International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 10 No. 6s,2024
https://theaspd.com/index.php

Energy Literacy Among Tertiary Students: A Systematic Review Of Determinants And Educational Interventions Towards Institutional Sustainability

Sidra Naim[1], Zeittey Karmilla Kaman[2] and Tamanna Khanm[3]
[1]Senior Lecturer, College of Continuing Education (CCED) Universiti Tenaga Nasional (UNITEN) , sidra@uniten.edu.my
[2]Resident Faculty, Othman Yeop Abdullah Graduate School of Business, Universiti Utara Malaysia
[3]Doctoral Student, College of Graduate Studies (COGS), Universiti Tenaga Nasional (UNITEN)

Abstract: *In the context of the global shift towards sustainable energy adaptation, energy literacy among tertiary students is paramount. However, a significant gap persists in higher education, where many students lack a comprehensive understanding of energy concerns and the skills necessary to support positive energy adaptation in the energy transition era. The objective of this article is to review the determinants of energy literacy among tertiary students towards achieving institutional sustainability in supporting energy decision-making objectives. This study conducts a systematic literature review (SLR) to identify the determinants influencing energy literacy among tertiary students and to evaluate educational interventions aimed at enhancing it. The review analyses peer-reviewed articles from various academic databases, categorizing them based on research focus areas related to energy literacy determinants within higher education institutions. Findings indicate that energy literacy is influenced by factors such as curriculum design, teaching methodologies, institutional policies, and students' socio-demographic backgrounds. Effective interventions include integrating energy topics into curricula, employing experiential learning, and initiating community engagement programs. This study offers valuable insights for educators, university administrators, policymakers, and students, providing evidence-based strategies to enhance energy literacy and promote sustainable practices within higher education institutions.*
Keywords: *energy literacy, determinants, tertiary education, institutional sustainability.*

1. INTRODUCTION - UNDERSTANDING ENERGY LITERACY IN HIGHER EDUCATION

Energy-literate students possess the knowledge to make informed choices regarding energy consumption, conservation, and sustainability. This understanding enables them to assess the environmental and economic impacts of their actions, leading to more responsible behaviour in both personal and professional contexts. Energy literacy in higher education extends beyond basic awareness of energy sources or conservation tips—it involves a deep, interdisciplinary understanding of how energy systems interact with environmental, economic, and social dimensions. Energy-literate students are equipped with the cognitive, affective, and behavioural competencies needed to engage critically with energy issues. This includes understanding how energy is produced, distributed, and consumed, as well as the implications of these processes for climate change, economic development, and global equity.

In higher education, developing energy literacy empowers students to make informed decisions about energy use in both their personal lives and future careers. For instance, engineering students may apply energy-efficient design principles, while business students might advocate for sustainable corporate practices. Additionally, energy literacy encourages students to reflect on their values and behaviour, fostering a sense of personal responsibility toward energy conservation. Universities play a key role in cultivating this literacy by embedding energy-related content across curricula, offering experiential learning opportunities, and promoting campus-wide sustainability initiatives. Ultimately, energy literacy contributes to producing graduates who are not only technically competent but also ethically and socially aware—capable of contributing to a sustainable energy transition and advancing institutional sustainability goals.

Energy literacy is a multifaceted concept encompassing knowledge of energy production and consumption, awareness of environmental and social impacts, and the attitudes and skills needed to use energy responsibly (Białynicki-Birula et al., 2022). In academic literature, three dimensions of energy literacy are often highlighted: cognitive (understanding key energy concepts and problem-solving skills), affective (awareness, values, and attitudes toward energy use), and behavioural (practical action and decision-making skills) (Białynicki-Birula et al., 2022). This framework assumes that increasing energy knowledge will shape attitudes, which in turn drive sustainable behaviours. However, empirical studies

have shown that the link is not automatic—simply imparting knowledge does not guarantee changes in behaviour, due to well-documented information deficits and attitude–behaviour gaps (Håkansson et al., 2024). In other words, while energy literacy provides an essential foundation, converting knowledge into action often requires engaging the attitudes and values of learners (Cotton et al., 2021).

Within tertiary education, energy literacy is viewed as a key lever for fostering sustainability mindsets in future leaders. Universities play a crucial role in formalizing pro-sustainability attitudes and behaviours among students, who will later make decisions affecting energy and climate policy (Białynicki-Birula et al., 2022). Studies from recent years reinforce that well-designed educational initiatives can translate energy literacy into tangible conservation actions. For example, a recent energy education program in Austria significantly boosted university students' overall energy literacy; approximately 75% of participants reported that they anticipated changing their future energy consumption behaviour as a result (Keller et al., 2022). Such findings illustrate how improving students' understanding of energy—from the science of energy efficiency to the societal impacts of energy choices—can empower them to adopt more sustainable habits in their daily lives.

Higher energy literacy has also been correlated with stronger pro-environmental attitudes. In a cross-country survey, students in the UK who exhibited greater awareness and concern for energy conservation were more likely to practice energy-saving behaviours than their peers in China, despite the latter scoring higher on factual energy knowledge (Cotton et al., 2021). This underscores that knowledge needs to be accompanied by the right attitudes and motivations to effectively drive behaviour change.

Importantly, energy literacy initiatives in higher education have shown success when they engage the affective and behavioural components, not just the cognitive. For instance, university-based programs often incorporate hands-on projects, campus energy audits, or peer learning, which connect abstract knowledge to personal action. One study found that female university members, despite having slightly lower technical energy knowledge on average, demonstrated more positive energy-saving attitudes and more frequent conservation behaviours than their male counterparts (Keller et al., 2022). This suggests that values like environmental concern and a sense of efficacy can compensate for knowledge gaps and lead to meaningful action.

Effective energy literacy programs therefore strive to cultivate not only informed students, but also motivated and confident change agents. By improving students' understanding of energy systems and illustrating how personal choices impact the environment, tertiary institutions can encourage habits such as reducing dorm energy use, participating in campus sustainability projects, and advocating for clean energy policies (Białynicki-Birula et al., 2022; Keller et al., 2022). In sum, energy literacy serves as both a conceptual framework and a practical tool in higher education—it integrates knowledge, attitudes, and behaviour in a way that prepares students to contribute to sustainable energy futures.

2. LITERATURE REVIEW: CONCEPTUALIZING ENERGY LITERACY WITHIN THE FRAMEWORK OF INSTITUTIONAL SUSTAINABILITY

Linking energy literacy to institutional sustainability in higher education involves integrating theoretical frameworks, implementing strategic policies, and fostering student-led initiatives. This comprehensive approach not only enhances students' understanding of energy issues but also aligns with universities' broader sustainability goals.

