Empowering Tertiary Students: Nurturing Energy Transition Knowledge in the Era of Society 5.0 Towards Sustainable Development Goals (SDGs)

Sidra Naim Taraq Naemzia[1], Zeittey Karmilla Kaman[2]

Abstract

Addressing the challenges of energy transition (ET) knowledge adoption among tertiary students requires urgent attention due to the limited awareness and understanding, especially among young individuals, alongside the imperative need for more comprehensive curricula within educational programs to effectively navigate the complexities of climate change mitigation and the transition to renewable energy sources. The overarching objective of this study is to; (1) systematically investigate the limitations in awareness and understanding of energy transition processes among tertiary students and (2) propose actionable recommendations for enhancing educational programs by developing robust curricula to effectively address the challenges and requirements associated with climate change mitigation and the transition to renewable energy sources. This paper will guide the readers in terms of energy transition knowledge among tertiary students which can empower them to act, understand the challenges, and contribute to a sustainable future. Furthermore, it will prove advantageous for individuals with a keen interest in energy transition knowledge including policymakers, academia, industries, professionals and experts who actively contribute to and shape the discourse surrounding energy-related matters.

Keywords: Energy Transition, Tertiary Students, Society 5.0, SDG

1.0 Introduction

Tertiary students can be prepared in Energy Transition (ET) knowledge towards Society 5.0 and Sustainable Development Goals (SDGs) through various approaches. Universities play a crucial role in shaping the ideals of society and can contribute to economic and sustainable development by educating students on scientific and technical issues, fostering communication among various stakeholders, and advancing socioeconomic progress [1]. Integration of knowledge from different disciplines is needed to address the complex challenge of energy production and consumption, and universities can provide interdisciplinary education to students [2]. Society 5.0, as a proposed form of a super-smart society, requires smart education to respond to the pressing problem of sustainability, and citizen-science logic can potentially provide tools for analysing its implementation [3]. Educational interventions and the integration of basic energy contents within education degrees are necessary to promote energy literacy in higher education institutions [4]. Sustainable universities should encourage

[1] Dr. Sidra Naim Taraq Naemzia, Senior Lecturer, College of Continuing Education, Institute of Sustainable Energy Universiti Tenaga Nasional, Malaysia
[2] Dr. Zeittey Karmilla Kaman, Senior Lecturer, College of Graduate Studies, Institute of Sustainable Energy Universiti Tenaga Nasional, Malaysia

L. F. Woon and S. Kaur Johl (eds.), *Proceedings of the International Conference on Environmental, Social, and Governance (ICESG 2024)*, Advances in Social Science, Education and Humanities Research 889,
https://doi.org/10.2991/978-2-38476-358-0_9

student engagement in real-world projects and the development of long-term teacher-student relationships to support younger generations in fostering ET knowledge [5].

2.0 Problem statement

Generally, issues and problems regarding ET knowledge adoption among tertiary students include limited awareness and understanding of the ET process. This lack of knowledge is particularly prevalent among young people which constitutes on those currently enrolled in tertiary education [6]. Additionally, educational programs on climate change and energy have not developed robust curricula to help students see the challenges and requirements for mitigating climate change and transitioning to renewable energy [7].

3.0 Methodology

In this paper, the author employs a rigorous content analysis methodology to meticulously track and examine top-tier journal articles published between 2018 and 2023. Central to this analysis are keywords carefully selected to hone in on critical themes, including “energy transition” “knowledge among tertiary students", "students’ preparedness” “society 5.0” and “SDG”.

The primary aim of this study is to intricately synthesize the intricate interlinkages among these focal points while diligently identifying any existing gaps within the academic discourse. Through this meticulous examination, the author not only sheds light on the current state of research but also underscores the significance of addressing discrepancies as a means of advancing our understanding in this vital domain. By emphasizing the importance of current research contributions, particularly within the context of tertiary students’ ET knowledge vis-à-vis Society 5.0 and SDGs, the author underscores the invaluable insights garnered from this study. This research not only contributes to the existing literature but also serves as a beacon guiding future scholarly inquiries in this dynamic field.

