
Sustainable educational ecosystems in public universities in Kenya: Assessing contributions of greening technology, investment, and finance

Article history: Revised format: 16th May 2025, Available online: 22nd June 2025

Leah Jemutai Barno¹; Prof. Ruth Jepkemboi Choge²

Abstract

Purpose: The study aimed to assess the contributions of green technology, investment, and finance toward the development of sustainable educational ecosystems in public universities in Kenya. Specifically, the study sought to examine the landscape of green initiatives and evaluate their individual and collective impact on sustainability in higher education.

Material/methods: The research adopted a traditional or narrative review approach, allowing for a comprehensive and objective analysis of existing literature and documented practices related to green universities and educational sustainability. The review focused on institutional-level data, national policy frameworks, and university-driven sustainability programs.

Findings: The findings revealed that public universities in Kenya have developed elaborate green technology, finance, and investment landscapes. These include initiatives such as solar energy installations, green buildings, income-generating activities, environmentally sustainable student housing, and the Green-STEM project. These practices have contributed to increased environmental awareness, improved operational accountability, enhanced financial flows, and reduced carbon emissions across campuses.

Conclusion: The study concludes that integrating greening initiatives into university systems plays a critical role in fostering sustainable educational ecosystems. Greening efforts not only promote environmental responsibility but also align institutional practices with national and global sustainability agendas.

Value: This study provides timely insights for policymakers, university administrators, and development partners. It underscores the importance of reinforcing current sustainability initiatives such as Kenya's National Climate Change Action Plan, the University of Nairobi–IFC partnership, and the Inter-University Green University Network (IGUN). These efforts collectively strengthen the role of higher education in achieving long-term environmental and institutional sustainability.

Keywords: Sustainability, educational ecosystem, green technology, green investment, green finance

Paper Type: Research Article

Recommended citation: Jemutai, L., & Choge, R. J. (2025). Sustainable educational ecosystems in public universities in Kenya: Assessing contributions of greening technology, investment, and finance. *Journal of Economics, Management Sciences and Procurement*, 4(1), 299–311.

¹ Researcher; Email: jemutaileah@yahoo.com

² Lecturer, Koitaleel Samoei University College; Email: jchoge@ksu.ac.ke

1. Introduction

The demand for long term answers to the increasing environment damage due to climate change has gained global urgency (Javadine-Jad et al., 2019; Radunsky & Cadman, 2021). In Kenya, the urgency for solutions to climate change is manifested through an elaborate policy framework, that includes the National Climate Change Action Plan 2013 – 2017 (GoK, 2013) and the Kenya National Adaptation Plan 2015 – 2030 (GoK, 2016). Moreover, Kenya has aligned itself with the United Nations Framework Convention on climate change and the Paris Agreement as anchored in the constitution 2010 and vision 2030.

The increasing frequency and intensity of extreme weather events caused by climate change is having a negative impact on educational ecosystems, disrupting academic programs in diverse ways (Marin et al., 2024). In a study conducted in six, Kenyan counties, including Mombasa, Kwale, Kilifi, Nairobi, Tana River and Turkana, Fitzpatrick and Amenity (2023) established that there were direct and indirect impacts of climate change such as learning losses and student drop outs that were causing disruption to academic programs. Higher Educational stakeholders are progressively taking cognizance of the need for trans-formative approaches to sustainable educational ecosystems. For instance, Kenyan Universities established the Kenya Green University Network (KGUN) with a view to promoting greening approaches in the campuses (Nyerere, 2022). Similarly, Strathmore University and Kenyatta University have installed the largest solar installations in the region generating solar power to the tune of 600KW and 100KW respectively (Nyerere, 2022).

Therefore, core to these trans-formative approaches are the GreenTech solutions that encompasses greening of technology, investment and finance to align quality education with climate action as envisaged in sustainable development goals (SDG) No. 4 and No. 13, while at the same time addressing the tenets of vision 2030.

1.1 Problem statement

As Kenya's public Universities continue to face the challenge of financial sustainability as evidenced through reduced government funding, unremitted statutory deductions, and growing debt (Kimathi & Irungu, 2024), the need for sustainable educational ecosystem solutions cannot be over emphasized. Educational ecosystems, including effective management of waste, water and energy conservation, transiting to solar, availing green spaces and greening the curriculum offer viable solutions to challenges these universities face.