2.1 Energy Literacy Conceptual Framework

This framework is increasingly viewed through the lens of sustainability education. A conceptual framework proposed by Gladwin and Ellis (2023) emphasizes the importance of understanding complex energy systems and their societal impacts, advocating for a holistic approach to energy education. In today's rapidly evolving energy landscape, energy literacy is no longer a niche concern—it's a critical skill for building a sustainable future. Within higher education, fostering energy literacy is increasingly being tied to institutional sustainability goals, and this connection is underpinned by several influential theoretical frameworks. These frameworks help us understand not only why energy literacy matters, but how it can be cultivated effectively within the university setting. One of the most insightful contributions in this area comes from the conceptual framework proposed by Gladwin and Ellis (2023), which views energy literacy as a component of sustainability education. They argue for a holistic understanding of energy—beyond mere technical knowledge—to include its social, environmental, and economic dimensions. According to their model, energy literacy involves not just knowing about energy sources and consumption patterns but also grasping the broader systemic impacts of energy decisions. This integrative

view aligns closely with the principles of education for sustainable development (ESD), which UNESCO (2020) promotes as essential for empowering learners to make informed choices and act responsibly.

The conceptual framework developed by Gladwin and Ellis (2023) positions energy literacy as a foundational element of sustainability education, advocating for a holistic and integrative understanding of energy systems. This framework emphasizes not only the acquisition of theoretical and technical knowledge but also the epistemological, ontological, and practical dimensions of energy use and governance. By situating energy literacy within a broader educational and societal context, the framework aims to facilitate meaningful engagement across diverse learning communities and institutional stakeholders. At its core, the framework promotes a shift in how energy is understood—moving beyond a purely technical domain to one that incorporates sociocultural and environmental dimensions. This reconceptualization reflects the recognition that energy systems are deeply embedded within societal structures and are shaped by cultural, economic, and political forces (Gladwin & Ellis, 2023). An effective energy literacy model, therefore, must include knowledge of energy generation, distribution, storage, and consumption, as well as a critical awareness of the environmental and social implications of energy choices (Santillán & Villavicencio, 2023). Such a comprehensive understanding supports the development of informed individuals capable of engaging with complex sustainability challenges.

The framework further identifies energy literacy as a multidimensional educational construct that spans various formal and informal learning environments. Its application across K–12 education, tertiary institutions, and community learning platforms underscores the importance of lifelong learning in achieving sustainable energy transitions (Ramachandran et al., 2023). Within higher education specifically, the integration of energy literacy into institutional curricula and strategic initiatives is crucial for fostering a culture of sustainability. This includes the development of pedagogical tools and assessment mechanisms that enhance energy understanding among diverse student populations (Santillán & Cedano, 2023). By embedding energy literacy within institutional frameworks, universities can position themselves as leaders in promoting environmental stewardship and responsible energy use. Clearly, energy literacy is not only an educational objective but also a critical enabler of informed decision-making.

Moving forward, it shows that the framework links energy literacy to individuals' capacity to engage in energy-efficient behaviors and to contribute meaningfully to sustainability initiatives at both institutional and societal levels (Santillán & Villavicencio, 2023). However, empirical findings suggest that increased energy knowledge does not always translate into behavioral change, pointing to the need for a more nuanced understanding of the factors that mediate this relationship (Santillán & Cedano, 2023). Moreover, as Lukszo et al. (2018) argue, sustainable energy transitions require coordinated efforts among a broad array of stakeholders, including regulatory bodies, institutional actors, and community groups. The decentralized and interdependent nature of energy systems necessitate an institutional approach that aligns energy literacy initiatives with strategic planning and policy development. By embedding energy literacy into their operational and educational frameworks, higher education institutions can play a pivotal role in shaping future energy landscapes and advancing broader sustainability goals.

2.2 Stakeholder theory

Another key framework that connects energy literacy with institutional sustainability comes from stakeholder theory. This theory, widely used in organizational and educational research, posits that institutions must respond to the needs and expectations of diverse stakeholders—including students, faculty, government bodies, and society at large (Freeman, 1984). When applied to energy literacy, stakeholder theory suggests that universities have a responsibility to equip students with the knowledge and skills needed to participate meaningfully in the global energy transition. As sustainability becomes a central concern for many of these stakeholders, enhancing energy literacy becomes both a moral obligation and a strategic advantage for institutions. Stakeholder theory, first introduced by Freeman (1984), offers a powerful perspective for understanding how higher education institutions (HEIs) can support energy literacy as part of their wider commitment to sustainability. At its core, the theory suggests that institutions don't exist in isolation. Instead, they function within a complex web of relationships involving internal stakeholders—like students, faculty, and staff—and external ones, such as government agencies, accreditation bodies, industry partners, and the broader community. Each of these groups brings its own expectations and priorities, especially when it comes to how universities address sustainability and energy issues.

When applied to energy literacy, stakeholder theory reminds us that universities have a responsibility to actively engage with these various groups and respond to their needs. Students are at the heart of this

mission. As the future leaders, innovators, and decision-makers of society, they need to be equipped with not only the technical knowledge but also the critical thinking and values required to participate meaningfully in the global energy transition. Recent studies reinforce this point, showing that graduates with a strong foundation in energy literacy are increasingly seen as vital contributors to institutional and national sustainability goals (Cotton et al., 2015; Ramachandran et al., 2023). Beyond the classroom, universities are also under growing pressure to align themselves with national sustainability frameworks, accreditation standards, and community expectations. These external demands push institutions to embed sustainability—including energy literacy—into their strategic plans and educational offerings (Leal Filho et al., 2019). This is not just about doing the right thing; it's also a smart move. Institutions that prioritize sustainability tend to gain greater trust from stakeholders, strengthen their reputations, and see higher levels of student engagement and satisfaction (Findler et al., 2019).

Good governance plays a key role in this process. When universities engage stakeholders in shaping curriculum and policy, they create more inclusive, relevant, and responsive educational experiences. As Lozano et al. (2021) point out, HEIs that adopt participatory governance and integrate feedback from their communities are often more successful at weaving sustainability into teaching, research, and campus operations. Stakeholder theory also highlights how these relationships are not one-sided. Universities influence stakeholder values through education, while stakeholders in turn shape institutional practices through their input, support, and expectations. In this sense, building energy literacy is less about delivering content and more about creating meaningful dialogue and collaboration (Cebrián et al., 2020). It's a shared journey—one that depends on mutual understanding and joint commitment. Ultimately, stakeholder theory gives universities a clear rationale for treating energy literacy not just as an academic topic, but as a strategic priority. By embracing the voices and needs of their stakeholders, institutions can embed energy literacy into their sustainability efforts, helping to shape a more informed, engaged, and responsible generation of citizens.