4.0 Discussion

Table: The association between energy transition knowledge, tertiary students’ awareness, society 5.0 and SGD: Analysis & Gaps

No	Title	Analysis	Gaps
1	Towards energy transition at the Faculty of Education of Bilbao (UPV/EHU): diagnosing community and building [4]	The paper mentions that there is a gap in understanding shown by the society, including tertiary students. This suggests that one of the issues regarding ET knowledge adoption among tertiary students is a lack of awareness and understanding of the current energy system and household energy consumption.	The research did not explore the reasons behind the low impact of the commitments gathered among students, which could have provided further insights into the barriers to ET. The study did not assess the long-term effectiveness of the educational interventions designed to promote energy literacy, leaving the impact of these interventions uncertain.
2	Energy Transitions: An Academia Take on Shaping the Future	The paper discusses the need for academia to adapt and enhance the academic forging of graduates in the oil and gas sector to keep up with the demands of the ET. It	Joint committees involving academia and industry are needed to accelerate the creation of new graduate profiles. However, it does not specifically

	Professionals of Oil and Gas [8]	highlights possible gaps in the knowledge base of graduates and proposes the creation of joint committees to accelerate the creation of new graduate profiles.	mention the issues or problems regarding ET knowledge adoption among tertiary students.
3	How Important Energy Awareness in Vocational Education to Support Energy Transition [9]	The paper discusses the barriers to renewable ET in developing countries, including economic factors, lack of infrastructure, and unclear regulations, among others. It also highlights the importance of ET knowledge in vocational systems as a means to promote awareness, provide knowledge, and increase understanding of renewable resources and technologies.	The paper does not explore potential solutions or strategies to overcome the identified barriers to ET in vocational education.
4	Understanding the urgency and complexities of the energy transition trough serious gaming [6]	The paper showcases insights derived from a pre-test and post-test conducted among university students in The Netherlands. These findings illuminate a notable improvement in both awareness and comprehension of ET and underscore the significance of collaboration among stakeholders. Moreover, it emphasizes the promising role of serious gaming within formal education settings, demonstrating its potential to effectively enhance awareness and understanding of intricate societal challenges.]	The discussion in the paper underscores a critical point: while educational games show promise, they currently lag behind commercial games in terms of engagement levels. This discrepancy poses a significant challenge to the efficacy of serious gaming within formal education contexts. Addressing this gap is imperative to fully harness the potential of serious gaming as a powerful educational tool.
5	Integrating the Energy Transition into Petroleum Engineering and Geoscience Education [10]	Petroleum engineering schools and geoscience programs are poised to provide invaluable educational pathways, offering a broad spectrum of learning opportunities. These programs have the capacity to furnish graduates and industry professionals alike with the requisite expertise and leadership acumen necessary to navigate the evolving landscape of ET. By leveraging their existing resources and adapting curriculum to incorporate ET principles, these institutions can play a pivotal role in shaping a skilled workforce capable of driving innovation and sustainability within the energy sector and beyond.	One potential gap could be the need for updated curriculum and training programs that address the specific requirements of the ET including renewable energy technologies, carbon capture and storage, and sustainable practices. Another potential gap could be the need for collaboration and partnerships between academia, industry, and government agencies to ensure that the education and training provided align with the evolving needs of the ET.
6	Student energy-saving in higher education tackling the	The study delved into students' attitudes towards sustainability and their behavioural intentions concerning energy use in higher	The study does not explore the long-term impact of student attitudes and behavioural intentions on energy saving and

	challenge of decarbonisation [11]	education environments, emphasizing the promotion of energy conservation and decarbonization. It pinpointed three critical dimensions each for sustainable attitudes and behaviours, which emerged as significant predictors of student energy consumption.	decarbonization efforts in higher education settings.
7	Energy Literacy of University Graduate Students: A Multidimensional Assessment in Terms of Content Knowledge, Attitude and Behaviour [12]	The paper highlights the pressing necessity for enhancing energy literacy in Ethiopia, a country characterized by restricted access to modern energy and heavy dependence on traditional biomass fuels. It centres on evaluating the level of energy literacy among university students, recognizing them as pivotal to the nation's future workforce.	The study may rely on self-reported data, which can be subject to social desirability bias and may not accurately reflect participants' actual energy-related knowledge, attitudes, and behaviours.
8	An Analysis of Energy Transitions at Different Scales: Fossil Fuel Divestment in Higher Education and Individual Behaviour [13]	The paper delves into the social aspects of renewable energy transition (ET) across various levels, particularly examining fossil fuel divestment within higher education institutions and individual behaviors. It scrutinizes the language employed by colleges and universities regarding divestment policies and assesses how behavioral interventions can influence energy consumption patterns. Through its analysis, the research offers insights and recommendations beneficial for utilities and policymakers, derived from its findings.	The study may rely on self-reported data, which can introduce potential biases such as social desirability bias, where participants may tend to present themselves in a more favourable light, thereby affecting the accuracy and reliability of the findings regarding participants' actual energy-related knowledge, attitudes, and behaviours.
9	To adopt or not to adopt? Insights on energy transitions from a study of advanced wood heating [14]	This study delves into the complexities of transitioning energy systems and specifically examines the adoption of advanced wood heating technology in the north-eastern United States. It employs a comprehensive approach, considering various systemic factors including macrolevel changes and the initial stages of technology diffusion. By doing so, the research sheds light on the challenges associated with promoting alternative energy technologies and offers insights into potential strategies to address these challenges effectively.	This study provides a concentrated investigation into the strategies and policies designed to encourage the adoption of advanced wood heating technology in the north-eastern United States. While its focus enhances the depth of analysis, it also restricts the extent to which the findings can be applied to other settings. Nevertheless, the research offers valuable insights into the unique dynamics of promoting such technology in this region, serving as a foundational resource for developing tailored strategies in similar contexts worldwide.