However, despite public universities being central to shaping change in societies, there are concerns that integration of climate change in the education system in Kenya has been neglected. For instance, in a research on how curriculum contributes to climate change awareness, Kariuki (2017) established that the issue of climate change is given casual treatment in Kenya's educational policies. Similarly, a survey by Huho (2015) on two public universities revealed that they had not incorporated the ideals of climate change in their programmes, creating a gap on sustainability of their educational ecosystems.

In view of the scanty literature referencing climate change in Kenyan Universities educational ecosystems featuring institutional governance, academic activities, and community engagement, this research paper seeks to fill this gap. The study reviews GreenTech solutions of green technology, green investment and green finance in relation to educational ecosystems. The aim is to understand how public universities in Kenya can leverage these solutions to make their educational ecosystems sustainable.

1.2 Objectives

This research is guided by three specific objectives

1. To identify the green technology landscape for Universities in Kenya and its subsequent contribution to their sustainable educational ecosystems.
2. To determine the current green finance landscape for Universities in Kenya and its resulting contribution to sustainable educational ecosystems in the institutions
3. To explore the existing green investment landscape for Universities in Kenya and its subsequent contribution to their sustainable educational ecosystems

2. Literature Review

2.1 Educational Ecosystems

The concept of education ecosystems is an emerging concept owing to the growing global consensus for a radical transformation to meet the needs of today's digital uncertain and fast growing world. Hannon et al. (2019) contends that this concept derives from evolutionary biology, where ecosystem relates to interdependent organisms brought together in a community and coexisting within the natural environment. In retrospect, Otto and Kerres (2023), aver that the concept of educational ecosystems relates to contemporary learning processes where there exists causal interactions between different elements. They add that in the context of higher education, educational ecosystems subsumes resources, all services and learning environments.

Several typology of ecosystems have been highlighted, including knowledge sharing systems, innovation systems and learning ecosystems. Andrade et al. (2022) identify knowledge sharing ecosystems as a network involving individuals and groups coalescing around the sharing of emerging knowledge on innovation and funding opportunities among others. Granstrand and Holgersson (2020) identify innovation systems as comprising of new and traditional providers of education, formal and informal opportunities for learning and higher education who are supported by digital technology to accelerate and drive radical innovation. Meanwhile, Hecht and Crowley (2020) define learning ecosystems as diverse combinations of providers, including government agencies, institutions and community organizations.

2.2 The Concept of GreenTech Solutions

Greentech solutions in this paper integrates ecological technologies, innovative financing, and impact investing in seeking to mitigate humanity's environmental impact. Marton (2022) defines ecological technology in the realm of digital technology, as all digital devices and sustainable engineering aimed at conserving biodiversity and

sustainable development by adopting ecology as their leverage. Such technology focuses on how such devices are produced, used and disposed and their interaction with the environment. Innovative financing is perceived in financial discourse as a way of combining available financing tools into one package that compliments traditional international resource flows, to mobilize additional resources through private investors (Sachs et al., 2023). Impact investing is viewed as an investment strategy that involves divergent asset classes to maximize financial gains while also creating beneficial social or environmental effects (Barber et al., 2021).

2.3 Empirical Evidence of GreenTech Solutions and Sustainable Educational Ecosystems

The potential for GreenTech elements of ecological technology, innovative financing and impact investing to impact educational ecosystems is highlighted in some existing empirical studies. Zhou (2022) approached the impact of ecological technology from a smart education ecosystem perspective that targeted three education scenarios of integration of virtuosity reality, resource collaborative interaction and ubiquitous spatial inquiry. Using six core technologies, Zhou demonstrated that the meta-verse perspective was critical for a Smart education ecosystem, raising interest in examining whether the same could be replicated in Kenyan Public Universities.

In another study, Varghese and Panigrahi (2023) based on the concerns of social, equity and economic rationality for continued public investment in higher education to explore innovations in financing. Using systematic reviews, they determined that most countries opted for reforms such as allowing income generating activities and cost-sharing in higher education as innovations for financing. In contrast, Guerrero et al. (2019) used an exploratory research to explore whether partnerships between universities and enterprises in Mexico mattered in resolving financing of Universities. Employing the multinomial regression model, they demonstrated that such innovations do matter, providing impetus to examine the Kenya public universities case.