2.3 Institutional theory

Institutional theory provides a robust framework for understanding how organizations—particularly universities—adapt their behaviours, structures, and priorities in response to both internal capabilities and external pressures. In the context of sustainability and energy education, this theory explains how higher education institutions (HEIs) incorporate practices like energy literacy based not only on strategic choices but also on broader environmental expectations and institutional norms (DiMaggio & Powell, 1983). According to Ofori et al. (2023), institutional pressures such as governmental policies, public expectations, accreditation requirements, and funding mechanisms significantly influence how universities adopt sustainable energy practices. Their study reveals that institutions demonstrating strong leadership commitment and the ability to mobilize resources are more likely to embed energy literacy into academic programs, research agendas, and operational practices. This aligns with earlier findings by Delmas and Toffel (2008), who argue that environmental and social norms exert coercive, normative, and mimetic pressures on institutions, prompting them to align with prevailing sustainability frameworks.

Recent research also supports the idea that HEIs respond to these institutional pressures in various ways, depending on their internal culture, strategic priorities, and stakeholder engagement. For example, Leal Filho et al. (2019) found that universities in countries with national sustainability mandates or green policy frameworks are more likely to develop interdisciplinary sustainability curricula, including components of energy literacy. Similarly, Findler et al. (2019) showed that universities with clear institutional sustainability strategies and dedicated sustainability offices are better positioned to operationalize energy education initiatives. The role of leadership and organizational culture is particularly important. As noted by Lozano et al. (2021), transformational leadership that prioritizes sustainability can drive systemic changes within universities, including the integration of energy literacy across departments. These leaders foster an institutional environment that values long-term sustainability goals, allocates resources to relevant programs, and builds institutional resilience against short-term political or economic shifts.

Furthermore, institutional theory emphasizes the importance of legitimacy and reputation in shaping organizational behaviour. As sustainability becomes a key metric in university rankings, accreditation, and funding decisions, HEIs increasingly view energy literacy as a component of institutional prestige and competitive positioning (Etzion, 2007; Ramos et al., 2015). This is supported by studies like those of Trencher et al. (2014), which highlight how universities embed sustainability and energy-focused programs not only for educational benefit but also to meet expectations from prospective students,

donors, and government agencies. Additionally, the integration of energy literacy is often driven by mimetic isomorphism—where institutions model the behaviours of peer universities considered leaders in sustainability. As observed by Yarime and Tanaka (2012), universities tend to replicate successful sustainability practices from top-ranking institutions, leading to the diffusion of energy literacy programs across the sector. In sum, institutional theory provides a compelling explanation for why and how universities embrace energy literacy. It highlights the interplay between external pressures (e.g., regulation, societal expectations), internal enablers (e.g., leadership, resources), and broader institutional dynamics (e.g., legitimacy, competitiveness). By understanding these factors, stakeholders can better design interventions and policies that support the systemic adoption of energy literacy in higher education.

3. RESEARCH METHODOLOGY

To address the main research objective, this study conducted a Systematic Literature Review (SLR) using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. PRISMA, developed by Moher et al. (2009), provides clear guidelines to ensure that systematic reviews are carried out in a transparent, consistent, and reliable way. Following this framework, specific keywords and search criteria were designed to help identify, select, and review relevant studies related to energy literacy (EL) in higher education.

The review process included several steps: searching databases, removing duplicate records, screening titles and abstracts, and assessing the full texts of potentially relevant articles based on set eligibility criteria. The selected studies then went through a quality check to determine their relevance and methodological quality. Information from these studies was extracted using structured guidelines based on the research questions, and a qualitative thematic analysis was used to identify common themes, patterns, and gaps in the existing literature. By applying the PRISMA framework, the review ensured that any exclusions were clearly documented and properly justified to avoid bias. Through this systematic process, the study aimed to identify the key factors influencing students' energy literacy levels and to recommend effective ways to integrate EL initiatives into tertiary education to promote sustainable energy habits.

As the search functions in Scopus and Google Scholar differ, separate search strings were used for each, as detailed in Table 1. Scopus offers an advanced search feature that enables researchers to apply specific inclusion and exclusion criteria during the initial article selection process. In comparison, Google Scholar's advanced search is limited to filtering by publication year and does not support screening based on other criteria like Scopus. Therefore, the search terms "Energy Literacy", Higher Education", and "Determinants" were used in Google Scholar. The literature search included studies published between 2015 and 2025, with the final search completed on 20 June 2025.

For Scopus database, we utilized advance search query option at initial stage on the title, abstract, and keywords with filters to exclude articles that were not in English, not in their final publication stage, and published before 2014, not from journal. The advanced query was- TITLE-ABS-KEY (Energy AND Literacy AND Determinants AND Higher Education) AND PUBYEAR > 2015 AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (LANGUAGE , "English")). In Scopus, the last search was conducted on 20/07/2025. The exclusion and inclusion criteria for conducting SLR in are depicted on table 2. The PRISMA workflow is presented in Fig. 1, which shows how the articles were identified, screened, and selected after matching eligibility criteria and quality appraisal [25].

Table 1: Search terms

Database	Search Terms
Google Scholar	"Energy Literacy" and "Higher Education" And Determinants
Scopus	TITLE-ABS-KEY (Energy AND Literacy AND Higher Education AND Determinants AND Factors) AND PUBYEAR > 2014 AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (LANGUAGE , "English"))

Table 2: The exclusion and inclusion criteria for the SLR

Criteria	Inclusion	Exclusion
Timeline	2015-2025	<2014
Document	Article Journal, conference	Chapter in books, Books series

type	paper	and books
Language	English	Non-English
Content	Social Impact Assessment, flood risk	Articles not related Impact assessment, flood risk

Finally, the selected articles were undergone on thematic analysis based on three type of content: presence of dimensions of EL, factors of EL and recommendations regarding integration of EL in higher educational curriculum.

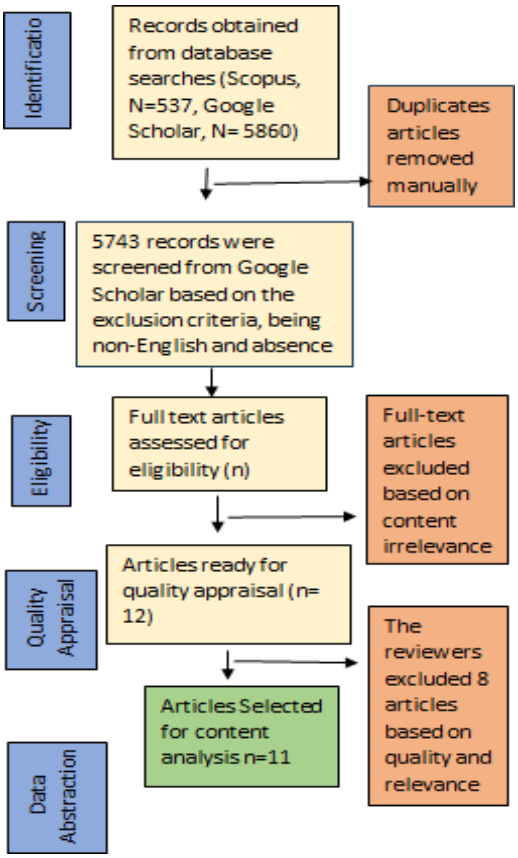

Figure 1: The overview of SLR process.