10	Networked learning to educate future energy transition professionals: results from a case study [2]	The paper focuses on the role of universities in sustainable development and the assessment of university activities by students.	Networked learning is effective for educating future ET professionals. Integration of knowledge from different disciplines is crucial for addressing energy challenges.
11	University 4.0 Sustainable Development in the Way of Society 5.0 [1]	The paper discusses the need for integrating knowledge from different disciplines to address the complex challenge of ET.	University 4.0s should spearhead proactive measures towards sustainable development, recognizing their pivotal role in shaping future generations and fostering environmental stewardship. Society 5.0 actively collaborates with and supports University 4.0s in their sustainable development endeavours, leveraging technology and innovation to address pressing environmental challenges and promote a harmonious relationship between humanity and nature.
12	Citizen Science in the Promotion of Sustainability: The Importance of Smart Education for Smart Societies [3]	The paper provides a critical examination of the concept of Society 5.0, envisioning a digitally advanced society that integrates digitalization and sustainability. It emphasizes the potential pitfalls of Society 5.0, including the perpetuation of existing inequalities and the emergence of new ones. To mitigate these challenges, the paper advocates for a critical approach and interdisciplinary citizen-science methods to analyse its implementation. Additionally, it underscores the significance of smart education in fostering sustainability within smart societies. Overall, the paper offers valuable insights into navigating the complexities of Society 5.0 and promoting equitable and sustainable societal advancements.	The paper acknowledges that ET isn't predetermined and raises awareness about various challenges and limitations that warrant careful consideration. Among these concerns are the potential for perpetuating existing inequalities while also introducing novel forms of disparity. However, the paper falls short in providing an exhaustive analysis of the specific hurdles associated with implementing Society 5.0, such as its implications for privacy, data security, and ethical considerations. Despite this gap, the paper prompts crucial dialogue regarding the need to thoroughly assess and address these complexities to ensure that Society 5.0 advances inclusivity, equity, and ethical standards alongside technological progress.
13	Sustainable education and youth confidence as pillars of future civil society [5]	The study conducted a comprehensive questionnaire survey among students enrolled at an Italian university, aiming to delve into their perceptions regarding sustainability and energy-related matters. The findings revealed a notable shift towards more sustainable attitudes	The study's scope was constrained by its focus solely on one course within a singular program, potentially compromising the broader applicability of its conclusions. Additionally, the small sample size of 66 students raises concerns regarding the