Empirical evidence has also underscored the value of impact investment in educational ecosystems. In the US for instance, the K-12 space has been dominated by Charter schools, with Walton Foundation being an active investor (DeAngelis, 2019). In developed countries, impact investment in higher education and TVET has often targeted improving access, raising chances of employment, and limiting drop outs. Therefore impact investors such as Bill and Melinda Gates Foundation, Bain Capital's Double Impact Fund and Penn Foster have been proactive (Aslami, 2021). With these revelations, it was motivating to explore impact investment from a Kenyan Public University educational ecosystem perspective.

3. Methodology

This paper used the more traditional narrative review, presenting a non-systematic summation and analysis of existing data on greening technology, finance, investment and sustainable educational ecosystems in public universities in Kenya. The choice of this approach was based on the historical perspectives underlying the focus of the research. Besides, several sources of information, including government reports, policy documents, peer reviewed journals, university websites, magazines and newspapers were used making a systematic review to be more complex.

Under this approach the research question was broad, literature sources were not comprehensively searched but were broadly drawn. First a search was conducted using several data bases including, Scopus, Science Direct and PubMed and Google Scholar for peer reviewed journals and Google search for university websites and government reports. Several key words were employed to facilitate the search. Duplicates were removed and the remaining abstracts, executive summaries, and articles were then reviewed. Following which results were documented.

4. Results

4.1 Universities, Climate change and Sustainability

This paper established that universities are strategically placed in societies, and that through their missions they can contribute significantly to the discourse on climate action and sustainability both locally and internationally (McCowan et al., 2021). According to Leal Filho et al. (2024), countries in Africa are the most predisposed to climate change. Yet, populations and politics in Africa find it challenging to comprehend climate change, making it necessary for Universities to be at the forefront to drive change. Leal Filho et al (2024) argue that Universities and other institutions of higher education must exploit their research capacity towards climate action.

The study also revealed that taking cognizance of the significant role universities play in educating the populace in climate change, a project labeled, accelerating impacts of CGIAR climate Research for Africa (AICCRA) has opted to establish collaborations with Kenyan Universities to come up with a climate Smart curricula for Kenyan Universities (Grossi et al., 2023). Moreover, these researches confirmed that Kenyan Universities are indeed concerned about climate change and are keen to address the challenge. For instance, in October, 2022, Karatina University and Strathmore University collaborated to hold the Kenyan Green Universities Network (KGUN) webner through which the Kenyan Universities could share experiences on going green in order to mitigate effects of climate change (Karatina University Weekly Dispatch, 2022). From the Webner, it was emphasized that Universities needed to go green in their activities, including managing the waste they generate, incorporating green activities in their curriculum, and conserving water and energy. The study also revealed that in line with the Berlin 2021 declaration on education for sustainable development requiring environmental education to be a co-curriculum component by 2025, the Kenyan government through the Cabinet Secretary promised to integrate climate change studies in the curriculum (Oloo, 2023).

This research further determined that despite public Universities in Kenya showing initiatives towards climate action there were several gaps. Firstly, lack of the enabling technology has made it difficult for these institutions to employ carbon capture and storage to mitigate climate change (Owino, 2022). Secondly, despite the existence of an elaborate policy framework for climate change, there was no evidence of strategies focusing on the same for universities. Besides, the study found no clear role that universities are expected to play in the governance of climate change action (Nyerere, 2022). Moreover, it was apparent that lack of finance was the main hindrance in incorporating climate change activities in the universities educational ecosystem (Otundo, 2024).

4.2 The Green Technology Landscape for Universities in Kenya

The study established that green technology in Kenya is an initiative of vision 2030 whose aim is to achieve a 100% use of renewable energy by 2030. Therefore, seeking to be a green model in Africa, Kenya exports renewable energy technology, drives innovation, and modernizes transport (Knight, 2024). In retrospect, Kenyan Universities have been at the forefront of green technology initiatives. The United Nations Environmental Programme (UNEP) ranks Strathmore University as one of the greenest universities in Africa. The University has put in place a raft of sustainable initiatives, including green buildings, recycling and a 600kw photovoltaic grid tie system (Kimani & Kiaritha, 2019). The University of Nairobi (UoN) has partnered with the International Finance Corporation (IFC) to promote green building practices in Kenya as part of the theme 'Pathways to Sustainable Real Estate Investment in Sub-Saharan Africa (SSA) countries (University of Nairobi, 2023).