4. RESULT AND DISCUSSION

The selected articles included in this research, which discussed EL and in educational sectors, and addressed factors or determinants that influences students' energy literacy are summarized and presented in Table 3. Thematic analysis revealed that there are gaps in the existing literature which assessed determinants of EL at higher education or tertiary levels of education. Although, incorporating EL is in educational program is suggested for both primary and secondary level of education there is a little focus made in case of tertiary or higher level of education.

Figure 2: Table showing review of included studies

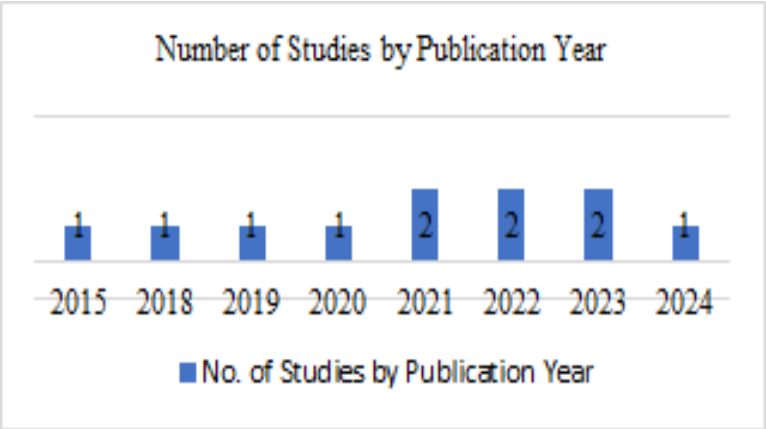

Figure 3: shows the countries of included studies.

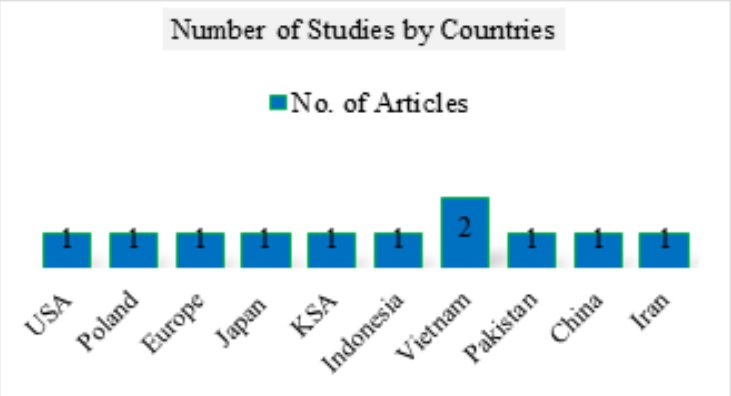

Table 3: Factors or determinants that influences students' energy literacy summarized

No.	Title	Author, Year	RO	Methods	Elements Studies	Recommendations
1.	Energy Literacy and Energy Related Financial Literacy in Iran: Case of Northwestern Academic Community	Hamidi Razi et al., 2021	To investigate the impact of economic and financial literacy on energy literacy and energy awareness in the northwest of Iran.	Questionnaire survey among university teachers and students	-Financial and economic literacy have positive impact on energy literacy index.	To promoting energy-related economic and financial literacy for citizens to stimulate energy savings.
2.	Improving Energy Literacy to Facilitate Energy Transition and Nurture Environmental Culture in Vietnam	Khuc et al., 2023	To assess young adults' intention to learn about energy conservation and its influencing factors .	-online survey among young adults	-the intention to participate in EL course mostly depends on perception and income -Women and people from rural areas has more intention to participate in such course -Demographic variables such as gender, location and monthly income highly influence intention to participate in energy related training program (at universities -Environmental concern/ climate concern	To enhance youth energy and environmental literacy, it is essential to foster a sustainable culture and accelerate Vietnam's energy transition, which requires policies and programs with reduced costs and improved information access.
3	Analysis Conception in Review of Attitudes and Behaviors On	Puspitasari et al., 2020	how students 'understanding of the role of energy through	-EL framework adapted from DeWaters measurement	-The attitude of EL of students is not affected by gender. --- However, all	The understanding of all three aspects of energy will improve students'

	Energy Roles in Life Based on Energy Literacy Framework		students' attitudes and behavior in saving energy as well as knowledge of alternative energy through relationships from 3 aspects	s using an online questionnaire conducted on students from several junior high schools.	three aspects of energy; energy saving aspect, renewable energy aspects, role aspect are related in terms of attitude and behavior.	attitude and behavior towards energy.
4.	Energy literacy among young adults in the European countries	Kovačič D, Ulbin A, Abina A, et al., 2024	To identify factors influencing young adults' attitudes and behaviours and knowledge of sustainable energy consumption practices	Data was collected from European countries, Austria, Croatia, Greece, Slovenia and Poland through questionnaire from young adults.	five significant factors were found to be influencing the energy literacy of young adults. The key factors were 1. education and awareness, 2. investment in energy efficiency, 3. age and gender, 4. climate change and environmental protection, 5. sustainable lifestyle and social environment.	Policymakers, educators and other stakeholders can work towards creating a more energy-literate and sustainable society by understanding the key factors that influence energy literacy
5.	Energy Literacy and Its Determinants among Students within the Context of Public Intervention in Poland	Białynicki-Birula et al., 2022	To investigate specific aspects of Policymakers should include comprehensive energy literacy programmes in national curricula.	-survey	-dimensions or components of energy literacy which are assessed (knowledge, behaviour, attitudes, and self-efficacy) -the primary factors found to be determining EL are are gender, going away from home to study, and the experience of energy poverty. - Self-efficacy, attitude, and the pro-ecological elements of both attitude and knowledge	The understanding of all three aspects of energy will improve students attitude and behaviour towards energy.

					are the factors that have the most impact on students' behaviour. -the impact of knowledge on behaviour is insignificant	
6	Energy literacy of high school students in Vietnam and determinants of their energy-saving behaviour	Lee, et al, 2022	To understand EL of high school students in Vietnam, to explore the factors that influence students' energy-saving behaviour to assess the effectiveness of the energy education program	online and paper version energy-literacy survey was conducted among 12th-graders from high schools	-energy knowledge tended to be low, while their perceived values, attitude, intention and behaviour related to saving energy were relatively high. - no direct effect of energy knowledge on their energy-saving intention or behaviour, -while an indirect effect was observed if value and attitude toward energy saving were taken as mediators	Policymakers, educators and other stakeholders can work towards creating a more energy-literate and sustainable society by understanding the key factors that influence energy literacy
7	A Learning Ecology Perspective of Energy Literacy among Youth: A Case Study from Alabama High Schools	Coronado, et al. 2023	To assess the factors across various learning environments play significant role in the development of energy literacy among youth.	Pre and post survey to know the impact of a clean energy program. Responses on both participant and non-participants high school students.	-family relationship -pre-existing personal interest in STEM subjects -virtual learning platform positively impacts students' information searches and attitude towards energy	
8	An Integrated Model Approach: Exploring the Energy Literacy and Values of Lower Secondary	Yutaka Akitsu, Kyoto University, JAPAN Keiichi N. Ishihara, 2018			-Awareness of consequences is a powerful predictor of the relationship between energy knowledge and behaviour. -the effect of	