		among students by the end of the term. Moreover, the study underscored the increasing recognition among students regarding the pivotal role of sustainable education and youth empowerment in shaping the future fabric of society. Furthermore, the study shed light on imperative avenues for action to advance sustainability objectives in Italy. It emphasized the urgency of developing robust renewable energy systems, implementing targeted interventions to bolster energy efficiency, providing subsidies to incentivize green production practices, fostering the establishment of energy communities, advocating for differentiated waste collection strategies, and enhancing professional skills training initiatives. These multifaceted approaches are deemed essential to pave the way for Italy's decarbonization journey and achieve greater energy independence in the long run.	representativeness of the findings. Furthermore, the potential impact of student non-attendance introduces a layer of bias that may influence the results. Notably, the absence of inquiries testing students' understanding of the institutional context and energy crisis may have limited the depth of insights gleaned from the study.
14	Advancing SDG competencies in higher education: exploring an interdisciplinary pedagogical approach [15]	The study's findings illuminate the efficacy of an interdisciplinary approach in not only fostering students' problem-solving abilities in addressing sustainability challenges but also in nurturing strategic competencies like systems thinking and anticipatory skills. By encouraging students to explore connections across disciplines, this approach equips them with the tools needed to navigate complex sustainability issues with holistic perspectives and forward-thinking strategies. Moreover, the pedagogical project showcased in the study emerges as a promising method to mitigate the tendency towards "cherry-picking" approaches observed in teaching the SDGs at Higher Education Institutions (HEIs). By integrating various disciplines and emphasizing key competencies for sustainability, this approach offers	The study only conducted a qualitative explorative experiment, which may limit the generalizability of the findings. The paper does not provide a detailed description of the sample size or characteristics of the participants, which makes it difficult to assess the representativeness of the results. The study focuses on the development of key competencies for sustainability but does not explicitly address the assessment or measurement of these competencies. The paper acknowledges that arranging an interdisciplinary pedagogical setting may not always be possible, which could limit the feasibility of implementing the approach in all higher education institutions.

		a more comprehensive and nuanced understanding of sustainability issues, thereby fostering a more robust foundation for meaningful engagement and action towards achieving the SDGs.	
15	Students leading students: a qualitative study exploring a student-led model for engagement with the sustainable development goals [16]	The study embarked on a quest to delve into the rich tapestry of experiences among student leaders actively engaged in the Sustainable Development Goals Alliance (SDGA). It became evident that involvement in the SDGA served as a catalyst, empowering students to transcend mere participation and embark on a profound journey of personal and collective growth. As leaders within this dynamic alliance, students found themselves uniquely positioned to deepen their understanding and commitment to the SDGs. Moreover, the study uncovered how these leadership roles became potent antidotes to common barriers encountered in sustainability endeavours, such as the daunting lack of knowledge and the pervasive sense of powerlessness. In essence, the study's findings underscored the pivotal role of student leadership within grassroots initiatives like the SDGA, not only in amplifying the impact of sustainability efforts but also in fostering a culture of empowerment, resilience, and meaningful engagement with global challenges.	The study only focused on the experiences of student leaders involved in the SDGA at the University of Calgary, which may limit the generalizability of the findings to other student-led initiatives or institutions. The sample size of the study was relatively small, with only 12 student leaders participating in the interviews. This small sample size may limit the representativeness of the findings and the ability to capture a diverse range of perspectives. The study did not explore the potential challenges or limitations of student-led initiatives in engaging with the SDGs, such as resource constraints or institutional support.
16	Competences to Address SDGs in Higher Education: A Reflection on the Equilibrium between Systemic and Personal Approaches to Achieve Transformative Action [17]	The paper explores the relevance of a personal dimension of competences in addition to the systemic dimension in higher education for sustainable transformation. The authors argue that pedagogies addressing the personal level should be further investigated and implemented in higher education to support sustainability-oriented programs.	The paper primarily focuses on the relevance of a personal dimension of competences in addition to the systemic dimension in higher education, but it does not extensively discuss potential challenges or barriers to implementing pedagogies addressing the personal level. The analysis of sustainability competences is based on existing competence frameworks reported in the literature and

			examples from practice, which may not capture the full range of competences relevant to addressing the SDGs in higher education.
17	Students between science and society: why students' learning experiences in transformative spaces are vital to higher education institutions [18]	The paper delves into the transformative potential of students' participation in self-led sustainability projects outside formal curricula, shedding light on their pivotal role in reshaping higher education towards sustainable development. Through these initiatives, students undergo deep learning experiences and emerge as agents of change. They act as "boundary agents," bridging the gap between formal education and real-world sustainability challenges, thus propelling higher education institutions towards sustainable development goals.	The study only focuses on students' learning experiences in self-led sustainability projects conducted outside formal curricula, which may limit the generalizability of the findings to other contexts within higher education institutions. The sample size of the study is relatively small, with only 13 participants, which may limit the representativeness of the findings.

