareness through targeted campaigns and educational programs can significantly enhance public support and adoption of renewable energy technologies.

3.3. Part III. Practices and behaviors of industrial technology students in relation to renewable energy usage and promotion.

Table 6 Practices and behaviors of industrial technology students in relation to renewable energy usage and promotion

Statement	Mean	Interpretation
I actively seek opportunities to learn about renewable energy technologies and their applications.	3.78	Agree
I regularly participate in workshops or seminars related to renewable energy innovations.	3.63	Agree
I incorporate renewable energy practices in my personal projects and assignments.	3.57	Agree
I advocate for the use of renewable energy within my community and peer groups.	3.43	Agree
I make efforts to reduce my carbon footprint by using energy-efficient appliances and renewable energy sources.	3.66	Agree
I support and participate in campus initiatives that promote renewable energy and sustainability.	3.87	Agree
I am involved in student organizations or clubs that focus on renewable energy and environmental conservation.	3.92	Agree
I stay informed about the latest developments and trends in renewable energy through various media sources.	3.50	Agree
I encourage others to adopt renewable energy practices and provide information on its benefits.	3.51	Agree
I collaborate with classmates and faculty members on projects that explore renewable energy solutions.	3.63	Agree
Overall Mean	3.65	Agree

The practices and behaviors of industrial technology students regarding renewable energy usage and promotion, as shown in Table 3, indicate a strong commitment to supporting sustainable energy initiatives, with an overall mean of 3.65, interpreted as "Agree." Students demonstrate active participation in renewable energy efforts, such as joining relevant organizations (mean: 3.92) and supporting campus initiatives (mean: 3.87). Additionally, their efforts to learn, reduce their carbon footprint, and collaborate on renewable energy projects highlight their proactive approach to sustainability.

These findings align with the study by Mittal & Bansal, (2024), that explores the transformative impact of student-led initiatives in promoting environmental sustainability within educational institutions. It highlights how students, through their passion and creativity, have become catalysts for change by leading projects such as campus greening, advocacy campaigns, and research on renewable energy solutions. The study emphasizes the importance of empowering students as agents of change, fostering leadership skills, and encouraging collaboration among peers and faculty. By showcasing successful case studies from around the world, the research demonstrates how these initiatives

not only contribute to environmental conservation but also inspire broader community engagement and policy reforms. The findings underscore the potential of student-led efforts to drive meaningful change and advance sustainability goals at local, national, and global levels.

3.4. Part IV. Strategies and recommendations for enhancing the knowledge, awareness, and practices of industrial technology students towards renewable energy innovations

Table 7 Strategies and recommendations for enhancing the knowledge, awareness, and practices of industrial technology students towards renewable energy innovations

Themes	Actions
Curriculum Integration	Incorporate renewable energy topics into academic programs, emphasizing practical applications and emerging technologies, such as smart grids and green hydrogen innovations.
Awareness Campaigns	Launch initiatives to promote understanding of the environmental, economic, and societal benefits of renewable energy, using workshops, seminars, and multimedia content.
Advocacy and Leadership Development	Encourage students to take active roles in sustainability campaigns and campus organizations focused on renewable energy, fostering leadership and advocacy skills.
Collaboration and Partnerships	Strengthening ties between educational institutions, industries, and government bodies to support research, innovation, and knowledge-sharing on renewable energy solutions.
Community Engagement	Facilitate outreach programs that enable students to work directly with local communities, advocating for renewable energy adoption and teaching sustainable practices.

To enhance industrial technology students' knowledge, awareness, and practices toward renewable energy innovations, table 7 indicated that strategic actions are recommended across five key areas. These include integrating renewable energy topics into the curriculum with a focus on practical applications and emerging technologies; launching awareness campaigns through workshops and multimedia to highlight environmental and societal benefits; fostering student leadership in sustainability initiatives and campus organizations; promoting collaboration among academic institutions, industries, and government for innovation and knowledge-sharing; and engaging communities through outreach programs that encourage renewable energy adoption and sustainable practices.

4. Conclusion

The findings collectively reveal a promising outlook on renewable energy knowledge, awareness, and practices among respondents, particularly industrial technology students. Their high levels of familiarity and active engagement reflect a strong commitment to sustainability, with evident efforts to integrate renewable energy into personal, academic, and community initiatives. However, gaps in understanding certain aspects, such as smart grids, environmental benefits compared to fossil fuels, and advancements in renewable energy technologies, highlight areas needing targeted educational interventions. By addressing these gaps and fostering further collaboration, advocacy, and education, these respondents have the potential to lead impactful efforts in advancing renewable energy adoption and promoting sustainable practices within their communities and beyond**.**

Compliance with ethical standards

Acknowledgments

We acknowledge that I have not used ChatGPT or Copilot for refining some of the sections in the document.

Disclosure of conflict of interest

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

Statement of informed consent

We affirm that the respondents voluntarily agreed to participate after being fully informed about the purpose, nature, and potential implications of the study. Their responses have been collected with utmost respect for their privacy and confidentiality, in accordance with ethical research guidelines.

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