	Students in Japan				knowledge on awareness also depends on scientific literacy, critical thinking and environmental overview	
9	Energy Literacy and Education: The Viewpoint of Stakeholders to Promote Energy Literacy in Education	Rohmatulloh et al., 2021	To know how existing literature defines energy literacy, its dimensions, sub dimensions and factors that influences literature to provide a clear concept of EL.	LR	**Dimensions:** Cognitive domain (Energy knowledge understanding skills), affective domain (attitude sensibility) and behavior domain (Intention, involvement action) **Factors:** gender, age, positive environment attitude such as encouragement, parents educational level, advertising campaign, performance on evidence-based games on energy**,** personal involvement in bill payment,	
10	Saudi Undergraduate Students' Needs of Pedagogical Education for Energy Literacy	Alghamd & El-Hassan, 2019				
11	Developing students' energy literacy in higher education	Cotton et al., 2015	aims to investigate students' energy literacy at a UK university, and recommends ways in which it can be enhanced using a	online survey and focus groups.	Attempts to reduce energy use in higher education are widely seen in campus operations. This research provides an indication of the potential	Therefore, the deficit of knowledge among students should constitute a rationale for enhancing curricula at the lower levels of education. It also appears that

			behaviour change model.		for enhancing energy-saving through different forms of curricula.	tertiary education presents potential for aligning these curricula is highlighted through the 4Es model of enable, engage, exemplify and encourage. ttempts to reduce energy use in higher education are widely seen in campus operations. This research provides an indication of the potential for enhancing energy-saving through different forms of curricula.

4.1 Factors Influencing EL

A range of socio-demographic, personal, and contextual factors have been identified as determinants influencing Energy Literacy (EL) among individuals, particularly students. Age and gender are consistently recognized as significant variables, where younger individuals and females often demonstrate differing levels of awareness and engagement with energy-related issues (Rets et al., 2024; Białynicki-Birula et al., 2022; Cotton et al., 2015). Educational level and discipline of study also play crucial roles, as students enrolled in environmental or energy-related disciplines tend to exhibit higher EL levels than their counterparts in other fields (Rets et al., 2024). Additionally, parental education level has been shown to indirectly affect students' energy literacy by shaping their early environmental values and attitudes (Samira Bahrami & Yawar Mohammadi, 2021). Income level and living situations, such as whether students live with family, alone, or with peers, can influence their exposure to and responsibility for energy-related decisions (Rets et al., 2024; Białynicki-Birula et al., 2022). Experiencing energy poverty and studying away from home are other situational factors that affect awareness and behaviour towards energy use, as these experiences often heighten personal sensitivity to energy costs and conservation practices (Białynicki-Birula et al., 2022).

Moreover, elements of students' personal and social environments, such as work and personal life balance, friendship groups, housemates, and participation in extra-curricular activities, influence their engagement with energy-related topics and practices (Cotton et al., 2015). The campus environment itself can act as a facilitating or constraining factor for energy-saving behaviours, depending on the institution's infrastructure and sustainability initiatives. Psychosocial factors such as self-efficacy, attitude, and particularly the pro-ecological elements of attitude and knowledge are found to be the strongest predictors of students' energy-related behaviours, often outweighing the direct influence of factual knowledge alone (Białynicki-Birula et al., 2022). While energy knowledge is an essential component of EL, its direct impact on behavior is sometimes limited unless reinforced by positive attitudes and a belief in one's capacity to effect change. Together, these interconnected factors illustrate that energy literacy is shaped not only by what individuals know but also by their values, lived experiences, social networks, and the environments in which they study and live.

Table 4: Determinants or Factors influencing EL

No.	Determinants/Factors influencing EL	Reference
1	Age	Rets et al., 2024, Białynicki-Birula et al., 20222, Cotton et al., 1015
2	Gender	Rets et al., 2024, Białynicki-Birula et al., 20222, Cotton et al., 2015
3	Educational level	Rets et al., 2024
	Discipline of study	

4	Parental Education Level	Samira Bahrami & Yawar Mohammadi , 2021
5	Income Level	Rets et al., 2024
6	Living Situations	Rets et al., 2024, Białynicki-Birula et al., 20222
7	The experience of energy poverty	Białynicki-Birula et al., 2022
8	Going away from home for study	Białynicki-Birula et al., 20222
9	Work and Personal Life	Cotton et al., 20
10	Friendship groups and housemates	
11	Self-efficacy	Białynicki-Birula et al., 20222
12	Extra-curricular activities	Cotton et al., 2015
13	Campus environment	Cotton et al., 2015
14	Self-efficacy, attitude, and the pro-ecological elements of both attitude and knowledge are the factors that have the most impact on students' behaviour. -the impact of knowledge on behaviour is insignificant	Białynicki-Birula et al., 2022
15	Attitude	Białynicki-Birula et al., 2022
16	Pro-ecological elements of attitude and knowledge	Białynicki-Birula et al., 2022

4.2 Dimensions or contents of EL

Energy Literacy (EL) is widely recognized as a multidimensional construct comprising cognitive, affective, behavioural, and conative (willingness) dimensions, each playing a critical role in shaping an individual's energy-related awareness and actions. The cognitive dimension involves knowledge and understanding of energy concepts, including awareness of energy sources, production and consumption processes, environmental impacts, and conservation strategies (Alghamdi & El-Hassan, 2019; DeWaters & Powers, 2011; Cotton et al., 2025; Rets et al., 2024). Without a solid cognitive foundation, individuals lack the factual basis needed to make informed and responsible energy decisions. Complementing this, the affective dimension reflects attitudes, emotions, and values concerning energy use and environmental sustainability. An individual with high affective energy literacy recognizes energy-related problems and maintains a positive, proactive attitude towards energy conservation and sustainable living (DeWaters & Powers, 2013; Alghamdi & El-Hassan, 2019; Rezaei et al., 2022; Cotton et al., 2025).