In the same realm, Moi University envisions a bright future by embracing renewable energy and clean energy utilization. The university has proposed a transformative initiative that would see the establishment of a renewable energy park and innovative research hub for green hydrogen, Ammonia, Fertilizer and other green products by 2025 (Moi University, 2024). Meanwhile, in 2016 the UN Environment Programme (UNEP) partnered with Kenyan Universities to launch the Kenya Green University Network (KGUN) aimed at promoting environmental and sustainability practices within the Universities (UNEP, 2016).

Therefore, the study established that the green technology landscape in universities in Kenya is evolving with many universities taking cognizance of the need to go green. Most of these institutions are promoting greening approaches, including the use of renewable and clean energy and shifting towards solar installation. The question however remains how this greening technology is likely to benefit education in public universities in Kenya.

4.3 Contributions of Greening Technology to Public Universities

Existing research unveiled several benefits that are likely to accrue from greening technology for public universities educational ecosystems. By adopting green technology, public universities in Kenya are likely to benefit by fostering a campus culture that is conscious of the environment and reduce ecological footprint as demonstrated in other university contexts (Ateeq et al., 2024). Existing research demonstrated the effectiveness of green technology innovations such as waste water treatment systems, renewable energy systems, and clean water practices to minimize emission of green house gases, conserve natural resources, improve water and air quality and to create jobs (Adebeye et al., 2020).

Another benefit of green technology to public universities that recurs consistently in existing research is nurturing of environmental awareness among students. This can help enhance undergraduates intentions on reusable drink water and moral norms. According to Roy (2023) initiatives on greening universities are significant predictors of moral norms. Jasmi et al., (2019) add that green technology is a driver for sustainable development education which addresses environmental issues.

Universities are also likely to boost employment potential of students by embracing green technology. Wandera and Olonde (2024) references the just energy perspective to argue that growth in green technology opens room for job creation and entrepreneurial activities.

4.4 The Green Finance Landscape for Universities in Kenya

Discourse on green finance revealed that in January, 2020 Kenya by seeking to construct environmentally conscious accommodation for university students listed a first ever green Bond of Kshs. 4.3 billion at the London Stock Exchange (Chumba et al., 2020). Subsequently, interest in green finance in Kenyan Universities has soared. Therefore, the green finance landscape in public universities in Kenya is inclusive of donor funding structures as demonstrated by Chumba et al. (2020). Research also highlights income generating activities, credit controls and external borrowing as among the finance landscape for public universities. The green bonds also feature along other green finance initiatives in Kenya's climate finance landscape. Evidence shows that the Green Bonds Programmes Kenya (GBPK) was launched in 2017 as a strategy to mitigate climate change (Odhengo et al., 2019).

The significance of greening finance in public universities in Kenya is also reflected in their plan to switch to solar in order to promote sustainable energy practices. While also cutting operational costs. They envisage that such a switch would save between 30% and 40% of their power expenses (Ng'ang'a 2024). Kenyan Universities are also stepping up the efforts to combat climate change through the universities fund (UF). According to existing reports, the Universities fund has partnered with Cooperative Bank to come up with a project dubbed 'Solarization project for public universities' aimed at cutting down electricity costs in these institutions and to also move towards eco-friendly energy (UF, News, 2024).

Although the literature on green financing in public universities in Kenya was scanty, it is clear that public universities in Kenya have taken note of the increasing need of green finance and are in the process of establish mechanisms through which such financing can be realized. The question then is how such greening of finance is likely to contribute to their educational ecosystems.

4.5 Contributions of Green Finance on Public Universities Educational Ecosystems

A review of existing publications identified several contributions that can accrue to public universities through greening finance. Of great significance is that green financing is likely to lead to increased levels of financial flows among these institutions. This can be achieved by better managing environmental and social risks. Research shows that social and environmental security in modern society is effectively achieved through green finance (Cheberyako et al., 2021). Moreover, Zhu et al., (2017) demonstrated that green finance related positively with environmental protection.