5.0 Recommendations

There is a need for the integration of basic energy contents within education degrees and the management strategy of educational institutions [8]. Furthermore, the academic forging of graduates in the oil and gas sector may be too slow to respond to the demands of the ET, resulting in a gap in the skills and competencies needed for new roles in the industry [19]. Collaborative efforts between academia and industry, facilitated by organizations like SPE, are proposed to accelerate the creation of new graduate profiles for the sector.

i. Integrate SDG Knowledge Across Disciplines

Implement a cross-disciplinary approach within university curricula to seamlessly integrate SDGs knowledge. Encourage collaboration among various departments to foster a comprehensive understanding of ET dynamics. Research and strategic partnerships exemplify a synergistic collaboration among HEIs, corporate entities, societal stakeholders, as well as governmental and non-governmental organizations. This collective effort is instrumental in fostering sustainable economic development at local, regional, and global scales [20].

ii. Enhance Learning Models with Smart Technologies

Embrace next-generation learning models that incorporate smart technologies and real-world projects. Leverage the potential of innovative technologies to create dynamic and immersive learning experiences, enhancing students' grasp of ET concepts. At its core, this environment amplifies engagement levels through interactive learning interfaces, facilitating seamless access to a wealth of knowledge resources. Leveraging rich-media technologies, it provides immersive learning experiences, enabling learners to seamlessly access pertinent information anytime, anywhere. Moreover, this environment transcends traditional boundaries by offering real-life and on-the-go mentoring opportunities. Harnessing the power of technology, it creates a dynamic ecosystem that continually enhances the learning process, empowering individuals to realize their full potential [21].

iii. Establish Real-Space Sustainability Labs

Create designated real-space sustainability labs within university campuses to serve as practical learning environments. Utilize existing infrastructure, like campus buildings, as laboratories for hands-on experiences in power systems and sustainable practices. Seven distinct research communities have envisioned sustainability-oriented labs, each catering to unique needs and contexts: Living, Urban Living, Real-world, Evolutionary Learning, Urban Transition, Change, and Transformation labs. These labs span various dimensions, notably space, process, and organization, offering a structured comprehension of their approaches to fostering sustainability [22].

iv. Promote Active Student Participation

Foster active student involvement in tasks such as designing modules and participating in real-world projects. Encourage students to take ownership of their learning experiences, promoting a sense of responsibility and engagement. To foster engaged and motivated student learning, educators should ensure clarity of purpose by connecting the material to real-world problems and emphasizing its relevance beyond grades. Challenging learning tasks should be designed to scaffold student learning, connect to their experiences, and encourage application of knowledge to new situations rather than just focusing on difficulty level. Additionally, classroom structures should facilitate collaborative learning experiences, acknowledging that learning is inherently social and providing opportunities for students to learn from one another through activities like storytelling or digital platforms for virtual communities [23].

v. Provide Guidance, Feedback, and Critique

Establish a supportive environment where students receive constructive guidance, timely feedback, and meaningful critique. Facilitate mentorship programs and industry collaborations to ensure students benefit from diverse perspectives and insights. The analyses revealed a compelling correlation: students who perceived their teachers as providing more effective feedback demonstrated significantly higher levels of behavioural engagement and school identification [24].

vi. Embed Sustainability Principles in Core Modules

Infuse sustainability principles into core modules across disciplines, ensuring that every student, regardless of their major, gains foundational knowledge in ET. This approach promotes a holistic understanding of sustainability challenges. Sustainability embodies a complex interplay between diverse systems, making it inherently interdisciplinary. To fully grasp this concept, students must appreciate the range of perspectives involved. Incorporating interdisciplinary teaching strategies, such as inviting guest speakers or team-teaching with colleagues from other departments, from the outset of a course is a powerful approach. Alternatively, listing a course in multiple disciplines can unite students with diverse viewpoints. These methods not only enhance understanding but also foster a collaborative culture crucial for addressing sustainability challenges both presently and in the future [25].

vii. Facilitate Industry-Linked Internships

Facilitate industry-linked internships and practical experiences to expose students to real-world challenges in the energy sector. This provides them with valuable insights, hones their practical skills, and enhances their employability upon graduation. These formative experiences significantly mould students' perceptions of the value of internships, thereby shaping their future aspirations. The internship journey is a dynamic process unfolding over time, where each experience interacts with and informs the next. In this intricate interplay, students' encounters

continually shape and refine their understanding, ultimately influencing their career trajectories [26].