The behavioural dimension pertains to the actual practices individuals adopt in their daily lives, such as turning off unused appliances, using public transport, and making energy-conscious consumer choices (Karpudewan et al., 2015; DeWaters & Powers, 2011; Cotton et al., 2025). It reflects the practical translation of knowledge and attitudes into consistent energy-saving actions. Importantly, recent studies emphasize the conative dimension, which captures the motivational aspect — an individual's willingness, intention, and personal drive to act in an energy-responsible manner and support sustainable energy initiatives (Rezaei et al., 2022; Rets et al., 2024; Alghamdi & El-Hassan, 2019). This dimension bridges the gap between knowledge and behaviour, as high willingness often determines whether individuals act upon what they know and believe. Together, these four dimensions offer a comprehensive framework for assessing and enhancing energy literacy, reinforcing the view that fostering sustainable energy behaviours requires more than just imparting knowledge — it necessitates positive attitudes, enabling environments for behavioural change, and personal motivation to engage in responsible energy practices (DeWaters & Powers, 2011; Karpudewan et al., 2015; Rezaei et al., 2022).

Table 5: Dimensions, Components or Contents of EL

No.	Dimensions, Components or Contents of EL	Elements	Reference
1	Cognitive Factors (Knowledge)	Knowledge about energy sources, production methods, consumption, conservation, and their environmental and social impacts.	Alghamdi & El-Hassan, 2019; Cotton et al., 2025; DeWaters & Powers, 2011;Rets et al., 2024

2	Affective Factors (Attitude)	Positive and proactive attitudes toward solving energy-related problems, using energy responsibly and efficiently, and valuing environmental sustainability.	Alghamdi & El-Hassan, 2019; Cotton et al., 2025; DeWaters & Powers, 2013; Rezaei et al., 2022
3	Behavioral Factors (Practice)	Actual energy-related behaviors: monitoring personal energy use, adopting energy-efficient habits, making rational energy decisions, and acting sustainably.	Alghamdi & El-Hassan, 2019; Cotton et al., 2025; Karpudewan et al., 2015; DeWaters & Powers, 2011

5. CHALLENGES AND BARRIERS

Implementing energy literacy programs in tertiary institutions is not without challenges. Common barriers include institutional resistance, resource constraints, and curricular inflexibility. Many universities have been slow to integrate comprehensive energy literacy into the curriculum, often limiting such content to engineering or environmental science departments. A survey noted that as of the mid-2010s, only about 8% of over 1,600 institutions had systematic, broad-based energy studies programs beyond technical disciplines (Blockstein et al., 2015). This indicates a serious curriculum gap—most students still lack access to energy education outside specialized courses. One reason is the enduring "siloed" nature of academia: energy topics are frequently isolated within specific departments, making it difficult to introduce interdisciplinary energy literacy content for all students (Blockstein et al., 2015). Faculty may be hesitant to teach outside their expertise, and adding new courses on sustainability or energy can face bureaucratic hurdles if they do not neatly fit existing degree requirements.

Institutional resistance can also stem from the academic culture and incentive structure. Developing and teaching interdisciplinary energy material often falls on individual faculty champions who receive little recognition or support (Blockstein et al., 2015). Faculty members have reported concerns that investing time in sustainability education might not be rewarded by tenure committees or may lack a community of peers for collaboration. Indeed, researchers note that faculty in this area are frequently self-taught and operate in isolation, which can discourage wider participation. Similarly, university administrators may be cautious about committing resources to new sustainability initiatives. They face pressure to balance budgets and may encounter internal or external criticism when pushing environmental programs perceived as non-core (Blockstein et al., 2015). This can lead to lukewarm institutional commitment, stalling the implementation of energy literacy efforts.

Another major barrier is limited resources and competing priorities. Implementing an energy literacy program often requires funding for curriculum development, training, and infrastructure. Financial constraints can be a significant hurdle; surveys of campus sustainability efforts consistently find that budget limitations are among the top challenges to advancing sustainability education (Leal Filho et al., 2023). Additionally, incorporating energy topics into an already crowded university curriculum is logistically difficult. Degree programs have strict credit requirements, leaving little room for new electives on energy or sustainability. Without a mandate or clear incentives, energy literacy content can be sidelined in favour of traditional coursework. There is also sometimes lack of awareness or urgency among both staff and students—energy issues may not be seen as immediately relevant to one's major field of study, leading to apathy (Leal Filho et al., 2023).

Despite these challenges, recent literature suggests several evidence-based strategies to overcome barriers and build a culture of sustainability in higher education. A key recommendation is to secure strong institutional support and leadership commitment for sustainability initiatives. Studies have found that visible support from university leadership is crucial for success (Leal Filho et al., 2023). University leaders can allocate funding, set sustainability targets, and encourage faculty to include energy topics, thereby creating an enabling environment rather than resistance.

Alongside leadership, faculty development and incentives are essential. Educators need training and resources to confidently teach interdisciplinary topics like energy and climate. A 2023 review concluded that improving faculty capacity through workshops and professional development is necessary to embed sustainability across the curriculum (Leal Filho et al., 2023). Universities can incentivize faculty by recognizing and rewarding innovative teaching in sustainability, which helps alleviate the fear that working on energy literacy will go unnoticed.

Curriculum innovation is another strategic avenue. Rather than adding isolated courses, universities are

encouraged to infuse energy literacy throughout existing curricula. This can involve integrating energy and sustainability modules into general education requirements or relevant courses in all majors. Recent trends show this integrated approach is gaining traction: sustainability topics are now being incorporated into diverse fields from engineering and economics to the humanities (Leal Filho et al., 2023). Additionally, experiential and action-oriented pedagogies are essential. Studies indicate that simply disseminating information is insufficient to change students' attitudes and behaviour—effective programs use interactive strategies like research projects, campus energy audits, and workshops to engage students actively (Leal Filho et al., 2023).

To address resource constraints, institutions can seek external partnerships and grants dedicated to sustainability education. Collaborations with government energy agencies, nonprofits, or industry can provide funding, expertise, or content for energy literacy initiatives (Blockstein et al., 2015). Moreover, partnerships can extend the reach of programs through guest lectures, industry visits, or co-created student projects. Some universities have also established campus sustainability offices to coordinate efforts and support energy literacy activities.

Finally, creating a campus culture of sustainability is both a goal and a strategy. This involves branding the university's commitment and empowering students to take part. Encouraging student-led initiatives like energy awareness campaigns or green clubs can complement formal curriculum efforts. When students co-create sustainability activities, their engagement increases, and learning outcomes improve (Leal Filho et al., 2023). In essence, overcoming the barriers to energy literacy in tertiary education requires a holistic approach: administrative commitment, faculty support and training, curriculum integration, and active student involvement all working together.

6. FUTURE DIRECTIONS AND RECOMMENDATIONS

To address the persistent gaps in energy literacy (EL) among tertiary students, future initiatives must be grounded in comprehensive, interdisciplinary, and institution-wide strategies. One critical direction is the integration of energy topics across various academic disciplines. This approach ensures that students in non-STEM fields also develop a foundational understanding of energy systems and sustainability issues (Cotton et al., 2015; Ramachandran et al., 2023). Embedding energy literacy within general education and domain-specific curricula allows for the normalization of energy-conscious thinking throughout the entire academic environment (Gladwin & Ellis, 2023).