Public universities in Kenya also stand to deliver greater accountability in their educational ecosystems through green financing. Pertiri et al., (2021) demonstrated that green financing is a basis for responsibility and accountability in social and environmental performance ecosystems in the universities. Another contribution that

greening finance can make to public universities is to enhance their capacity to achieve sustainability development and to lower their carbon transmission. Evidence shows that green finance offers a great chance to facilitate transition to a low-carbon economy and the realization of SDGs (Ngara, 2024). Through green finance, public universities can also benefit from development of environmentally friendly infrastructure and enhanced economic prospects. Kelker (2023) in delineating a typology of green finance, including green mortgages, green loans, green credit cards, and green bonds points out that green financing encourages the development of environmentally friendly infrastructure.

The review also identified competitive advantage as a potential contribution that greening finance can bring to public universities in Kenya. Okanovic et al., (2021), demonstrated that green financing facilitates eco-labeling and green content that increases competitiveness among universities. Last but not least, green financing can add value to public universities, by offering campuses a green edge that enables them to attract more environmentally concerned customers. According to Yan and Lyu (2023), green finance drives innovative decision making in higher education.

4.6 The Green Investment Landscape for Universities in Kenya

The green investment landscape for universities in Kenya is shaped by the Draft National Green Fiscal Incentive Policy Framework of 2022. This policy framework desires to move Kenya's economy on the trajectory of low carbon, climate resilience and green development by pursuing several fiscal and economic mechanisms (Republic of Kenya, 2022). These green fiscal reforms are particularly beneficial to public universities because they can engage private investments university projects and programs that adopt climate friendly mechanisms. Among sustainable public investments made to public universities through such private sector participation includes the development of Kenyatta University student hostels aimed at accommodating 10,000 students a 20 year project valued at Kshs. 6.9billions and undertaken by Africa integras (PPP. Directorate, 2024).

The green investment landscape for universities also includes the Green-STEM project, a cross-regional cooperation involving a consortium of universities, including the University of Nairobi, University of Lagos, University of Rwanda, University of Witwatersrand, and University of Paris Science et Lettres (EACEA, 2024). The project co-funded by the European Union addresses challenges such as sensitivity to carbonized economies experienced in most African countries. It's main mission is to put African universities at the forefront of sustainable and green development.

Another green investment initiative is the UNEP supported Kenya Green Universities Network (KGUN) aimed at green universities educational ecosystems by ensuring inclusion of environmental and sustainability practices in the campus designs, research projects and university curricular (Chumba et al., 2020).

Another green investment milestone in the context of universities in Kenya is the construction of student hostels through the green bond (Ng'ang'a, 2019). The private equity fund Helios was asked to raise a US \$500 million green bond for the construction of climate resilient student hostels. This research therefore established that greening investment is an ongoing endeavour among universities, raising the question of how public universities are bound to benefit from such investments.

4.7 Contributions of Greening Investment to Public Universities Educational Ecosystems

The review revealed that public university educational ecosystem can benefit immensely by greening investment. Key among the highlighted benefits is reducing the carbon footprint in the institutions, integrating green technology in their curricular and supporting research and innovation. Literary evidence shows that green investments has reduced carbon footprint in universities in different contextual settings (Kiehle et al., 2023; Patarlageanu et al., 2020). Similarly, scholars have demonstrated that greening investment facilitates integration of green energy technologies in the curriculum, albeit in the Nigerian Tertiary Institutions Context (Jebba, et al., 2024). Meanwhile Vanickova (2020), established that efficiency in green investment was critical to the management of innovation corporate energy.

Greening investment can also contribute to enrolment rates in public universities. The review revealed that greening investment is a sustainability endeavour that is likely to appeal to students (Eyrand et al., 2013). By greening investments, public universities would be committing to sustainability through visible means including recycling programs, increased biodiversity, green spaces, and eco-friendly transport options which may attract eco-conscious students.