6. Conclusion

In conclusion, the imperative to empower tertiary students with ET knowledge in the era of Society 5.0 and SDGs is evident. To achieve this goal, a multifaceted approach is essential, encompassing the integration of SDG knowledge into university education, the implementation of next generation learning models leveraging smart technologies, and the active involvement of students in real-world projects. By carefully planning university curricula and enforcing educational policies, institutions can lay the groundwork for a comprehensive understanding of ET dynamics. Additionally, adopting innovative learning models, such as utilizing campus spaces as sustainability labs, contributes to practical and experiential knowledge, enhancing students' analytical thinking and employability. Active student participation in designing modules, coupled with guidance, feedback, and critique, further refines their skills, preparing them to actively contribute to the ET challenges of Society 5.0. Through these concerted efforts, universities play a pivotal role in equipping tertiary students with the knowledge and skills necessary to navigate the complex landscape of ET and actively contribute to the realization of SDG in the dynamic context of Society 5.0. This holistic approach ensures that graduates are not only well-informed but also empowered change agents, ready to address the pressing issues of our time.

Acknowledgement

The authors extend their sincere appreciation to the Human Resource Department of Universiti Tenaga Nasional for their support under the C5100A2 – HR Department HRDF Claimable Training Grant 2024.

References

[1] J. Rosak-Szyrocka, S. A. Apostu, J. Ali Turi, and A. Tanveer, "University 4.0 Sustainable Development in the Way of Society 5.0," *Sustainability*, vol. 14, no. 23, p. 16043, Dec. 2022, doi: https://doi.org/10.3390/su142316043.

[2] J. C. C. M. Huijben, A. Van den Beemt, A. J. Wieczorek, and M. H. Van Marion, "Networked learning to educate future energy transition professionals: results from a case study," *European Journal of Engineering Education*, pp. 1–21, Sep. 2021, doi: https://doi.org/10.1080/03043797.2021.1978403.

[3] M. J. Sá, S. Serpa, and C. M. Ferreira, "Citizen Science in the Promotion of Sustainability: The Importance of Smart Education for Smart Societies," *Sustainability*, vol. 14, no. 15, p. 9356, Jul. 2022, doi: https://doi.org/10.3390/su14159356.

[4] U. Ortega Lasuen, M. A. Ortuzar Iragorri, and J. R. Diez, "Towards energy transition at the Faculty of Education of Bilbao (UPV/EHU): diagnosing community and building," *International Journal of Sustainability in Higher Education*, vol. 21, no. 7, pp. 1277–1296, Sep. 2020, doi: https://doi.org/10.1108/ijshe-12-2019-0363.

[5] A. Biancardi, A. Colasante, and I. D'Adamo, "Sustainable education and youth confidence as pillars of future civil society," *Scientific Reports*, vol. 13, no. 1, p. 955, Jan. 2023, doi: https://doi.org/10.1038/s41598-023-28143-9.

[6] T. O. Peralta and W. Elving, "Understanding the urgency and complexities of the energy transition trough serious gaming," in *18th European Conference on e-Learning*, Nov. 2019, pp. 461–467.

[7] J. H. Perkins, "Energy Transitions: Linking Energy and Climate Change," in *Climate Change and the Role of Education*, Switzerland: Springer Nature , 2019, pp. 87–106. doi: https://doi.org/10.1007/978-3-030-32898-6_6.

[8] H. Passalacqua and M. Alsaba, "Energy Transitions: An Academia Take on Shaping the Future Professionals of Oil and Gas," in *SPE Annual Technical Conference and Exhibition*, Oct. 2020. doi: https://doi.org/10.2118/201593-MS.

[9] I. R. Putri and A. Setiawan, "How Important Energy Awareness in Vocational Education to Support Energy Transition," in *Advances in social science, education and humanities research*, Jan. 2022. doi: https://doi.org/10.2991/assehr.k.220305.017.

[10] Iraj Ershaghi and D. L. Paul, "Integrating the Energy Transition into Petroleum Engineering and Geoscience Education," in *SPE Western Regional Meeting*, Apr. 2022. doi: https://doi.org/10.2118/209302-ms.

[11] D. Franco, J. Macke, D. Cotton, A. Paço, J.-P. Segers, and L. Franco, "Student energy-saving in higher education tackling the challenge of decarbonisation," *International Journal of Sustainability in Higher Education*, vol. 23, no. 7, pp. 1648–1666, Jul. 2022, doi: https://doi.org/10.1108/ijshe-10-2021-0432.

[12] Divya Chandrasenan, J. Mammen, and Vaisakh Yesodharan, "Energy Literacy of University Graduate Students: A Multidimensional Assessment in Terms of Content Knowledge, Attitude and Behavior," in *Springer proceedings in energy*, Oct. 2020, pp. 879–889. doi: https://doi.org/10.1007/978-981-15-5955-6_83.