Experiential learning continues to be among the most effective pedagogical approaches for enhancing energy literacy. Activities such as campus energy audits, hands-on projects, laboratory experiments, and field visits enable students to directly apply theoretical knowledge in practical settings. These experiences facilitate the development of critical thinking and problem-solving skills, and they help foster more enduring behavioural changes towards sustainable energy practices (DeWaters & Powers, 2011; Van Der Horst et al., 2015; Karpudewan et al., 2015). The effectiveness of these approaches is further supported by findings that experiential learning deepens both affective engagement and behavioural commitment (Leal Filho et al., 2023).

The use of technology in energy education also offers promising opportunities. Interactive platforms, simulations, and gamified learning modules can enhance students' motivation, personalize their learning experiences, and help them visualize complex energy systems more effectively. Digital tools are particularly effective in engaging students who are accustomed to online and multimedia environments, and they can significantly improve cognitive and attitudinal dimensions of energy literacy (Kellberg et al., 2024; Rezaei et al., 2022).

Engaging with communities through structured service-learning and collaborative partnerships with local organizations adds a valuable dimension to energy education. These community-based approaches allow students to observe and respond to real-world energy challenges while simultaneously contributing to public awareness and advocacy. Such initiatives reinforce the social relevance of energy literacy and help students internalize their roles as agents of change (Cebrián et al., 2020; Coronado et al., 2023). This strategy also resonates with stakeholder theory, which emphasizes the university's responsibility to serve and involve both internal and external communities in sustainability efforts (Freeman, 1984; Lozano et al., 2021).

In light of emerging trends, many universities are aligning energy literacy initiatives with broader institutional sustainability goals. These efforts include incorporating energy literacy indicators into university rankings and sustainability assessments, investing in green infrastructure, and encouraging

interdisciplinary faculty collaborations (Findler et al., 2019; Trencher et al., 2014). Institutional theory supports this movement by explaining how external pressures and internal leadership priorities influence the adoption of sustainability practices across higher education institutions (DiMaggio & Powell, 1983; Ofori et al., 2023).

Several recommendations can be made to advance energy literacy effectively. Policymakers should embed energy literacy within national education frameworks and allocate resources to support its implementation. Funding mechanisms should prioritize interdisciplinary and community-oriented energy education projects (Leal Filho et al., 2023; Białynicki-Birula et al., 2022). Educators should be supported with professional development programs that provide the tools and knowledge needed to teach energy literacy effectively across diverse subject areas (Lozano et al., 2021). Institutions should demonstrate strategic commitment by embedding energy literacy into mission statements, curriculum policies, and campus operations, thereby fostering a culture of sustainability that influences both students and faculty (Etzion, 2007; Gladwin & Ellis, 2023).

In conclusion, enhancing energy literacy among tertiary students requires an integrated approach that combines curriculum reform, experiential learning, technological engagement, community partnership, and institutional leadership. Through such a holistic model, higher education institutions can play a pivotal role in cultivating energy-literate graduates who are well-equipped to contribute meaningfully to a sustainable energy future.

7. CONCLUSION

Energy literacy has emerged as a vital component of sustainability education, particularly in the context of the global energy transition and institutional responsibilities within higher education. This study has shown that energy literacy is a multidimensional construct encompassing cognitive, affective, behavioural, and conative elements, each of which contributes to students' capacity to engage critically with energy-related issues (DeWaters & Powers, 2011; Rezaei et al., 2022). While knowledge forms the foundation of energy literacy, it is the alignment of attitudes, motivation, and behaviour that ultimately leads to meaningful action (Białynicki-Birula et al., 2022; Cotton et al., 2021).

The findings from this systematic review suggest that although educational institutions have made progress in embedding sustainability themes into academic discourse, significant gaps remain in how energy topics are integrated across curricula, especially for students outside of STEM disciplines. Furthermore, empirical evidence indicates that cognitive understanding alone does not consistently lead to behavioural change, highlighting the importance of pedagogical strategies that address emotional engagement, self-efficacy, and social influences (Lee et al., 2022; Håkansson et al., 2024).

To promote comprehensive energy literacy, this paper recommends a combination of curriculum integration, experiential learning, digital tools, and community-based initiatives. These approaches must be supported by institutional leadership and policy frameworks that prioritize sustainability outcomes and stakeholder engagement (Gladwin & Ellis, 2023; Leal Filho et al., 2019). Embedding energy literacy in institutional culture and governance not only enhances the sustainability profile of universities but also empowers students to become informed citizens and responsible energy users in their personal and professional lives.

In conclusion, higher education institutions must move beyond fragmented efforts and adopt a system-wide, evidence-based approach to energy literacy. By integrating energy topics into diverse learning environments, fostering values-driven engagement, and aligning institutional strategies with global sustainability goals, universities can contribute to cultivating a generation of proactive, energy-conscious graduates. These individuals will be better equipped to navigate the complexities of the energy transition and to lead in the creation of resilient, equitable, and environmentally sustainable societies (Ramachandran et al., 2023; Cotton et al., 2015).

ACKNOWLEDGEMENT: The authors which to thank UNITEN for supporting this study under Internal Research Grant (J510051078 – Pocket Grant 2024). This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

REFERENCES

1. Alghamdi, A. K. H., & El-Hassan, W. S. (2019). Saudi undergraduate students' needs of pedagogical education for energy literacy. *Journal of Turkish Science Education* 16(4), pp. 521-537, doi: 10.36681/tused.2020.5.
2. Bahrami, S., & Mohammadi, Y. (2021). Assessing Energy Literacy of Iranian Ninth-Grade Students. *Journal of Turkish Science*