5. Conclusion

Adoption of GreenTech that integrates green technology, green finance and green investment is the answer to improving the education ecosystems in public universities in Kenya. Greening technology provides opportunities to foster a campus culture that is environment sensitive alongside reduction of the carbon footprint within the institutions. Universities that have adopted green technology such as Strathmore and University of Nairobi are reaping dividends from their solar installations. Greening finance has the potential to enable public universities to enhance social and environmental security while delivering enhanced accountability in their educational ecosystems. This would further be enriched by the environmental infrastructure facilitated through greening finance. Meanwhile, by greening investment, public universities stand to benefit not only from reduced carbon footprint but also from green curricular and research. Through this research, policy makers can draw insight to boost the ongoing endeavours of greening education, including the National Climate Change Action Plan, the Partnership between UoN and IFC, and the IGUN initiatives.

References

- Adegbeye, M. J., Reddy, P. R. K., Obaisi, A. I., Elghandour, M. M. M. Y., Oyebamiji, K. J., Salem, A. Z. M., ... & Camacho-Díaz, L. M. (2020). Sustainable agriculture options for production, greenhouse gasses and pollution alleviation, and nutrient recycling in emerging and transitional nations-An overview. *Journal of Cleaner Production*, 242, 118319.
- Andrade, R., Pinheiro, P., Carvalho, L., & Rocha, R. (2022). Building a bridge: Knowledge sharing flows into entrepreneurial ecosystems. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(3), 144.

- Ateeq, A., Alaghbari, M. A., Al-refaei, A. A. A., & Ahmed, A. Y. (2024, January). Sustainable Solutions: The Impact of Green Technologies in University Operations. In *2024 ASU International Conference in Emerging Technologies for Sustainability and Intelligent Systems (ICETISIS)* (pp. 225-229). IEEE.
- Barber, B. M., Morse, A., & Yasuda, A. (2021). Impact investing. *Journal of Financial Economics*, *139*(1), 162-185.
- Chebryako, O. V., Varnalii, Z. S., Borysenko, O. A., & Miedviedkova, N. S. (2021, November). "Green" finance as a modern tool for social and environmental security. In *IOP Conference Series: Earth and Environmental Science* (Vol. 915, No. 1, p. 012017). IOP Publishing.
- Chumba, J. A., Muturi, W., & Oluoch, O. (2020). Green Finance for Kenya's Universities? Unpacking the Effect of Donor Funding Resource Mobilisation Structure on the Financial Sustainability of Universities in Kenya. *IOSR Journal of Business and Management (IOSR-JBM) e-ISSN*.
- Chumba, J. A., Muturi, W., & Oluoch, O. (2020). Green Finance for Kenya's Universities? Unpacking the Effect of Donor Funding Resource Mobilisation Structure on the Financial Sustainability of Universities in Kenya. *IOSR Journal of Business and Management (IOSR-JBM) e-ISSN*.
- DeAngelis, C., Wolf, P., Maloney, L., & May, J. (2019). A good investment: The updated productivity of public charter schools in eight US cities.
- European Education and Culture Executive Agency (EACEA)(2024). Green, REsilient and ENtrepreneurial Science, Technology, Engineering and Mathematics for Africa. An Intra-Africa Academic Mobility Program 2024-2027. <https://green-stem.uonbi.ac.ke/>
- Eyraud, L., Clements, B., & Wane, A. (2013). Green investment: Trends and determinants. *Energy policy*, *60*, 852-865.
- Fitzpatrick, R., & Ameyna, D. (2023). Climate Change and Education in Kenya. Research Report. *Education Development Trust*.
- Government of Kenya, National Climate Change Action Plan; 2013.
- Government of Kenya. Kenya National Adaptation Plan 2015-2030; 2016.
- Granstrand, O., & Holgersson, M. (2020). Innovation ecosystems: A conceptual review and a new definition. *Technovation*, *90*, 102098.
- Grossi, A., Dinku, T., Hansen, J., Trzaska, S., Ruirie, O., & Crane, T. (2023, December). Climate Risk Management in Agricultural Extension Curriculum Validation and Training of Trainers Workshop in Kenya. In *AICCRA Workshop Report. Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA)*. <https://hdl.handle.net/10568/135194>.
- Guerrero, M., Urbano, D., & Herrera, F. (2019). Innovation practices in emerging economies: Do university partnerships matter?. *The Journal of Technology Transfer*, *44*, 615-646.
- Hannon, V., Thomas, L., Ward, S., & Beresford, T. (2019). Local learning ecosystems: emerging models. *Innovation Unit*.
- Hecht, M., & Crowley, K. (2020). Unpacking the learning ecosystems framework: Lessons from the adaptive management of biological ecosystems. *Journal of the Learning Sciences*, *29*(2), 264-284.
- Huho, J. M. (2015). Climate change knowledge gap in education system in Kenya.