[13] E. Palchak, "An Analysis of Energy Transitions at Different Scales: Fossil Fuel Divestment in Higher Education and Individual Behavior - ProQuest," ProQuest Dissertations Publishing, 2019.

[14] L. Edling and C. Danks, "To adopt or not to adopt? Insights on energy transitions from a study of advanced wood heating," *Energy Research & Social Science*, vol. 45, pp. 331–339, Nov. 2018, doi: https://doi.org/10.1016/j.erss.2018.06.019.

[15] K. Alm, M. Melén, and C. Aggestam-Pontoppidan, "Advancing SDG competencies in higher education: exploring an interdisciplinary pedagogical approach," *International Journal of Sustainability in Higher Education*, vol. ahead-of-print, no. ahead-of-print, Jul. 2021, doi: https://doi.org/10.1108/ijshe-10-2020-0417

[16] B. Lee, K. C. Liu, T. S. Warnock, M. O. Kim, and S. Skett, "Students leading students: a qualitative study exploring a student-led model for engagement with the sustainable development goals," *International Journal of Sustainability in Higher Education*, vol. 24, no. 3, Aug. 2022, doi: https://doi.org/10.1108/ijshe-02-2022-0037.

[17] J. Dlouhá, R. Heras, I. Mulà, P. Salgado, and L. Henderson, "Competences to Address SDGs in Higher Education—A Reflection on the Equilibrium between Systemic and Personal Approaches to Achieve Transformative Action," *Sustainability*, vol. 11, no. 13, p. 3664, Jul. 2019, doi: https://doi.org/10.3390/su11133664.

[18] L. J. Trechsel, C. L. Diebold, A. Zimmermann, and M. Fischer, "Students between science and society: why students' learning experiences in transformative spaces are vital to higher education institutions," *International Journal of Sustainability in Higher Education*, vol. 24, no. 9, pp. 85–101, Jan. 2023, doi: https://doi.org/10.1108/ijshe-09-2021-0407.

[19] C. Thomas, P. J. Jennings, and B. Lloyd, "Issues in Renewable Energy Education," *Australian*

journal of environmental education, vol. 24, pp. 67–73, Jan. 2008, doi: https://doi.org/10.1017/s0814062600000598.

[20] A. B. A. Avelar, K. D. da Silva Oliveira , and M. C. Farina, "The integration of the Sustainable Development Goals into curricula, research and partnerships in higher education," *International Review of Education*, vol. 69, Jul. 2023, doi: https://doi.org/10.1007/s11159-023-10013-1.

[21] S. K. S. Cheung, L. F. Kwok, K. Phusavat, and H. H. Yang, "Shaping the future learning environments with smart elements: challenges and opportunities," *International Journal of Educational Technology in Higher Education*, vol. 18, no. 1, Mar. 2021, doi: https://doi.org/10.1186/s41239-021-00254-1.

[22] G. McCrory, N. Schäpke, J. Holmén, and J. Holmberg, "Sustainability-oriented labs in real- world contexts: An exploratory review," *Journal of Cleaner Production*, vol. 277, p. 123202, Jul. 2020, doi: https://doi.org/10.1016/j.jclepro.2020.123202.

[23] L. Ferlazzo, "Nine Strategies for Promoting Student Engagement," *Education Week*, Feb. 07, 2021. https://www.edweek.org/teaching-learning/opinion-nine-strategies-for-promoting-student-engagement/2021/02

[24] V. Monteiro, C. Carvalho, and N. N. Santos, "Creating a Supportive Classroom Environment through Effective Feedback: Effects on Students' School Identification and Behavioral Engagement," *Frontiers in Education*, vol. 6, pp. 1–14, Jun. 2021, doi: https://doi.org/10.3389/feduc.2021.661736.

[25] National Science Foundation (NSF), "Infuse Sustainability into Your Course," *Infuse Sustainability*, 2023. https://serc.carleton.edu/integrate/teaching_materials/themes/infuse/index.html

[26] M. N. Thompson, J. Perez-Chavez, and A. Fetter, "Internship Experiences Among College Students Attending an HBC: A Longitudinal Grounded Theory Exploration," *Journal of Career Assessment*, vol. 29, no. 4, p. 106907272199275, Feb. 2021, doi: https://doi.org/10.1177/1069072721992758.