Education, 18(4), 707-731. DOI no: 10.36681/tused.2021.99
3. Białynicki-Birula, P., Miciuła, I., & Mroczek, K. (2022). Energy literacy and its determinants among students: A cross-national study. *Energies*, 15(15), 5368.
4. Blockstein, D. E., Libarkin, J., & Middlestadt, S. (2015). Energy education: Easy, difficult, or both? *Journal of Sustainability Education*, 8.
5. Cebrián, G., Junyent, M., & Mulà, I. (2020). Competencies in education for sustainable development: Exploring the student teachers' views. *Sustainability*, 12(3), 784.
6. Coronado, A. B., Mueller, M. A., & Esposito, L. J. (2023). *A learning ecology perspective of energy literacy among youth: A case study from Alabama high schools*. *Sustainability*, *15*(22), 16055. https://doi.org/10.3390/su152216055
7. Cotton, D. R. E., Miller, W., Winter, J., Bailey, I., & Sterling, S. (2015). Developing students' energy literacy in higher education. *International Journal of Sustainability in Higher Education*, 16(4), 456–473.
8. Cotton, D. R. E., Winter, J., Miller, W., & Bailey, I. (2021). Reducing energy demand in China and the United Kingdom: The importance of energy literacy. *Journal of Cleaner Production*, 278, 123876.
9. DeWaters, J., & Powers, S. (2011). Energy literacy of secondary students in New York State (USA): A measure of knowledge, affect, and behavior. *Energy Policy, 39*(3), 1699–1710. https://doi.org/10.1016/j.enpol.2010.12.049
10. DeWaters, J., & Powers, S. (2013). Establishing measurement criteria for an energy literacy questionnaire. *The Journal of Environmental Education, 44*(1), 38–55. https://doi.org/10.1080/00958964.2012.711378
11. Delmas, M. A., & Toffel, M. W. (2008). Organizational responses to environmental demands: Opening the black box. Strategic Management Journal, 29(10), 1027–1055.
12. DiMaggio, P. J., & Powell, W. W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. American Sociological Review, 48(2), 147–160.
13. Etzion, D. (2007). Research on organizations and the natural environment, 1992–present: A review. Journal of Management, 33(4), 637–664.
14. Findler, F., Schönherr, N., Lozano, R., & Stacherl, B. (2019). Assessing the impacts of higher education institutions on sustainable development—an analysis of tools and indicators. *Sustainability*, 11(1), 59.
15. Freeman, R. E. (1984). *Strategic Management: A Stakeholder Approach*. Boston: Pitman.
16. Gladwin, D., & Ellis, N. (2023). Energy literacy: towards a conceptual framework for energy transition. *Environmental Education Research,* 1–15. https://doi.org/10.1080/13504622.2023.2175794
17. Håkansson, M., Adawi, T., & Molin, P. (2024). Energy literacy for all? Exploring whether prior interest and energy education affect knowledge, attitudes, and behaviour. *Environmental Education Research*, 30(1), 1–17.
18. Hamidi Razi, M., Bahadori, A., & Amiri, M. (2021). Energy literacy and energy-related financial literacy in Iran: Case of Northwestern academic community. *Energy Reports, 7*, 3879–3887.
19. Karpudewan, M., Zain, A. N. M., & Mohd Nor, M. (2015). Integrating green chemistry experiments with sustainable development concepts in pre-service teacher training. *International Journal of Environmental and Science Education, 10*(5), 577–588.
20. Keller, L., Kuhn, T., & Forster, M. (2022). Can education save money, energy, and the climate? *Energies*, 15(3), 1118.
21. Khuc, Q. V., Nguyen, H., & Bui, M. (2023). Improving energy literacy to facilitate energy transition and nurture environmental culture in Vietnam. *Journal of Cleaner Production, 385*, 135661.
22. Kovačič, D., Ulbin, A., Abina, A., et al. (2024). Energy literacy among young adults in the European countries. *Energy Research & Social Science, 103*, 103247.
23. Leal Filho, W., Salvia, A. L., do Paço, A., & Brandli, L. L. (2019). Implementing and operationalising integrative approaches to sustainability in higher education: The role of project-oriented learning. Journal of Cleaner Production, 233, 1006–1015.
24. Lozano, R., Barreiro-Gen, M., Lozano, F. J., & Sammalisto, K. (2021). Leadership and organisational change for implementing sustainability in universities. Journal of Cleaner Production, 299, 126733.
25. Lozano, R., Barreiro-Gen, M., Lozano, F. J., & Sammalisto, K. (2021). Stakeholder engagement for sustainability: The role of higher education institutions. Sustainability, 13(10), 5612.
26. Leal Filho, W., Shiel, C., Paço, A., Mifsud, M., Veiga Ávila, L., & Londero Brandli, L. (2019). Sustainable development goals and sustainability teaching at universities: Falling behind or getting ahead of the pack? *Journal of Cleaner Production*, 232, 285–294.
27. Leal Filho, W., Skanavis, C., do Paço, A., & Mifsud, M. (2023). Assessing the impacts of sustainability teaching at HEIs. *Discover Sustainability*, 4(1), 15.
28. Lukszo, Z., Lukszo, Z., Bompard, E., Hines, P., & Varga, L. (2018). Energy and Complexity. Complexity, 2018, 1–2. https://doi.org/10.1155/2018/6937505
29. Ramachandran, A., Ellis, N., & Gladwin, D. (2023). Energy literacy: A review in education. The Journal of Environmental Education. https://doi.org/10.1080/00958964.2023.2283694
30. Ramachandran, A., Liew, C. Y., & Ismail, M. (2023). Energy education in higher learning institutions: Current landscape and future directions. Renewable and Sustainable Energy Reviews, 178, 113208.
31. Ramachandran, A., Ellis, N., & Gladwin, D. (2023). Energy literacy: A review in education. The Journal of Environmental Education. https://doi.org/10.1080/00958964.2023.2283694
32. Santillán, O. S., & Cedano, K. G. (2023). Energy Literacy: A Systematic Review of the Scientific Literature. Energies. https://doi.org/10.3390/en16217235
33. Santillán, O. S., & Cedano Villavicencio, K. G. (2023). Energy literacy: a systematic review of scientific literature. https://doi.org/10.20944/preprints202309.2079.v1
34. Ofori, D. F., Addo, E. A., & Arthur, D. A. (2023). Institutional pressures and sustainability practices in higher education: Evidence from Ghanaian universities. Journal of Cleaner Production, 395, 136945.
35. Puspitasari, H., & colleagues. (2020). Analysis conception in review of attitudes and behaviors on energy roles in life based

on energy literacy framework. *Jurnal Pendidikan IPA Indonesia, 9*(1), 88–98.

36. Ramos, T. B., Caeiro, S., Van Hoof, B., Lozano, R., Huisingh, D., & Ceulemans, K. (2015). Experiences from the implementation of sustainable development in higher education institutions: Environmental management for sustainability. Journal of Cleaner Production, 106, 3–10.
37. Rets, I., Idris, N. M., & Abdullah, A. (2024). Sociodemographic factors affecting energy literacy among university students in Malaysia. *Energy Education Science and Technology, 40*(2), 211–230.
38. Rezaei, M., Karimi, H., & Fahim, M. (2022). Energy awareness, values, and behavior: Exploring the conative dimensions of energy literacy among university students. *Sustainability, 14*(1), 458.
39. Rohmatulloh, R., Abdullah, R., & Syamsudin, A. (2021). Energy literacy and education: The viewpoint of stakeholders to promote energy literacy in education. *International Journal of Educational Development, 83*, 102394.
40. Trencher, G., Yarime, M., & Kharrazi, A. (2014). Co-creating sustainability: Cross-sector university collaborations for driving sustainable urban transformations. Journal of Cleaner Production, 50, 40–55.
41. Yarime, M., & Tanaka, Y. (2012). The issues and methodologies in sustainability assessment tools for higher education institutions: A review of recent trends and future challenges. Journal of Education for Sustainable Development, 6(1), 63–77.