- Jasmi, N., Kamis, A., & Farahin, N. (2019). Importance of green technology, Education for Sustainable Development (ESD) and environmental education for students and society. *Journal of Engineering Research and Application*, 9(2), 56-59.
- Javadinejad, S., Dara, R., & Jafary, F. (2019). Taking urgent actions to combat climate change impacts. *Annals of Geographical Studies*, 2(4), 1-13.
- Jebba, M. M., bin Nordin, M. S., & Isa, M. U. (2024). Integration Of Green Energy Technologies Into Automobile Technology Education Curriculum In Tertiary Institutions In Nigeria: Challenges And Prospects. *Migration Letters*, 21(S5), 412-419.
- Karatina University Weekly Dispatch (2022, October 21). Kenyan Universities Share Experiences On 'Going Green' Towards Mitigation of Climate Change Effects. <https://karu.ac.ke/>
- KARIUKI, C. N. (2017). Curriculum and its contribution to awareness of climate change among learners in secondary schools in Githunguri Sub-county, Kiambu County, Kenya. *Unpublished Thesis, Kenyatta University, Kenya*.
- Kelkar, G. (2023, January 9). How Does Green Finance Benefit Organizations and the World. *Emeritus*. <https://emeritus.org/>
- Kiehle, J., Kopsakangas-Savolainen, M., Hilli, M., & Pongrácz, E. (2023). Carbon footprint at institutions of higher education: The case of the University of Oulu. *Journal of environmental management*, 329, 117056.
- Kimani, L., & Kiaritha, H. (2019). Social economic benefits of green buildings in tertiary institutions in Kenya. *Africa Journal of Technical and Vocational Education and Training*, 4(1), 24-32.
- Kimathi, B. K., & Irungu, A. M. (2024). Revenue Diversification on Financial Sustainability of Public Universities in Kenya. *Journal of Finance and Accounting*, 4(3), 31-41.
- Knight, C. (2024, March 12). A green model in Africa. <https://www.eib.org/>
- Leal Filho, W., Sierra, J., Kalembo, F., Ayal, D. Y., Matandirotya, N., de Victoria Pereira Amaro da Costa, C. I., ... & Baldeh, D. (2024). The role of African universities in handling climate change. *Environmental Sciences Europe*, 36(1), 130.
- Marin, S. V., Schwarz, L., & Sabarwal, S. (2024). *The Impact of Climate Change on Education and what to Do about it*. World Bank.
- Marketing and Management of Innovations, 2, 56-67. <http://doi.org/10.21272/mmi>.
- Márton, A. (2022). Steps toward a digital ecology: ecological principles for the study of digital ecosystems. *Journal of Information Technology*, 37(3), 250-265.
- McCowan, T., Leal Filho, W., & Brandli, L. (2021). Universities facing climate change and sustainability.
- Moi University (2024, May 20). Establishment of Moi University's Renewable Energy Park and Innovative Research Hub for Green Hydrogen, Ammonia, Fertilizer & Other Green Products (murepha). <https://www.mu.ac.ke/>
- Ng'ang'a (2019, September 07). New student hostels to be funded through green bond. Public universities in Kenya discuss plan to switch to solar. *University World News-Africa Edition*. <https://www.universityworldnews.com/>

- Ng'ang'a, G. (2024, April 02). Public universities in Kenya discuss plan to switch to solar. *University World News-Africa* Edition. <https://www.universityworldnews.com/>
- Ngara, B. (2024, July 12). Green financing key to sustainable development, low-carbon transition. *Business Daily*. <https://www.businessdailyafrica.com/>
- O'Grady, M. (2023). Transformative education for sustainable development: A faculty perspective. *Environment, Development and Sustainability*, 1-17.
- Odhengo, P., Atela, J., Steele, P., Orindi, V., & Imbali, F. (2019). Climate finance in Kenya: review and future outlook. *Climate Finance Policy Brief, 1*.
- Okanović, A., Ješić, J., Đaković, V., Vukadinović, S., & Andrejević Panić, A. (2021). Increasing university competitiveness through assessment of green content in curriculum and eco-labeling in higher education. *Sustainability*, 13(2), 712.
- Oloo, A. (2023, July 03). Kenya to integrate Climate Change studies in the curriculum. *Citizen Digital*. <https://www.citizen.digital/>
- Otto, D., & Kerres, M. (2023). Distributed Learning Ecosystems in Education: A Guide to the Debate. In *Distributed Learning Ecosystems: Concepts, Resources, and Repositories* (pp. 13-30). Wiesbaden: Springer Fachmedien Wiesbaden.
- Otundo Richard, M. (2024). Assessing the Integration of SDGs into Higher Education in Kenya; Identifying Gaps and Practical Strategies for Effective Curriculum Development. papers.ssrn.com
- Owino, D. O. (2022). *Responding to Impacts of Climate Change: A case study of Kenya* (Master's thesis). <https://hdl.handle.net/11250/3063264>
- Pătărlăgeanu, S. R., Negrei, C., Dinu, M., & Chiocar, R. (2020). Reducing the carbon footprint of the bucharest university of economic studies through green facades in an economically efficient manner. *Sustainability*, 12(9), 3779.
- Pertiwi, I. F. P., Puspita, R. E., & Saifudin, S. (2021). Responsibility and Accountability of University Social and Environmental Performances: A Sustainability Balanced Scorecard Model. *Shirkah: Journal of Economics and Business*, 6(1), 1-17.
- PPP Directorate (2024). Kenyatta University Students Hostels. <https://pppkenya.go.ke/>
- Radunsky, K., & Cadman, T. (2021). Addressing climate change risks: Importance and urgency. In *Handbook of Climate Change Management: Research, Leadership, Transformation* (pp. 1405-1431). Cham: Springer International Publishing.
- Roy, S. K. (2023). Green university initiatives and undergraduates' reuse intention for environmental sustainability: The moderating role of environmental values. *Environmental Challenges*, 13, 100797.
- Sachs, J. D., Lafortune, G., Fuller, G., & Drumm, E. (2023). Sustainable development report 2023: Implementing the SDG Stimulus.
- The Republic of Kenya (2022). DRAFT NATIONAL GREEN FISCAL INCENTIVES POLICY FRAMEWORK 12/2022. <https://www.treasury.go.ke/>
- UF News (2024, March 13). Universities Fund, Cooperative Bank Spark University Sustainability Drive. A Newsletter of The Universities Fund. <https://www.universitiesfund.go.ke/>
- UNEP (2016, February 5). UNEP, Partners Launch Kenya Green University Network. <https://sdg.iisd.org/>
- University of Nairobi (2023, September 14). UoN and IFC Partner to Promote Green Building Practices in Kenya. <https://www.uonbi.ac.ke/>

- Vanickova, R. (2020). Innovation Corporate Energy Management: Efficiency of Green Investment.
- Varghese, N. V., & Panigrahi, J. (2023). Innovations in Financing of Higher Education: An Overview. *Financing of Higher Education: Traditional Approaches and Innovative Strategies*, 1-13.
- Wandera, D. F., & Olonde, J. (2024). Enhancing Industrialization And Job Creation In The Context Of Just Energy. Scoping Paper on Kenya. <https://www.iddri.org/>
- Yan, B., & Lyu, J. (2023). How does an innovative decision-making scheme affect the high-quality economic development driven by green finance and higher education?. *Environmental Science and Pollution Research*, 30(54), 115721-115733.
- Zhou, B. (2022). Building a smart education ecosystem from a metaverse perspective. *Mobile Information Systems*, 2022(1), 1938329.
- Zhu, W., Zhu, Z., Fang, S., & Pan, W. (2017). Chinese students' awareness of relationship between green finance, environmental protection education and real situation. *Eurasia Journal of Mathematics, Science and Technology Education*, 13(7), 3753-3769.